EE491 Senior Design I

Stop Sign Tracking System

Group May14-18
Client: Dr. Halil Ceylan
Advisor: Dr. Daji Qiao
Group Members:
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Website: http://seniord.ece.iastate.edu/may1418/index.html

Project Objective

1. Develop a sensor-based (e.g., use of MEMS magnetic compass and an accelerometer to detect the rotation of the stop sign and the static tilt of the sign) tracking/monitoring prototype system that locates the whereabouts of critical warning/stop sign or damage sustained by a warning sign.

2. Develop a prototype wireless communications system in relation to goal #1 to communicate that information back to a central location (e.g., the Department of Transportation office).

Task responsibility

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Simeng Liu	David Paul	Aaron Cannon	Zheng Luo	Together
Weekly Report	Design Website	Contact Dr. Daji and Dr. Halil.	Design Sketch	Project Plan
Research Tilt Sensor	Research Microcontroller	Testing Each Components	Research Supercapacitor	Design Documents
	Research Power Supply	Research GSM Module.		Presentation
				Other Group Assignment

Market Research:

- First system to specifically track the function of critical traffic/warning signs.
- Currently there are traffic signs equipped with solar cells but for the purpose of powering lights for increased visibility.
- There are also various tracking systems available but are used as a geofence detection for higher profile equipment such as mobile stop lights for construction sites.

Budget

Total Current Cost for this Project: $132.80 + $0.20/text

- Arduino Pro 328: $14.95
- GPRS Shield V2.0: $59.90
- Accelerometer: $27.95
- Wireless Service: $10 SIM card + $0.20/text
- USB Cable: $20

Total Estimated Future Cost Including the Power Supply: $41.50

- Solar Panel (5V): $20.00
- Battery (5V): $3.00
- Nema Enclosure Box: $18.50

Total Estimated Cost for this Project (Approximation): $180.00

Requirements:

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Functional:

- 1.Tilt threshold: +/-15 degrees
- 2. Send Alerts
- 3. Wireless Communication
- 4. Self-Calibrate
- 5. 10% False-Positives
- 6. No False-Negatives
- 7. Power Supply: 5V
- 8. Tracking

Non-Functional:

- 1. Size
- 2. Package
- 3. Weather Resistant
- 4. Functional Temperatre Range: 115 to -35 degrees Fahrenheit
- 5. Lifetime: System should be able to sustain itself for 10 years.

Technical Risks

Risk	Probability of Going Wrong	Criticality (0 - 100)	Risk Factor	Mitigation Strategy
GSM module may not send the message if the signal is bad.	10%	95	95 * 0.1 = 9.5	To mitigate the issue, we will do our best to find a best carrier to be used in GSM module.
The solar system may not supply enough energy to whole package.	20%	80	80 * 0.2 = 16	We will test the solar system to find a best suitable one to supply power in our package.
Micro Controller may not handle the computation from the sensor	5%	100	100 * 0.05 = 5	We will test the microcontroller to find a most suitable for compute all data.

Organizational Risks

Risk	Probability of Going Wrong	Criticality (0 - 100)	Risk Factor	Mitigation Strategy
The whole package may cost over our budget.	25%	60	0.25 * 60 = 15	Setting up a realistic budget from the start with extra wiggle room is the key. We will decide a cheapest combination of all components to test. If it doesn't work, we will try second cheap component.
There is not enough knowledge on programming the microcontroller and sensors connection	10%	30	0.1 * 30 = 3	We are going to do some researches and find some tutorials. Also we will ask Dr. Daji for more coming problems.

Design sketch

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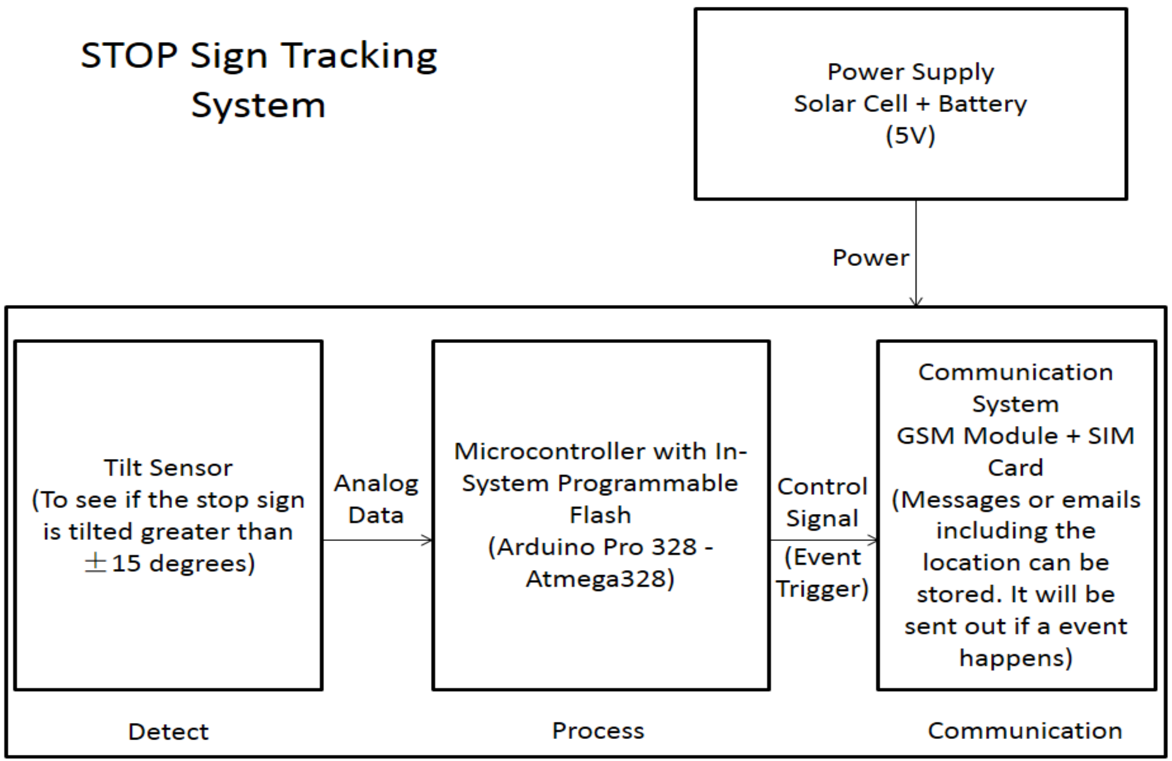
Components:

1. Power Supply
2. Tilt Sensor
3. GSM Module
4. Microcontroller



Tilt Sensor

An accelerometer is being used as our tilt sensor to measure the stop sign's tilt.

When the stop sign is tilted, the sensor will be able to know how many degrees the sign is tilted by. If the range exceeds ±15 degrees, an alert should be sent out.

Typically, a accelerometer is not too expensive compared to other components. It can be just connected to the header of the board of the microcontroller. After comparing with other choices, we decided to use ADXL345 accelerometer.

We compared prices and functionality to gyroscopes and a basic tilt sensor

GSM module

The GSM module will be alert driven and only a message is sent out if an event occurs. The message should contain the position of the stop sign and also specify if it is tilted by certain degrees.

The GPRS Shield V2.0 will work in the temperature range demanded from 115 to -35 degrees F and has a good interface for the Arduino Pro 328. The price is the lowest we that found acceptable.

Other options we thought about using was RFID tags and wifi hotspots. With further research these options didn’t fit our project goals.

Microcontroller

A microcontroller is necessary to process the data from sensors and control the GSM module to send out alerts when events happen.

The ATmega328 has an excellent operating temperature range and is able to control the whole system.

Arduino Pro 328 which uses ATmega328 has a very cheap price compared to other boards.

We compared the Arduino Pro to Raspberry Pi and Pic microcontroller.

Power supply

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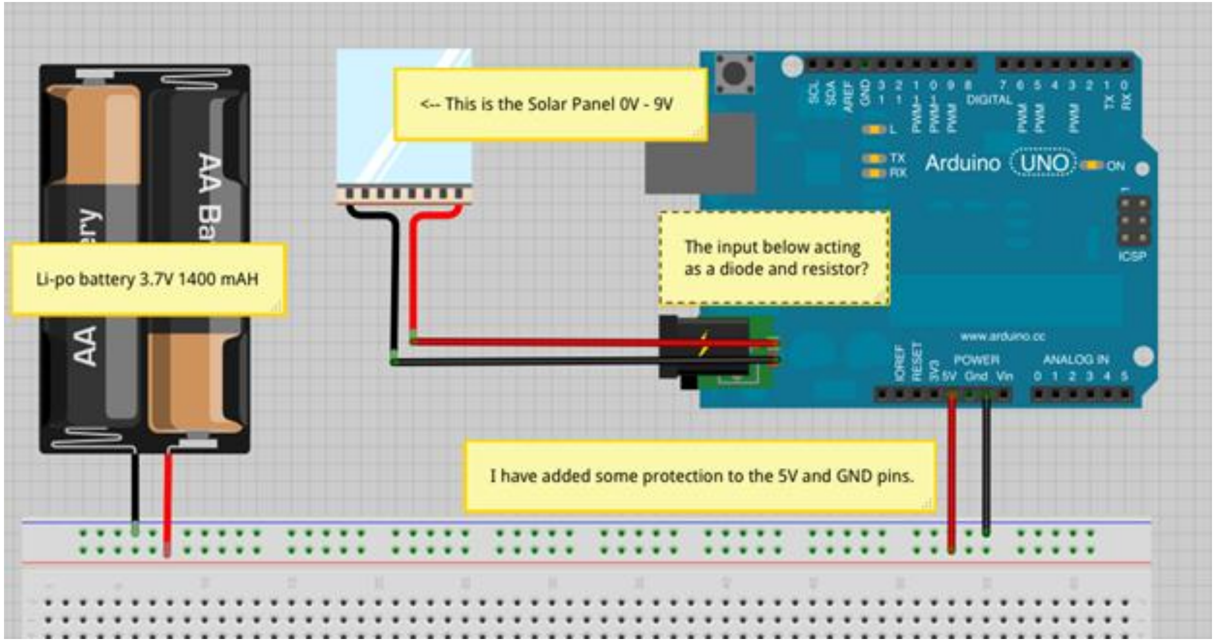
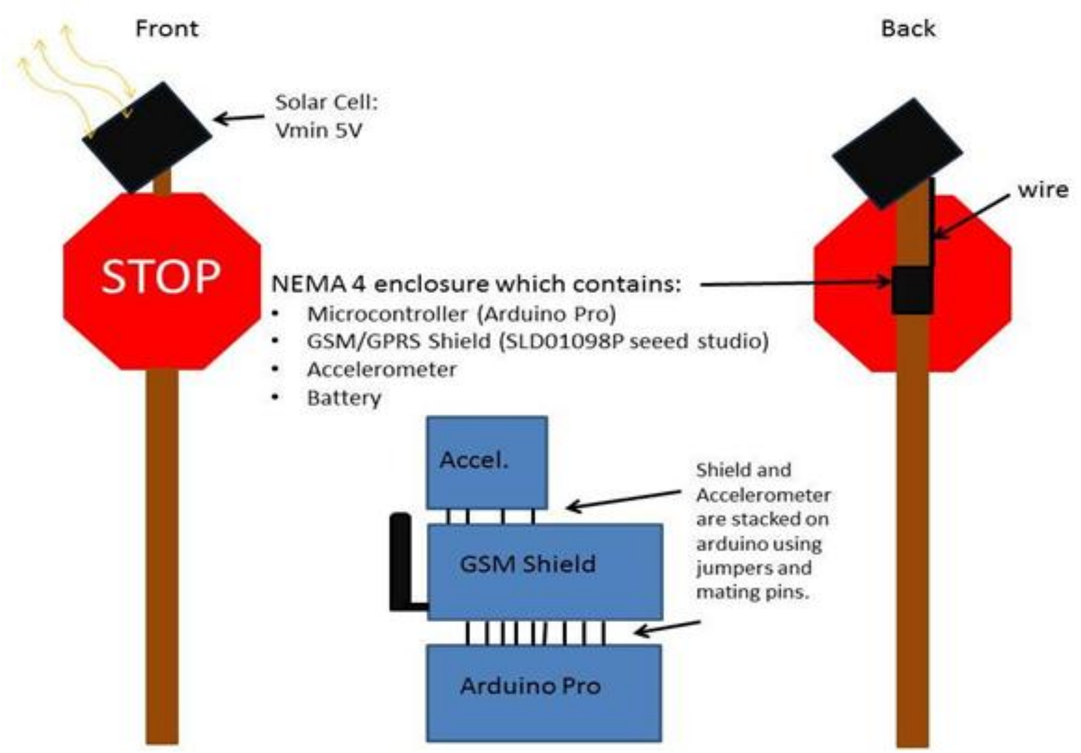
A power supply is needed for the whole system. Our idea is to use a rechargeable battery plus a solar panel. We also use a charging circuit to connect the solar panel with the battery.

Other Options included wind charging system and supercapacitor.



Integration and bird's-eye view

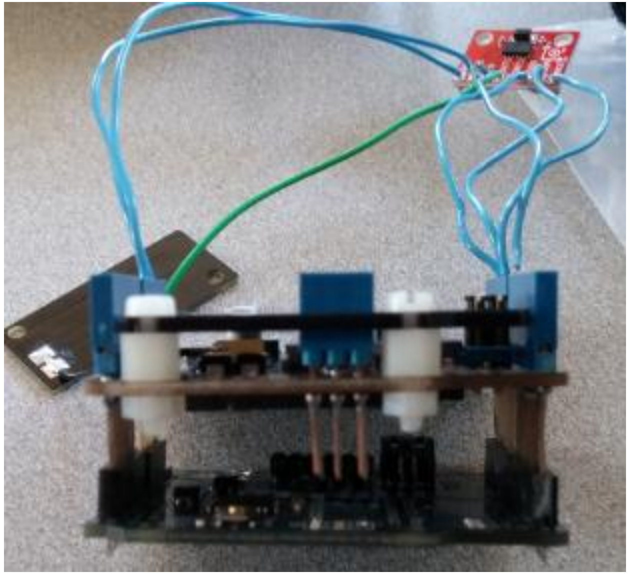


Accelerometer can be connected to the Arduino directly.

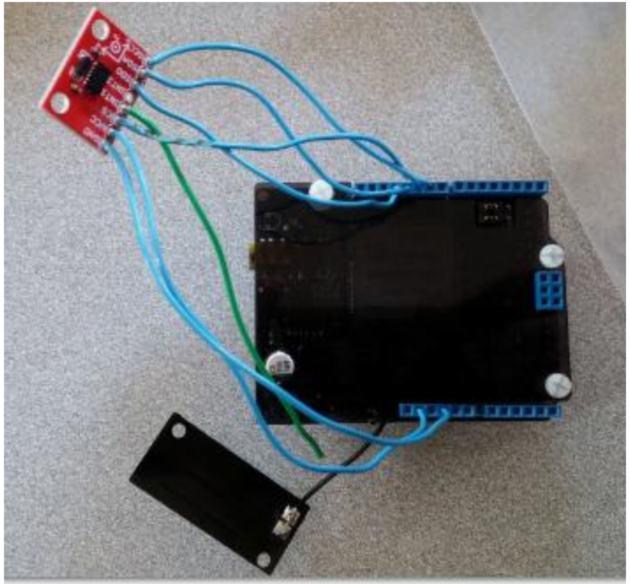
The GSM Shield has the same interface with the Arduino.

The solar cell and charging circuit can be connected as shown in the former slide.

Integration (cont.)



Interconnection of communication system



Birds eye view of system

Testing

a) Temperature test

b) Wind test, Shock/Vibration tests (ex. sign falls over is the equipment reusable)

c) Water test

d) Cell signal reliability

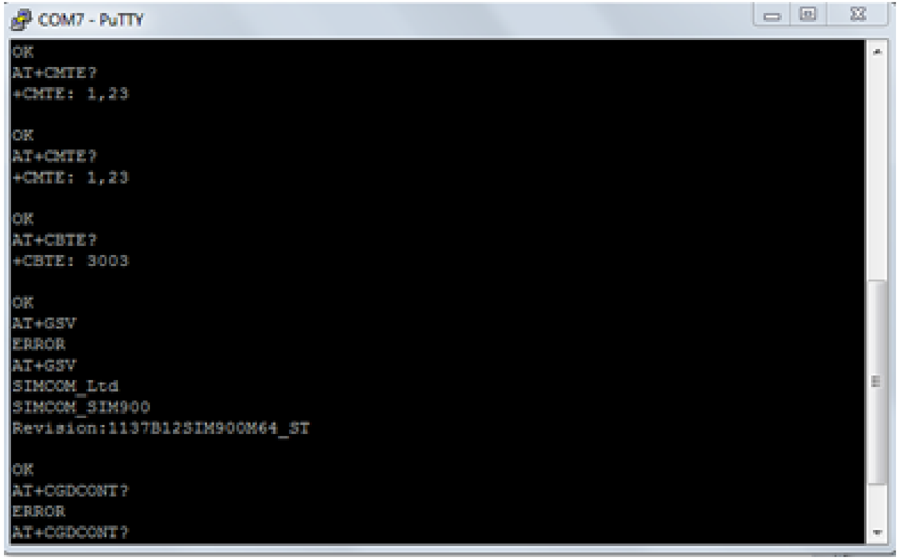
e) Accuracy of tilt sensor and calibrations

f) Longevity of power system

Progress

Thus far we have been able to accomplish:

- Communication system parts have been chosen.
- Interface to the GSM module.
- Interface the accelerometer evaluation board.
- Continually researching power system options.



Issuing AT commands to GSM module over serial connection

Progress:

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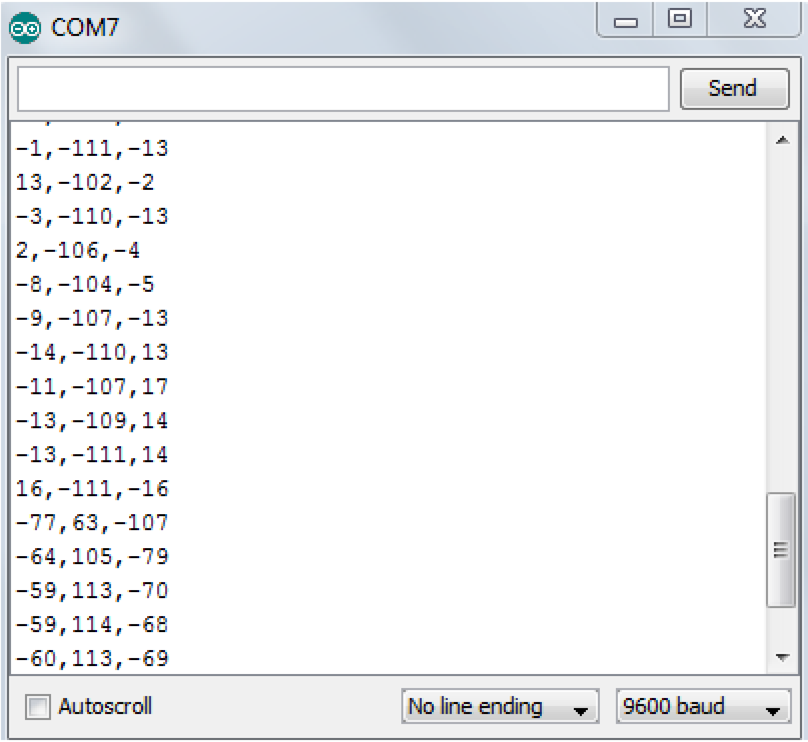
- Seen to the right is the raw data being sent back from the accelerometer.
- As accelerometer was moved values would change accordingly.
- data printed out as x,y,z coordinates



Schedule

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January 19: Discuss plan for spring semester and refresh where we left off.

January 26: Research Power supply system (renewable energy, energy storage, charging circuit). Tilt testing accuracy/reliability.

February 2: Continued Power Supply Research. Make changes to communication system as test results come back. Start temperature testing.

February 9: Finalize power supply design and order parts. Test NEMA enclosure for water resistance. Test mounting hardware for wind/vibration.

February 16: Receive parts. Build power system**.**

February 23: Begin Testing power system longevity if system is built and consistently working.

March 2: Test weather resistance of solar cell. Begin putting all pieces together into final design.

March 9: Make alterations and finalize design

March 16: Finish working prototype. Begin Documentation.

March 23: SPRING BREAK (The Last One)

March 30: Continue to draft outline for poster, presentation, and other documentation. Test final prototype for good measure.

April 6: Put together first draft of materials to be put on poster and presentation. Real world prototype testing.

April 13: Revise documentation.

April 20: Finalize Documentation

April 27: Practice presentation. Print and organize other documentation.

May 3: Presentations

Conclusion

Achieved:

- Communication system purchased and ready for development / testing.
- Power system plan.

Moving forward:

- Make final decision on power supply
- Test product and make revisions as needed