VERSION 2.1

NOVEMBER 15, 2013

EE 491 PROJECT PLAN

GROUP MAY14-11 // IMPEDANCE MEASUREMENT DEVICE FOR DETECTION OF MICROCYSTIN-LR

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EE 491 PROJECT PLAN

PROBLEM STATEMENT

A type of bacteria called cyanobacteria, commonly known as blue green algae, can be found in fresh water sources all over the world. The cyanobacteria can reproduce rapidly in a blooming period. During the bloom the bacteria can secrete toxins, which can be harmful to aquatic life, humans, and other mammals. In our project we are concerned with a particular toxin called Microcystin-LR (MCLR) which can damage a mammal's liver.

Cyanobacteria is causing problems here in the Midwest. It has affected water sources for people and livestock as well as swimming areas. Currently the methods for detecting the presence of MCLR are slow and expensive. For instance, if a farmer's cow gets sick and he/she suspects that it is because of a cyanobacteria bloom in a pond that the livestock drink form, he/she can take a sample of the water and send it to a lab to be analyzed.

There are several problems with the existing test method. The first is the slow turnaround of the process: it takes at least a week for someone to send a sample of water to a lab where it is analyzed and results are sent back. In the end the analysis may not help because cyanobacteria blooms can run their course in just a couple days. The device that is used in labs to detect MCLR is large and cumbersome so it is not practical to bring on site. Finally, the current measurement devices are too expensive and require too much technical knowledge for the average individual to justify owning it.

SYSTEM DESCRIPTION

ABSTRACT

The struggle that Midwestern farmers are experiencing to get fast, reliable, inexpensive test results suggests a need for a device that can test their water for the bacteria. Our system aims to provide a quick, accurate, and substantially less expensive method that the average user can easily operate.

The proposed system needs to detect the capacitance change seen by an electrode in the presence of Microcystin-LR. The device should take advantage of a study done regarding the relationship between Microcystin and electrode capacitance.

FUNCTIONAL REQUIREMENTS

The functional requirements for the proposed system are as follows:

Specification	Range
Microcystin-LR concentration Detection	~0.001- 2ug/L
Capacitance	3200-3500 nF/cm^2
Capacitance Change	Decrease of 25- 50 nF/cm^2
Size of PCB	3"x4"
Supply Voltage	Run off 9V battery
Output Resolution	12 bits
Measurement Time	Below 3 minutes
Measurement Sample Size	Below 500mL
Impedance Measurement Technique	Bridge method
Probe Model	Series RC circuit

Microcontroller	TI Tiva C Series Launchpad
Oscillator Frequency	1 kHz
LCD Display	6 cm x 8cm
Electrode Size	4.9087 mm^2 (diameter of 2.5 mm)

NON-FUNCTIONAL REQUIREMENTS

The few non-functional requirements for this system are tabulated below:

Non-Functional Specification	Preference
Color	Green
Hand Grip	Ergonomic
Total Size	Comfortably Handheld

OPERATING ENVIRONMENT

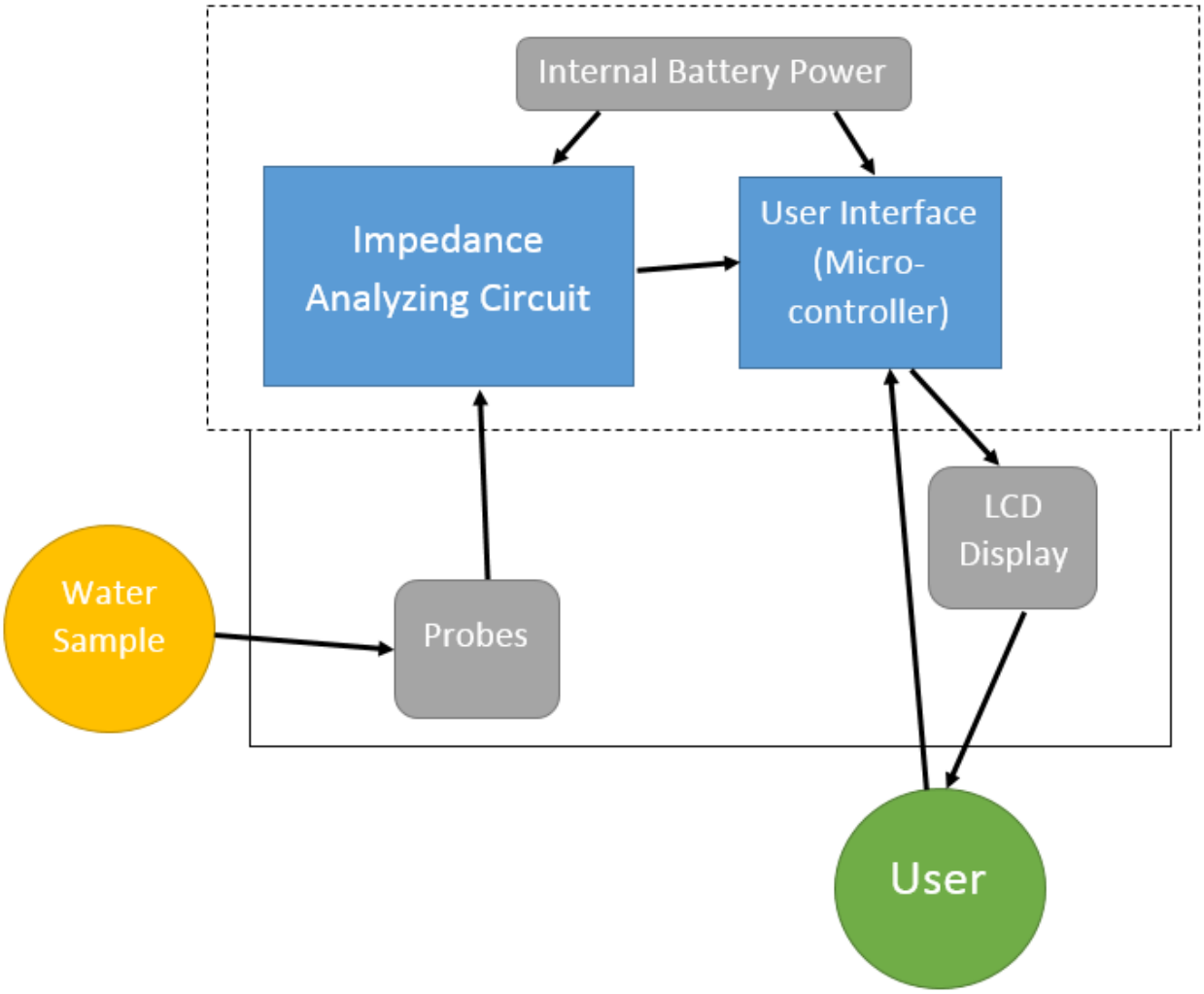
The proposed system should be able to operate in typical outdoor environments. The operating temperature range will be from 0°C to 45°C or more. The device will be operational under a variety of humidity and pressure ranges as well.

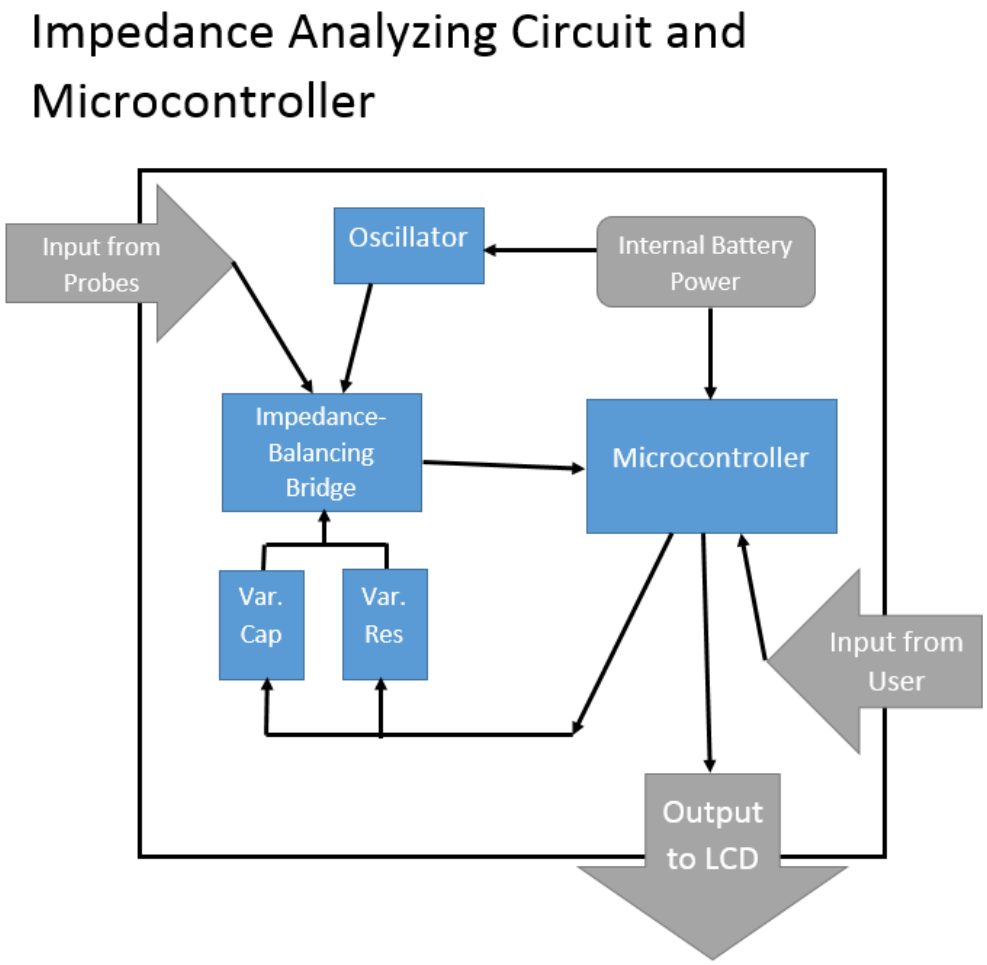
USER INTERFACE

The intent is to keep the user interface as simple as possible so that individuals with non-technical skills can operate the devise with ease. The final goal is to have the user simply turn the device on and submerge it in a predetermined amount of contaminated water. The display will then yield a precise value of capacitance as well as a script that says whether or not the water is contaminated to the extent that it is harmful to swallow, touch, etc.

While the microcontroller serves as the “user interface,” the user doesn’t actually manipulate the chip itself. Instead, the microcontroller serves to process the necessary calculations, and output the results to an LCD.

General System Block Diagram



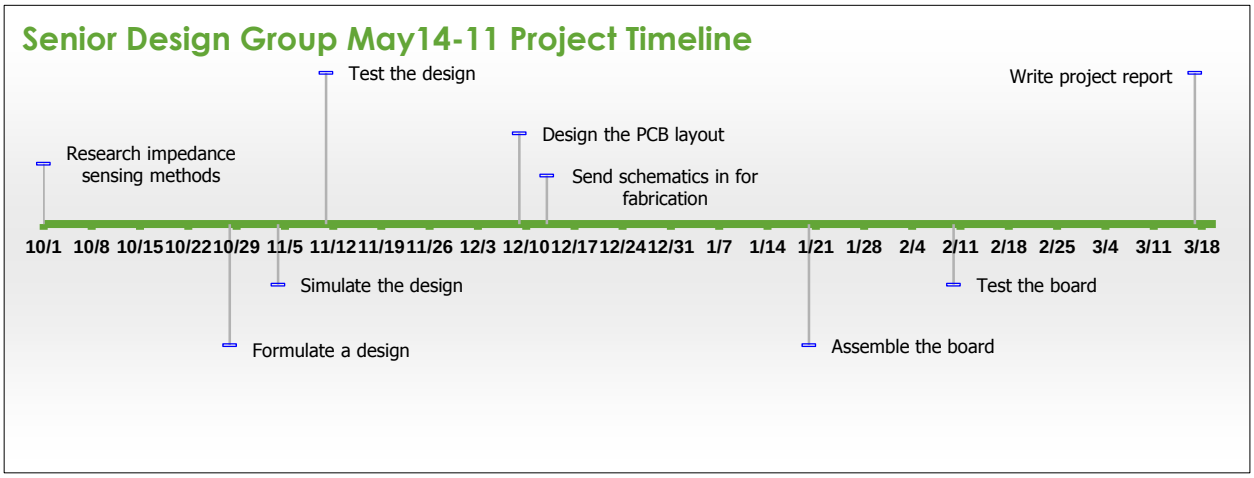


DELIVERABLES

Deliverable	Description	Team leads
Fabricated electrodes	2.5mm diameter gold electrodes with silver nanoparticles, to be painted with microcystin antibody.	Li Xu, Huanhuan Zhang, Danielle Kimler
Oscillating component	Need a low distortion sinusoidal wave for use in bridge circuitry described below.	Tyler Bohlke, Watson Mulder
Capacitance measurement component	Using a bridge technique, find needed specifications for a circuit that can measure capacitance change differentially.	David Callen, Danielle Kimler

Deliverable	Description	Team leads
Printed PCB containing measurement circuitry	Combining the above components, a PCB should be laid out and printed for testing.	All
Test data using known capacitance values	Need to deliver correct results when testing measurement circuit using known capacitance values. An accuracy of 1% is desired.	All
Microcystin test data using vet med bacteria samples	Using samples from the vet med department, test whether or not our device can detect the presence of microcystin bacteria, and whether its concentration values are accurate within 1-5%.	Li Xu, Huanhuan Zhang

PROJECT TIMELINE



TEAM ROLES AND RESPONSIBILITIES

Communications: **David Callen**

Responsible for all group materials being turned in, helps coordinate meeting times with group, provides knowledge of digital, analog, and RF circuit analysis.

Editor: **Danielle Kimler**

In charge of managing any required documentation including but not limited to weekly, project, and design reports. Proof reads any literature produced by the group before submission.

Research Lead: **Watson Mulder**

In charge of researching and ordering circuit components for the project, involved with the verification and design of technical aspects of the system, background in semiconductors.

Team Leader: **Tyler Bohlke**
Communicate with advisors and Dr. Mina on behalf of the group, helps plan tasks for each week, provides a background in circuit and RF analysis.

RISKS AND ISSUES MANAGEMENT

POTENTIAL EXCEPTIONS AND PROBLEMS

- Potential environmental effects from using device in pond water vs. tap water
- Parasitic capacitance from device components may skew readings
- Electrodes are not prepared by the time PCB is printed

TRACKING RISKS AND ISSUES

Date recorded	Risk description	Probability	Impact	Mitigation plan
10/7/13	Possibility of electric shock from placing device in water	Small/Medium	Slight pain, potentially destroy device	Use appropriate materials to mitigate potential for electric shock
10/7/13	If device gives a false negative, toxic water could cause moderate to severe illness in humans or animals	Small	Potential illness	Keep error to an absolute minimum, encourage second test