UNIVERSITY OF CENTRAL FLORIDA

# Wattzilla

EEL 4914 – Senior Design


Group 3

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**Project Narrative Description**

Our project is a home power monitoring and control system that will keep a user more aware of their power usage. Every month countless people are surprised by their power bill, partly due to the fact that they just aren't aware of how much power they are using on a daily basis. Occasionally, in situations such as vacations or day trips, or even just daily life, someone may accidentally leave something on in their house that contributes to higher electricity bill, or maybe they just want to remotely turn on or off their lamps. Our project is designed to help with all of these issues.

This project has two application goals in mind: keep the user aware of their home power usage and allow them convenient remote control of some of their appliances. We plan to design a system that monitors total home power usage to display back to the use, as well as monitoring the individual power usage of whatever is plugged in to our custom-designed power outlets. The usage statistics will be provided to the user in a number of different methods, including a website, a phone app and possibly even SMS text message.

In order to monitor the power for the entire house, we have decided to get a video feed of the house's power meter and use optical character recognition (OCR) software to "read" the meter, using that data for total power use statistics. Other more direct and intrusive methods may provide less complicated monitoring, but messing with our homes' power lines would be a dangerous and foolish plan, which is why we decided on OCR. We will design the OCR software ourselves, loading it onto a microprocessor in our system's central hub. The software will include error-checking capabilities and would be able to handle rollover, should a meter get to that point. The software will not be specific to one style of meter, and will be designed to handle different styles of digits, whether a meter's display is digital/7-segment or analog.

For individual electronic device monitoring, we plan to develop a type of power-strip-style outlet that plugs into an existing outlet. This outlet will allow us to both monitor the power usage of the device plugged into the outlet as well as control power to the outlet, allowing the outlet to be turned off. This would be useful for finding out how much of your power bill comes from any particular item, such as a refrigerator or a washing machine (of course this wouldn't work for things that are hard-wired into the house's electrical lines, like air conditioning or built-in lighting). It also allows for remotely turning on or off a device such as a lamp or a fan

In order for a user to view their power usage, we plan to develop a website and possibly a phone app for our system. The user would provide the site with their specific power costs, including any variables such as a higher price after a certain amount of power and the day of each month that readings are taken by the power company for the bill, in order to provide a real time estimate for the user's current power bill for the month and possibly a projected estimate of the final bill. The user could of course also view the actual amount of power used, and possibly a record of past months' power usage/bill amounts. The website/app would also provide controls for any of the custom outlets that

are part of the system, allowing them to turn on or off power to the individual outlets. The user could label particular outlets for ease of knowing what device they're controlling, and of course would be able to see the individual power usage for each outlet. A timer feature may even be implemented to turn on/off certain outlets at pre-defined times. We may include a feature to allow the user to receive a daily SMS text message to their phone with their current power bill. The interface for the website/app will be user-friendly and easy to understand. While the real-time power information should be fairly accurate, any power bill information will be pure estimation based on user input.

At the center of the system is the central hub. The hub will be where the meter video feed runs to and the OCR software will be installed; it will be where individual outlet monitoring data is fed to and controls are sent out from; it will be what uploads all of this data to and receives remote control commands from our website/app. Communication with power outlets will use wireless technology, while the video feed will be wired if possible. The hub should connect to a home router with an Ethernet cable in order to allow connection to the website for data upload and remote control input. The central hub will not be interacted with by the user regularly and will not have its own data display methods.

Our custom outlets will be powered by a battery. While it may seem to make more sense to just use the house power, that power is very strong and would require manipulation so that it does not destroy our outlets' electrical components. The power from a battery is much more suitable to what we envision for our outlets. The central hub may also be powered by a battery, but may plug into a regular wall outlet if we determine that to be the best course.

**Specifications and Requirements**

1. Camera (Most likely USB)
    1.1. Black and White Preferred (For Simplicity)
    1.2. Good Enough Resolution to Read Seven Segment LED's
    1.3. If Not USB, Alternate Power Source Needed

2. Central Hub
    2.1. Hardware
        2.1.1. Microprocessor
            2.1.1.1. Image Decoding and Processing Capabilities
            2.1.1.2. Internet Capabilities
            2.1.1.3. Bidirectional Communication Capabilities
        2.1.2. Video Signal Port (Most likely USB)
        2.1.3. Ethernet Port
        2.1.4. Power Source
            2.1.4.1. Nine Volt Battery
            2.1.4.2. Voltage Regulator
        2.1.5. Communications Options
            2.1.5.1. Power Line Superposition
            2.1.5.2. Bluetooth
            2.1.5.3. Other Wireless, but not Wi-Fi
        2.1.6. Communications Requirements
            2.1.6.1. Bidirectional
            2.1.6.2. Multiple Hosts
    2.2. Software
        2.2.1. Image Decoding and Processing
            2.2.1.1. Convert Incoming Image Signal into Usable Format (2-D Array)
            2.2.1.2. Implement Optical Character Recognition Algorithms
            2.2.1.3. Reconstruct Characters into Usable Data Format (int/long)
        2.2.2. Check for Meter Overflow
        2.2.3. Check if Result is Reasonable
        2.2.4. Calculation of Total Power Used for Current Month
        2.2.5. Calculation of Current Bill
        2.2.6. Extrapolation of Energy Usage Trends
        2.2.7. Calculation of Expected Bill, Based on Extrapolation
        2.2.8. Web Page Updating
        2.2.9. SMS Message Sending

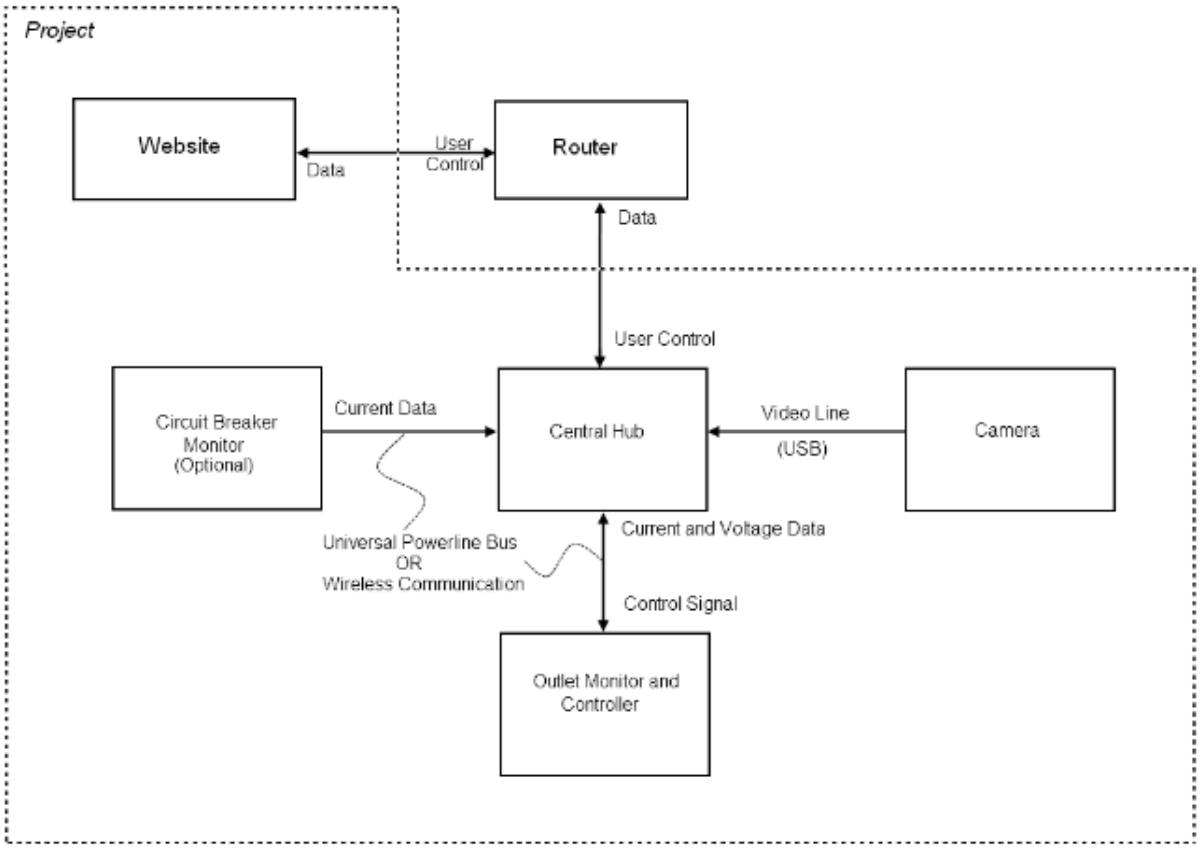
3. Outlet Monitor and Controller
    3.1. Hardware
        3.1.1. Microcontroller
            3.1.1.1. Bidirectional Communication Capabilities
            3.1.1.2. Minimum of Two Analog to Digital Converters
                3.1.1.2.1. Accurately Detect Peaks, and/or RMS Values
        3.1.2. Voltage Monitoring Circuit

3.1.2.1. Voltage Divider
3.1.2.2. Analog Output Sent to A2D Converter on Microcontroller
3.1.3. Current Monitoring Circuit
3.1.3.1. Inductive, Hall Effect, or Sense Resistor Circuit
3.1.3.2. Gain Stages as Necessary
3.1.3.3. DC Offsets to be Corrected in Software, if Significant (Or, a digital potentiometer if we need more work)
3.1.3.4. Analog Output Sent to A2D Converter on Microcontroller
3.1.4. Control Switch
3.1.4.1. Relay Circuit
3.1.4.2. Controlled by Pin on Board
3.1.4.2.1. Toggle Logic Desired (so a power failure won't change the state)
3.1.5. Power Source (Same as 2.1.4)
3.1.5.1. Nine Volt Battery
3.1.5.2. Voltage Regulator
3.1.6. Communications Options (Same as 2.1.5)
3.1.6.1. Power Line Superposition
3.1.6.2. Bluetooth
3.1.6.3. Other Wireless, but not Wi-Fi
3.2. Software
3.2.1. Set Up Analog to Digital Converters
3.2.2. Sample Current and Voltage Levels
3.2.3. Calculate RMS Values (Optional)
3.2.4. Send Data to Central Hub
3.2.5. Receive Status Updates from Central Hub

4. Circuit Breaker Power Monitor (Optional)
4.1. Hardware
4.1.1. Microcontroller
4.1.1.1. Transmitting Communication Capabilities Only
4.1.1.2. One Analog to Digital Converter
4.1.1.2.1. Accurately Detect Peaks, and/or RMS Values
4.1.2. Current Monitoring Circuit
4.1.2.1. Inductive, or Hall Effect (Current Clamp/Probe)
4.1.2.2. Gain Stages as Necessary
4.1.2.3. DC Offsets to be Corrected in Software, if Significant (Or, a digital potentiometer if we need more work)
4.1.2.4. Analog Output Sent to A2D Converter on Microcontroller
4.1.3. Power Source (Same as 2.1.4 and 3.1.5)
4.1.3.1. Nine Volt Battery
4.1.3.2. Voltage Regulator
4.1.4. Communications Options (Same as 2.1.5 and 3.1.6)
4.1.4.1. Power Line Superposition
4.1.4.2. Bluetooth
4.1.4.3. Other Wireless, but not Wi-Fi

**Block Diagram**

| Block Diagram Legend | |
|---|---|
| **Block** | **Description** |
| Website | *Interface for user to access data retrieved by the system and control elements in the system.* |
| Router | *Access point to the internet*. |
| Central Hub | *Main processor of all incoming and outgoing information. The "brain" of the system.* |
| Camera | *Reads the power usage as displayed on the meter, and sends it to the Central Hub.* |
| Outlet Monitor and Controller | *Monitors voltage and current used by outlet, and sends the data to the Central Hub. Also controls on/off state of the outlet.* |
| Circuit Breaker Monitor | *Monitors the current going to all the main sections in the house. Sends the data to the Central Hub.* |



## Block Status & Responsibilities

Camera (To be acquired)
Software development for processing data from camera image - Kyle

Central Hub (Research)
Hardware - Matthew
Software - Dejan

Website (Research) – Kyle/Dejan

Outlet Monitor and Controller (Research)
Hardware – Travis/Matthew
Software – Dejan

Circuit Breaker Power Monitor (Research)
Hardware – Travis/Matthew
Software – Dejan

Router (Acquired)

## Project Budget & Financing

This project will be funded by each individual group member
Available funds: $400

Estimated Project Cost: $170

| Part | Quantity | Cost | Total |
|---|---|---|---|
| Digital Camera | 1 | $30 | $30 |
| Usb extension cable | 1 | $10 | $10 |
| Microprocessor | 1 | $15 | $15 |
| Pcb | 3 | $30 | $90 |
| Wireless Microcontroller | 3 | $15 | $45 |
| Misc. Electronics Parts | ? | Misc. | ~$100 |
| | | | $270 |

## Milestones

| Week- Ending Date | Tasks |
|---|---|
| **6/10/2012** | Research; Begin paper |
| **6/17/2012** | Research; 5 Pgs. written |
| **6/24/2012** | Research; 10 Pgs. Written |
| **7/1/2012** | 15 Pgs. Written; |
| **7/8/2012** | 20 Pgs. Written; Part ordering |
| **7/15/2012** | 25 Pgs. Written; Part acquisition |
| **7/22/2012** | 30 Pgs. Written; Begin devel. Board use |
| **7/29/2012** | Development board use |
| **8/5/2012** | **Paper Due (8/2/12); Begin PCB design; Software Design** |
| **8/12/2012** | PCB design; Software design |
| **8/19/2012** | Order PCB's; Software design |
| **8/26/2012** | Receive PCB's; Begin Assembly |
| **9/2/2012** | Assembly |
| **9/9/2012** | Assembly/Troubleshooting |
| **9/16/2012** | Assembly/Troubleshooting |
| **9/23/2012** | Assembly/Troubleshooting |
| **9/30/2012** | Troubleshooting; Communication between Soft/Hard-ware |
| **10/7/2012** | Finish Up Design |
| **10/14/2012** | Finish Up Design |
| **10/21/2012** | Finish Up Design |
| **10/28/2012** | Finish Project |
| **11/4/2012** | Prepare Presentation |
| **11/11/2012** | Prepare Presentation |
| **11/18/2012** | Finish Presentation |
| **11/25/2012** | Practice! |
| **11/30/2012** | Show project/Presentation |

*Weeks begin on Mon.