Name(s)
Justin N. Quan

Project Number
S1014

Project Title
Intelligent Switch Employing Modular Sensors for Improved Power Control with a Focus on Energy Efficiency

Abstract

Objectives/Goals
Electricity is often wasted when devices plugged into outlets are on when unused. Internet of Things (IOT) smart plugs and switches try to prevent this, but they require frequent monitoring, have limited applications, and actually waste energy themselves. It is especially difficult among groups like the elderly and those with disabilities to actively switch devices on and off. My objective is to combat these issues by creating an unobtrusive and power efficient Modular Sensor Switch (MSS) that gathers data from its surroundings using sensor modules to autonomously switch the power of appliances, giving everyone, including groups like the elderly and people with disabilities, more control over their electronics.

Methods/Materials
The MSS uses the Arduino Pro Mini and an HC-06 Bluetooth module to switch a mechanical relay; I included 2 public online Arduino libraries for 2 of the sensors in my Arduino program. The 6 sensor modules that I used detect light, motion, gas, IR signals, temperature & humidity, and sound. To interface with the MSS via Bluetooth, I created an app in Android Studio, and I made the schematic in Fritzing before soldering my custom circuit. I used Autodesk Fusion 360 to design the enclosure with CAD, Cura 3 to slice it, and an Ultimaker 2 to 3D print it. To measure the MSS power use, I powered the MSS in different setups with a variable PSU at 5V and recorded the current draws. To measure the accuracy of each sensor, I induced trigger events and recorded how often the MSS recognized them.

Results
The MSS with no sensor uses 55mW, or 3.66% of the 1.5W by the Wemo Smart Plug, when the relay is open and 380mW, or 19% of the 2W by the Wemo, when the relay is closed. The average sensor accuracy is 93.4%. Each of the sensors only increased the power consumption by 0-5 mW except for the MQ-2 smoke sensor, which uses about 655 mW.

Conclusions/Discussion
Although I could use Bluetooth 4.0 or a latching relay to save even more power, I demonstrated that the MSS model still saves significantly more energy than IOT devices in a variety of applications. The MSS makes it so that people including the elderly and those with disabilities have more power control without consuming much power itself. From start to finish, I fully designed an automated switch that outperforms industry smart plugs in low energy consumption by more than 25 times in its open state while possessing a plethora of applications.

Summary Statement
I created a power efficient Modular Sensor Switch that autonomously controls AC outlets with sensor modules to afford accessible power control to people while conserving energy in numerous applications by making outdated technology "smart".

Help Received
I designed and created every component of the project -the 3D printed enclosure, the electrical board, the Arduino program, and the Android app- myself. I taught myself online how to program in Android Studio and the Arduino IDE and how to use Cura for slicing, Fritzing for schematics, and Fusion 360 for CAD.