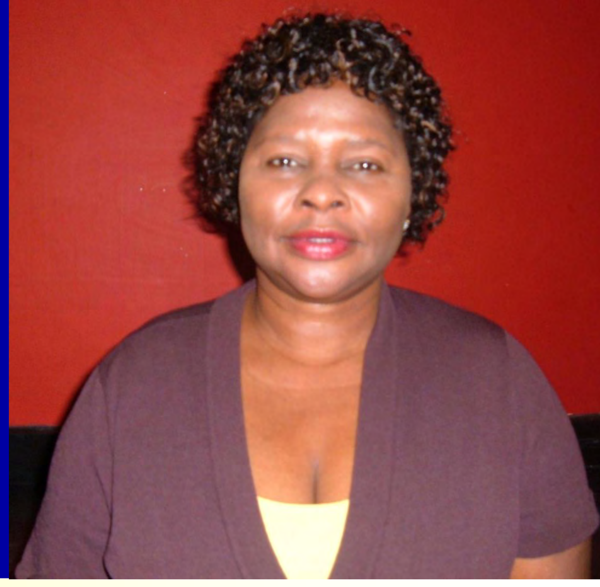
Development of MEMS-Based Integrated Wireless Remote Biosensors



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OBJECTIVES

Over the past decade, research has been active in developing methods for measuring the levels of stress in aquatic animals for the purpose of monitoring water pollution on the basis of Micro-Electro Mechanical Systems (MEMS). This research proposes the design and implementation of a two-phased integrated wireless, low-power embedded biosensor monitoring system for the acquisition and transmission of biological functions from aquatic animals. These signals can be used to measure the stress induced in aquatic animals due to water pollution. The ultimate objective of this study is to develop a MEMS-based integrated wireless biosensor. Phase I objectives of this study include:

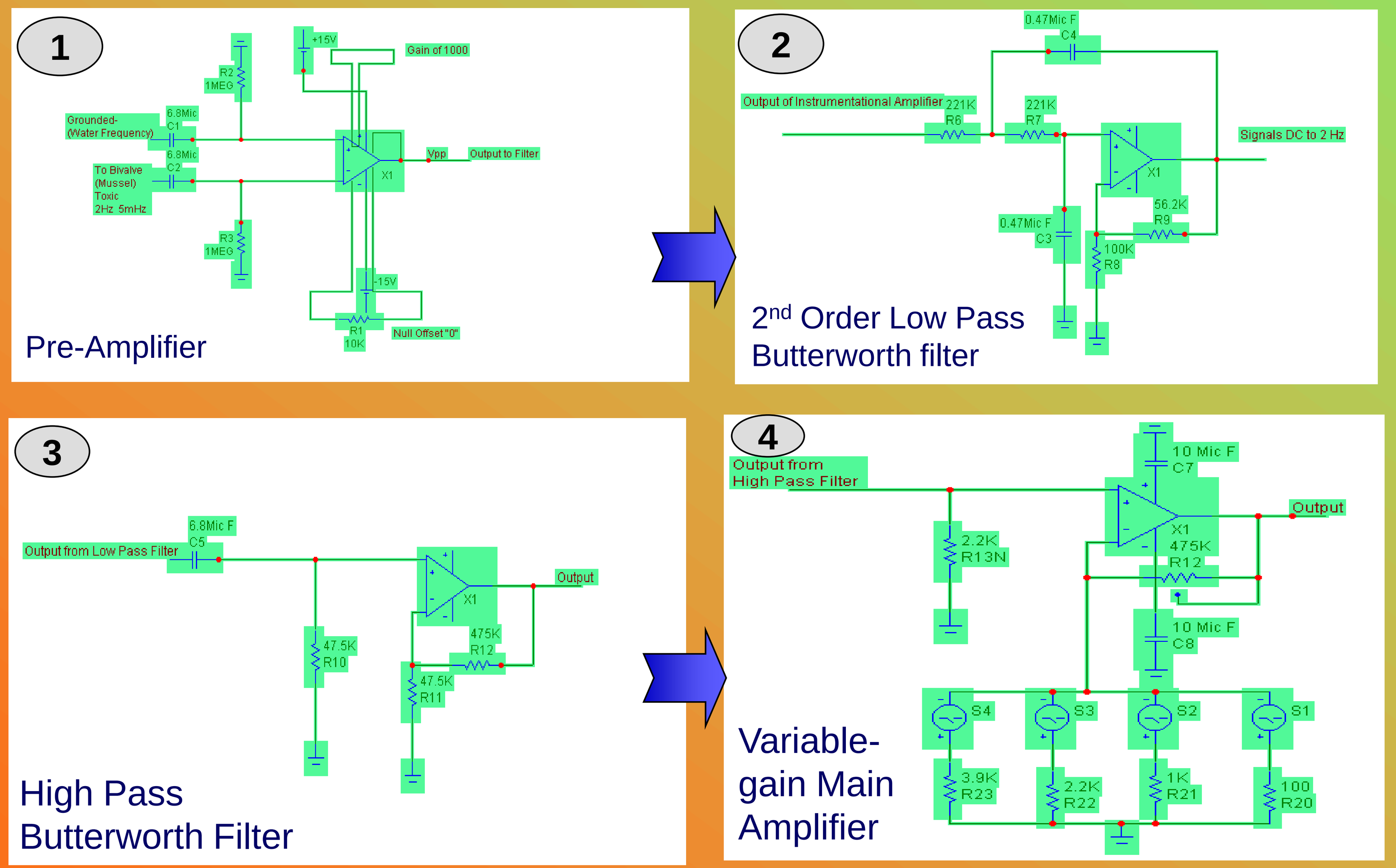
•Design an instrumentation system for Bio-monitoring,
•Identify toxins in estuaries, and
•Initialize research to determine types of toxins.

MATERIALS AND METHODS

Approaches

Clams respond to irritating stimuli by closing their two shell halves together. Otherwise, they are typically feeding and respiring with their shells open. Quantifying such clam response to stimuli is a surrogate measure of water quality. Using clams, the design and implementation of MEMS-based integrated biosensors was completed in 6 stages:

1. Application of the pre-amplifier stage with a closed loop amplification gain of 10;
2. Application of the second-order low-pass Butterworth filter to filter out high frequency and electronic noise;
3. Application of the Butterworth high-pass filter to filter out unwanted low-frequency noise;
4. Application of the variable-gain main amplifier stage with signal amplification gain of 100 to 1000;
5. Application of the voltage detector to limit or attenuate signals to 5V; and
6. Development of a solar labi to remotely provide energy for the biosensor.



Scheme of the four steps to build MEMS-based integrated

Bivalve Sensing Configuration

- Adhering a silver tipped probe to a depression made in the bivalve shell with dental adhesive to restrict the movement of the electrode.
- One probe measures myoneural activity of the bivalve and the second served as a reference electrode.

Probing of Clam

- 48 hr acclimatization in lab tank
- Water at 19+/- 0.5 degrees Celsius
- Water air equilibrated
- Solution of dog food mixture

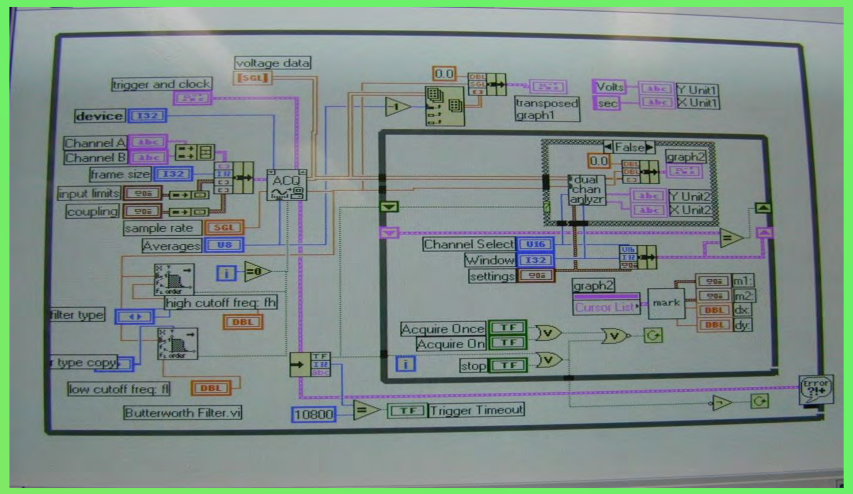
Sampling environment

- Shell Closure
- Adductor Muscle Contraction (Gape Closing)
- Action Potential captured by electrode

Data acquisition and signal conditioning

LabVIEW:

Front Panel



Schematic Diagram

Solar lab

The Solar lab was developed to remotely power the Data Acquisition System when conducting field work at a river bank. This setup makes use of renewable energy sources.

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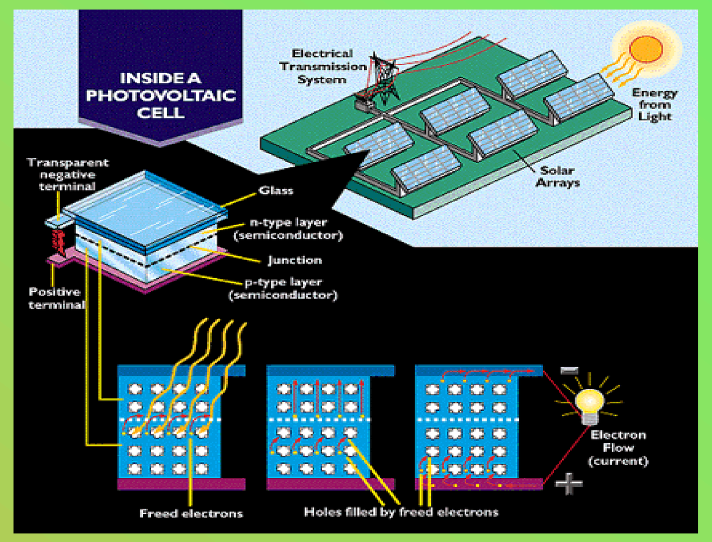
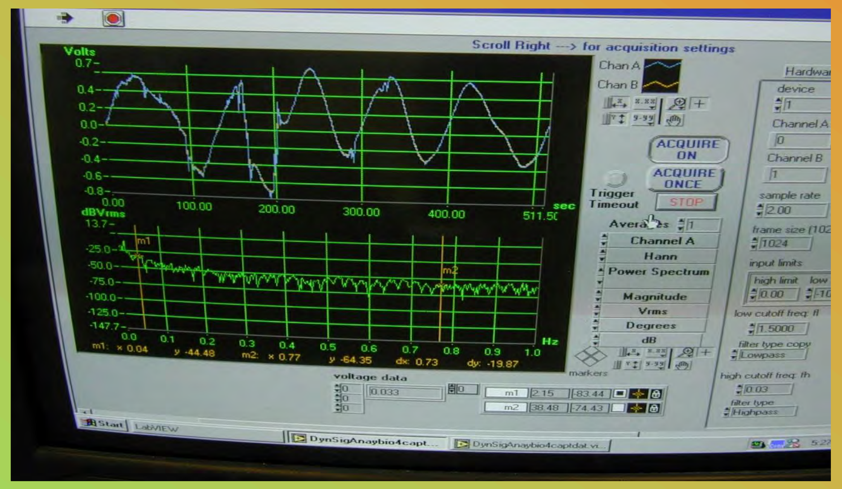
A: Solar Panel
B: Inverter
C: Controller
D: Battery
E: DC Out

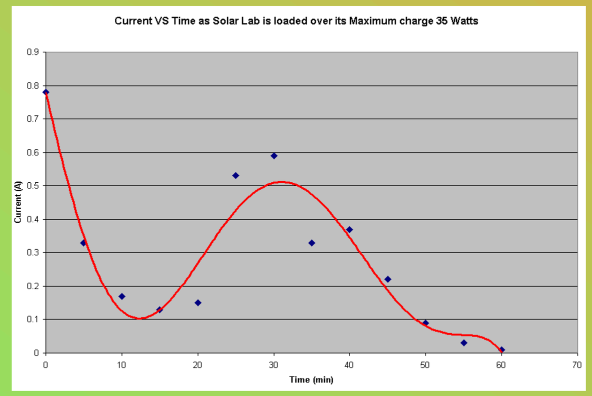


RESULTS AND DISCUSSION

Data acquisition and signal conditioning in LabVIEW:



Solar Lab:



- The results show the potential application of the proposed biosensor on measuring toxicity in aquatic environments.
- Characteristics of bivalves that make them suitable organisms for bio-monitoring application includes very abundant, relatively inexpensive, high sensitivity to environmental impacts, high filtration rates and limited mobility.
- A data acquisition system was evaluated to continuously acquire and display bivalve myoelectric information.

TAKE HOME MESSAGE

- Bio-monitoring applications can be used to determine toxicity in estuaries.
- A data acquisition system was designed and implemented to continuously acquire and display the myoelectric data for multi-species aquatic animals.
- Further research includes applying different toxins and comparing results to determine toxin types, and packaging the instrumentation circuit in a micro chip.

ACKNOWLEDGEMENTS

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