Smart Home

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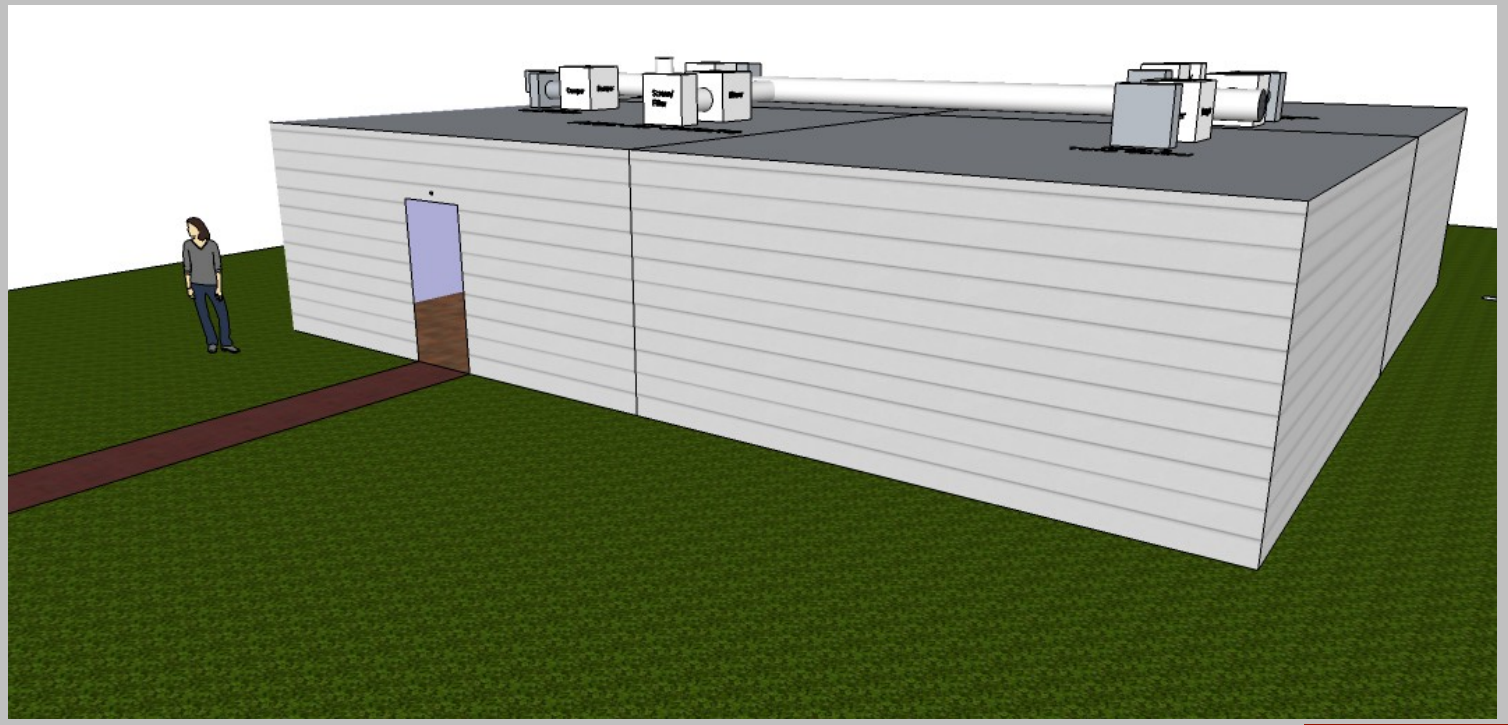


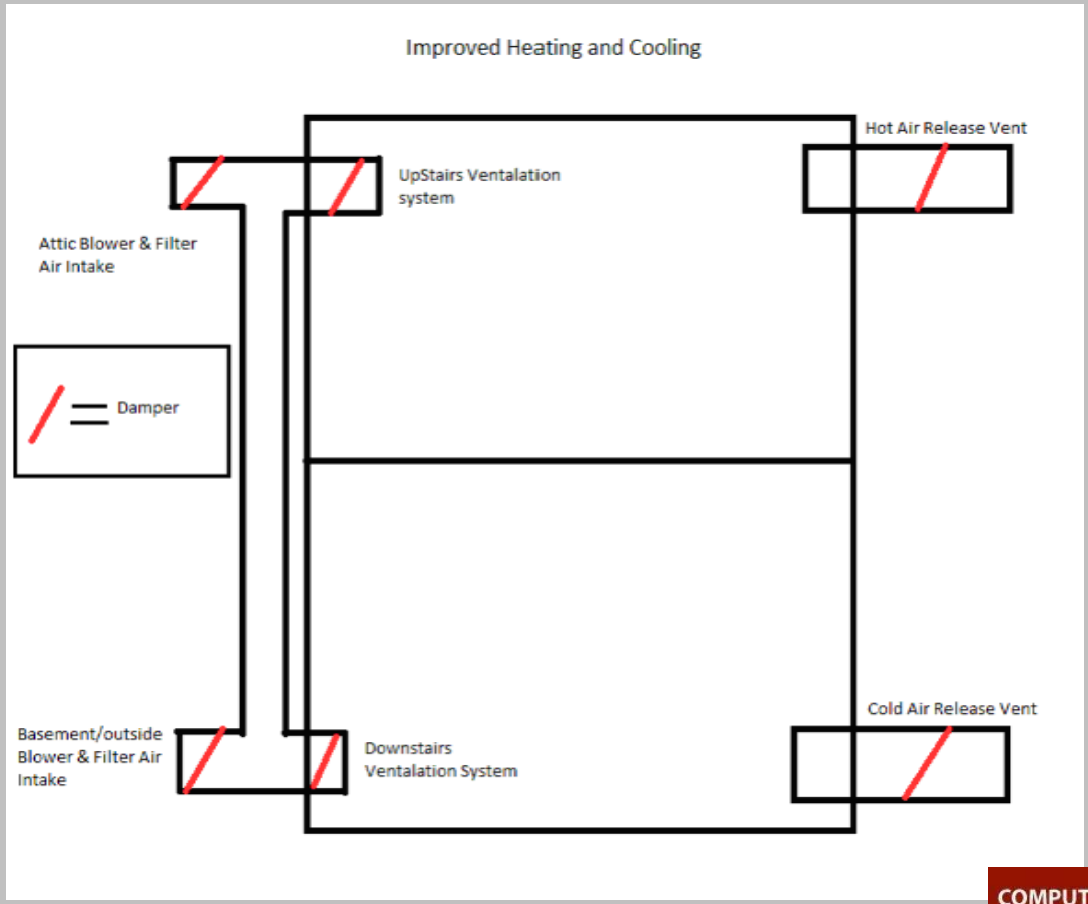
Overview

Temperature Control
Outlet Control
Occupancy Detection
Wi-Fi and networking
Server

Temperature Control

Review

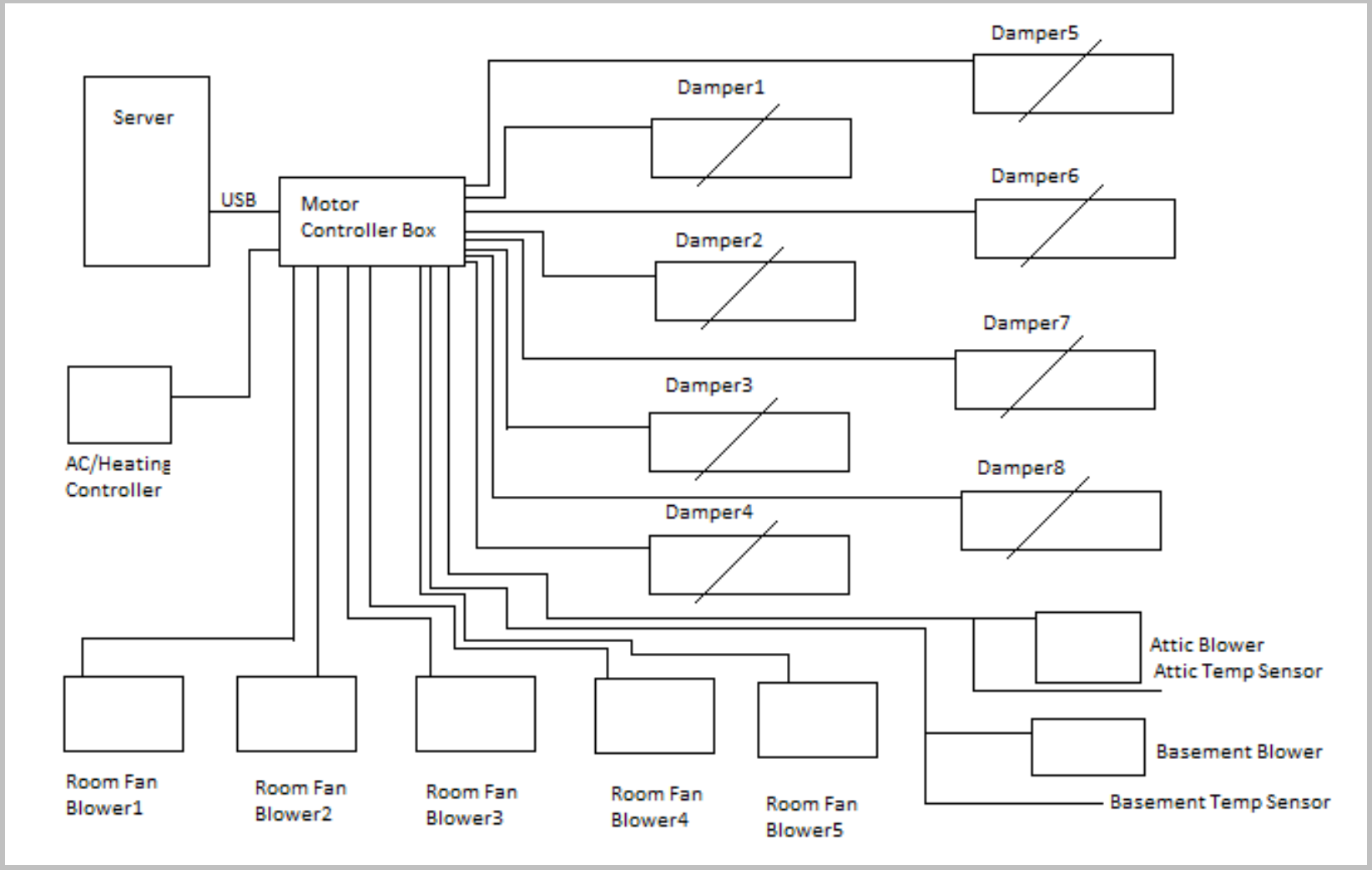
- Control individual Room Temperature.
- Take advantage of outside weather conditions.
- control a set of dampers so that the system will optimize house temperature comfort levels.



Temperature Control

Interfaces

The Server will communicate over USB line to the Motor controller box. The motor controller box will in turn communicate with all the other devices in the house.

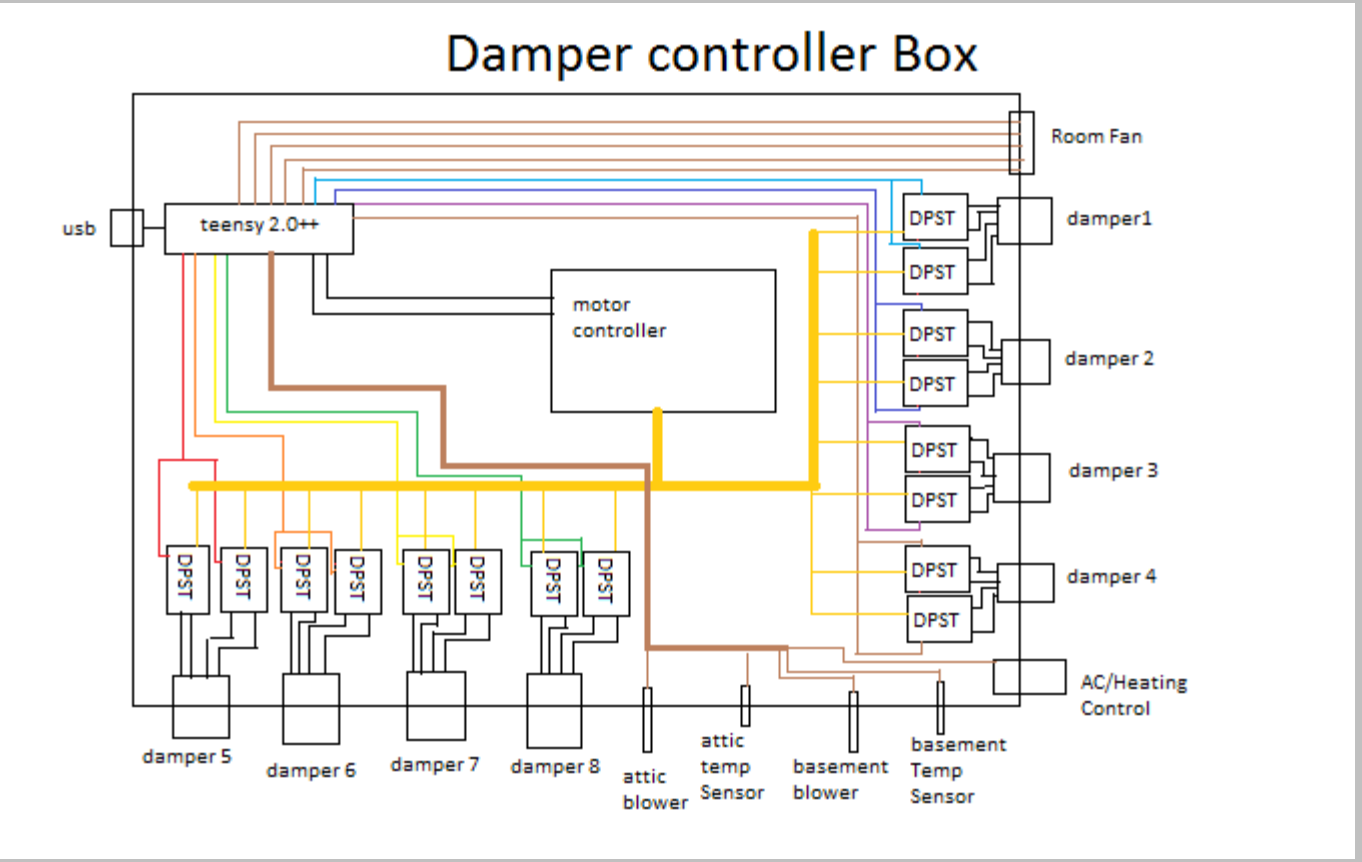


Temperature Control

Interfaces

The Motor Controller Box

- Bi-polar 4 wire motor controller
- Relay controlled bus
- Signals will be controlled with USB serial interface to teensy 2.0++ to the server

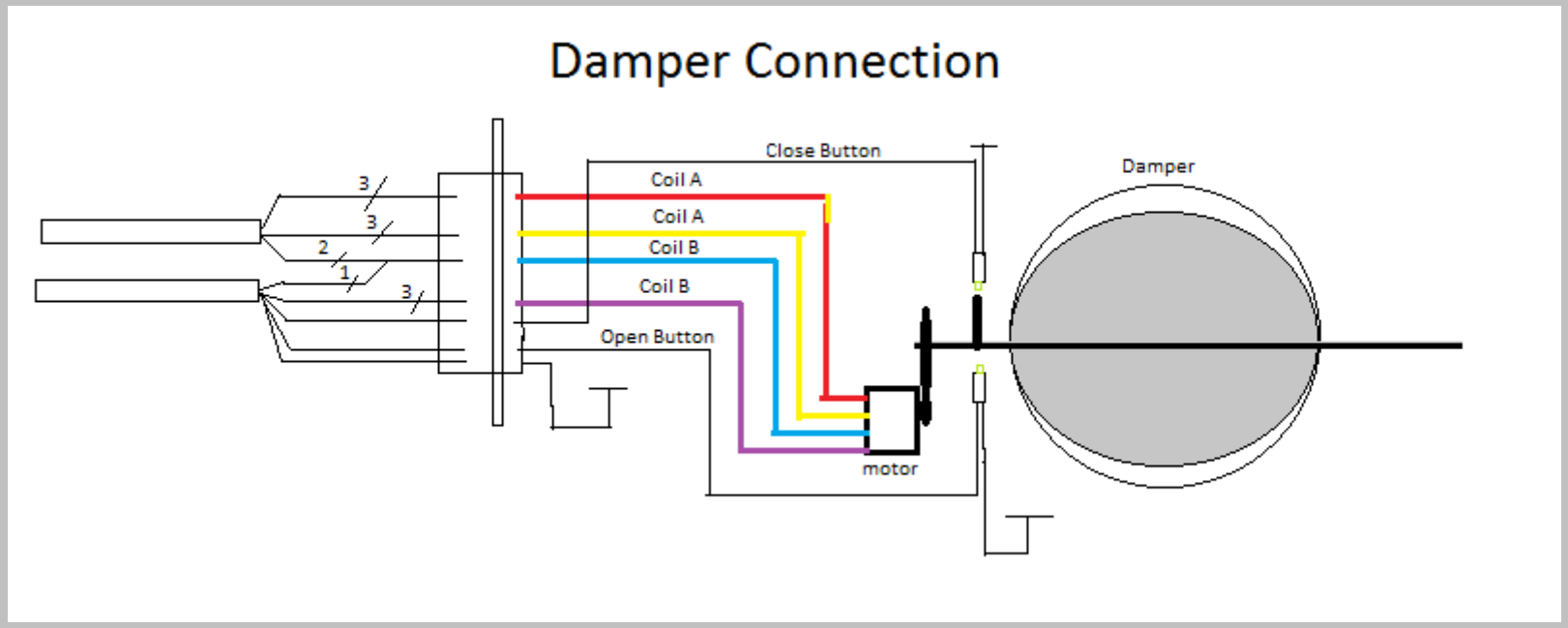


Temperature Control

Interfaces

Damper

- DB9 connector
- 4 coil wires, with 3 cat5 wires connected to each coil pin (Imax =1.731 amps)
  - Fuse rate for copper 24 AWG wire is 7 amps
- 1 pin for 12V or 5V
- 2 pins for damper open/close

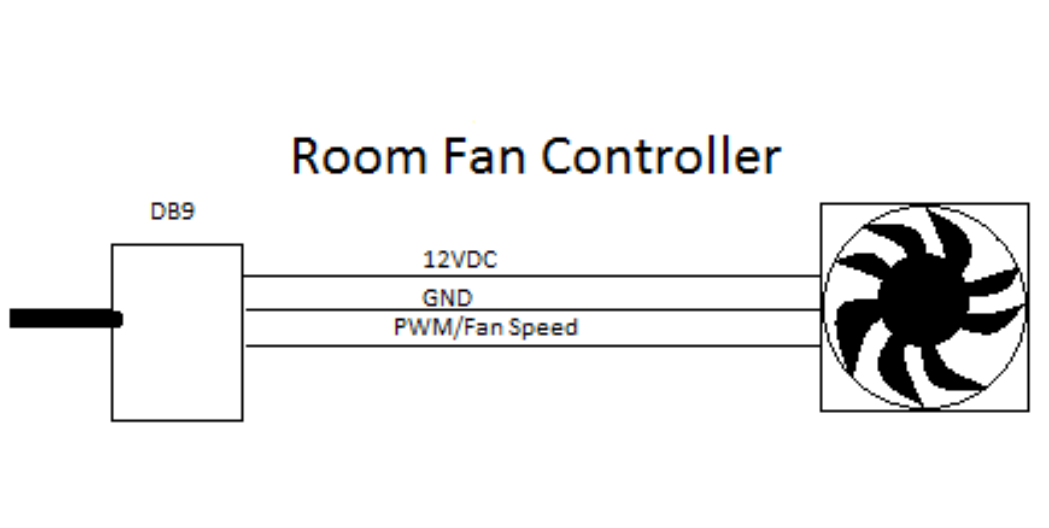


Temperature Control

Interfaces

Room Fan Controller

- 1 Delta AFC1212DE Fan
- 100Hz PWM signal



Temperature Control

Risks

Schedule and Risk Scale 1-10(10 being Huge risk)

Motor controller from example (http://home.cogeco.ca/~rpaisley4/Bipolar.html)

- Alternative: purchase one for $20
- Time: 2 weeks
- Risk: 7

Motor controller Box

- Time: 3 weeks
- Risk: 7

Motor Controller Code (open, close, getTemperature,...)

- Time: 2 weeks
- Risk: 3

Fan Controller Code

- Time: 1 day
- Risk: 2

Cables

- Time: 1.5 weeks
- Risk: 2

Temperature Control

Risk/Schedule

Schedule of completion

Time	Risk	Task
week 1-2	7	Develope Motor Controller
week 3-6	7	Motor Controller Box
week 7-8	2	Motor Controller Code
week 9	1	Fan Controller Code
week 9	1	Temperature Sensor Code
week 9-10	2	Cables
week 11-12	4	Demo Setup
week 13-15	7	Debug

Temperature Control

Bill of Materials

Qty|Part

Motor Controller parts

1| 555timer (timer chip)
1| MC74HC194N (4 bit Shift Reg)
1|SN754410NE(Quad Half-H Bridge)
1|LM7805(Voltage Regulator)
6|2N3904 or 2N4400
1|LED
1|1N4148
1|1N4001
5|3.3Kohm
2|470ohm
7|10Kohm
1|1uF
2|4.7uF
1|470uF

Damper

8|bipolar motor
16| buttons
8| DB9 female
~10'x10'| tin sheets

Motor Controller Box

15|DB9 female
16|5VDC Relay
16|2N3904
1|teensy2.0++
2| 100 mill sockets
16| resistors
2| temperature connectors

Room Fan Controller

5|fans
5|DB9 female

Basement/Attic Blower Controller

2|DB9 female
2|A/C 120V Socket
2|A/C 120V Plug
2|DSPT Relay

Outlet Control

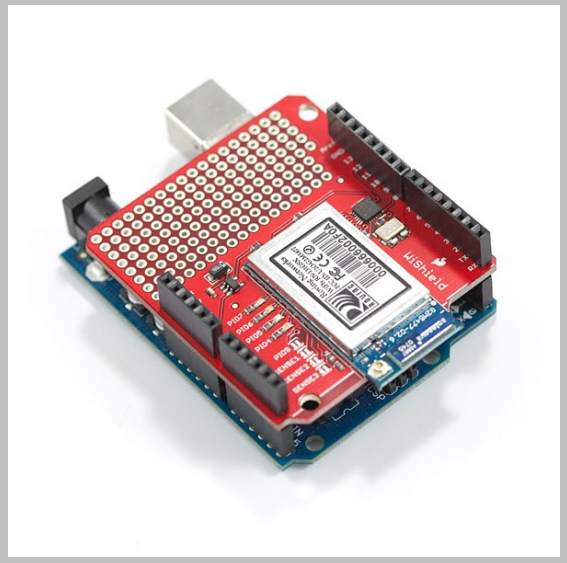
Review

- Control power to individual outlets from server.
- Power strip for mobility, communication to server through WIFI.
- Monitor power for each outlet. Stats available on server.

Outlet Control

Interfaces

The power strip will have its own MCU(Arduino) and WIFI.
12V Automotive Relays will switch the 120V 60Hz power on/off.
Current Sensors will read into Arduino ADC.



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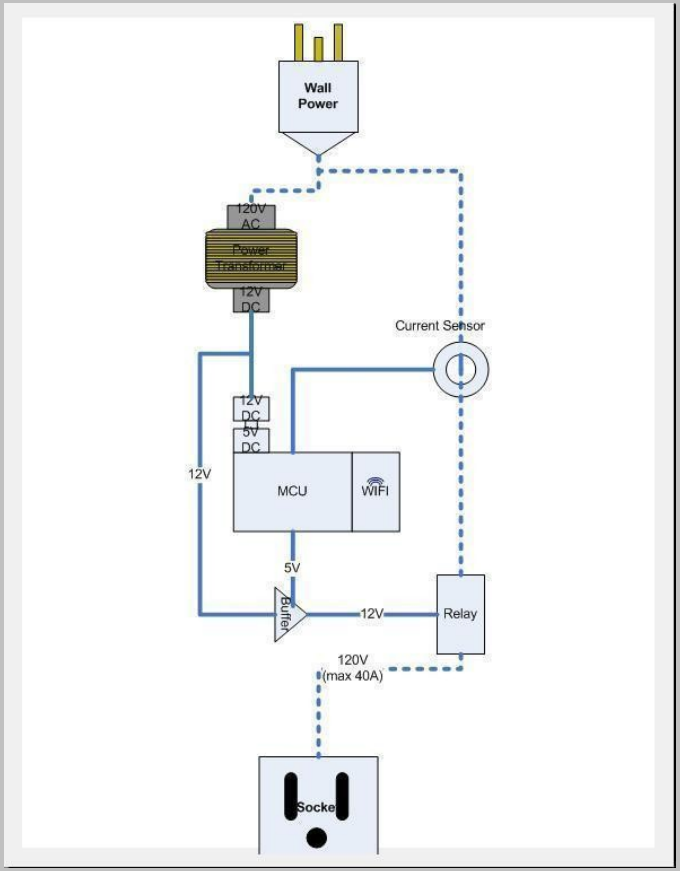
Outlet Control

Interfaces

On-board electronics will be powered with a 12V power supply.
Voltage regulators will power 5V lines.
Transistors(2N3904) will be used to switch 12V lines from Arduino board.



Outlet Control

Interfaces

Schedule of completion

Time	Risk	Task
week 1	2	Component wiring/testing
week 2-4	6	Arduino wiring, ADC tuning, Current sensors
week 5-6	3	Power controls/programming
week 7-9	5	WIFI shield interfacing
week 9-11	5	Server communication
week 12-13	7	Power strip casing, making things fit
week 14-15	1	Demo Setup

Outlet Control

Interfaces

Bill of Materials

Qty|Part

5 Relays - CB1AHF-12VRELAY AUTOMOTIVE SPST 70A 12V, Panasonic

5 Current Sensors - ACS709LLFTR-35BB-TSENSOR CURRENT 75A 5V BI 24QSOP, Allegro Microsystems Inc

5 Transistors - 2N3904TFTRANSISTOR NPN 40V 200MA TO-92-Fairchild Semiconductor

1 Power Supply -VOF-25-12PWR SUPPLY 24W OPEN 12V 2.0AV-Infinity VOF-25CUI Inc

2 Voltage Regulators - LM78L05ACZXAIC REGULATOR 5V 0.1A 5% TO-92-Fairchild Semiconductor

1 Arduino Demilanove Board

1 Wifi Shield

1 Power supply

Why is room-based occupancy detection important?

- convenience
  - Lights and appliances can be turned on and off automatically without needing to always be flipping a switch.
- efficiency
  - Forgetting to turn off lights and appliances wastes energy and can run up the electric bill.
  - Heat and air conditioning can heat or cool unoccupied rooms or areas less to conserve energy.
- security

How has room-based occupancy detection been performed?

- Usually just with PIR (passive infrared) motion sensors and timers.

Motion sensor activity

- makes the room assumed to be occupied for a set time period
- after which, with no further motion, the room is deemed unoccupied.

Problems with PIR-only occupancy detection

- Periodic motion is required to main the occupied status of room.
- This leads to two problems:
  - Short timer durations makes it necessary for occupants to be periodically waving at the motion sensor as it repeatedly mis-concludes that the room is empty.
  - Long timer durations mean that the room is not judged to be unoccupied until long after it has been vacated.

What are light beam interruption detectors (LBIDs)?

LBIDs

- have a transmitter which shoot a beam of light (often an invisible one) across a distance to a receiver
- output one signal when the beam is received
- output a different signal when the beam is not received because of an obstruction between the transmitter and the receiver.
- are usually installed in doorways or between rooms

How can LBIDs improve occupancy detection?

- Whether a room is occupied or vacant, its status cannot change without someone walking through a doorway (ruling out windows).
- If a light beam interruption detector is placed across each doorway to a room, people will not pass through such a doorway without producing a change in the output of the detector.

How can LBIDs improve occupancy detection? (continued)

When combining a PIR motion detector with LBIDs at all entrances and exits to a room,

- the occupied or vacant status of a room need only be determined ONCE after the LBID signal changes
- the status of the room will remain the same so long as the LBID signal remains constant.

How does a system with both PIR motion sensors and LBIDs work?

When an LBID bordering two rooms is tripped

- both rooms begin counting down from 5 to 10 second toward zero
- whichever rooms are occupied sense motion and set their states accordingly.
- otherwise, after a room counts to zero, its state is set to vacant
- If motion is detected in a room after its state is presumed vacant, it is changed to occupied.

Using occupancy detection with lighting

With lighting, usually the lights are turned on in both rooms adjoining an LBID, before it is ascertained which room(s) is occupied.

Other than this, the lights turn on when the room is deemed occupied and go out when the room is deemed vacant.

Switches allow the lights to be forced on or forced off irrespective of occupancy.

Room Occupancy

- Schedule of Completion
- Time Risk Task
- Week 1-2 |2| acquire sensors
- Week 3 |3| test sensors in lab, stand alone
- Week 5-6 |4| connect sensors to room controller
- Week 7-8 |5| test room-controller/sensor in combination
- Week 9 |3| fine tune sensors to work in demo setup
- Week 14-15 | 4| demo

Wi-Fi and networking

Review

Use Arduino MCU with an Wi-Fi shield for collecting data from sensors and sending it over Wi-Fi to the server. The communication will be bi directional it will present the data from the sensors to the user and will accept controlling the peripherals via specific commands sent from the server to the Arduino MCU.

Wi-Fi and networking

Interfaces

- Temperature Sensors will be connected to Arduino MCU
- Send data over Wi-Fi 802.11b to the server
- Each Wi-Fi shield will have an unique IP address
- Apache server will be in charge of collecting data and presenting to user
- Each peripheral unit such as power strip, light control will have its own Arduino MCU and an Wi-Fi shield (WiFi Shield WiShield V2.0)

Wi-Fi and networking

Interfaces

Each of those MCU's will have an assigned IP address which will be distinguished at the server side for us to know what kind of data we are getting and from what sensor. Commands such as turning on the lights in the room manually will be sent to the specific Arduino MCU to turn that light on or off. Data sent over the Wi-Fi with the Arduino shield can be secured view WEP encryption or it can also be unsecured. The server controls will be available from anywhere there is an internet connection.

Wi-Fi and networking

Schedule of completion

Time	Risk	Task
week 1	2	Communicate with the sensors
week 2-4	6	WIFI shields interfacing assign specific IP addresses
week 5-6	3	Wi-Fi shields communicate with Server
week 7-9	5	Server communication - store gathered data from sensors
week 9-11	5	Send commands back to the Arduino MCU
week 12-13	7	Testing
week 14-15	1	Demo Setup

Server

Interface

- Secure website control panel
- Apache Server
- Communicates to different IP address on the network
- Communicates to Motor Controller Box via Com port

Server

Schedule of completion

Time	Risk	Task
week 5	2	Setup web server(apache)
week 7	5	Setup security
week 8	4	Communicate to COM port (pyserial)
week 9-12	9	Communicate to IP addressed wifi devices
week 12-14	7	Debug
week 15	5	Demo Setup

Server

Bill of Materials

Qty|Part

Room Monitoring system

2| garage door safety sensors

2| PIR Motion Sensors

WIFI

WiFi Shield WiShield V2.0

1| PC (Dell Precision 380)

Questions?