LOW-COST, REMOTE DATA ACQUISITION PLATFORM FOR *IN SITU* BIOLOGICAL AND FLUIDIC MEASUREMENTS

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Motivation

- The low-cost, remote data acquisition platform is designed to increase dynamic in situ data collection in confined and isolated environments (i.e. incubator)
- Currently, lab technicians are unable to access the environment and this results in a loss of critical data points.

Available market options are:

1. Costly
2. Limited Sensor Capabilities
3. Restrictive User Interface

Objectives

- Our product enables a user to record humidity, temperature, PH, turbidity, time-stamped imaging, etc. at specified intervals and observe the data remotely.
- The device will remain in an isolated environment such as an incubator and utilize a modular power supply and network connection.
- Remote monitoring of polymeric scaffold degradation and off-grid refrigeration systems are potential applications.

Overall Approach

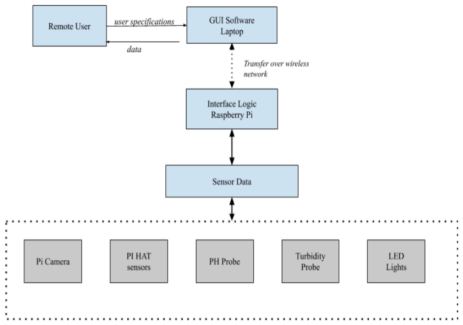


Figure 1: Context Level Block Diagram with Inputs and Outputs of System

Implementation of Approach

- **Single-board computer (SBC):** A **Raspberry Pi (Model 3B +)** computer with Raspbian Stretch operating system is configured as a data acquisition unit with additional benefit of a user-operated interface.
- **Sensor module:** It is a specified array that **houses temperature, humidity, pH, turbidity sensors,** and a **camera**. This module reads in data from the experimental setup when activated from an external user interface.
- **Data transfer protocol:** A password-less, **'rsync' (SSH) transfer** using a wireless connection, is setup before each experiment. The experimental data that include time-stamped sensor readings and images automatically transferred to a remotely located computer in a single batch operation. These data will also be stored locally on the SBC to prevent any loss due to failures of transfer protocols.

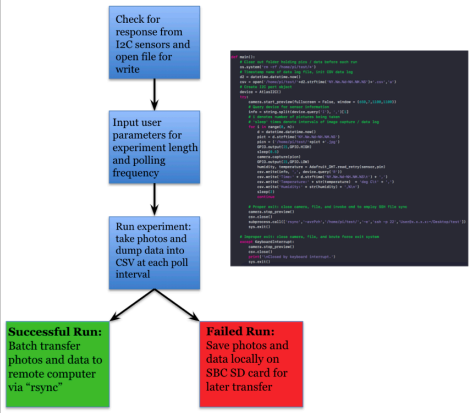
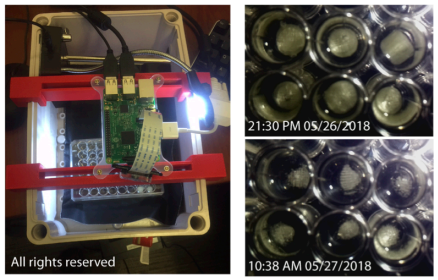


Figure 2: Program Flow Diagram & an excerpt of the Python script

Results from Previous Studies



Scaffold degradation monitor designed by K. V. Bulusu, MAE Department and supportive results from a previous study (See reference below for details)

Reference:
Bulusu, K. V., Lee, S. –J., Holmes, B., Paulson, P., **Zhang, L. -G.**, and **Plesniak, M. W.**, Diffusion and Transport Mechanisms in 3D-printed Scaffolds for Bone Tissue Repair, *Proceedings of the 18th U.S. National Congress for Theoretical and Applied Mechanics, Multiphysics and Multiscale Modeling in Mechanics of Materials*, June 5- 9,Chicago,2018.

Mechanical Design

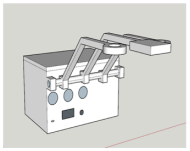


Figure 3: Concept Design of Sensor Mount

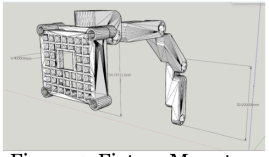


Figure 4: Fixture Mount for Pi Camera Manipulation

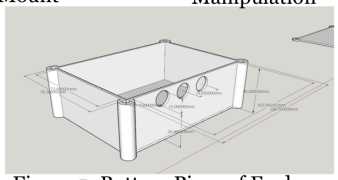


Figure 5: Bottom Piece of Enclosure

Figure 6: Atlas Scientific Conductivity Sensor (Left), Atlas Scientific PH Sensor (Right)

Figure 7: RPi with Atlas Scientific TentacleT3 Hat

Project Impacts

Public Health & Welfare:

- Promotion of ease of access of data acquisition
- Increase the opportunities to have full experiment length data measurement

Global:

- This device will make it possible to run data acquisition experiments in confined areas without wired power, having the potential to drive this system as an alternative for taking large-scale equipment to remote research sites.

Economic:

- Low cost of entry to employ device, will save money, specifically research resources, that can then be routed to more pressing needs.

Future Work

- Design a GUI that can be accessed by a remote user through a desktop or mobile application.
- This GUI will display a live feed of the data and it will display the corresponding information similar to the Cayenne App which is a GUI used to remotely control SBC (such as Raspberry Pi).

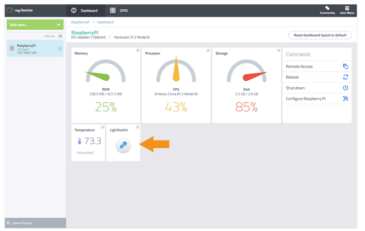


Figure 8: Image of Cayenne Application

Acknowledgments

This project is supported by:

- Electrical and Computer Engineering Department
- Biofluid Dynamics Laboratory (PI: Prof. M. W. Plesniak), Department of Mechanical and Aerospace Engineering.
- Tissue Engineering Laboratory (PI: Prof. L. –G. Zhang), Department of Mechanical and Aerospace Engineering.