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Applications and Improvements of the OSDT Android Sensor Pod

Abstract

There has always been a problem of man power when it comes to doing field research and measuring and collecting data. A major device that has helped facilitate that need for many has been the Android Sensor Pod which can provide a real-time, remote, and cheap solution. The Android Sensor Pod project had only been operational for a relatively short amount of time and making improvements and adding other sensor capabilities would help increase usability and popularity. In order to achieve this four new sensors were added over the course of the summer. Three of the four sensors were successfully added and tested; these are the Solar Irradiation sensor, Soil Moisture Sensor, and Water Depth Sensor. The Android Sensor Pod Project is now growing in maturity and popularity and has opened up a whole new world of possibilities in terms of its uses.

Introduction

A huge problem to tackle for researchers in the natural sciences is the difficulty in gathering data from the field; the process can be painstakingly long and cumbersome with some researchers just sitting in the field for hours at a time monitoring the movements of bees. In order to help support and supplement the work of field researchers it would be hugely beneficial for them to be able to obtain and analyze real-time data from a remote location. Instead of having to go into the field and check every sensor and write down readings they would instead log in to a server and analyze the readings from their office for relatively cheap. This is what the Android Sensor Pod already did for researchers in Taiwan and Thailand and can easily branched to other fields that require real-time, remote, and cheap data gathering sensor networks.

Objective

The project aim was to improve capabilities of the Android Sensor Pod by connecting new sensors and new communication protocols. The main objective was to connect and have the sensor pod communicate with the Kipp & Zonnen SMP-3 Solar Pyranometter, the Decagon 10HS Soil Moisture Sensor, the Decagon CTD Sensor, and the FTS FS-3 Fuel Stick Sensor.

Materials/Methods

The Kipp & Zonnen SMP-3 Solar Pyranometer was connected using an analog output of range 0-1 VDC at 4-20 mA. The supply voltage was 5 VDC. It was able to measure 300-2800 nm of solar irradiation levels. In order to parse the analog voltage level as a nanometer value the voltage was multiplied by 2200 and then the result subtracted by 200.

The Decagon 10HS Soil Moisture sensor was also connected using an analog output of 300 mV to 1250 mV powered by 3 VDC at 12 mA. It was able to measure the Volumetric Water Content in the range of 0 to 57%. Given the analog voltage level the percentage was calculated by taking the voltage divided by 1.250 and the result multiplied by 57.

Decagon's CTD Sensor communicated with the Android Sensor Pod using the SDI-12 communication protocol with 3.6 V levels. It was powered by 3 to 15 VDC with a 0.5 mA measurement current. The CTD was able to measure water depth from 0 to 3.5 m, electrical conductivity from 0 to 120 dS/m, and temperatures from -40 to 50 degrees Celsius. Because the CTD Sensor had a digital output communicated through SDI-12 it was a requirement that it the sensor was first connected to an SDI-12 to RS232 translator before it interfaced with the RS232 shifter on the Sensor Pod. The IOIO board on the sensor pod only has a Universal Asynchronous Transmitter/Receiver (UART) which can interface with the RS232's dual receive and transmit ports while the SDI-12 communication protocol only uses one line for both transmission/receiving. Before reading or taking measurements the Android phone also had to send commands to the translator and so commands like "T 0M!" were sent to the translator to send to the sensor to take measurements and "T 0D0!" to transmit the measurement. The message received from the sensor was then parsed and any irrelevant data like metadata from the translator was removed and separated into the water depth, electrical conductivity, and temperature.

The FTS FS-3 Fuel Stick sensor was able to communicate with the Android Sensor Pod in two ways, using an analog output voltage from 0 to 1 VDC and a thermistor that was 10 kOhms at 25 degrees Celsius. It was powered at 9.6-20 VDC and could take measurements using the thermistor from -40 to 60 degrees Celsius and 0 to 100% humidity. The humidity measurement was taken by reading the analog voltage and multiplying the result by 100. The temperature was planned to be implemented using a Linear Technologies IC called the LT1168, but it was not completed before the end of summer. The LT1168 would have been connected to both ports of the thermistor and would give out an analog voltage value to the IOIO board. The Android phone would then read the voltage value, convert it back to a resistance value, and then use the Steinhart-Hart Equation that converted resistance readings of specific thermistors into temperature readings.

Results

At the conclusion of summer the Android Sensor Pod was able to include three new sensors to its repertoire: the Kipp & Zonnen SMP-3 Solar Pyranometer, the Decagon 10HS Soil Moisture Sensor, and the Decagon CTD Sensor are all now tested and functional with the Android Sensor Pod. The SMP-3 Solar Pyranometer's connection was able to ensure that the Sensor Pod could read the levels of solar irradiation it was receiving to power the solar panels it was connected to. The Decagon 10HS Soil Moisture sensor sparked interest with agricultural researchers as it could help monitor underground moisture levels in soil. As a result of getting the Sensor Pod to work with the Decagon CTD Sensor the Sensor Pod was readily able to be configured with any other sensor that uses the digital SDI-12 communication protocol which the CTD used. The Sensor Pod with a CTD sensor also was proved to be usable as a water depth monitor in an agricultural field site owned by the Taiwanese Agricultural Research Institute. Finally, the FTS FS-3 Fuel Moisture Sensor's plans for compatibility had been made and all that was left was to physically create the setup and test it in the field.

Conclusion

Before summer it was important that the capabilities of the Android Sensor Pod were built upon so that it could be used more widely. With the accomplishments made at TFRI, the Android Sensor Pod was able to better facilitate the TFRI team in gathering weather data and has even garnered interested from other government agencies like TARI (Taiwanese Agricultural Research Institute). Sensor Pod's addition of the Solar Pyranometer would become especially important in the case that there was a Sensor Pod deployment in an area that lacks power lines. The CTD along with the Soil Moisture sensor could help agricultural researchers gather live data on farming sites to discern factors in growing crop. The Fuel Stick Moisture sensor would also be able to make a huge impact in the way forest researchers determine the risk of forest fires occurring. Instead of having people physically go to sensors and check for their moisture content forest researchers could easily be benefited by the real-time and remote aspects of the Android Sensor Pod in checking the Fuel Moisture Content. With the inclusion of new sensors and the relative ease with which new SDI-12 sensors can be added in the future, the appeal of the Android Sensor Pod can look to spread in the near future. This could potentially open the door to many researchers everywhere that require live, remote, and cheap options for data surveillance. Companies that sell sensors, sensor networks, and databases charge a large amount more than the cost for the Sensor Pod and the free Open Source Data Turbine software to run the server. In the future the Sensor Pod could also branch out to a myriad of other uses and industries. Underwater data gathering could be made a lot easier with real time and remote sensing or other services like remote temperature/humidity monitoring could be done for cheap. These expansions of the Android Sensor Pod would enable cheap and fast research to be done everywhere.

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