

Client/Company/Organization: ECpE Student Services

Submitter Name: Vicky Thorland-Oster

Email: vlthorl@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Class Scheduler

Project Abstract:

Project Goal - software program to schedule labs and classes for the ECpE department. I believe that a constraint is access to the schedule of classes.

Expected Deliverables:

I would like an easy to use software program to schedule classes into the future (one semester).

Specialized Resources Provided by Client:

Anticipated Cost: _____

Financial Resources Provided by Client: _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all

1 – A Little

2 – Somewhat

3 – A Lot

4 – Completely

On this project, students will need to apply knowledge of mathematics, 0 1 2 3 4

science, and engineering

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE

0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems

0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

Approved: sdmay24-proj001

Project Assigned: _____

Advisor(s) Assigned: _____

Client/Company/Organization: 7 Elements LLC

Submitter Name: Troy Benjegerdes

Email: dahozer@gmail.com

Project Contact: _____

Email: _____

Project Title:

POE water leak detection ASIC

Project Abstract:

The project goal is to provide a path to develop a single-chip integrated sensor and power-over-ethernet powered network interface that can utilize existing off-the-shelf water leak detection sensor cable such as <https://www.cmrelectrical.com/products/liquid-leak-sensors/sensor-with-leak-detection-cable-type-rwm/>

The proposed design should:

- 1) provide minimum 1500V electrical isolation between ethernet power and sensing wire
- 2) leverage, as much as possible, open source hardware and software solutions
- 3) have a plan/roadmap to support high-volume production using, as much as possible, silicon produced at Skywater foundry in Bloomington, MN

Expected Deliverables:

- * A submission to the Efabless MPW program of a mixed-signal ASIC to be taped out at Skywater foundry in Bloomington, MN. (<https://platform.efabless.com/projects/shuttle/14>)
- * Schematics in KiCAD for a board with an MPFS025T FPGA with appropriate ethernet MAC, power-over-ethernet switching hardware, and Raspberry-pi or arduino compatible GPIO header(s)
- * Prototype demonstration with the PolarBerry board from Sundance DSP (to be provided by client)

Specialized Resources Provided by Client:

PolarFire SOC FPGAs for prototyping

Can we consider in-kind donation of the FPGA platforms as a donation?

Anticipated Cost: _____

Financial Resources Provided by Client: _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Interest and aptitude in open source hardware and software ecosystems

Anticipated Client Interaction (estimate):

- 1 meeting per week

- In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all

1 – A Little

2 – Somewhat

3 – A Lot

4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj002
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: DigiClips

Submitter Name: Bob Shapiro

Email: bobshapiro40@gmail.com

Project Contact: Henry Bremers

Email: hbremers@gmail.com

Project Title:

DigiClips Media Search Engine

Project Abstract:

Front End Options Email Alerts Administration this will tell what is needed
<https://docs.google.com/document/d/1kUdH1-uKylRizgd7ZFH3c166RTUL-omJctwjtCINZVc/edit?usp=sharing>

Expected Deliverables:

Allow 45 days before end of semester for testing fixing problems and then make it deliverable and presentable.

Specialized Resources Provided by Client:

We have several computers assigned to each part of the project that is worked on remotely that we provide for the students. We help set up their environment.

Anticipated Cost: _____

Financial Resources Provided by Client: We are very very small startup company with very limited resoures

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Software to be familiar with would be Ubuntu-Mate 22.04, C, nodejs, react, angular 15, typescript, mysql relational database, with AI Artificial Intelligence and security

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj003
 - Project Assigned: _____
 - Advisor(s) Assigned: _____
-

Client/Company/Organization: Akhilesh Tyagi / Iowa State University

Submitter Name: Akhilesh Tyagi

Email: tyagi@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Senior Design Server/Client Development for Project Matching [Phase 3]

Project Abstract:

Iowa State Senior Design has multiple constituencies - students, clients, faculty advisors. Clients - both from industry and faculty propose projects. Students specify their preferences. Additionally, students can specify preferences about team members up to a certain number.

Additional constraints on project matching come from ABET need for diversity in team composition, discipline-specific skill sets appropriate for the project, and senior design admin team's determination of the appropriateness of a project in terms of its complexity and design attributes.

This project will formulate the project matching optimization problem as an entity relationship diagram, develop a suitable client-server software architecture, formulate the optimization problem, develop all the heuristics for the optimization, develop a database to support all the constituents, and finally build the client and server with all the appropriate attributes & test it.

Expected Deliverables:

A web hosted system for senior design project entry with all the needed metadata; student preferences entry with all the suitable metadata; a decision/optimization engine to come up with a project and team assignment; a project management layer to automate all the related communication with project clients, faculty mentors, and students.

Specialized Resources Provided by Client:

Anticipated Cost: _____

Financial Resources Provided by Client: _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: web development, databases, optimization heuristics

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month

- In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj004
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Iowa State University

Submitter Name: Akhilesh Tyagi **Email:** tyagi@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:
An Exploration of Turing Pi Based Edge Cloud with Dockers/Kubernetes

Project Abstract:

Turing Pi provides a simple, cheap platform for adding raspberry Pi based nodes to a simple, low power cluster, which can be turned into cluster based Cloud with HypriotOS (a Debian Linux variant with Dockers). See <https://ieeexplore.ieee.org/document/9606504>. <https://turingpi.com/5-reasons-to-build-a-raspberry-pi-kubernetes-cluster-for-your-homelab/> gives more of the framework.

The primary goal of the project is to allow a team of computer engineering students to toy with various hardware configurations of a cluster (what kind of cluster nodes, storage, OS). A team of software engineering students can then toy with various dockers/kubernetes implementations to build a CI/CD pipeline. Additional activities can include building an edge machine learning application such as object identification in images or video feed with this platform.

Expected Deliverables:

- (1) An edge cloud platform based on Turing Pi board and Raspberry Pi nodes.
- (2) HypriotOS implementation on this platform.
- (3) Dockers and Kubernetes enabled Cloud.
- (4) An ML framework implementation on this Dockers/Kubernetes layer.
- (5) Some machine learning edge capability on image or video streams.

Specialized Resources Provided by Client:

- (1) Turing Pi board; (2) raspberry Pi boards.

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Cloud development; System development; Dockers; ML;

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month

- In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj005
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Reiman Gardens Iowa State University

Submitter Name: Nathan Brockman

Email: mantisnb@iastate.edu

Project Contact: Nathan Brockman

Email: mantisnb@iastate.edu

Project Title:

Unified Captive Reared Caterpillar Tracker

Project Abstract:

Providing Easy Digital Data Entry for Butterfly Captive Propagation Programs, Case Study: the island marble butterfly (*Euchloe ausinodes insulanus*)

Statement of Need: Butterflies are in decline across the globe. Conservation strategies for imperiled butterfly species are increasingly utilizing captive propagation facilities to combat dwindling numbers. Populations of butterflies are raised indoors for release. Due to ease of start-up, data is typically recorded onto written data sheets which are later distilled and transcribed into digital records for analysis and archiving. Digital data are usually stored within spreadsheets, rarely databases. Although quite common, this multi-step method of record-keeping is problematic for numerous reasons:

- For maximal success, all technicians must consistently write legibly throughout the season.
- Adherence to data collection methods is volitional (not automatically enforced).
- Transcription of written data requires an inordinate amount of time.
- Data is vulnerable to translation/transposing errors when being transcribed.
- Data that fails to meet distillation criteria is not readily available for future analyses.
- Pairing data of like individuals among data sheets addressing different life stages is labor intensive and prone to error.
- Photo and video data is not readily linked to text data.
- Spreadsheets are renowned for being corruptible.
- Season-long data collection often requires numerous physical pages for each individual which is tedious to track, maintain, and search.
- Coupling rearing data with weather data within the lab is delayed preventing timely feedback for climate management within the lab.
- Data back-up does not occur until the end of the season.

Purpose Statement: The purpose of this project is to create a web-based digital application to facilitate data collection and management in a butterfly propagation facility. The target organism for this effort will be the island marble butterfly. Each butterfly species has slightly different life cycles that are performed in facilities with different features. Therefore, the needs of each program will vary slightly. Ideally the core application built for island marble butterfly propagation data collection will develop code and concepts that can be modified to fit the needs of all butterfly propagation programs.

Desired Deliverables: In the island marble butterfly propagation facility, early stage individuals (eggs/larvae) are collected from the wild and tracked daily. Data collected includes permanent data: name of the individual (alphanumeric code based on year, host plant type, and chronological order found) location the individual was found, what type of host plant it was found upon, what stage it was when first collected, and the date it was collected. It also includes data that changes or may change over time: what cage the individual resides in (10 individuals per cage, ~12 cages) lifestage, where on the plant it is located, if it was transferred onto a new sprig, what activity it is engaged in, any notable observations, observer's initials. After an individual successfully pupates, it will await transfer to an

overwintering cage (~30 individuals per cage). Once it has been transferred to an overwintering cage, it will be examined twice per month during diapause (the next ~10 months). The following spring, the following permanent data will require recording: date of emergence from its chrysalis, sex, date of release, location of release. In the case of a successful release, thus ends the data lifetime for that individual. Some individuals will not survive to release and their data lifetime will be shorter.

DNA samples may be gathered from certain individuals at various points throughout their lifetime. If such samples are taken, recording the date of collection, tissue type comprising the sample, stage of sample, the buffer used, and the sample collector's initials will be necessary, as will the pairing of this collection with the rest of the individual's data. Ideally all photos/videos could be easily paired with the featured individual. Collecting as many fields as possible using diction is highly desired—in a best-case scenario, data collection would be hands free, and the program could recite back to the observer entries made to verify the entry. Weather data from the lab would be automatically paired with each data entry.

Expected Deliverables:

By the end of the class an application with an interface that can quickly, faster than paper, accept data points needed for tracking process involved with rearing caterpillars. This same application will need to manage this data from multiple butterfly rearing programs around the world in a standardized manner and create reports to assist in the analysis of the rearing programs. The goal would be to have a working prototype by March so it can be tested and a complete working program by May.

Specialized Resources Provided by Client:

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
 - 1 meeting per month
 - In person, Over the phone, Web / video conferencing
 - 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
 - 1 meeting per semester
 - In person, Over the phone, Web / video conferencing
-

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj006
 - Project Assigned: _____
 - Advisor(s) Assigned: _____
-

Client/Company/Organization: _____

Submitter Name: Elmin Didic

Email: edidic@iastate.edu

Project Contact: Simanta Mitra

Email: smitra@iastate.edu

Project Title:

ResumeUp

Project Abstract:

ResumeUp is a website designed to create resumes with the help of AI to optimize it. The goal of this project is to leverage OpenAI language models to optimize the wording on the resume. Design constraints is OpenAI API that we will be using as our AI. To create this website we will use Vue.js, NodeJS, DynamoDB, AWS EC2. [This is a student-proposed project]

Expected Deliverables:

The deliverable would be a website that allows resume creation and optimization with AI. This website will have user account creation to save progress and host multiple resumes, Use OpenAI APIs to optimize resume text.

Specialized Resources Provided by Client:

Anticipated Cost: _____

Financial Resources Provided by Client: _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj007
 - Project Assigned: _____
 - Advisor(s) Assigned: _____
-

Client/Company/Organization: Iowa State University

Submitter Name: Timothy Bigelow **Email:** bigelow@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:
Race of Doom

Project Abstract:

The goal of this project is to design an autonomous vehicle that can travel around a track as quickly as possible while avoiding certain traps. The goal will be to make the trip as quickly as possible in competition with other vehicles. In addition to physical traps, the track will also have several nodes that will attempt to "hack" into the control system and cause the vehicle to crash. Each vehicle will have its speed controlled by remote control, but the steering of the vehicle must be autonomous and handled by onboard sensors to detect objects. If "hacked," the vehicle will either be caused to accelerate into a trap or brought to a dead stop. The students on the project will be subdivided into at least 3 teams. One of the teams will be responsible to designing the track with a particular focus on designing the traps to "hack" the vehicles. The remaining teams will be responsible for designing vehicles to race. The vehicles themselves will be the size of a typical RC car. To be successful, this project needs at least 12 students (4 students on track, 8 students building 2 cars). The project can accommodate up to 20 students (4 on track, 16 students building 4 cars).

Expected Deliverables:

1. Track with obstacles and at least 4 nodes that attempt to hack vehicles in different ways or different outcomes. The track will measure about 60 ft (circumference) and will involve setting up various features in a parking lot on a Saturday.
2. Two vehicles that can be controlled remotely with on-board sensors to detect obstacles and avoid them.

Specialized Resources Provided by Client:

None

Anticipated Cost: _____ **Financial Resources Provided by Client:** None

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: At least 2 cyber security engineering students
At least 2 EE students
At least 2 CPRE students.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month

- In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj008
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Ashraf Gaffar

Submitter Name: Ashraf Gaffar

Email: gaffar@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Skin Cancer diagnosis using Artificial Intelligence on the Cloud

Project Abstract:

Learning simple AI principles and tools (no previous AI or cloud computing knowledge required). Creating simple AI models to recognize skin Cancer. Training and gradually expanding the model on Premises and on the cloud. Expanding the model to train using real images from different medical institutes. The project has a strong appeal to Mayo Clinic and previous projects were adopted by Mayo clinic already.

Expected Deliverables:

- Training students on AI and cloud computing: 3-4 weeks
- Introducing students to AI skin cancer practices as done by Mayo Clinic: 2 weeks
- Starting a small AI model on premises: 4 weeks
- Improving the model accuracy: 4-6 weeks
- Porting the model on the Cloud and training it: 4-6 weeks

Specialized Resources Provided by Client:

Students will be provided with a high power GPU computer and will be trained to use it.

Anticipated Cost: _____

Financial Resources Provided by Client: No financial resources needed

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Good knowledge of programming language. No AI or cloud computing skills required.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj009
 - Project Assigned: _____
 - Advisor(s) Assigned: _____
-

Client/Company/Organization: SwAPP lab

Submitter Name: Amir Niaraki

Email: niaraki@iastate.edu

Project Contact: Amir Niaraki

Email: niaraki@iastate.edu

Project Title:

Path Planning of Aerial Robots with Reinforcement Learning

Project Abstract:

Unmanned aerial vehicle are increasingly employed for exploratory missions in outdoor environments. This project is focused on a generalizable and device-agnostic path planning framework that provides a 3dimensional navigation plan based on the pattern of the detected targets and the wind field at the time of flight. The goal is to first develop an exploratory RL-based policy in simulation environment, then train on aerial imagery and finally deploy a quadrotor for anomaly detection in the real world.

A custom OpenAI-GYM environment is developed by the SwAPP lab to train an RL agent using stable-baseline-3. A dataset of Near-Inferared (NIR) was created by flying over multiple soccer fields in various days to train the object detector on real-world data. An automated annotation method, Double-clustering, was developed to localize plant anomalies. The goal is to develop a generalizable algorithm to maximize the number of detected objects within a single battery life of a drone. The project is a combination of research amongst RL and DL frameworks and a study of state-of-the-art tools for robust performance of a quadrotor in real-world.

Expected Deliverables:

1st Semester. Get familiar with stable-baseline, how to train an RL model and the developed custom environment. Try the existing RL algorithms (i.e. DQN, A2C) and prepare to use pytorch/keras to optimize the training architecture. Contribute to the code-base to use the massive dataset of aerial images which are gathered across different times of the year.

2nd Semester. Work with the senior developers and engineers to discover and develop relevant tools for deploying the developed algorithm to one of the existing drones in the SwAPP lab. Create benchmark data and compare the performance of the pathing algorithm w.r.t the state-of-the-art path planning algorithm.

Specialized Resources Provided by Client:

- GPUs for training the model
- lab equipment and electronics as needed
- A quadrotor with 4k camera and near-infrared camera

Anticipated Cost: _____

Financial Resources Provided by Client: N/A

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: python

Anticipated Client Interaction (estimate):

- 1 meeting per week
 In person, Over the phone, Web / video conferencing
 - 1 meeting per month
 In person, Over the phone, Web / video conferencing
 - 2 or more meetings per month
 In person, Over the phone, Web / video conferencing
 - 1 meeting per semester
 In person, Over the phone, Web / video conferencing
-

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj010
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Color Works

Submitter Name: Rebecca Bockart

Email: suburbanhouseelf@gmail.com

Project Contact: Shannon Ward

Email: familycolorworks@gmail.com

Project Title:

Personality based coaching/mental health app

Project Abstract:

The small, female owned, company provides parental coaching for the general public as well as mental health/suicide prevention for special forces teams in the military. The app will provide simpler interaction for people seeking help and assistance with mental health and parenting in their daily lives'. The project goal is to create a fully functioning app for this company. This will include personality quiz, account creation, links to podcasts and other mental health websites within the organization. The senior design team will be creating the entire app from scratch including the UX/UI frontend design, which will provide great experience working one on one with the company to create a good design for what they are looking for. The rest of the app creation for the backend will be similar to the work completed in 309.

Expected Deliverables:

The IOS app will be the final deliverable, however with extra time and or resources we might make adjustments to their already functioning website.

Specialized Resources Provided by Client:

The client is willing to pay for IOS development which means we don't have to use android studios and will gain experience creating apps on Apple software. Since it is a smaller company we will also be permitted to speak directly with the owners consistently for project development.

Anticipated Cost: _____

Financial Resources Provided by Client: _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other: Average tech/computer student could
- complete required tasks

Other Special Skills: Some frontend workers (3) and some backend workers (2)

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month

- In person, Over the phone, Web / video conferencing
 1 meeting per semester
 In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all

1 – A Little

2 – Somewhat

3 – A Lot

4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj011
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Ashraf Gaffar (potential collaboration with Digistain)

Submitter Name: Ashraf Gaffar **Email:** affar@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:
Accurate Cancer Prediction using Artificial Intelligence

Project Abstract:

Cancer remains one of the largest mysteries in medicine with limited ability to predict its occurrence and recurrence. Recent research shows that AI can provide more accurate results than human doctors alone, and has become a top priority in medicine. This project will build and train a simple AI model to provide accurate prediction of cancer. No prior AI knowledge is needed. Students will be trained on AI from scratch and will learn to build and train a medical AI diagnosis tool, highly sought after in today's cancer treatment. Students will receive full support and training as needed to help them overcome any technical challenges. Students will learn how to use common AI tools and libraries like Tensorflow and Keras as well as Transfer Learning to give them a head start.

Expected Deliverables:

A basic AI model trained to recognize and predict the risk of cancer occurrence and recurrence. The model will be gradually improved by training it on multiple sets of data provided by leading research institutes and hospitals

Specialized Resources Provided by Client:

A GPU, which is readily available at Iowa State University IT as well as HPC centers.

Anticipated Cost: _____

Financial Resources Provided by Client: No cost is associated with this project.

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Knowledge of programming language (Java is OK, Python is a plus)

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj012
 - Project Assigned: _____
 - Advisor(s) Assigned: _____
-

Client/Company/Organization: RSM US LLP

Karthik Kasarabada, Ashler

Submitter Name: Benda

Email: ashlerb@iastate.edu

Project Contact: Jon Schnell

Email: Jon.Schnell@rsmus.com

Project Title:

Cloud Based Pentest Simulation Environment (Updated)

Project Abstract:

The goal of this project designs a cyber range to be used to expose potential RSM hires to a simulated Internal Penetration Test of a client's network with Active Directory and AWS cloud resources. The team should start by exploring existing solutions both open source and commercial and evaluate whether they can be leveraged or improved to accomplish the design goals. The team should also evaluate the AWS user agreement to determine how attacks can legally and safely be conducted in the environment.

This environment should include opportunities to practice common pen testing activities such as enumeration, capturing/relay of network traffic, exploitation, privilege escalation and web app testing with the goals of compromising a Domain Controller and AWS account. The environment should have at least one path to Domain Admin and one path to AWS account compromise. The environment should include at least one vulnerable web application demonstrating at least 4 OWASP top 10 vulnerabilities such as XSS or SQL injection. The vulnerable environment should be realistic and contain attacks with a variety of difficulty. None of these vulnerabilities should be publicly reachable only the owner of the AWS account should be able to interact with the vulnerable web application and AD environment. The environment should be safe allowing for mistakes to be made without causing any damage.

The environment should have some way of tracking metrics and progress via dynamic flags, specified in the CloudFormation template or generated based on PKI signatures. the team does not need to implement a standalone web application for scoring but instead should evaluate open source and commercial scoring platforms and design the environment to be compatible with such a system.

Finally, the system should also incorporate an incident response component that allows the user to evaluate logs in order to identify attacks and compromises conducted in the environment. The incident response component should allow attackers to evaluate logs from both the AD environment and the AWS account.

The team will deliver a portable CloudFormation template that creates this vulnerable environment in AWS. The team will also provide a detailed write up that includes an overview, network diagram, application diagram, and walk through that demonstrates all the attack paths that can be used to compromise the environment.

Design Constraints:

Portable
Free or Low cost deployment of the template.
Scalability

Technical Approaches:

Virtualization
Gamification of educational content

Cloud Resources

Tools:

AWS EC2
AWS S3
AWS VPC
AWS IAM
Some Web framework such as Django or Apache
Kerberos
ntlm relayx
responder
certipy
petit potam
BloodHound
BurpSuite Community

Expected Deliverables:

By May of 2024 the team should deliver a JSON CloudFormation template as well as a write up describing all of the vulnerabilities and attack paths that can be used to compromise the environment. The CloudFormation template should deploy a vulnerable AD environment and a vulnerable web application demonstrating at least 4 OWASP top 10 vulnerabilities such as XSS or SQL injection. Compromise of the AD environment should require the use of common AD pen testing tools such as ntlm relayx, responder, certipy, petit potam, and BloodHound.

Specialized Resources Provided by Client:

Access to AWS via an account managed by RSM.

RSM will not be able to provide this donation. AWS costs encored during development will be billed directly to RSM.

Anticipated Cost: _____

Financial Resources Provided by Client: billed directly to RSM.

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Active Directory, AWS, and Web development skills will be required.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month

- In person, Over the phone, Web / video conferencing
 2 or more meetings per month
 In person, Over the phone, Web / video conferencing
 1 meeting per semester
 In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj013
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: John Deere

Submitter Name: Nathan Francque

Email: francquenathan@johndeere.com

Project Contact: Nathan Francque

Email: francquenathan@johndeere.com

Project Title:

Pipelined Hardware Video Compressor and Decompressor

Project Abstract:

This project's goal is to create a fully pipelineable image compression scheme that is mappable to an FPGA or ASIC to enable near-zero latency computer vision processing. It is known that the algorithm will likely be lossy, part of the project scope is to quantify likely loss on a standard image set. A successful project will allow for higher image processing throughput at a given FPGA price point.

Many computer vision workloads require convolutions to be performed on incoming data. It is desirable to perform these convolutions as quickly as possible. An FPGA or ASIC can do this on incoming data in a fully pipelined manner, allowing for near-zero latency processing. But the FPGA is limited by how much RAM it has available to store line buffers to be capable of pipelining the convolutions.

Much of this data is redundant - i.e., a 24 bit RGB image likely contains many similar pixels next to each other and could be represented mostly by just a few bits of difference. Many compression schemes exist, but are primarily focused on large circuits that compress video data for transmission.

We are interested in a very lightweight image compression and decompression core that can be placed at the input and output of each convolutional line buffer to minimize on-chip RAM usage. Therefore, the project should prioritize logic simplicity and pipelineability over compression ratio, and should provide tuning parameters for the user to make this tradeoff.

The key requirement to being fully pipelineable is that each encoded pixel must be of a pre-determined size to allow for a lowered RAM requirement than would be needed for the whole pixel.

Expected Deliverables:

1st semester - Research existing approaches to the problem and evaluate their pros and cons. Use these to devise some possible strategies. Deliver a report of options with a description of the tradeoffs for each. Determine criteria by which algorithms will be judged (image set(s), tracked metrics)

2nd semester, first half - Deliver software (preferably Python) implementations of the most promising options and a report on their performance

2nd semester, second half - provide an RTL or HLS implementation of the most promising option and integrate on a zynq dev board. Deliver a demo with HDMI video into an FPGA, compression and decompression being performed on the live input stream, and HDMI output, ideally with a clock displayed in the video feed to demonstrate the zero latency aspect. Registers reporting on compression ratio and loss rate are desirable but not necessary.

Specialized Resources Provided by Client:

Anticipated Cost: _____ Financial Resources Provided by Client: 5000

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: FPGA, Computer Vision

Anticipated Client Interaction (estimate):

- 1 meeting per week
 In person, Over the phone, Web / video conferencing
- 1 meeting per month
 In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

Approved: sdmay24-proj014

Project Assigned:

Advisor(s) Assigned:

Client/Company/Organization: Vermeer

Submitter Name: Nick Bergan **Email:** njbergan@iastate.edu

Project Contact: Ty Hartwick **Email:** thartwick@vermeer.com

Project Title:
GitHub CI Scheduler

Project Abstract:

A custom GitHub Continuous Integration Scheduler System to offload lengthy and routine compiling from user's machines, and to use a shared resource (server network) continuously. Needs to be scalable by keeping it serverless or decentralized and can parameterize standardized workflows across different team's repositories.

Expected Deliverables:

Take the CI prototype that has been started, and rework it so that it has a cloud hosted GUI and to have an efficient job picking algorithm for n jobs. Also to provide analytics in the form of utilization percentages and graphs of server utilization for administrators to decide when to make changes to the servers. Needs to have the ability to easily manage servers. Will spend time meeting with the 'customer' to verify project progress aligns to needs.

Specialized Resources Provided by Client:

GitHub, Matlab, various other standard programming or markup languages

This should not require specialized hardware, only existing ISU servers

Anticipated Cost: _____ **Financial Resources Provided by Client:** and software.

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Learn new languages easily or, knowing Matlab scripting, and GitHub.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester

In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj015
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Ashraf Gafar

Submitter Name: Ashraf Gaffar

Email: gaffar@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Allergy Prediction using Artificial Intelligence

Project Abstract:

Allergy is becoming a major medical challenge due to the growing number of new chemicals we are exposed to. The project aims to revolutionize the approach to allergy treatment by implementing Intelligent Search and Personalized Product Recommendations. The challenge lies in creating a diagnostic AI system with strong intelligent engine and intuitive search that allows doctors and other users to find products and predict their allergic reaction to individuals. This is an important area of AI that is highly needed by hospitals, doctors, and chemical manufacturing companies. I will be working closely with students as needed.

Expected Deliverables:

Data analysis and preparation: 3-4 weeks
AI preparation and training: 4 weeks
Model selection and training: 4-6 weeks
Additional refinements and training...

Specialized Resources Provided by Client:

N/A

Anticipated Cost: _____

Financial Resources Provided by Client: Not needed

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj016
 - Project Assigned: _____
 - Advisor(s) Assigned: _____
-

Client/Company/Organization: Iowa State University

Submitter Name: Alexander Stoytchev

Email: alexs@iastate.edu

Project Contact: Alexander Stoytchev

Email: alexs@iastate.edu

Project Title:

Implement the i281 CPU in Hardware

Project Abstract:

The i281 CPU is an 8-bit microprocessor that was designed to support the curriculum in CprE 281: Digital Logic. The CPU was designed as a teaching tool. Everything is implemented down to the logic gates. The design runs on the Altera FPGA boards that are available in the labs in Coover hall. It is called a CPU, but it is actually a computer. It has memory and can run the sample programs that ship with it. The output is displayed on the 7-segment indicators. User input can be accepted through the switches on the Altera boards. A simulator is also available.

The goal of this project is to take that design and implement it in hardware. The results will be used to support and enhance the curriculum in Computer Engineering and Electrical Engineering. The design and specification documents could be used as educational materials or to support future lectures and labs.

The project will be implemented in two phases. In phase one, the CPU will be implemented on breadboards with TTL chips. It is estimated that the design can comfortably fit on approximately 30 breadboards. This part is similar to how this was done for a different 8-bit architecture in these youtube videos:

<https://www.youtube.com/playlist?list=PLowKtXNTBypFbtuVMUVXNR0z1mu7dp7eH>

<https://www.youtube.com/playlist?list=PLowKtXNTBypGqlmE405J2565dvjafgIHU>

Time permitting, in phase two, the design and the lessons learned from phase one will be used to implement the CPU with printed circuit boards (PCBs). The design will be split into several parts and each will be implemented as a separate PCB. It is envisioned that there will be 7 or 8 of these PCBs. They will be connected with ribbon cables that will carry the datapath and control signals between the modules. Clock and power will be provided via different cables to all PCBs as well. The team will have to design, optimize, order, solder, and verify the PCBs. And, finally, build the entire CPU out of these components.

The hardware implementation must be as close to the original design as possible, but some optimizations are possible. For example, the control logic box can be implemented as a lookup table mapped to EEPROM. RAM chips can be used for the IMEM and the DMEM (instead of the register files used in the FPGA implementation). Additional LEDs could be used to illustrate the contents of registers and control signals.

Some design constraints: The clock should support variable speeds and manual stepping for easy debugging. The target goal is to reach 1MHz clock speed. Also, it should be possible and easy to switch from one sample program to another. The PONG game must be included as well :)

The ideal team will consist of a mixture of EE's and CprE's that have taken CprE 281, preferably with Stoytchev in Fall 2019, 2020, 2021, or 2022 when the i281 CPU was covered. Prior experience with breadboards is a must. Previous experience with designing PCBs is also required.

Supporting materials:

The CPU is described in the following slides:

https://www.ece.iastate.edu/~alexs/classes/2022_Fall_281/slides/41_i281_CPU_Architecture.ppt

https://www.ece.iastate.edu/~alexs/classes/2022_Fall_281/slides/42_Assembly_Language.ppt

https://www.ece.iastate.edu/~alexs/classes/2022_Fall_281/slides/43_ALU_and_PC.ppt

https://www.ece.iastate.edu/~alexs/classes/2022_Fall_281/slides/44_Intersection_of_Software_and_Hardware.ppt

https://www.ece.iastate.edu/~alexs/classes/2022_Fall_281/slides/45_Assembly_Examples.ppt

The FPGA implementation of the CPU is posted here:

https://www.ece.iastate.edu/~alexs/classes/2022_Fall_281/i281_CPU/i281_CPU_Hardware.zip

The assembly examples and the compiler from assembly to machine code:

https://www.ece.iastate.edu/~alexs/classes/2022_Fall_281/i281_CPU/i281_CPU_Software.zip

The i281 simulator:

<https://www.ece.iastate.edu/~alexs/classes/i281/index.html>

Expected Deliverables:

Working CPU that runs the sample programs.

Specialized Resources Provided by Client:

Expertise in the subject matter.

None. The parts will have to be purchased with departmental funds.

Anticipated Cost: _____

Financial Resources Provided by Client: _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Prior experience with breadboards. Some PCB design experience. Familiarity with CPU design principles. Assembly programming skills.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj017
 - Project Assigned: _____
 - Advisor(s) Assigned: _____
-

Client/Company/Organization: BAE Systems

Submitter Name: Alice Crutcher

Email: alice.crutcher@baesystems.com

Project Contact: _____

Email: _____

Project Title:

PTSD Detection Device

Project Abstract:

America's VetDogs provides enhanced mobility and renewed independence to veterans, active-duty service members, and first responders with disabilities, allowing them to once again live with pride and self-reliance. While the service dogs are trained to support their owners when they exhibit PTSD symptoms visibly or audibly, the ideal situation is to stop the episode before it happens. America's VetDogs in partnership with BAE Systems is seeking to develop a device that monitors a spike in an individual's heart rate and blood pressure before a PTSD episode begins. The device should alert the service dog so it can in-turn provide the veteran with comfort. This project is part of BAE Systems' Tech Power: Innovating for Impact program. BAE Systems employees will serve as mentors on these projects. The mentors will play an important role in evaluating students work and making recommendations related to BAE Systems' end of year showcase and recognition awards.

Requirements:

The device is only able to be heard/felt by the dog, as opposed to everyone in the vicinity
The technology should be able to be turned off
Detachable and hangs off collar

Expected Deliverables:

Prototype at end of spring semester

Specialized Resources Provided by Client:

BAE Systems employee mentors and a cohort of Veterans with PTSD to consult with (that have service dogs)

Anticipated Cost: _____

Financial Resources Provided by Client: 5000

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing

- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all

1 – A Little

2 – Somewhat

3 – A Lot

4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj018
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: BAE Systems

Submitter Name: Alice Crutcher

Email: alice.crutcher@baesystems.com

Project Contact: _____

Email: _____

Project Title:

Temperature Sensors for Veterans with Paralysis

Project Abstract:

Individuals who experience a traumatic injury such as limb loss or paralysis are often left without sensation in their limbs or the ability to regulate their body temperature. This loss of function can lead to potentially life-threatening situations exacerbated by activity, extreme weather and friction. In adaptive sports, this can present a barrier to participation for fear of frostbite, autonomic dysreflexia and pressure sores to name a few. Individuals may be timid to try adaptive skiing for fear of not knowing whether their toes are cold and numb and potentially experiencing frostbite or if they are overheating while riding their handcycle and can't see their physically presented symptoms of occurrence.

Adaptive Adventures in partnership with BAE Systems is seeking to develop sensors and an app that alerts individuals and/or their instructor that they are getting too hot or too cold to avoid damaging health conditions.

This project is part of BAE Systems' Tech Power: Innovating for Impact program. BAE Systems employees will serve as mentors on these projects. The mentors will play an important role in evaluating students work and making recommendations related to BAE Systems' end of year showcase and recognition awards.

Expected Deliverables:

Prototype required by end of second semester.

Specialized Resources Provided by Client:

The client team will consist of BAE Systems industry mentors and a cohort of Veterans with paralysis to consult with

Anticipated Cost: _____

Financial Resources Provided by Client: 5000

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing

- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4
This project requires students to identify, formulate, and solve engineering problems	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj019
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Iowa State University

Submitter Name: Rachel Shannon **Email:** rshannon@iastate.edu

Project Contact: Rachel Shannon **Email:** rshannon@iastate.edu

Project Title:
Engineering Art - Reverse Engineering the Brain Phase II

Project Abstract:

This project is a continuation of Engineering Art. See link: <https://sdmay23-04.sd.ece.iastate.edu/>

Reverse Engineering the Brain is one of the 21st Century Grand Challenges outlined by the National Academy of Engineering. See link: <http://www.engineeringchallenges.org/challenges.aspx>

The goal of this project is to express engineering in the form of art that cleverly demonstrates the use of electrical, computer, software, and/or cybersecurity engineering. The end product should be an interactive installation that educates the public about topics of engineering.

This project is meant to showcase ECpE students' talent and skillsets in a fun and creative way. Students will also have the opportunity to work with others from the College of Design.

Design approaches such as Design Thinking, Double Diamond design method, Systems Thinking, and Sketchnoting will be used to compliment technical skill sets learned in ECpE.

Expected Deliverables:

hands-on demo or prototype for public exhibition

Specialized Resources Provided by Client:

Students may have the opportunity to work closely with Dr. Johnny Diblasi (jdiblasi@iastate.edu) and his group as part of research that involves AI and the brain.

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Students must be open to different types of creative processes. Multidisciplinary background preferred but not required.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing

- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all

1 – A Little

2 – Somewhat

3 – A Lot

4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj020
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Iowa State University

Submitter Name: Rachel Shannon **Email:** rshannon@iastate.edu

Project Contact: Rachel Shannon **Email:** rshannon@iastate.edu

Project Title:
Engineering Art

Project Abstract:

The goal of this project is to express engineering in the form of art that cleverly demonstrates the use of electrical, computer, software, and/or cybersecurity engineering. The end product should be an interactive installation that educates the public about topics of engineering.

This project is meant to showcase ECpE students' talent and skillsets in a fun and creative way that also tackles one of the 21st Century Grand Challenges as outlined by the National Academy of Engineering. See link: <http://www.engineeringchallenges.org/challenges.aspx>

Design approaches such as Design Thinking, Double Diamond design method, Systems Thinking, and Sketchnoting will be used to compliment technical skill sets learned in ECpE.

Expected Deliverables:

hands-on demo or prototype for public exhibition, process book

Specialized Resources Provided by Client:

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Must be open to different types of creatives processes. Multidisciplinary background preferred by not required.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester

In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj021
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Akhilesh Tyagi/Manish Manepalli, Iowa State University

Submitter Name: Akhilesh Tyagi **Email:** tyagi@iastate.edu

Project Contact: Manish Manepalli **Email:** mmanish@iastate.edu

Project Title:
Wrapped Execution Engine: RISC-V BOOM on an FPGA

Project Abstract:

RISC-V instruction set architecture (ISA) is implemented as an out-of-order core in BOOM (Berkeley out of order machine) (boom-core.org). There is some support to map these Boom cores onto various Zynq FPGA boards (<https://github.com/wyanzhao/boom-fpga-zynq>).

Wrapped execution framework allows a programmer to wrap any granularity of code (one statement, one loop, one procedure, entire program) with a wrapper program. Wrapped execution engine supports this wrapped execution framework. The traditional execution core (BOOM in this work) is wrapped in a wrapper execution engine. All the fetches (and technically memory accesses) from the wrapped core go through the wrapper engine. Wrapper engine executed the wrapper program - which can modify the wrapped program code (dynamic binary optimization), alter the instructions or system calls (virtualization), prevent or modify some program state (security applications).

This project is a very rudimentary exploration of this very ambitious idea. In its full implementation, it would involve (1) an enhanced programming language (C or C++) to support writing wrappers, (2) compiling tool-chain for the wrapped programs (LLVM), (3) Object file format (modified ELF) to support wrapped programs, (4) wrapped execution engines, (5) some test applications. Whatever we achieve in this two semester sequence, in terms of taking baby steps, would be acceptable for this project.

Expected Deliverables:

(1) Chisel (HDL) design of a wrapped execution engine where the wrapped core is a RISC-V BOOM core, (2) Migration of compiled RTL from this HDL design to an FPGA board, (3) Some rudimentary annotated C, C++ language for wrapped program and LLVM support for it.

Specialized Resources Provided by Client:

Some Zynq board like Zybo, Zedboard, ZC706

Anticipated Cost: _____ **Financial Resources Provided by Client:** None

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: HDL, FPGA, Processor architecture, compilers, binary representation

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj022
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Black & Veatch

Submitter Name: Adam Schroeder

Email: SchroederA@bv.com

Project Contact: _____

Email: _____

Project Title:

115/34.5kV Solar Power Plant & Substation Design Project

Project Abstract:

Due to increasing Renewable Energy requirements for utilities, a [fictitious] 115/34.5kV Distribution substation and 60MW Solar Plant will need to be designed by Iowa State University. The project team will be responsible for the complete design of Solar layout, electrical layout, and associated construction deliverables. The project team will also perform various calculations required of a typical substation, including load-flow analysis, short-circuit studies, system protection design, and grounding calculations. There will be an opportunity to create a unique process or tool that optimizes or expedites aspects of design (allowing the students to be creative in their approach).

Black & Veatch will provide conceptual design information and design standards to support the senior design team's work.

Expected Deliverables:

- * Equipment sizing calculations (breakers, transformers, etc) – Excel files
- * Solar layout drawings – Bluebeam/CAD/PDF editor
- * Solar panel string sizing design – Excel files
- * Electrical layout drawings (substation equipment) – Bluebeam/CAD/PDF editor
- * Grounding analysis and ground-grid developed with IEEE-80 – Excel files
- * Bus calculations for substation – Excel files
- * Possibility of additional calculations (DC battery bank, lightning protection, etc.) – Excel files
- * Creation of solar/substation design-optimizing tool – TBD
- * Simulation of designed substation – SIMULATION SOFTWARE – STUDENT LICENSE [ETAP/SKM/ASPEN]
- * Coordination Study / AC Arc Flash Study / Protection Element Analysis – SIMULATION SOFTWARE – STUDENT LICENSE [ETAP/SKM/ASPEN]
- * Load Flow Scenario Wizard / Configuration Manager – SIMULATION SOFTWARE – STUDENT LICENSE [ETAP/SKM/ASPEN]

Specialized Resources Provided by Client:

Black & Veatch will provide engineering support to help the senior design team complete the project.

Anticipated Cost: _____

Financial Resources Provided by Client: 1000

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering

Other Special Skills: Electrical Engineering students taking courses in power systems (EE 303, 455, 456, 457, and 457) and

- Software Engineering
- Cyber Security Engineering
- Other:

knowledge in AutoCAD, Bentley Microstation CAD, or Bluebeam Revu PDF editor. These skills are preferred but not required.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	<input type="checkbox"/> 0	<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4
This project requires students to identify, formulate, and solve engineering problems	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj023
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: ECE, ISU

Submitter Name: Goce Trajcevski

Email: gocet25@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Link Prediction for Evolving Heterogeneous Networks

Project Abstract:

Evolving heterogeneous networks (e.g., social networks with different participants and preferences) investigate the structural interactions and their evolution over time in graphs with multiple types of nodes or edges. Most of the works describe evolving networks as a sequence of graph snapshots and adopt mechanisms from static heterogeneous networks to capture the spatial-temporal correlation. These works are confined to the discrete-time setting and the implementation of stacked mechanisms often introduces a high level of complexity, both conceptually and computationally. Another type of approaches rely on continuous-time link prediction. A recent work that integrates continuous dynamics maintains a historical interaction memory for each node. A link encoder is used that incorporates two components - type encoding and relative time encoding - to encapsulate implicit heterogeneous characteristics of interaction and extract the most informative temporal information. The objective of this work is to develop a system which, given the input data (from a specific network/domain) and a particular model (discrete or continuous) will: (a) execute a model for predicting an existence/formation of a link; (b) will visualize the change of the evolution at a particular time-instant. The code for the models (i.e., training/learning) and the datasets will be provided.

Expected Deliverables:

The expected schedule for the Fall 2023 is:

- week #2: introductory meeting and problem overview;
- week #3: datasets and algorithms introduction;
- week #4: narrowing the scope of project (which queries/algorithms to implement);
- week #5: identifying of requirements;
- week #6: identifying of use-cases;
- week #7: tools and frameworks selection;
- week #8: preliminary system design;
- week #9: identifying testing scenarios;
- week #10: completing non-functional requirements;
- week #11: refining the system design
- week #12: refining the testing/validation
- week #13: draft of the design document
- week #14: revision of the design document and preparation of presentation
- week #15: presentation and final design document

The deliverable is the Design Document

Spring 2023:

Weekly or bi-weekly meetings to discuss implementation issues/progress.

The deliverable is the operational system that implements the desired functionalities.

Specialized Resources Provided by Client:

server and software

Anticipated Cost: _____ **Financial Resources Provided by Client:** N/A

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Experience with data structures and algorithms; coding experience (preferably Python, but can work around it and will train) and development experience equivalent to a Senior.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Approved: sdmay24-proj024

Project Assigned: _____

Advisor(s) Assigned: _____

Client/Company/Organization: ECE, ISU

Submitter Name: Goce Trajcevski

Email: gocet25@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Convoys in Atomic and Molecular Trajectories

Project Abstract:

Due to extreme costs and risks involved, drug manufacturers often resort to simulation to detect how certain substrates and drug molecules may interact over time, so that their effects in curing diseases can be assessed. Upon completing the simulation, the data consists of (x, y, z, t) values -- which is, sequence of locations in time of individual atoms -- i.e., their trajectories, which are subsequently analyzed for the purpose of detecting certain events of interest. Typically, those events amount to forming particular bonds (e.g., Hydrogen bond) which persist for a period of time. The crucial criterion for forming an HB is the spatial proximity of the atoms creating the bond -- however, it is also important

that the surrounding atoms co-move within certain spatial bounds.

The objective of this project is to develop a system that will implement the algorithmic solutions which, for a given dataset of atomic/molecular motion, will detect the co-moving pattern which persists for a given (user-defined parameter) period of time.

The datasets and the algorithms (actually, the code implementing them) will be provided.

Expected Deliverables:

The overall-deliverable is a system that will provide:

- (a) front-end UI that will enable: (i) users to select dataset; (ii) users to enter parameters; (iii) selection of algorithms; (iv) presentation of the results to the end-user;
- (b) back-end that will store the molecular simulation datasets;
- (c) "middleware" that will connect the front-end and back-end;

The expected schedule for the Fall 2023 is:

- week #2: introductory meeting and problem overview;
- week #3: datasets and algorithms introduction;
- week #4: narrowing the scope of project (which queries/algorithms to implement);
- week #5: identifying of requirements;
- week #6: identifying of use-cases;
- week #7: tools and frameworks selection;
- week #8: preliminary system design;
- week #9: identifying testing scenarios;
- week #10: completing non-functional requirements;
- week #11: refining the system design
- week #12: refining the testing/validation
- week #13: draft of the design document
- week #14: revision of the design document and preparation of presentation
- week #15: presentation and final design document

The main deliverable is the design document.

Spring 2024:

Weekly or bi-weekly meetings to discuss implementation issues/progress.

The main deliverable is the operational system that implements the desired functionalities.

Specialized Resources Provided by Client:

server; dataset; code of algorithms.

Anticipated Cost: _____

Financial Resources Provided by Client: N/A

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Experience in coding and software systems development expected by a Senior.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all

1 – A Little

2 – Somewhat

3 – A Lot

4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve 0 1 2 3 4

engineering problems

This project gives students an opportunity to use the techniques, skills,
and modern engineering tools necessary for engineering practice

0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj025
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Mohamed Selim / ECE / ISU

Submitter Name: Mohamed Selim

Email: myoussef@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Utilizing PAWR Program to Develop Advanced Hands-on Labs For Networking and Cybersecurity Courses

Project Abstract:

The rapid evolution of networking and cybersecurity technologies demands innovative educational approaches that equip students with practical skills and real-world experiences. This senior design project aims to leverage the Platforms for Advanced Wireless Research (PAWR) program to create advanced hands-on laboratory modules for networking and cybersecurity courses such as CPRE489 and CPRE431. By harnessing the capabilities of PAWR platforms such as CloudLab and ARA, this project seeks to bridge the gap between theoretical knowledge and practical application. The proposed labs will empower students to engage with cutting-edge wireless research environments, fostering a deeper understanding of network protocols, security mechanisms, and emerging technologies. This project aims to enrich the learning experience, producing graduates who are better prepared to address the complex challenges of modern networking and cybersecurity landscapes.

Expected Deliverables:

1- Lab Module Development:

Develop a series of hands-on lab modules that align with the learning objectives of networking and cybersecurity courses. Each module will be designed to leverage the capabilities of PAWR platforms (CloudLab and ARA) to create realistic and immersive environments for experimentation. Lab topics may include but are not limited to:

- Network protocol analysis and simulation.
- Intrusion detection and prevention techniques.
- Wireless network configuration and optimization.
- Secure communication and cryptography implementation.

2- Interactive Learning Materials:

Develop supplementary learning materials to enhance the educational value of the lab modules. This may include interactive simulations, video tutorials, and conceptual explanations to provide a holistic learning experience for students with varying learning styles.

Specialized Resources Provided by Client:

All resources are available online and the access to PAWR platforms is given by default to the students.

Anticipated Cost: _____

Financial Resources Provided by Client: N/A

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering

Other Special Skills: Linux command line is a fundamental skill for students participating in this project.

- Software Engineering
- Cyber Security Engineering
- Other:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4
This project requires students to identify, formulate, and solve engineering problems	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj026
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Iowa State University/ECpE Department

Submitter Name: Long Que

Email: lque@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Chip based concentrators for nanoparticles with a smartphone reader

Project Abstract:

Goal: Development of a battery-less microchip for concentrating nanoparticles

Technical approach: using a microfluidic chip to demonstrate the aggregation of fluorescence nanoparticles, which can be observed by a smartphone.

Expected Deliverables:

Schedule:

First semester: (1) literature review; (2) design the chip;

Second semester: (3) fabricate the chip; (4) experiments

Specialized Resources Provided by Client:

Materials/chemicals for fabricating the chip and demonstrations.

Anticipated Cost: _____

Financial Resources Provided by Client: Some general sources from ECpE will be needed.

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: None.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all

1 – A Little

2 – Somewhat

3 – A Lot

4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering

0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE

0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems

0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj027
 - Project Assigned: _____
 - Advisor(s) Assigned: _____
-

Client/Company/Organization: _____

Submitter Name: Henry Duwe

Email: duwe@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Digital ASIC Fabrication

Project Abstract:

Digital ASIC Fabrication

Fabrication of a digital ASIC (application-specific integrated circuit) requires significant investment not only in design, but also in software development, verification, analog component design (e.g., PLLs, ADCs, DACs, voltage reference, voltage regulators), circuit and system level design and simulation, system level digital/analog/mixed-signal/power/IO circuit block integration for chip fabrication, PCB design, and materials. Coupled with the closed-source nature of hardware designs, this has meant that, for several decades, the number of unique ASICs fabricated declined and students (even graduate students) had the opportunity to work on a design that was fabricated. However, with a concerted push for open-sourced hardware (e.g., <https://www.fossi-foundation.org/> and <https://riscv.org/>) and industrial support (https://efabless.com/open_shuttle_program), ASIC fabrication is within the grasp of individuals and, indeed, motivated and talented undergraduate students.

This project's goal is to design and fabricate a fully-functional digital ASIC using the efabless process. The specific choice of the fabricated chip's design goals will be up to the team in consultation with Prof Duwe and limited by the constraints of available area and open IPs. A few possibilities:

1. Visual or audio wake-word accelerator
2. Bitcoin hash generator
3. Point-of-care signal processing accelerator
4. Crypto core resistant to power side-channel
5. Custom multi-wire I/O bus
6. Custom FPGA fabric for intermittent computing
6. ...your imagination...

Additionally, this team is expected to have the unique opportunity to help bring-up the first chip successfully submitted by an ISU team: <https://platform.efabless.com/projects/1318> during the first semester. Expected ETA is Nov 2023.

WARNING:

This project is guaranteed to be challenging and will require a team of students with diverse skill-sets (including some SE/DevOps), a willingness to learn and work together, and persistence. *** For SEs and EEs, you should have taken at least CPRE381 or are willing to put in significant additional time outside of your course commitment. *** Given these, this experience is also guaranteed to be a highly-rewarding capstone experience you can leverage for years to come.

Expected Deliverables:

- * Well-organized repository of the hardware and software components of the system.
- * Simulation-based testing framework demonstrating functional correctness of design.
- * Submitted MCU + accelerator project repository to efabless (https://efabless.com/open_shuttle_program/5) that

passes precheck verification.

* Detailed bring-up plan, including test plans, test software (pre-verified in simulation or on a real RISC-V processor), and any test hardware (e.g., PCBs) needed.

Specialized Resources Provided by Client:

Prof Duwe has significant resources to aid with the design, verification, and bring-up for a digital ASIC, including the following:
oscilloscopes, logic analyzers, solder-station, test RISC-V boards, servers that can run any CAD software required
Perhaps most importantly, you will also have access to multiple semesters worth of student experiences.

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: All students should have completed CPRE 381.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, 0 1 2 3 4

and SE

This project requires students to identify, formulate, and solve engineering problems

0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

Approved: sdmay24-proj028

Project Assigned: _____

Advisor(s) Assigned: _____

Client/Company/Organization: _____

Submitter Name: Henry Duwe **Email:** duwe@iastate.edu

Project Contact: Cheng Wang **Email:** chengw@iastate.edu

Project Title:
ReRAM Compute ASIC Fabrication

Project Abstract:

Resistive Random Access Memory (ReRAM) is a non-volatile RAM that has the potential to also be used to perform computations in the analog domain. Such computation has the benefit of requiring less data movement and less energy than traditional digital computation where individual pieces of data are moved from memory to a processor's digital ALU for execution and the results moved back to memory. However, there are many challenges in building variation-tolerant ReRAM accelerators and converting data between the digital and analog domains. Profs Wang and Duwe would like to evaluate a real ReRAM crossbar for compute potential.

This project's goal is to design and fabricate a small ReRAM compute crossbar ASIC using the efabless and Skywater 130nm process. Note that this will almost invariably require the choice, modification, and/or design of analog components. The specific choice of the fabricated chip's design goals will be up to the team in consultation with Profs Wang and Duwe and limited by the constraints of available area and open IPs. A few possibilities:

Warning, this project is guaranteed to be challenging and will require a team of students with diverse skill-sets (including SW and DevOps), a willingness to learn and work together, and persistence. *** A team should have at least two students with a VLSI background and two who have taken 381. *** Given these, this experience is also guaranteed to be a highly-rewarding capstone experience you can leverage for years to come

Expected Deliverables:

- * Well-organized repository of the hardware and software components of the system.
 - * Simulation-based testing (i.e., SPICE-level) framework demonstrating functional correctness of design.
 - * Submitted MCU + ReRAM project repository to efabless (https://efabless.com/open_shuttle_program/5) that passes precheck verification.
 - * Detailed bring-up plan, including test plans, test software (pre-verified in simulation or on a real RISC-V processor), and any test hardware (e.g., PCBs) needed.
-

Specialized Resources Provided by Client:

Profs Duwe and Wang have significant resources to aid with the design, verification, and bring-up for a digital ASIC, including the following:
oscilloscopes, logic analyzers, solder-station, test RISC-V boards, servers that can run any CAD software required. Perhaps most importantly, you will also have access to multiple semesters worth of student experiences.

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

Electrical Engineering

Other Special Skills: Two students should have a VLSI focus. Two

- Computer Engineering should have completed CPRE 381.
- Software Engineering
- Cyber Security Engineering
- Other:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj029
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: _____

Submitter Name: Goce Trajcevski **Email:** gcet25@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:
Visualizing Probabilistic Whereabouts of Moving Objects

Project Abstract:

Location measurements (e.g., via GPS) from people and vehicles often have long temporal gaps between them. However, one may still like to reason about location behavior during these gaps. The common method of linear interpolation typically makes tacit assumption about the "regularity" of the motion in-between sample location. However, recent works have done explicit representation of the location uncertainty in the gaps, along with probability estimates.

The objective of this project is to develop a system which, given an input trajectory-dataset (i.e., a sequence of (location, time) pairs) will visualize the possible whereabouts of the moving object in-between the consecutive location, with color-coded probabilities.

References with the model and algorithms will be provided.

Expected Deliverables:

The targeted deliverable is a system that will provide:

- (a) front-end UI that will enable the users to: (i) select a trajectory/dataset; (ii) select an algorithm and time-instants; (iii) display the results
- (b) back-end that will store the trajectories datasets (and code(s));
- (c) "middleware" that will connect the front-end and back-end;

The expected schedule for the Fall 2023 is:

- week #2: introductory meeting and problem overview;
- week #3: datasets and algorithms introduction;
- week #4: narrowing the scope of project (which queries/algorithms to implement);
- week #5: identifying of requirements;
- week #6: identifying of use-cases;
- week #7: tools and frameworks selection;
- week #8: preliminary system design;
- week #9: identifying testing scenarios;
- week #10: completing non-functional requirements;
- week #11: refining the system design
- week #12: refining the testing/validation
- week #13: draft of the design document
- week #14: revision of the design document and preparation of presentation
- week #15: presentation and final design document

The main deliverable is the Design Document.

Spring 2024:

Weekly or bi-weekly meetings to discuss implementation issues/progress.

The main deliverable is the operational system that implements the desired functionalities.

Specialized Resources Provided by Client:

datasets; algorithms;

Anticipated Cost: _____

Financial Resources Provided by Client: N/A

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Experience matching the expectation for a Senior.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – *for use by ECpE Senior Design Committee*

- Approved: sdmay24-proj030
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Cheng Huang

Submitter Name: Cheng Huang Email: chengh@iastate.edu

Project Contact: _____ Email: _____

Project Title:
Wirelessly charged nursery night light

Project Abstract:

This project is to develop a nursery night light that can: 1) be wireless charged, 2) battery powered, 3) change brightness level by tapping on it, 4) auto dim and shut off, 5) smooth turn-on/-off to not wake up a baby.

Expected Deliverables:

A working hardware prototype.

Specialized Resources Provided by Client:

Anticipated Cost: _____ Financial Resources Provided by Client: _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: microcontroller programing, basic knowledge on circuit design, printed circuit board prototyping

Anticipated Client Interaction (estimate):

- 1 meeting per week
 In person, Over the phone, Web / video conferencing
- 1 meeting per month
 In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, 0 1 2 3 4

science, and engineering

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE

0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems

0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

Approved: sdmay24-proj031

Project Assigned: _____

Advisor(s) Assigned: _____

Client/Company/Organization: ISU Center for Wireless, Communities and Innovation

Submitter Name: Hongwei Zhang

Email: hongwei@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Experimental Exploration of 5G-and-Beyond Wireless Systems and Rural Broadband

Project Abstract:

As a key milestone in wireless communications, 5G wireless networks are expected to enable not only Gbps mobile connectivity but also machine-type communications for precision agriculture, beyond-visual-line-of-sight unmanned aircraft systems (UAS), connected and automated vehicles, extended reality (XR), smart grid, and Industry 4.0. Besides advanced communication technologies such as ultra-reliable, low-latency communications, 5G wireless networks represent the convergence of computing and networking in many aspects of the telecommunication industry, and they embrace opportunities such as software-defined, open-source innovation and infrastructure virtualization. 5G wireless is projected to reach a market size of \$2.2 trillion by 2025, and it has been attracting significant investment from industry and government worldwide.

Through this project, students will learn, develop, and prototype advanced wireless solutions for 5G and beyond. In particular, students will have the opportunity to participate in the ISU-led \$16M project ARA on advanced wireless and rural broadband (<https://arawireless.org>), and “play” with bleeding-edge hardware and software platforms for 5G-and-beyond wireless systems such as free-space optical communications, massive MIMO, mmWave, and LEO satellite communications. Open-source 5G software and hardware platforms such as srsRAN (<https://www.srsite.com>), OpenAirInterface (<https://openairinterface.org>), and USRP software-defined radios (<https://www.ettus.com>) will be available to students in the project.

Students will work as a team and with Prof. Hongwei Zhang as well as other faculty members, research scientists, and Ph.D. students in the Center for Wireless, Communities and Innovation (<https://wici.iastate.edu>). Students also have the potential to interact with industry partners such as John Deere, Collins Aerospace, Microsfot, AT&T, T-Mobile, and U.S. Cellular. Information about Prof. Zhang’s work can be found at <http://www.ece.iastate.edu/~hongwei>.

Expected Deliverables:

A tentative project roadmap is as follows (which is open for revision by the project team):

* August - December 2023: Study basics of the ARA project (<https://arawireless.org>) and related 5G-and-beyond hardware and software platforms (<https://arawireless.org/equipment>), as well as 5G wireless systems (<https://5g.systemsapproach.org>) and computer networking (<https://book.systemsapproach.org>) in general; Contribute to 5G learning materials to prepare undergraduate students for using and researching advanced wireless systems, based on your own learning experience in the project; Participate in the development and field deployment of 5G-and-beyond wireless infrastructures of ARA; (Optional) Learn about novel 5G-and-beyond algorithms for safety-/mission-critical applications;

* January – April 2023: Conduct field testing and scientific performance measurement of 5G-and-beyond wireless systems in precision agriculture and smart city applications (e.g., public safety, smart transit, water security surveillance), and participate in broad community engagement activities (e.g., tutorials); Prepare example

experiments as learning materials for undergraduate students new to 5G-and-beyond wireless systems; (Optional) Prototype, demonstrate, and evaluate the performance of novel 5G-and-beyond algorithms using advanced wireless platforms in ARA, and write related technical reports.

Specialized Resources Provided by Client:

ARA wireless living lab (<https://arawireless.org>), hardware and software components for advanced wireless systems, algorithms for 5G and beyond

Research fund to support the project (e.g., equipment and NSF Research Experience for Undergraduate program)

Anticipated Cost: _____

Financial Resources Provided by Client: _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other: Interdisciplinary teams with computing, software, and electrical/wireless expertise will be fantastic!

Other Special Skills: Programming, passion and dedication for learning, passion for society impact, teamwork; background in computer networking and wireless systems is a plus, but not required.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE

0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems

0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj032
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: ARA Wireless (<https://arawireless.org/>)

Submitter Name: Daji Qiao **Email:** daji@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:
IoT Applications and Demos based on ARA and MultiTech LoRaWAN

Project Abstract:

ARA (<https://arawireless.org/>) is an at-scale platform for advanced wireless research to be deployed across the ISU campus, City of Ames, and surrounding research and producer farms as well as rural communities in central Iowa, spanning a rural area with diameter over 30 miles. It serves as a wireless living lab for smart and connected rural communities, enabling the research and development of rural-focused wireless technologies that provide affordable, high-capacity connectivity to rural communities and industries such as agriculture. One of the wireless technologies available on the ARA platform is MultiTech LoRaWAN. The goal of this project is to leverage ARA and the available MultiTech gateway and developer kits to develop multiple IoT applications or demos.

Expected Deliverables:

The IoT applications or demos shall be based on ARA platform and MultiTech gateway and developer kits. Additional sensors may be acquired if needed.

- 1st application/demo ready by 12/2023.
- 2nd application/demo ready by 04/2024.

Specialized Resources Provided by Client:

- MultiTech IoT gateway
Conduit IP67 Base Station
<https://www.multitech.com/brands/multiconnect-conduit-ip67>
https://www.multitech.com/documents/publications/brochures/MT_Brochure_mPower_Edge_Intelligence_2019-06.pdf
- MultiTech xDot® Micro Developer Kit
<https://shop.multitech.com/mtmdk-xdot-na1-a00.html>

Additional sensors
may be acquired if

Anticipated Cost: _____ **Financial Resources Provided by Client:** needed.

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: 4-5 EE/CPRE/SE students in total. Prior experience with embedded systems design and programming is preferred.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 In person, Over the phone, Web / video conferencing
 - 1 meeting per month
 In person, Over the phone, Web / video conferencing
 - 2 or more meetings per month
 In person, Over the phone, Web / video conferencing
 - 1 meeting per semester
 In person, Over the phone, Web / video conferencing
-

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj033
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Iowa State University (Academic Project)

Submitter Name: Esmat Farzana

Email: efarzana@iastate.edu

Project Contact: Esmat Farzana

Email: efarzana@iastate.edu

Project Title:

Design and modeling of wide-bandgap power devices

Project Abstract:

The project aims at design and modeling of advanced wide-bandgap (WBG) and ultra-widebandgap (UWBG) semiconductor power devices. These semiconductors are of extensive interest for energy-efficient power devices due to their superior material properties of higher breakdown field that enable compact devices with higher voltage rating, high-temperature stability, and extreme radiation robustness compared to existing silicon-based power electronics. However, to extract the full material benefits of WBG semiconductors, these power devices need to be designed with proper electric field management, electrical contacts, and high-quality epitaxy materials with expected electrically-active carriers. Hence, this project will focus on understanding the fundamental physics, carrier-transport, field-management, and breakdown phenomena of power devices using the existing and emerging WBG and UWBG semiconductors, such as III-nitrides (GaN, AlGaN, AlN) and beta-Ga₂O₃. At the first stage, students will perform simulation of material properties and carrier transport from device physics using Matlab. This will take into account the effect of shallow and deep dopants and defects on contact properties and device breakdown performance. Later, Silvaco TCAD device modeling will be performed to demonstrate the ways of enhancing device performance with advanced field-management using high-permittivity dielectrics, deep etch, guard ring, as well as Schottky and Ohmic contact materials and passivation strategies.

The power device performance will also be analyzed using different application condition of high-voltage and high-temperature. In this way, the project will also reveal how the breakdown voltage is impacted as a function of temperature and possible thermal management approaches to improve the thermal stability of the UWBG power devices.

Expected Deliverables:

The end goal project aims to show successful demonstration of multiple kilovolt device (5 kV-10 kV) design using emerging (ultra)wide-bandgap semiconductors that can reliably operate at least minimum upto 200 degree C temperature.

Specialized Resources Provided by Client:

Required Software access: Silvaco TCAD and Matlab

Anticipated Cost: _____

Financial Resources Provided by Client: _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other: Materials Engineering with interest in

Other Special Skills: Fundamental understanding of semiconductor materials and devices, Matlab. TCAD skill is encouraged but not required

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
 - 1 meeting per month
 - In person, Over the phone, Web / video conferencing
 - 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
 - 1 meeting per semester
 - In person, Over the phone, Web / video conferencing
-

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj034
 - Project Assigned: _____
 - Advisor(s) Assigned: _____
-

Client/Company/Organization: Jiming Song

Submitter Name: Jiming Song **Email:** jisong@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:
Sonar: Ultrasonic radar

Project Abstract:

The goal is to build an air sonar (ultrasonic radars) to detect small objects. This project will focus on designing circuits to change phases (time delay of pulses) to each transducer to control the scanning directions and locations. An ultrasonic sensor (transducer, used as both transmitter and receiver) sends an ultrasonic pulse. The mechanical wave is reflected back from any objects and detected by the transducer. The time delay in the pulse-echo can be used to calculate the distance of the objects. The use of a number of transducers to form a phased array has following advantages: increasing the signal to noise ratio; increasing detection distance, having much narrow beam to have higher direction resolution, and scanning all directions automatically by changing phase of each transducer electronically. By scanning all directions, the ultrasonic phased array will generate 3D images like a radar.

Expected Deliverables:

Ultrasonic radar with phase control circuits and user interface

Specialized Resources Provided by Client:

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj035
 - Project Assigned: _____
 - Advisor(s) Assigned: _____
-

Client/Company/Organization: _____

Submitter Name: Henry Duwe **Email:** duwe@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:
Distributed Sniffer Nodes for Batteryless Sensor Nodes

Project Abstract:

Batteryless sensor nodes are an emerging technology that enables low-cost, low-maintenance, and long-lifetime embedded sensing. Rather than being wired into a continuous power supply or provisioned with a battery, these sensor nodes survive solely on harvesting energy from ambient sources available in their environment, such as RF signals, solar, vibrational, or thermal. As such they are a challenge to design since these sources are often highly variable and very low power.

A particular challenge my group has addressed is dependable communication between nodes. As part of our research we've developed a multi-node testbed for batteryless sensor nodes with a single central constantly-powered "sniffer" node hooked to a host workstation. However, experimentation is still very challenging due to the unique energy environment at each node and the complex system design within each node that enables it to survive on miniscule amounts of energy. This senior design project aims to develop a distributed sniffer node to enable recording of node-specific information such as incident energy and communication protocol state.

Expected Deliverables:

- * Well-organized repository of the hardware and software components of the system.
- * Physical prototype of sensor node. Preferrably PCB.

Specialized Resources Provided by Client:

Prof Duwe has significant resources to aid with the simulation, design, and debug of batteryless sensor nodes including the following:
oscilloscopes, logic analyzers, solder-station, servers that can run any CAD software required

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: * Some embedded programming required CPRE 288+.
* Debugging mindset.
* At least one student with some hardware experience (e.g., breadboarding or PCB design).

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj036
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: _____

Submitter Name: Berk Gulmezoglu **Email:** bgulmez@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:
Detailed Security Analysis of Serverless Functions with Interpreted Languages

Project Abstract:

This project will investigate whether running serverless functions can be detected by adversaries in the same cloud platform. We will use interpreted languages such as Rust to collect serverless functions related information through attack codes. Amazon Firecracker and Google gVisor environments will be leveraged to run both serverless functions and attack codes. One team will develop these attack codes and one team will work on identifying different functions using deep learning models. The design constraints will include 1) a limited time of information gathering from the attack code, 2) stealthiness against detection systems, 3) more than 50% accuracy for function detection.

This project will help students to learn different interpreted languages such as Python, Rust, and Java to create attack codes. Moreover, students will have experience on different virtualization environments and Machine Learning models.

Expected Deliverables:

Students will determine the limitations of interpreted languages in terms of memory access capabilities, available APIs that provide high timing resolution, and the capabilities of Machine Learning models in distinguishing different workloads in the first semester. In the second semester, students will create end-to-end attack codes to collect fingerprints from memory traces and classify them with Machine Learning models. The deliverables will be serverless function monitoring codes that work in restricted environments such as microVMs in Firecracker. Also, machine learning models to classify the collected dataset will be a deliverable.

Specialized Resources Provided by Client:

One laptop in the lab to collect measurements. One GPU server to train machine learning models

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing

- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all

1 – A Little

2 – Somewhat

3 – A Lot

4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj037
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Iowa State University

Submitter Name: Meng Lu

Email: menglu@iastate.edu

Project Contact: Meng Lu

Email: menglu@iastate.edu

Project Title:

IoT-based sensors and data analytics for lab-scale bioreactors

Project Abstract:

Bioreactors play a pivotal role in the bioeconomy, where biological resources and processes are harnessed for economic and sustainable purposes. They provide a controlled environment for the cultivation and manipulation of microorganisms, cells, or tissues, facilitating the production of biofuels, bioplastics, enzymes, pharmaceuticals, and other bio-based materials. To optimize biological processes, ensure product consistency and quality, and enable scale-up capabilities, sensors are needed for real-time monitoring and control of various parameters and conditions within a bioreactor. This project will focus on the development of an IoT-based sensor system for bioreactors with the volume below 5L. The sensor would enable continuous monitoring of important parameters such as cell density, pH, dissolved oxygen, and nutrient concentrations. This information allows operators to closely monitor the bioprocess, ensuring optimal conditions for cell growth, metabolism, and product formation. Our sensor will be based on an ESP-32 microcontroller that automate the sampling, measurements, and data analysis. Realtime data will be displayed on the ESP32 webserver and transferred to a database to identify trends, correlations, and patterns that could lead to process improvements and better understanding of the bioprocess dynamics.

Expected Deliverables:

1. Design and prototype of O2/pH/cell density sensors
2. An ESP32 microcontroller that can control sampling and record sensor results
3. A web server for real-time data display

Specialized Resources Provided by Client:

1. 5-6 ESP-32 chips
2. Optical components to build the sensors
3. Chemicals and reagents

Anticipated Cost: _____

Financial Resources Provided by Client: 1000

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Embedded system (took Cpre288)

Anticipated Client Interaction (estimate):

- 1 meeting per week

- In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj038
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: _____

Submitter Name: Sami Bensellam

Email: samib@iastate.edu

Project Contact: Alexander Stoychev

Email: alexs@iastate.edu

Project Title:

Machine to Human Vision

Project Abstract:

[This is a student proposed project]

The primary objective of this endeavor is to develop an advanced navigation solution tailored for individuals with visual impairments. This endeavor seeks to harness the capabilities of machine vision and machine learning technologies to devise an innovative alternative perception approach. Through the integration of these cutting-edge advancements, the intention is to convey relevant information to users through the senses of touch and sound.

The crux of the proposed feedback mechanism revolves around two critical aspects: firstly, the determination of object proximity achieved through the application of stereo triangulation; secondly, the precise identification of objects facilitated by sophisticated machine learning algorithms. This holistic feedback mechanism serves as a fundamental guide for users, allowing them to comprehend their surroundings, navigate through obstacles, and gain a comprehensive understanding of their environment.

Haptic Feedback for Object Proximity

Employing stereoscopic cameras, the system will meticulously gauge depth information, subsequently conveying these depth metrics to users via haptic feedback motors that generate vibrations. Notably, there are 16 distinct haptic feedback motors deployed within the design. These motors serve as conduits of tactile information, translating the concept of proximity into distinct and discernible vibrational patterns. The vibrational intensity emitted by each motor is calibrated in accordance with the relative distance of objects.

We determine object proximity based on the image disparity (The farther away, the smaller the disparity)

Object Identification

Use the camera images and identify objects within the image. There are many existing apis that can be used to identify objects within an image. This could be expanded to identify individuals similar to google photos. After identification, the aim is to utilize an existing text-to-speech converter to read all of the objects that are identified within the image.

Expected Deliverables:

Object Deliverables:

- Determining the most suitable existing stereo camera system to buy.
- Developing a working prototype utilizing a laptop for stereo only.
- Determining the best API for object identification and getting it to work with the existing stereo system.
- Getting a fully functional prototype for the project using a computer by combining the two functionalities.

- Shifting the project towards creating a mobile application that:
 - Gets Stereo camera image data.
 - Uses the existing code in the prototype and implements that functionality within the application.
 - Move the image processing to the cloud.
- Bring a person with visual impairments to use the product and provide feedback.

Specialized Resources Provided by Client:

None Currently - Department reliance for the project at the moment

None Currently -
Department reliance
for the project at the
moment

Anticipated Cost: _____

Financial Resources Provided by Client: _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Experience in computer vision, Software Engineering, AWS experience, Python experience and App building.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and 0 1 2 3 4

safety, manufacturability, and sustainability

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj039
 - Project Assigned: _____
 - Advisor(s) Assigned: _____
-

Client/Company/Organization: Gelli Ravikumar

Submitter Name: Gelli Ravikumar

Email: gelli@iastate.edu

Project Contact: Gelli Ravikumar

Email: gelli@iastate.edu

Project Title:

GridAI: Cloud-based Machine/Deep Learning for Power Grid Data Analytics

Project Abstract:

This project is an extension of “sdmay23-38: GridAI: Cloud-based Machine/Deep Learning for Power Grid Data Analytics” (<https://sdmay23-38.sd.ece.iastate.edu/>). This project aims to design and implement cloud-based machine learning or deep learning algorithms for grid data analytics. We use Google Cloud Platform (GCP) resources for the design and implementation. Students will receive all the required materials for working on the GCP and/or VMware-based testbed. Students will receive all the required materials for working on these platforms, including sdmay23-38’s software resources. Programming experience and a Linux working environment are two essential prerequisites. Having expertise in React and Svelte is plus. At the end of the project, you will learn cloud computing architecture, web-based visualization, microservice-based frontend/backend system architecture, and Machine Learning (ML), or Deep Learning (DL). This software-based project includes the following modules to be developed: 1) Extend the existing design and implementation of the current GridAI web-based visualizations, including advancing the geographical Maps for the power grid data, and data analytics, 2) Extend the Generative AI-based voice assistant for the GridAI software to provide an interactive and intelligent interface to users or grid operators, and 3) Test and validate the application with available power grid simulators such as OpenDSS and/or OPAL-RT.

Expected Deliverables:

1) Software codes and 2) Technical project report.

Specialized Resources Provided by Client:

PowerCyber private cloud testbed hosted at Iowa State University, and Google Cloud Platform (GCP) resources.

Anticipated Cost: _____

Financial Resources Provided by Client: Yes, GCP resources/credits as required.

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Web-based backend and frontend programming

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing

- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all

1 – A Little

2 – Somewhat

3 – A Lot

4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj040
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Gelli Ravikumar

Submitter Name: Gelli Ravikumar

Email: gelli@iastate.edu

Project Contact: Gelli Ravikumar

Email: gelli@iastate.edu

Project Title:

Cy-HELICS: Simulating Large-scale Power Grids and Cyberattacks using HELICS

Project Abstract:

This project aims to develop cyberattacks and simulate them on large-scale power grids to understand their impact and provide suitable mitigation scenarios. The open-source software HELICS: Hierarchical Engine for Large-scale Infrastructure Co-Simulation can be used to execute large-scale power grids. This software-based project requires building a software system environment using HELICS and integrating cyberattacks and analytics into it. Students will receive access to our VMware-based testbed environment for the project. Students will receive all the required materials for working on these platforms, including guidance on HELICS software, web-based frontend, and backend platforms as needed. Programming experience and a Linux working environment are two essential prerequisites. At the end of the project, you will learn microservice-based software systems, cyberattacks, and the cybersecurity of large-scale power systems. This software-based project includes the following modules to be developed: 1) Understand, build HELICS testbed, and integrate cyber network simulation -- CyHELICS, 2) Develop cyberattacks, integrate into the CyHELICS, and observe power grid impacts, and 3) Test and validate the application with various cyberattacks on multiple large-scale power grids.

Expected Deliverables:

1) Software codes and 2) Technical project report.

Specialized Resources Provided by Client:

PowerCyber private cloud testbed hosted at Iowa State University

Anticipated Cost: _____

Financial Resources Provided by Client: NA

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: GitLab, Understanding Power Systems, Cybersecurity

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month

- In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
- In person, Over the phone, Web / video conferencing
- 1 meeting per semester
- In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj041
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Gelli Ravikumar

Submitter Name: Gelli Ravikumar

Email: gelli@iastate.edu

Project Contact: Gelli Ravikumar

Email: gelli@iastate.edu

Project Title:

Grid-SIEM: Cybersecurity for Power Grid using SIEM tools and Machine/Deep Learning tools

Project Abstract:

This project aims to build a platform for artificial intelligence (AI)-integrated cybersecurity for power grids. Security information and event management (SIEM) tool is a widely used technology for traditional information security. In this project, the open-source SIEM software "SecurityOnion" can be used to build a platform to integrate with the power system monitoring and control environment, which we refer to as Grid-SIEM. The real-world problem is the power system monitoring and control environment is vulnerable to cyberattacks, and this project aims to build a cyber defense against it. Once the Grid-SIEM is designed, students will be required to develop Machine/Deep Learning-based algorithms for cyberattack data analytics. Students will get access to the PowerCyber lab and the power system monitoring and control environment for integrating SecurityOnion and conducting cyberattack and defense experiments. Students will receive all the required materials for working on SecurityOnion software and the cybersecurity and power system testbed. Programming experience and a Linux working environment are two essential prerequisites. At the end of the project, you will learn cyberattacks, SIEM, and Machine/Deep Learning. This software-based project includes the following modules to be developed: 1) Understand SecurityOnion and integrate to power system monitoring and control testbed -- Grid-SIEM, and 2) Develop and simulate cyberattacks, and build ML/DL-based analytics.

Expected Deliverables:

1) Software codes and 2) Technical project report.

Specialized Resources Provided by Client:

PowerCyber private cloud testbed hosted at Iowa State University

Anticipated Cost: _____

Financial Resources Provided by Client: NA

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: GitLab, Dockers, Understanding Cybersecurity, Wireshark

Anticipated Client Interaction (estimate):

- 1 meeting per week

- In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4
This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4
This project involves students from a variety of programs, i.e., CprE, EE, and SE	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4
This project requires students to identify, formulate, and solve engineering problems	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4
This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4

Project Approval – *for use by ECpE Senior Design Committee*

- Approved: sdmay24-proj042
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: _____

Submitter Name: Jim McCalley **Email:** jdm@iastate.edu

Project Contact: _____ **Email:** _____

Project Title:

New Nuclear Design for Electric Power Systems

Project Abstract:

Nuclear power generation has been a mainstay in US electric power systems since the 1970's. Today, there are about 90 nuclear reactors in the US with generating capacity of almost 100 GW; they provide about 20% of the nation's total electric energy. However, most of these plants were built in the 1970's and 1980's and so are at or beyond expected life. Many have been retired already, and many more will be retired over the next 10 years. Since the old designs were typically large, financially risky due to high cost and long construction times, and often subject to significant public resistance due to the perceived radiation dangers of meltdown, only two new reactors have come on-line in the last 20 years. Yet, these plants are and will remain highly desirable since they are one of the most economically attractive forms of zero-carbon electric generation technologies that are also fully dispatchable (meaning, unlike wind and solar, their output can be specified, i.e., they are capable of following control-command to generate at any MW level between their minimum and maximum capabilities).

In an attempt to balance the negatives (long construction times, high financial risk, perceived low safety) with the positives (zero carbon, dispatchability), the US Department of Energy has been heavily funding over the past 20 years several "new nuclear" technologies, e.g., see [1], [2]. The objective of this project is to identify a "new nuclear" design that provides the highest benefit to cost ratio under a high renewables future.

[1] <https://www.energy.gov/ne/articles/5-advanced-reactor-designs-watch-2030>.

[2] <https://www.energy.gov/ne/nuclear-reactor-technologies>.

Expected Deliverables:

Basic steps associated with this project are as follows:

1. Identify all reasonably practical "new nuclear" designs that have been suggested so far. Develop a summary report of these technologies that identifies their strengths and weaknesses. Estimate the Benefit to Cost ratio of each design.
 2. Based on the various technologies surveyed in step 1, identify a "recommended design" (RD). The RD could be one of the technologies surveyed, or it could be an extension of one of them, or it could be an integration of two or more of them.
 3. Illustrate and describe the RD in detail. Identify any significant problems with the design, and describe solutions for these problems. Provide a convincing argument that the RD's Benefit to Cost ratio is better than all other designs considered.
-

Specialized Resources Provided by Client:

Anticipated Cost: _____ Financial Resources Provided by Client: _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj043
- Project Assigned: _____

Advisor(s) Assigned:

Client/Company/Organization: Ahmed Nazar / ECE / ISU

Submitter Name: Mohamed Selim **Email:** myoussef@iastate.edu

Project Contact: Ahmed Nazar **Email:** amnazar@iastate.edu

Project Title:

LiDAR-Based Environmental Object Classification System

Project Abstract:

This senior design project focuses on harnessing LiDAR technology to create an advanced environmental object classification system. The project's objective is to develop a robust system that collects LiDAR data from the surrounding environment, processes it, and constructs a comprehensive database. This database will serve as the foundation for training a deep learning-based classification model capable of accurately identifying a variety of objects, including cars, trucks, pedestrians, and buildings. The resulting system will contribute to enhanced many applications such as public safety, communication networks, attendance and interaction in educational environments, urban planning, and resource management.

Expected Deliverables:

- 1- LiDAR Data Collection and Processing System:
Design and implement a LiDAR data collection system capable of accurately capturing 3D point cloud data from the environment. Develop algorithms for data preprocessing, noise reduction, and outlier removal to ensure high-quality data input for the classification model.
 - 2- Database Architecture and Construction:
Design and create a structured database to store the collected LiDAR data. Organize the database to efficiently store and manage the data, including metadata associated with each scan. Develop methods for data retrieval and management.
 - 3- LiDAR Data Preprocessing and Feature Extraction:
Implement algorithms to preprocess the raw LiDAR data, including calibration, point cloud segmentation, and spatial filtering. Extract relevant features from the processed data, such as object dimensions, positions, and orientations.
 - 4- Deep Learning Classification Model:
Train a deep learning model (e.g., convolutional neural network or point cloud-based network) using the preprocessed LiDAR data. The model should be designed to classify objects in the environment accurately. Consider employing transfer learning to leverage existing models and enhance performance.
 - 5- Data Labeling and Validation:
Collaborate with a team to manually label and annotate a subset of the LiDAR data for training and validation purposes. Develop a labeling tool or use existing software to ensure accurate annotations for the deep learning model.
 - 6- Real-Time Classification System:
Integrate the trained deep learning model with the LiDAR data collection system to achieve real-time object classification. Develop software that can process LiDAR data on-the-fly and provide instant classification results.
-

Specialized Resources Provided by Client:

The LiDAR System will be provided by the client.

Anticipated Cost: _____ **Financial Resources Provided by Client:** N/A

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Programming skills.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

- Approved: sdmay24-proj044
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Dr. Phillip Jones

Submitter Name: Phillip Jones

Email: phjones@iastate.edu

Project Contact: _____

Email: _____

Project Title:

MicroCART mini : Microprocessor Controlled Aerial Robotics Team

Project Abstract:

The main goal of the MicroCART mini project is to showcase the skill sets students develop through the ECpE department by designing a mini (about 4-inch by 4-inch) quad-copter platform to be used in the Department's advanced embedded systems course (CPRE 488), and for Controls & Embedded Systems research. The most visible outcome of the project will be a min-quadcopter platform that will be user-tested by students taking CPRE 488 in Spring 2024.

The team will:

1. Develop, and/or augment a mini-quadcopter printed circuit board (PCB). Which will contains Integrated Circuits (ICs) such as: a Microcontroller, RF , IMU, and Wi-fi chip
 2. Develop Software to stabilize, and communicate with the mini-quadcopter
 3. Develop testing rigs to allow the team and users (CPRE 488 students, and Researcher) to remotely interact with the mini-quadcopter. For example, for tuning control algorithms to stabilize the mini-quadcopter
 4. Develop a ground basestation to communicate with the mini-quadcopter and testing rig(s).
 - 5) User and Developer documentation and video tutorials to allow others to quickly get up to speed on the project in the future.
-

Expected Deliverables:

A mini-quadcopter platform and test rigs that will be user-tested by students taking CPRE 488, and Researchers in Spring 2024, along with user and developer documentation and video tutorials.

Specialized Resources Provided by Client:

This project may need approximately \$500 in department support, and perhaps a laptop computer to have a mobile base station.

Anticipated Cost: _____

Financial Resources Provided by Client: N/A

Preferred Students for the Project:

- Electrical Engineering
 - Computer Engineering
 - Software Engineering
 - Cyber Security Engineering
 - Other:
-

Other Special Skills:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj045
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Dr. Phillip Jones

Submitter Name: Phillip Jones

Email: phjones@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Interactive Embedded Systems Learning using the Prairie Learn framework

Project Abstract:

The objective of this project is to use the Prairie Learn framework (<https://www.prairielearn.org/>) to develop an interactive learning environment for use in CPRE 288 (Embedded Systems). This will primarily involve: 1) using Python, JavaScript, and C to develop interactive questions/activities that can be randomized, and auto-graded, and 2) integrating third party tools such as microcontroller emulators to create an interactive environment in which students can learn and practice Embedded Systems concepts introduced in CPRE 288. A stretch goal would be to have an emulated (and perhaps actual) Cybot robot interface with the framework. A significant portion of the team will need to be very comfortable with the material covered in CPRE 288.

Interactive questions/activities developed will cover topics such as:

- 1) Converting numbers between bases
- 2) Writing simple C programs
- 3) General Purpose I/O
- 4) Bitwise operations
- 5) UART communication
- 6) Analog to Digital Conversion
- 7) Timers
- 8) Pulse wave generation
- 9) Assembly Programming

A larger vision for this project is to act as an example that other courses in the department can use to develop interactive learning environments. Depending on the progress of the team, there is an opportunity to experiment with developing interactive educational material for courses beyond CPRE 288.

Expected Deliverables:

1) Refinement of existing interactive questions for initial student feedback by mid Fall 2023, 2) a larger set of more advanced interactive questions/activities to be completed by the end of Fall 2023 so that they can be deployed to CPRE 288 in the Spring of 2024, 3) A final large set of interactive questions/activities that will be used by CPRE 288 students in the Summer of 2024, and 4) Developer documentation, and tutorial videos to help others quickly get up to speed with setting up a PrairieLearn server, and developing interactive questions/activities for courses in the department.

Specialized Resources Provided by Client:

Anticipated Cost: _____

Financial Resources Provided by Client: _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj046
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Iowa State University and Michigan Tech University

Submitter Name: Dr. Rover

Email: drover@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Code Critiquer System for the C Language

Project Abstract:

In this project, your team will design, prototype, test and demonstrate a code critiquer system for the C language based on the existing system developed by the RICA project at Michigan Tech University. The system will have potential future use in C programming courses at Iowa State University, including CPRE 288 (which uses C for embedded programming), as well as to the larger user community served by the RICA project.

The RICA project is described in this paper: <https://digitalcommons.mtu.edu/michigantech-p/16803/>

The RICA project is aimed at detecting subpar coding solutions to common problems, termed antipatterns, in student code and providing feedback that guides the student to better solutions. A code critiquer system is used to detect antipatterns in student code and generate appropriate feedback. Refer to figures 2 and 4 in the paper for an overview of a critiquer system.

In the first phase of the project, team members will capture output from C program compilation, recording error messages, and restating them in a way that is accessible to novice programmers. If there are no compilation errors, then a static analysis of the source code will search for other kinds of issues with the code and generate further advice. The information collected will be used with a local or remote platform to implement an initial prototype of a C code critiquer system.

The prototype will be further developed depending on the interests and background of team members. Development could focus on user interface design as a tool for instructors, database or storage system design, parser design to build an abstract syntax tree for generating advice, or using AI approaches for recognizing issues and generating advice. The prototype system would be tested with students during the second semester.

Dr. Rover will serve as the faculty advisor, a CPRE graduate student will also help advise the team, and RICA project developers from Michigan Tech University will be involved in client and/or consultant roles.

This is a software development project, and students should be prepared to use various software platforms, use and modify an existing code base, and develop new software functionality. The project may be especially suited for software and computer engineering students. The project may also be relevant to cybersecurity engineering students, for example, if security errors or issues are considered. The project may also be relevant to electrical engineering students, for example, if C code issues related to embedded systems are considered.

Expected Deliverables:

First semester tasks and deliverables: Fully define the problem and requirements for a code critiquer system; use an existing system from the RICA project; plan or implement an initial prototype; collect an initial set of data for antipatterns; and identify features the team will focus on for further development of the system.

Second semester tasks and deliverables: Further develop the prototype based on functionality decided on by the team; further develop the antipatterns and advice as needed; test and demonstrate system functionality; and recommend next steps.

Specialized Resources Provided by Client:

RICA project software

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Preferably some experience with C programming

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

Approved: sdmay24-proj047

Project Assigned: _____

Advisor(s) Assigned: _____

Client/Company/Organization: 7 Elements LLC

Submitter Name: Troy Benjegerdes

Email: dahozer@gmail.com

Project Contact: _____

Email: _____

Project Title:

BlackWire SmartNIC on PolarFireSOC

Project Abstract:

Port the open-source hardware BlackWire FPGA VPN solution to the PolarFire SOC FPGA platform.

Expected Deliverables:

An implementation of the open repos at <https://github.com/brightai-nl/BrightAI-Blackwire> ported to run in the Libero design tool for PolarFire SOC FPA's, with options for additional packet processing provided by the RiscV hard-cores in the chip.

Proposed Schedule:

Week 1-4: review documentation, get familiar with Libero tools, and prepare an implementation plan

week 5-6: port and test core encryption code to Libero, validate with testbenches

week 6-10: integration and prep for first semester demonstration using on-board ethernet

Semester 2:

week 1-2: review current status, adjust final design deliverable documents based on experience with the platform

week 2-4: evaluate feasibility of integration with linux drivers for a 4-port PCI-E card, vs using the available SERDES lanes on the PCI connector to speak directly to one or more Icicle boards

week 5-10: implementation and plan to be finalized during semester 1

Specialized Resources Provided by Client:

<https://www.microchip.com/en-us/development-tool/mpfs-icicle-kit-es>

Please let me know if the FPGAs can be considered in-kind

Anticipated Cost: _____

Financial Resources Provided by Client: donations

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Linux drivers, IP routing, firewalls, VPNs, Verilog and VHDL, FPGA experience

Anticipated Client Interaction (estimate):

- 1 meeting per week
 In person, Over the phone, Web / video conferencing
- 1 meeting per month
 In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj048
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Iowa State University and the University of Iowa

Submitter Name: Dr. Rover

Email: drover@iastate.edu

Project Contact: _____

Email: _____

Project Title:

IINSPIRE STEM Survey Visualization Tool

Project Abstract:

In this project, your team will design, prototype, test and demonstrate an IINSPIRE STEM survey visualization tool that will be used to visually present statistical results of a survey in a web-based tool or app. The IINSPIRE STEM survey is taken by STEM undergraduate students who participate in undergraduate research or other high impact practices. The survey was developed by University of Iowa researchers and has been used by the IINSPIRE LSAMP Program at Iowa State University. The visualization tool will support students, mentors and program staff in understanding, using, and reporting the results of the survey. The tool has potential future use by other NSF LSAMP programs around the country and other undergraduate research programs.

The STEM survey is described in this paper: <https://iastate.app.box.com/s/lxbosi72fjqycsfeo9jyhg55dpb6zefg>
Refer to figures 1 and 2 in the paper. Students take a survey before and after participating in a program. The statistical results of the survey provide information about a student's progress during the program in relation to STEM career development and opportunities for growth. Currently the charts in these figures are manually created. The goal of this project is to develop a tool to automatically create the charts, generate explanations of the charts, and provide options to save and print the charts for posters or reports.

Some features of the visualization tool will be developed depending on the interests and background of team members. Development could focus on user interface design for different users, database design, or customizability for different programs or measures. The prototype tool would be tested with students during the second semester.

Dr. Rover will serve as the faculty advisor, a graduate student will also help advise the team, and University of Iowa researchers will be involved in client and/or consultant roles. Dr. Rover is the alliance director for the IINSPIRE LSAMP program (<https://www.iinspirelsamp.org>).

This is a software development project, and students should be prepared to develop a web-based application based on user needs and client input. The project may be especially suited for software and computer engineering students. The project may also be relevant to cybersecurity engineering students, for example, if data security and privacy issues are considered.

Expected Deliverables:

First semester tasks and deliverables: Learn about the IINSPIRE STEM survey and measures; fully define the problem and requirements for an IINSPIRE STEM survey visualization tool; plan or implement an initial prototype; set up an initial dataset; and identify features the team will focus on for further development of the tool.

Second semester tasks and deliverables: Further develop the prototype based on functionality decided on by the team; further develop the survey database as needed; test and demonstrate tool functionality; and recommend next steps.

Specialized Resources Provided by Client:

Survey data

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Web-based application development

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – *for use by ECpE Senior Design Committee*

- Approved: sdmay24-proj049
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: 7 Elements LLC

Submitter Name: Troy Benjegerdes

Email: dahozer@gmail.com

Project Contact: _____

Email: _____

Project Title:

Open source hardware SERDES on SKY130

Project Abstract:

The project goal is to produce an analog SERDES design targeted for the SKY130 open-source PDK at Skywater Technology foundry in Bloomington, MN, using the eFabless open-source EDA tools. Some starting points to review are:

*

https://www.linkedin.com/posts/tony-chan-carusone-2799a38_introduction-to-serdespy-activity-7042449496282169344-QOTx

* #serdes channel on <https://open-source-silicon.slack.com/>

* https://github.com/yrrapt/amsat_txrx_ic

* <https://github.com/tmagik/infiniband-fpga>

* ISU Senior Design project May 09-04 (infiniband-fpga)

Expected Deliverables:

Deliverables should include:

* Design document with literature review of existing work

* Review of Efabliss Chiplgnite and OpenMPW programs for fabrication schedule

* Debian linux image or container of full toolchain for producing the GDS file for fabrication

* Documentation linking to original sources

* Design files, simulation models, and test harnesses for the SERDES functionality

* optional: RiscV compiled binaries for toolchain, targeted to run on Icicle (RiscV) eval board, or other readily available RiscV linux system

* optional: Review of alternative foundries (GF180, etc) for lower cost/faster tapeout

Specialized Resources Provided by Client:

\$1000 towards
tapeout costs .. let's
discuss this more if
when we have more

Anticipated Cost: _____

Financial Resources Provided by Client: details

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering

Other Special Skills: Verilog, VHDL, Analog design

- Cyber Security Engineering
- Other:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all *1 – A Little* *2 – Somewhat* *3 – A Lot* *4 – Completely*

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

Approved: sdmay24-proj050

Project Assigned: _____

Advisor(s) Assigned: _____

Client/Company/Organization: John Deere

Submitter Name: Nathan Francque

Email: francquenathan@johndeere.com

Project Contact: Nathan Francque

Email: francquenathan@johndeere.com

Project Title:

Pipelined Convolutional Neural Net on FPGA

Project Abstract:

The goal of this project is to create a pipelined CNN inference design on an FPGA for computer vision.

CNN's tend to be simpler types of models that lend themselves well to pipelining. ConvNext is one relevant modern CNN architecture. Commonly layers in this design include depthwise convolution (with stride), max pooling, addition, layer normalization, and upsampling.

The advantage of using an FPGA for inference is that it can be pipelined, allowing for incoming sensor data to be run through a model without adding system latency or using CPU/GPU resources.

This project's goal is to create a minimum viable product of a CNN similar to ConvNext. Hand-written RTL, generated RTL, HLS, or any other appropriate solutions are welcome.

Expected Deliverables:

First semester - survey already completed work in this space and evaluate what difficulties have been presented with completed this in previous attempts. Choose an architecture that is implementable and justify the choice. Provide a report of likely obstacles and risk mitigation options if the implementation becomes difficult or too large to fit fully pipelined.

First half of first semester - a manually generated first pass at the choice of model. A demo either in simulation or on target of performing inference on generated images.

Second half of second semester - create a system on a Zynq dev board that demonstrates the low latency aspect of this design. One option is to have an HDMI input and output, and use the model's output to generate hardware overlays onto the video stream. Display a video of a clock with the overlays inserted.

Stretch goal - create a software tool that can aid in / automatically perform the mapping of a given network to the hardware design. It is more valuable to make this simple and reliable for supported model layers than to try to support many layer types.

Specialized Resources Provided by Client:

Anticipated Cost: _____

Financial Resources Provided by Client: 5000

Preferred Students for the Project:

Electrical Engineering

Other Special Skills: Computer Vision, Machine Learning, FPGA

- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj051
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: ECE, ISU

Submitter Name: Goce Trajcevski

Email: gocet25@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Motif discovery in multivariate time series

Project Abstract:

Traditional time series have members (of a dataset) that correspond to a sequence of (time, value) pairs pertaining to a single attribute. Such data is adequate in applications such as stocks monitoring, electricity consumption, EKG, etc. In the recent years, plethora of applications have emerged where a time series corresponds to a collection of multiple heterogeneous attributes that (co)evolve simultaneously - and yet pertain to a single entity. These are called multivariate time series. Examples include: (1) patients monitoring with multiple on-body sensors (e.g., temperature, blood pressure, oxygen levels); (2) vehicular monitoring with multiple sensors (e.g., GPS location, odometer, emission, ...); (3) environmental studies (CO₂, temperature, humidity, air-pressure,...) at given locations; etc. Certain applications (e.g., astrophysics) have over 100 attributes that co-evolve in time (H, He, C, mass, luminosity, temperature, radius,...). The meaning of a motif in time series is a subset of consecutive instants creating a "shape" of values which repeats multiple times in the series.

The goal of this project is to develop an end-to-end system which will enable detection (and reporting) of motifs in time series data. This is important in pretty much any application dealing with multivariate time series (e.g., detection of repeating patterns of bursty traffic activities; origination of interactions in molecular trajectories; etc.) and algorithms exist that, in one way or another, solve the problem. However, what is missing is an actual system that can enable users to select certain parameters of interest (e.g., sub-interval of the series; duration of potential motifs; etc.).

Expected Deliverables:

The expected schedule for the Fall 2023 is:

- week #2: introductory meeting and problem overview;
 - week #3: introduction to literature and discussion of algorithms;
 - week #4: narrowing the scope of project (which queries/algorithms to implement);
 - week #5: identifying requirements;
 - week #6: identifying use-cases;
 - week #7: tools and frameworks selection;
 - week #8: preliminary system design;
 - week #9: identifying testing scenarios;
 - week #10: completing non-functional requirements;
 - week #11: refining the system design
 - week #12: refining the testing/validation
 - week #13: draft of the design document
 - week #14: revision of the design document and preparation of presentation
 - week #15: presentation and final design document
- The deliverable is the Design Document
-

Spring 2024:

Weekly or bi-weekly meetings to discuss implementation issues/progress.

The deliverable is the operational system that implements the desired functionalities.

Specialized Resources Provided by Client:

References (reading) will be provided, along with the code to be used in (the back-end of) the system. Also, access to a server.

Anticipated Cost: _____

Financial Resources Provided by Client: N/A

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: Experience in coding and problem solving commensurate with the expectations from Seniors.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all

1 – A Little

2 – Somewhat

3 – A Lot

4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve 0 1 2 3 4

engineering problems

This project gives students an opportunity to use the techniques, skills,
and modern engineering tools necessary for engineering practice

0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj052
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Henry Duwe, ISU ECpE

Submitter Name: Mat Wymore

Email: mlwymore@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Using generative AI to assess learning

Project Abstract:

Can ChatGPT deliver an oral exam? The goal of this project is to design and implement a Canvas integration that uses generative AI to aid instructors in assessing learning in their courses. The vision is a tool that allows the instructor to define and configure an exam. Students then take the exam by having a conversation with a generative AI such as ChatGPT. At the end of the exam, the tool will enter a grade for the exam into Canvas for the student and provide methods for allowing the instructor to quickly verify the results. Team members should be interested in generative AI and/or working with APIs.

Expected Deliverables:

- Sep 2023: background and system design
- October 2023: system design and prototyping
- November 2023: proof-of-concept finished
- December 2023: design review
- February 2024: implementation
- March 2024: implementation and integration, testing and refinement
- April 2024: acceptance testing, presentation, and reporting

Specialized Resources Provided by Client:

None

Anticipated Cost: _____

Financial Resources Provided by Client: None

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month

- In person, Over the phone, Web / video conferencing
 1 meeting per semester
 In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all

1 – A Little

2 – Somewhat

3 – A Lot

4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj053
- Project Assigned: _____
- Advisor(s) Assigned: _____
- _____

Client/Company/Organization: Randall Geiger Senior Design

Submitter Name: Randall Geiger

Email: rlgeiger@iastate.edu

Project Contact: _____

Email: _____

Project Title:

On-chip Microheaters for Test Cost Reduction

Project Abstract:

This project will focus on the design of on-chip microheaters that can be used for test cost reduction in a semiconductor production test environment.

Many precision integrated circuits have performance characteristics that change with temperature. To compensate for this temperature change, the circuits are trimmed or calibrated at production test. The cost associated with production testing on a commercial tester (ATE) operating at a single ambient test temperature with a single insertion into the tester can be high and for some parts the testing costs exceed the cost of fabricating the integrated circuit itself. The cost of two or more insertions to test at multiple temperatures is even higher and often economically unviable. Unfortunately, trimming or calibration to compensate for temperature degradation invariably requires making measurements at two or more temperatures thereby dramatically increasing production costs.

This project will focus on the design of on-chip microheaters that can be used to locally and precisely heat the temperature critical part on a semiconductor die so that multi-temperature testing performance can be obtained with a single insertion operating at a single ambient test temperature. Fortunately the time required to heat the temperature critical part of an integrated circuit is very short so the on-chip microheaters can be used to obtain multi-temperature calibration performance at a single test temperature thereby significantly reducing production test costs.

This project will involve the design and characterization of microheaters that can be placed at various positions on a semiconductor die. The time required to reach thermal equilibrium, the uniformity of heat affected zone, and the relationship between the temperature rise and the power applied to the microheaters will be investigated.

Analytically, closed-form expressions for predicting the thermal profile introduced by the microheater are not obtainable even for very simple structures so extensive use of a commercially available electro-thermal simulator (Legato) provided by Cadence will be used on this project.

The concept of using microheaters for reducing production test costs is new and it is anticipated that good results should be of considerable interest to the semiconductor industry.

Expected Deliverables:

New structures and performance characteristics of several microheaters that can be used for testing and calibration of precision temperature-sensitive integrated circuits. Included will be the layouts of the proposed structures suitable for fabrication in a standard CMOS process.

Specialized Resources Provided by Client:

Anticipated Cost: _____

Financial Resources Provided by Client: _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering

Other:

Other Special Skills: One or more of the team members should have taken or should be currently registered in EE 330. All team members should have interest in using CAD tools. Though emphasis on the project is on applications for testing precision temperature-sensitive integrated circuits, the heaters themselves are dominantly resistive devices and the electro-thermal simulator provides heat-transport characteristics of a semiconductor device rather than electrical characteristics of the embedded electronic circuits.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

Approved: sdmay24-proj054

Project Assigned: _____

Advisor(s) Assigned:

Client/Company/Organization: Randall Geiger Senior Design

Submitter Name: Randall Geiger

Email: rlgeiger@iastate.edu

Project Contact: _____

Email: _____

Project Title:

Sound Effect Devices for Musicians

Project Abstract:

This project will involve the design and testing of a special effects device targeting use by live entertainment musicians. There are numerous sound-effects devices available that provide interesting and creative effects. These include wah-wah, fuzz, overdrive, phasing, flanging, chorus, vibrato, tremolo, rotary speaker, octave dividers, and a host of others. These devices usually have an input coming from a guitar or some other musical instruments. A large number of these devices have emerged over the years but the demand exists for other devices that produce effects that are more interesting or novel than what is available or are easier to use and integrate. A somewhat dated issue of Guitarworld magazine (Nov 30, 2015) reviewed 50 such devices that have been used over the years.

The specific sound effects device that is targeted will depend upon the interests and innovation of the students but two devices that might be considered are:

Device 1: "Super-tube amplifier"

One electronic device that receives a lot of attention is the "tube amp". In their natural form, tube amplifiers use vacuum tubes rather than transistors and op amps to build the power amplifiers. Though tubes introduce distortion and are both more expensive and less reliable than transistor-based amplifiers, some people think they sound better and actually like the type of distortion that they cause. So the project could take the path of designing a "super-tube" amplifier whereby the goal would be to actually enhance the distortion that makes a tube amp appealing and come up with a type of amplifier using transistors or other solid-state devices that is even more appealing than an actual tube amp.

Device 2: Looper

One particularly interesting effect is produced by a looper. With a looper, a sample of a signal is recorded and then added back into the real-time signal path in a recirculating manner. For example, a sample 4 seconds long might be recorded and then added back in each 4 seconds until the musician decides to stop the looping. Variants of the looper that automatically grab the looping signal from the beat of the music, that have it fade out, that reverse the order of the looping, that alternately loop forwards and backwards, etc. would be investigated to obtain a new effect device that is hopefully of interest to musicians.

Expected Deliverables:

Design and fabrication of a prototype device along with test results and assessment of interest in the device by musicians that are not a part of the design team. Flexibility on this project is intentionally broad to allow individual creativity and interests to dictate the direction of the project.

Specialized Resources Provided by Client:

Anticipated Cost: _____

Financial Resources Provided by Client: _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering

- Other:

Other Special Skills: Only students that are interested in exploring their creativity in the audio arena or that have ideas that they would like to bring to the prototype level should consider this project. Experience as a performer or performing tasks associated with those of an audio engineer would be most useful but are not required

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj055
- Project Assigned: _____
- Advisor(s) Assigned: _____

Client/Company/Organization: Randall Geiger Senior Design

Submitter Name: Randall Geiger

Email: rlgeiger@iastate.edu

Project Contact: _____

Email: _____

Project Title:

UAV-Assisted Energy Delivery

Project Abstract:

This project will focus on developing a method for drone-assisted (alternatively termed an Unmanned Aerial Vehicle or UAV) energy delivery for powering untethered nodes which are critical components in the emerging Internet of Things (IoT). There are fundamental trade-offs in data communication networks between distance, bandwidth, spectrum allocation, and power. When network nodes are tethered to the power distribution grid, power is of secondary concern but on untethered nodes, a source of power is of critical concern and many of the emerging IoT applications will come to fruition only if a practical source of energy becomes available. There is a lot of research ongoing on harvesting energy to power these untethered nodes. However, it appears that there are fundamental physical limits on essentially all proposed methods of harvesting energy that will doom these approaches to low-distance, low data-rate applications with limited availability and reliability.

Drones are widely used in military applications for reconnaissance and unmanned targeted attacks and by hobbyists primarily for mobile camera applications. Proposals for other applications such as package delivery have been forwarded by Amazon and others.

This project will focus on using drones as a system component for energy delivery to untethered nodes and for the bidirectional shuttling of data between the grid and the untethered nodes. Energy will be delivered-scheduled from a tethered location to an untethered location on-demand. While transferring energy, the drone will dock with the untethered node rather than "hover" to minimize energy loss. It is envisioned that these drones can become an extremely low-cost commodity that can be readily replaced if failures do occur thereby achieving good availability and system reliability.

Aspects of this project will include developing autonomous drone docking methods and methods for drone-assisted energy delivery. The project will also include a WEB interface that can be used to interface data collected from the untethered nodes to the cloud.

It is expected that participants will use existing commercially available drones and commercially available network components to develop and demonstrate performance capability of these drone-assisted networks. It will be expected that all participants demonstrate competence in piloting drones using existing commercial software.

Expected Deliverables:

Review of methods of drone-assisted data transmission/shuttling and drone-assisted energy delivery. Development of a low-cost drone-assisted system that can be used for both energy and data delivery. The drone should be able to autonomously go back and forth between a grid-connected docking point and an untethered node shuttling energy from the grid-connected docking point to the untethered node and shuttling data between the two nodes.

Demonstration of the performance of this network using commercially available drones and network components.

Specialized Resources Provided by Client:

Anticipated Cost: _____ **Financial Resources Provided by Client:** _____

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Other Special Skills: An UAS (unmanned aircraft systems) pilots license and/or experience flying drones would be useful but is not required.

Anticipated Client Interaction (estimate):

- 1 meeting per week
 - In person, Over the phone, Web / video conferencing
- 1 meeting per month
 - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
 - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
 - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all 1 – A Little 2 – Somewhat 3 – A Lot 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering 0 1 2 3 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability 0 1 2 3 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE 0 1 2 3 4

This project requires students to identify, formulate, and solve engineering problems 0 1 2 3 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice 0 1 2 3 4

Project Approval – for use by ECpE Senior Design Committee

- Approved: sdmay24-proj056
- Project Assigned: _____

Advisor(s) Assigned:
