ELECOMP CAPSTONE SUMMIT
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THE UNIVERSITY OF RHODE ISLAND

THINK BIG WE DO℠

Cellular Pump Controller

Connecting Industrial Grade Water Pumps to the Internet of Things

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Project Motivation

The mining and agricultural industries use pumps for irrigation and water removal respectively. Easy access is not always possible since the pumps are often located far from the owner's base of operations. Currently, the pump operators must drive out into a remote field or travel deep into a mine to switch the pumps on/off and sometimes just to check if the pump is operating properly. If a pump were to malfunction, fields could flood destroying a farmer's crops. In mining, it is essential that water levels are monitored and controlled as flooded mines can result in loss of life. To better ensure the safety of their employees and to protect their operations, customers want a solution that will allow them to control and monitor their pumps remotely. Currently, there are no options which provide wireless long-range communication to an industrial grade water pump on the market. Taco Comfort Solutions, Inc. hopes to be the first to put a product on the market that will satisfy their customer's requests and hopefully their competitor's customers as well.

Key Accomplishments

- **Creation of Prototype:** We were successful in creating a prototype pump controller which could be powered by the 480, 277, 240, 208, or 120 Volts AC supply which is present with most standard TACO pumps, communicate remotely via a Verizon cellular modem through a web app with any pump with a variable frequency drive through our controller. (See figures 2 and 3)
- **UL Listed:** We sourced exclusively UL listed components. The process to obtain UL Listing is costly and time consuming. By using only previously UL Listed components we have negated the time and cost of UL testing for our prototype in favor of a design that is inherently UL Listed.
- **FCC Compliant:** All of our communications components were prefabricated and meet FCC requirements as designed. By only using components which already meet FCC Guidelines we have created a design that meets FCC requirements without the need to test compliance.
- **Safety:** All major metallic parts are grounded through the attached power cord and plug. There are three individual fuses integrated into the design. One for each voltage level: 120 V AC. 24 Volts AC, and 24 volts DC are each separately protected by a dedicated fuse. This provides safety at each of the voltage levels present within our design.
- **Mobile Application:** The parameters for the mobile application were changed several times, underwent many iterations and were not fully finished. We were successful in creating a prototype which can connect to the controller and has basic functionality. (See figure 4)
- **Communication:** We implemented a cellular connection to allow the controller to access the internet from any location where a Verizon signal can be received.
- **Interface:** We created an interface through our mobile app to allow user interaction with the pump controller anywhere their device is connected to the internet.
- **IP66 Rating:** We used a polycarbonate watertight enclosure as well as a watertight cellular antenna Both of these components give our design an IP66 rating. An IP66 Rating means that our design, in addition to being protected from dust and environmental contaminants, is protected from *"Powerful water jets: Water projected in powerful jets (12.5 mm nozzle) against the enclosure from any direction shall have no harmful effects."*
- **Easy of Access:** Our Consumer First design created with easy access, installation and maintenance in mind. This will hopefully lead to a better image and reputation for Taco in the eyes of its consumers.
- **Sensors:** Our sensor connections are adaptable so the user can modify it to only the sensors desired. Sensor Data is fed from the controller to the user. The sensors were selected to have 4-20mA or 0-10V output, which are very common in industrial applications.
- **App Functionality:** Our app provides a *Remote Power Control* and *Status of the Pump* from the mobile app.
- **AWS Backend:** We used AWS to provide all the backend tools necessary to keep these devices connected.
- **Bill of Materials:** We created a complete bill of materials listing quantity, cost, supplier, and vendor contact information for all of the components which we selected to be used in our project.
- **Block Diagram:** Created a block diagram to as shown in figure 1

Anticipated Best Outcome

We expected to have a working prototype of our design. Minimally, we hoped to have a functional proof of concept for Taco to develop and to produce. Our goal is to exceed the minimum. We were aiming to lay the foundation for a marketable product that the company can continue developing and begin selling. A large portion of this project involved the building of infrastructure which lies outside of the scope of this project. We planned to have a final design for this infrastructure. These were the best possible outcomes.

Project Outcome

The Anticipated Best Outcome was achieved: remote and wireless long-range communication to monitor and control industrial grade water pumps.

Figures

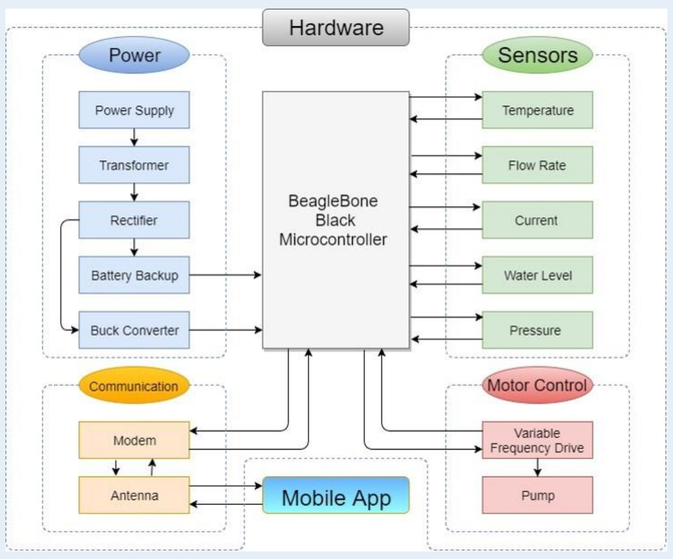

Figure 1 Our block diagram showing how each of the components are interconnected.

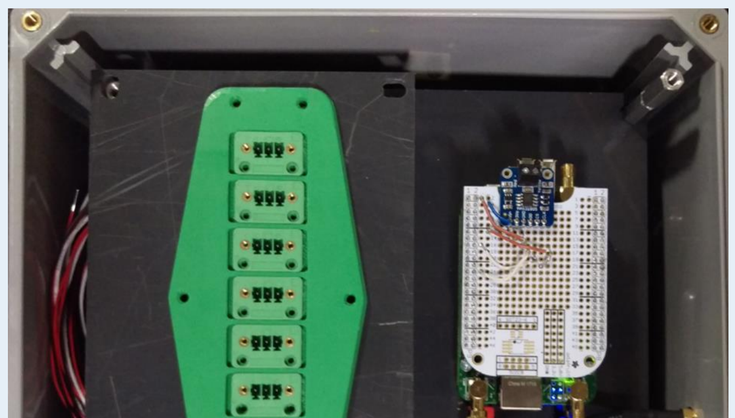

Figure 2 The top level of our enclosure, including the microcontroller and terminal blocks for attaching sensors.

Figure 3 The lower level of our enclosure where the voltage conversion and power circuitry are located.

Figure 4 The mobile app displaying a sensor reading and the button to turn the pump on/off

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