Development of Wireless Energy Monitoring Systems and Smartphone Apps

Carl Cooper and Professor Yoon Kim

As renewable energy systems are becoming more and more popular and accessible to individual users, there arises a need to monitor these systems. There are many different aspects that we would want to measure data on these systems, such as power, energy generated, solar intensity, winds speeds, ambient temperature, and more. However, these systems do not come equipped to measure these things, much less display them for the user. The goal of this project was to develop a wireless system that will be able to monitor these kinds of systems, among others, and for convenience send data to a smartphone app. By developing a wireless system, the user would be able to manage their system while reducing human intervention. For example, the user would not have to bury cable or make frequent trips to retrieve data. This is not only more environmentally friendly, as it disturbs the environment less, but it also reduces risk for the user if the energy system is in a potentially dangerous or inaccessible place.

My research involved learning how to use a microprocessor, WiFi shield, and how to program an Android app. I also had to design a system that would allow the microprocessor to communicate with the Android app and send reliable real time data.

First I had to make sure that I could get data from the energy system into the microprocessor. We used a small circuit where the output voltage could be controlled with a dial for testing purposes. This was then connected to an Arduino microprocessor with a WiFly shield attached to it. Once the data could be read in the terminal window in the format that we wanted, we moved to sending it wirelessly. This required setting up a wireless network with the WiFly shield as an access point so that other devices could connect to it. We decided on this method because it could be used anywhere regardless if there was already a WiFi network there or not. This also meant that it was completely separate from any existing network, thus the network was isolated from any problems that may occur in a network from an internet service provider, such as data caps, network speed, or other errors that may cause the network to go down.

With the Arduino able to receive and send data, I had to write an Android app that would receive the data and display it real time to the user. I started with a simple app that would just print out the data coming from the Arduino as it received it. Once I was successful in doing that, I was able to add more and more capabilities to the app as well as to the Arduino. The Android app will now connect and disconnect from the Arduino and while it is connected, it will display the data in two forms. One is a line graph that shows the data with respect to time. Next to this, lining up with the corresponding values on the line graph is a bar graph that goes up and down as the value from the Arduino goes up and down. It also keeps track of the minimum and maximum value and displays these values. The data is stored and can be viewed at any time in another screen with each value stored with a timestamp that indicates the date and time so that the user knows exactly when the data was from. The Arduino also runs on a wake and sleep cycle to save power. When it is awake it waits for a client to connect until it is time to sleep. If a client does connect, it waits until the client disconnects before waiting its allotted time and going to sleep. The user can also send the Arduino to sleep from the app with a button.

This project has personally benefitted me greatly. Microprocessors, smartphone apps, and wireless technology are used quite widely in the world today. Having the opportunity to work with these three technologies has given me a better understanding of these areas as well as provided me a sense of the capabilities of these technologies. I had to research these technologies and learn what was possible and what protocols or limitations I had to follow to achieve our goals and this improved my research methods as well as my problems solving skills.