SHAND-Y: A Smart Power Strip Connected to the IoT

Chad Barth, David Jacob, and Thomas Wassel

Faculty Advisor: Dr. Mark Scott

Department of Electrical and Computer Engineering, Miami University, Oxford, Ohio, USA

Introduction

Phantom Power:

- Consumer electronics utilize electricity when off or not in use
  - Average American has 25 consumer electronic devices
- According to the Dept. of Energy, phantom load is responsible for average 10% increase in home electric bill

Common Appliance	Avg. Phantom Load[i]	Annual Cost[ii]
Laptop Computer	8.9 W	$8.97
Desktop Computer	2.84 W	$2.86
Computer Display (CRT)	0.8 W	$0.81
Speakers, computer	1.79 W	$1.80
Modem, cable	3.84 W	$3.87
Printer - inkjet	1.26 W	$1.27
Copier	1.49 W	$1.50
Fax - inkjet	5.31 W	$5.35
Scanner	2.48 W	$2.50
Surge Protector	1.05 W	$1.06
Phone - cordless with answering machine	2.92 W	$2.94

[1]

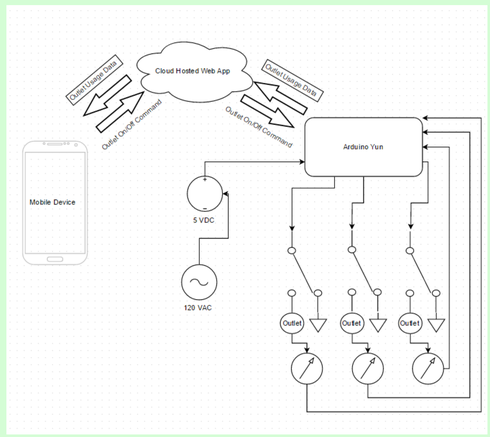
The Internet of Things:

- Connects hardware devices to the internet.
- Uses data to monitor devices in real time and improve efficiency

Our Proposed Solution

High-Level Solution

- Utilize the internet of things to connect outlets to the user.
- Report consumption data and be able to remotely switch outlets ON and OFF.
  - Reduce phantom power to devices that are in standby mode by making smart decisions.



First Semester Goals

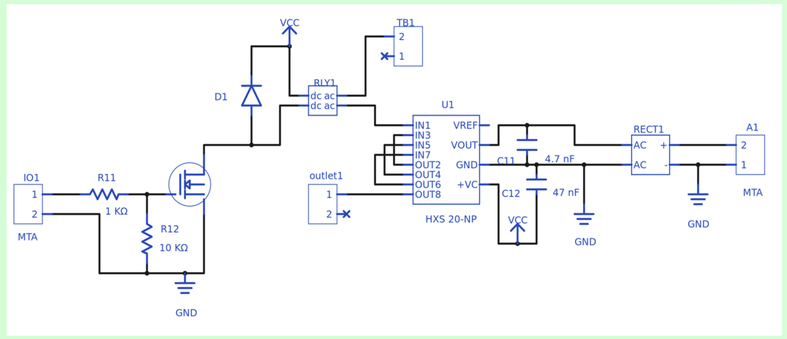
- Design control circuit and identify components
- Establish a websocket connection between power strip and server
- Toggle an outlet ON and OFF from a web application

Second Semester Goals

- Integrate LEM Sensor and report data to webpage
- Create graph's of each outlet's history and deliver to user on the web
- Create more ergonomic design, including printed circuit board

Hardware

- The control circuit runs on 5 V DC from an AC to DC power supply
- Switching the outlet ON/OFF is driven by a control signal and a MOSFET which allows the 5 V to activate a relay
- A LEM sensor is used to measure the current being drawn from the outlet The LEM uses the Hall effect to produce a voltage proportional to the current running through the outlet
- PCB was designed using Upverter
  - The AC circuit has wider traces than the DC circuit in order to withstand higher current



Software

Server

- Linux server running a JavaScript file via node.js
- Node modules used and purpose
  - Express – Set up web application and server
  - Socket.io – Create web socket
  - File System(fs) – Log power consumption history

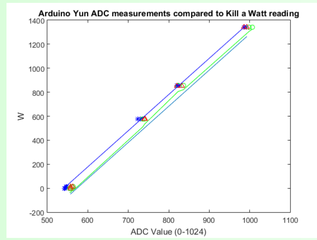
Web Application

- Standard HTML webpage with jQuery and CSS
  - Live data displayed for each outlet
  - Command buttons that can turn each outlet ON and OFF
- Power Consumption Graph
  - Implemented using the JavaScript library D3.js

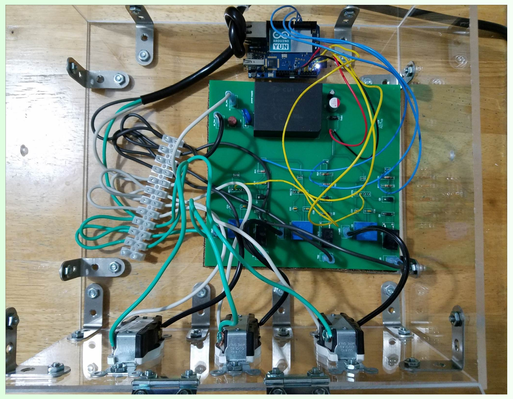
Testing and Comparisons

LEM Sensor Output and Yun ADC

- The Arduino Yun has a 8 bit analog to digital converter (ADC)
- The LEM sensor outputs a voltage proportional to the current draw, which we read into the Arduino's ADC
- Using a Kill-A-Watt™ to measure power consumption, the values from the ADC were translated into power



- ADC resolution was found to be approximately 3 W per ADC value
- No current draw produced an ADC reading around 550
  - Caused by the 2.5 V offset of the LEM sensor



Conclusion

SHANDY as a proof of concept

- The device reports back usage data and can be remotely controlled via accessing a web page
- The power used is calculated by the micro-controller and delivered to the socket
- The team achieved all goals for this semester with regards to the design and creation of this device

Future Work

- Improve sensor quality; more sensitive LEM, measure voltage for more accurate power calculation
- Allow users to set a schedule to turn each outlet ON/OFF automatically
- Design more compact PCB to fit in a standard size power strip
- Replace the controller with a more power efficient embedded system

[1]"Phantom load: How unplugging can save you $100 or more | NativeEnergy Blog",Nativeenergy.com, 2016. [Online]. Available: http://www.nativeenergy.com/phantom-load-how-unplugging-can-save-you-$100-or-more.html. [Accessed: 04- May- 2016].