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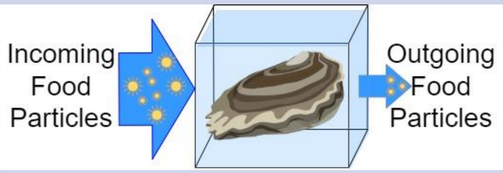
Flow and Robotic Arm Controllers for Bivalve Physiology Analysis

Introduction

Current bi-valve feeding research methods require the use of specialized water probes to take samples in the feeding chamber. The process suffers from 3 major drawbacks;

1) The probe has a high cost (~$30,000 CAD).
2) The sampling process is labor intensive.
3) The yield of the sampling process is low (i.e., a single chamber sample takes approximately 1 minute).



Example testing process.

Automating this system would provide a low-cost solution that would significantly free up user time and allow sampling to be performed over longer periods.

Project Description

Our system shall:

1) Provide a specified water flow to each chamber, and measure flow for accuracy.
2) Move the probe to the sampling position for a specified chamber.
3) Record the water flow and probe data for external processing.

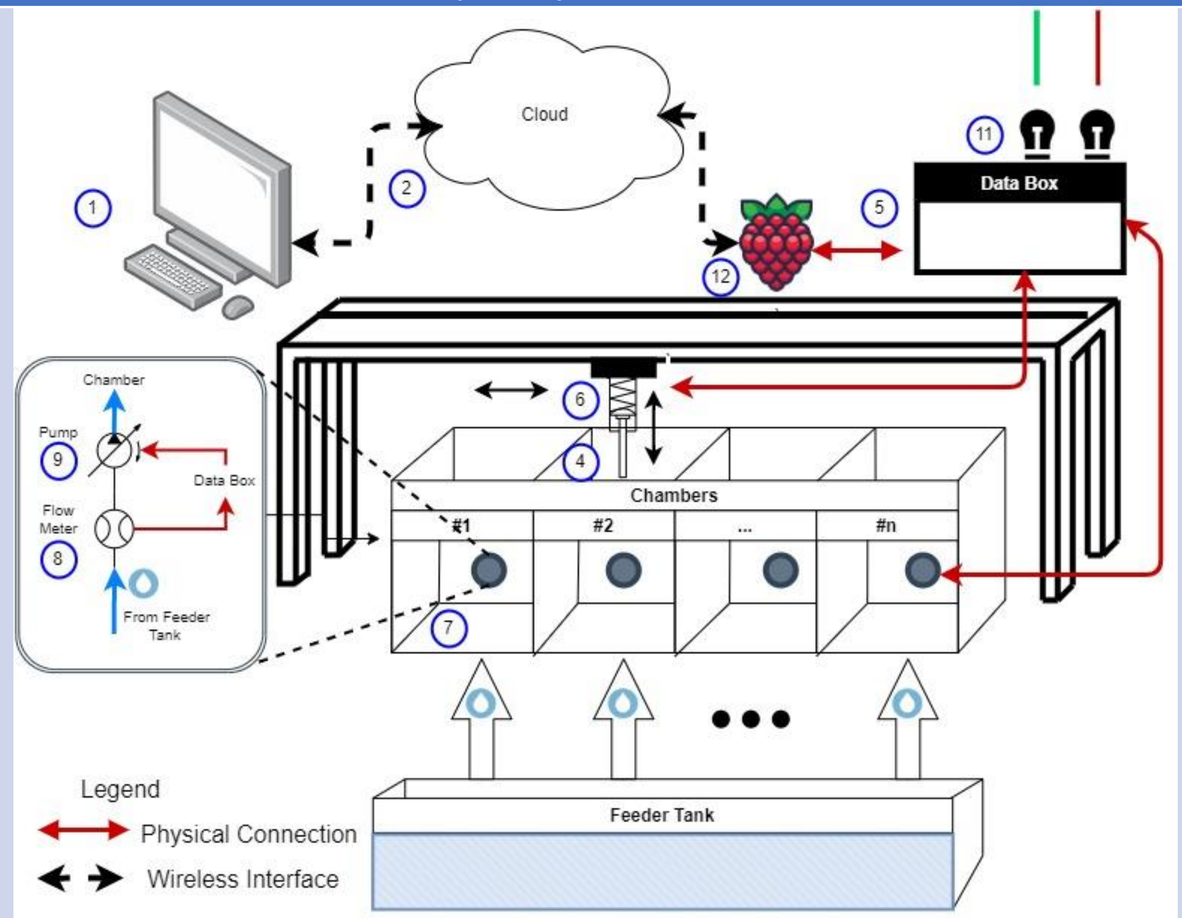
The project is divided in three major subsystems:

1) **Robotic Rail:** A robotic cart will traverse the chambers horizontally to extend and retract the probe vertically into a specified chamber.

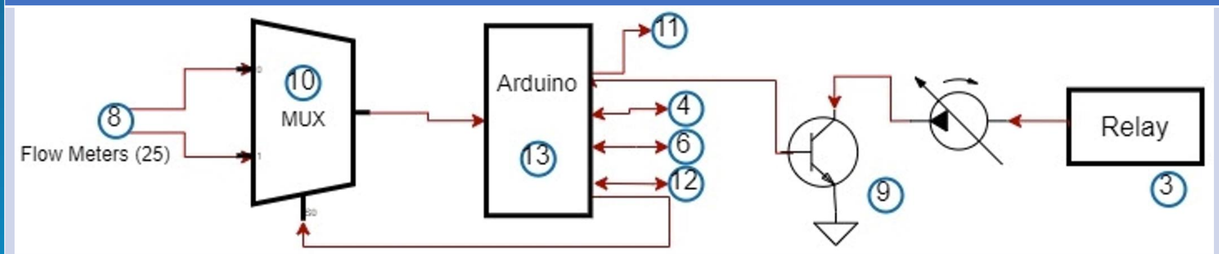
2) **Flow Control** (Pump and Flowmeter): A flow pump and flow meter combination will be assigned to each of the chambers in order to provide a user specified flow rate to the chamber.

3) **Central Microcontroller:** A microcontroller will execute user commands and record data from the various peripheral systems. The user will interface with the microcontroller over Wi-Fi.

Proposed System Architecture



Databox Interfaces



Project Requirements

General System Requirements

The system shall:

- Be waterproof, use surface coating to avoid salt corrosion.
- Support wireless connection via internet.
- Implement an emergency power disconnect to avoid shock hazard.

Robotic Rail

The system shall:

- Submerge and retract the probe without causing disturbance in the test chamber.
- Be able to perform continuous sampling over 12 hours while accumulating a positional error of less than +/- 2 cm.

Flow Control

The system shall:

- Supply power to a variable number of pumps and flowmeters.
- Use a feedback system to reduce error.
- Record the flow rates for each chamber at a maximum time interval of one minute.
- Send notification to the microcontroller if a pumps performance has degraded below a specified threshold.

Central Microcontroller

The system shall:

- Accept user parameters for testing routines (i.e., number of chambers, chamber width, etc.).
- Accept and execute testing routines over Wi-Fi.
- Record peripheral system data over Wi-Fi.
- Illuminate an LED to notify the user of pump degradation and send relevant details over Wi-Fi.

System Components

1. Laptop: User will control the system from a laptop that is remotely connected to the Raspberry Pi.
2. Cloud (Iot): The cloud will allow data and testing information to be stored and accessed remotely.
3. Power Relay: The relay will supply variable power to the pumps using pulse width modulation (PWM) from the Arduino.
4. Probe: The probe is attached to the robotic arm rail. It gathers water from the chamber and sends it to the sample analyzer in the data box.
5. Data Box: The databox houses the microcontroller, and the water sample analysis unit.
6. Robotic Arm Rail: The robotic arm rail will move the probe from chamber to chamber to sample water.
7. Chambers: The chambers are where the mussels will be growing. Each chamber has one corresponding pump and flow meter.
8. Flow Meters: The flow meters monitor water flow rates through each chamber.
9. Pumps: The pumps flow the water through each chamber at a desired rate.
10. Multiplexer (MUX): The multiplexer sends the data from the flowmeters to the Arduino.
11. LED Indicator: The LED indicator will illuminate when one of the pumps is not flowing water as expected. It is used to indicate to a nearby user to check the laptop for a corresponding error message.
12. Raspberry Pi: The Raspberry Pi will receive data from the Arduino and send it to the cloud, where it can be accessed via the laptop
13. Arduino: An Arduino Duo will be used as the microcontroller to sub-systems, input user routine parameters and export data.

Conclusion

Once the proposed system has been accepted by both our supervisor and client, subsystems will be assigned to each team member for development throughout the summer. Our group will present a working prototype to our client to test use before the end of summer. We will gather feedback on the prototype that will be implemented in the final design.

Acknowledgements

ECED group 1 would like to thank our project advisor, Dr. Jason Gu, for his dedication and guidance throughout the project. In addition, we are extremely grateful to our client, Dr. Ramon Filgueira, for his patience, understanding, and flexibility in creating clear and reasonable project expectations.
Finally, we would like to thank and acknowledge Dr. Antonio Agüera from the Institute of Marine Research, Norway, for the inspiration and initial prototyping of the project.