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 Agricultural and Mining industries use pumps for irrigation and water removal respectively. The pumps are located out in the field or down in a mine. It's a time consuming process for the operators to regularly drive to the location of these pumps in order to turn them on/off and see how they're performing. When something goes wrong with the pumps, the operators have no idea or are notified too late of the problem. Causing a delay in service and costing the customer time and money.

The Cellular Pump Controller (CPC) would allow customers to remotely monitor and control the pumps, and in turn, would save them time, money, and energy. Customers would be able to monitor and change the speed of the pump as well as get alerts right when something goes wrong. This means the customer would no longer need to perform routine maintenance checks and would only need to service the pumps when necessary.

Key Accomplishments

- **Amazon Web Services (AWS):** AWS is the backbone of the project. It is used as a storage cloud or non-local storage device for variables and values. The values are either "desired values", the values we want the pump to show, or the "current values", the actual values of the pump and the sensors. Both the pump controller and the app monitor these values and update themselves accordingly. AWS also monitors one of these fields for an error alert. If something goes wrong and the pump notified AWS of the issue it will send a text alert.
- **Security:** Special security features had to be implemented for interacting with AWS. The app has a sign in/ sign up screen when first launching where someone at Taco can choose the users access. The cellular pump controller (CPC) needs to have special files placed onto the device prior to being placed into the field. These files are also a way to gain access to AWS.
- **Embedded Code:** The embedded code is the code being placed on the CPC. This code needed to be able to monitor the sensors, interpret the sensor readings, and if something goes wrong immediately send an alert to AWS. It also needed to not continuously send error if one was previously sent. Lastly it updates AWS about every 30 min even if everything is fine to keep AWS updated. As the cellular connections you pay for amount data sent per month a cost effective time was needed
- **Cellular Connection:** Connect and talk to a cellular modem over a serial communication. Currently it talks over the Verizon network as a way to stay connected even in a remote location.
- **React-Native App:** A working application that has the ability to both see the current values on AWS and change the desired values. As well as having authentication through AWS cognito
- **Sensor Readings:** The sensors included are a differential pressure sensors, a differential pressure sensor, a flow sensor, and a depth sensor. These sensors are wired to the microcontroller through the pluggable terminals on the PCB. The microcontroller then interprets this data and displays it on the application in readable values. **(FIG 2)**
- **Custom PCB:** The PCB allows the sensors to be wired to the microcontroller with pluggable terminal blocks. The PCB also contains the user interface, AC/DC converter, 2 DC/DC converters, an op amp system, as well as a security chip. The AC/DC converter will take in the 24VAC input from the transformer and converts it into the 24VDC that the sensors use. The first DC/DC converter turns the 24VDC to 15VDC that powers the op amp. Then the 15VDC is converted into the 5VDC that will power the microcontroller as well as the cellular modem. **(Fig 3)**
- **Battery Backup System:** A system that is run by a standby chip on the microcontroller. When there is power failure, the battery provides uninterrupted power for the microcontroller. The microcontroller then sends an error message to the user saying that something went wrong and the pump needs to be checked. This battery will last 10-20 minutes, which is more than enough to get the message to the user.
- **User Interface:** The user interface will show the customer on site what is happening with the pump. On the PCB it displays, using LEDs, the status of the sensors, the running status of the VFD, and the cellular strength of the modem. It allows for easy troubleshooting of the CPC when on site.

Anticipated Best Outcome

The Best Anticipated Outcome would be a working prototype of the cellular pump controller which would contain the software and hardware to allow the pump(s) to be controlled and monitored via a mobile application. A printed circuit board (PCB) layout for the prototype should be developed. The pump controller would also transmit data over a cellular network to interact with amazon web services (AWS). A final report on goals achieved and next steps for further development of the product should be produced, along with a proof of concept design for beta testing and a current bill of materials.

Project Outcome

The Anticipated Best Outcome was achieved.

Figures

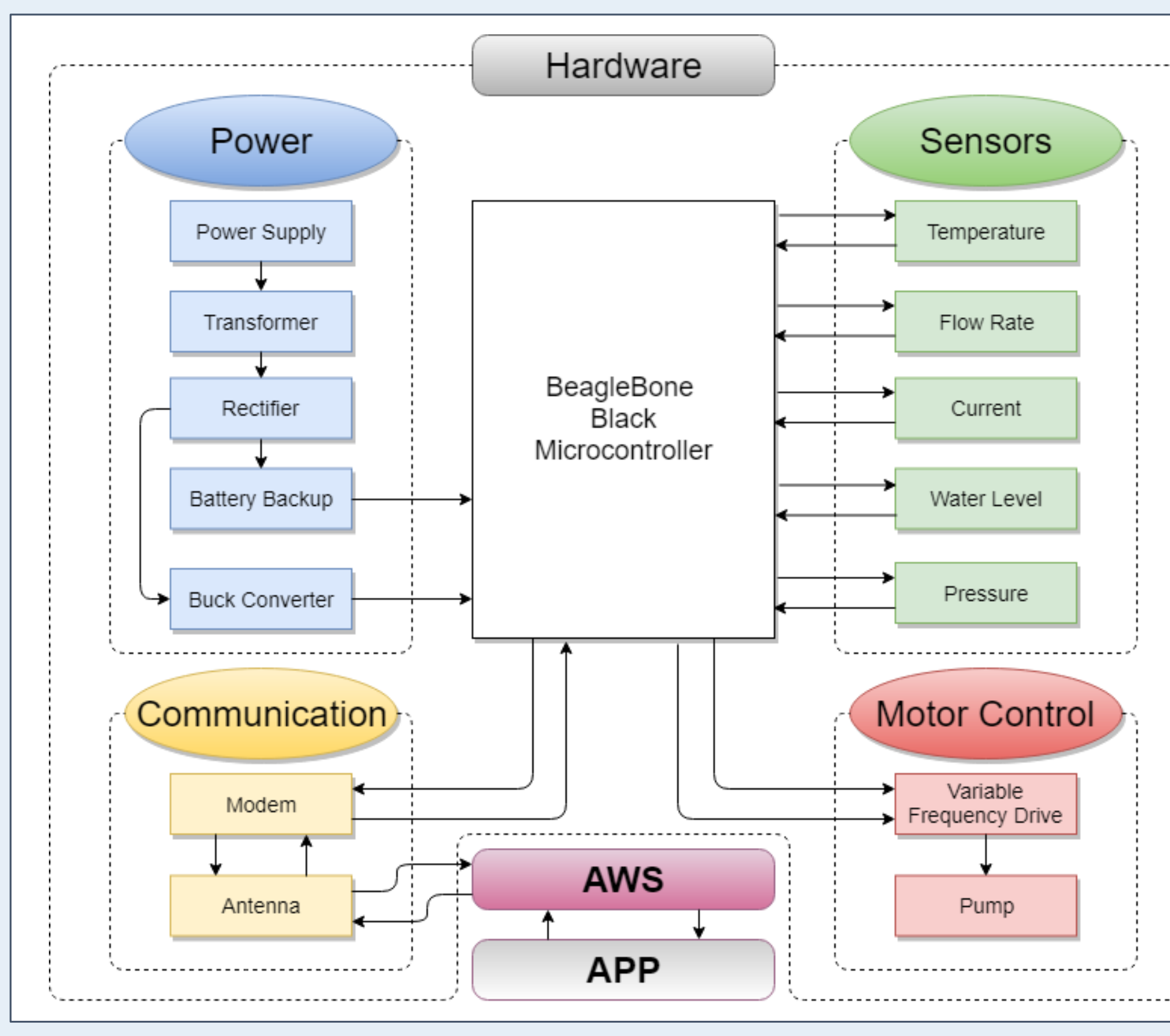
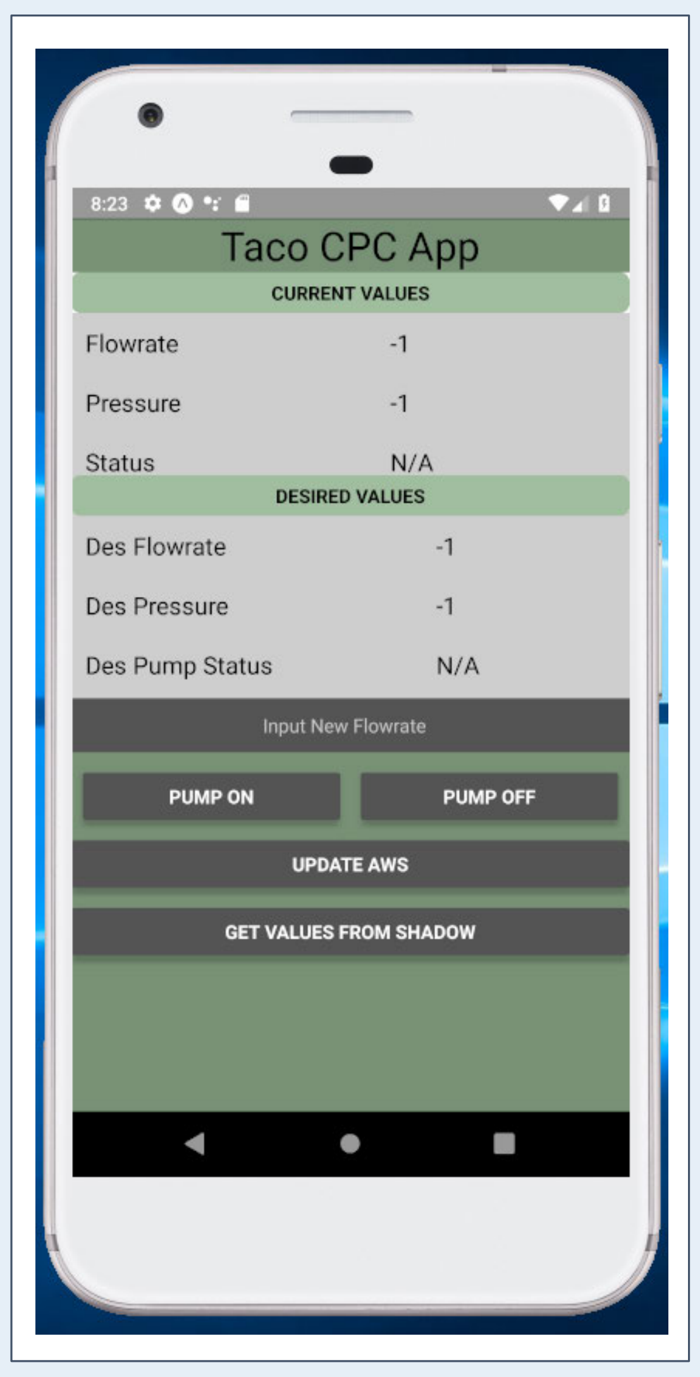


Fig 1: An overview and summary of every key component of the project.


8:23
Taco CPC App
CURRENT VALUES

Flowrate -1
Pressure -1
Status N/A

DESIRED VALUES

Des Flowrate -1
Des Pressure -1
Des Pump Status N/A

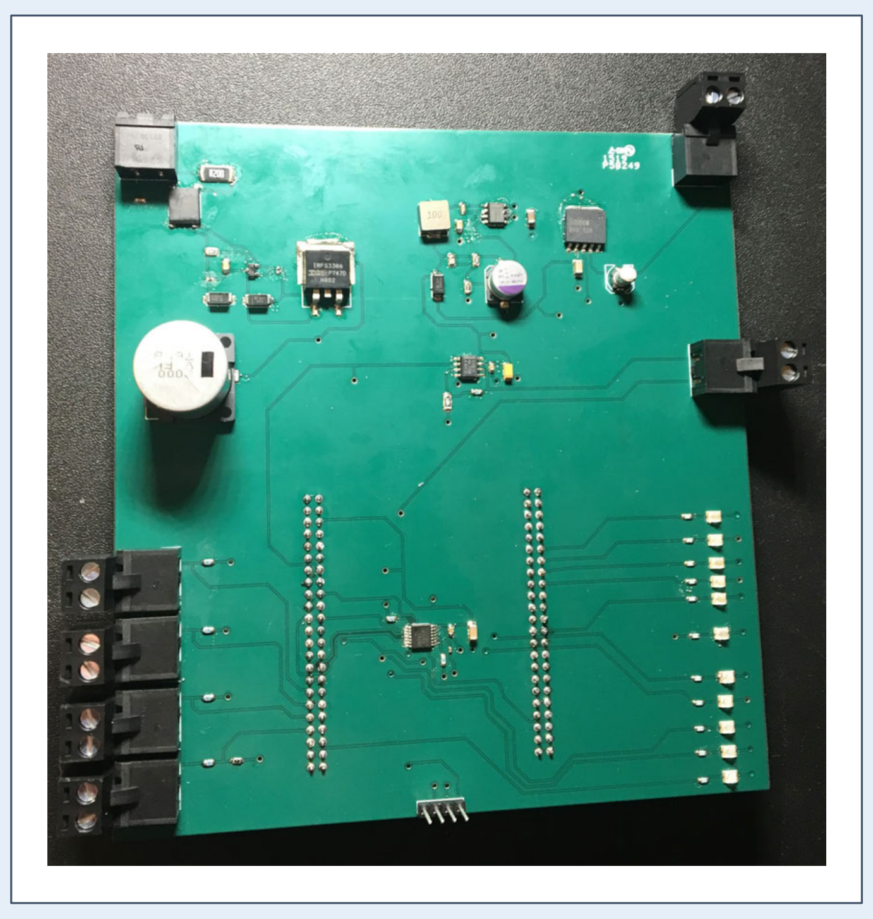


Fig 3 (Above): The PCB used to connect all the parts in the CPC

Fig 4 (Left): The App used to interact with the CPC running on an Android Emulated Google Pixel 2

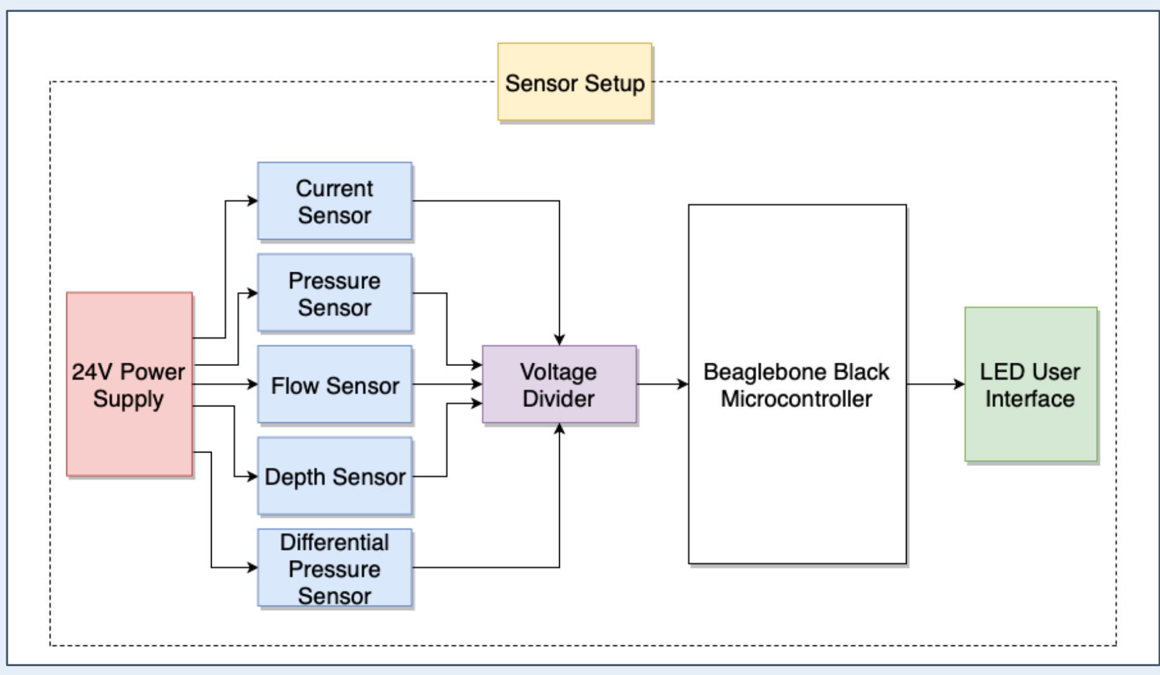


Fig 2 (Left): A block Diagram Showing the Sensor connections.