Smart Home

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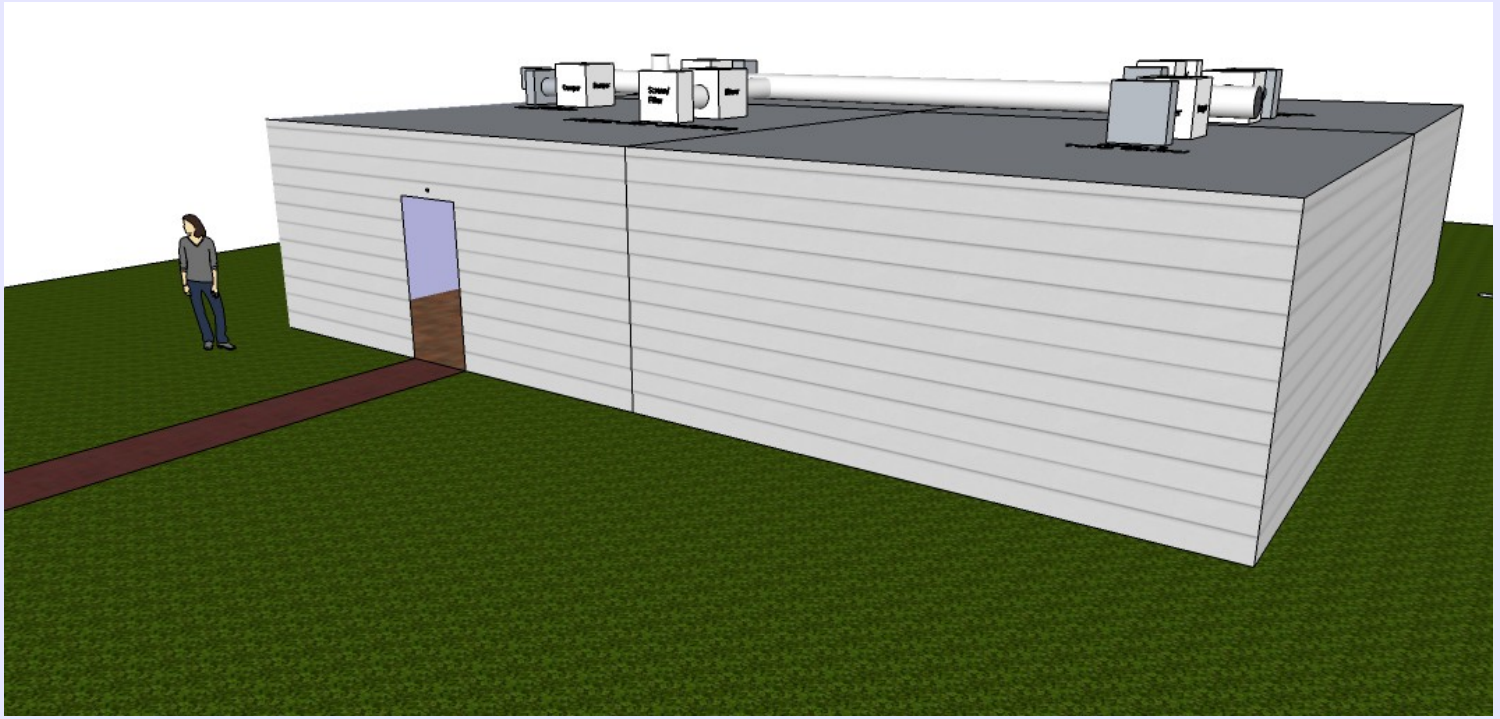


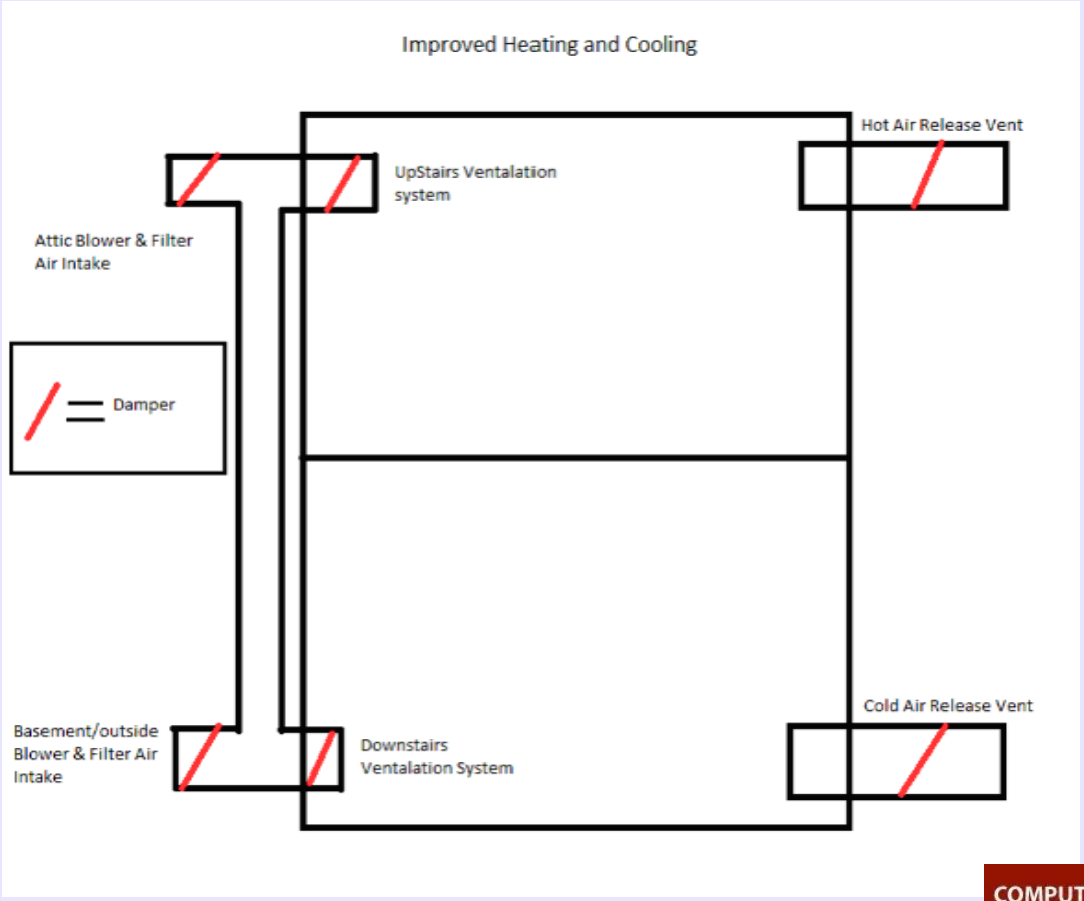
Overview

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

Temperature Control

Review

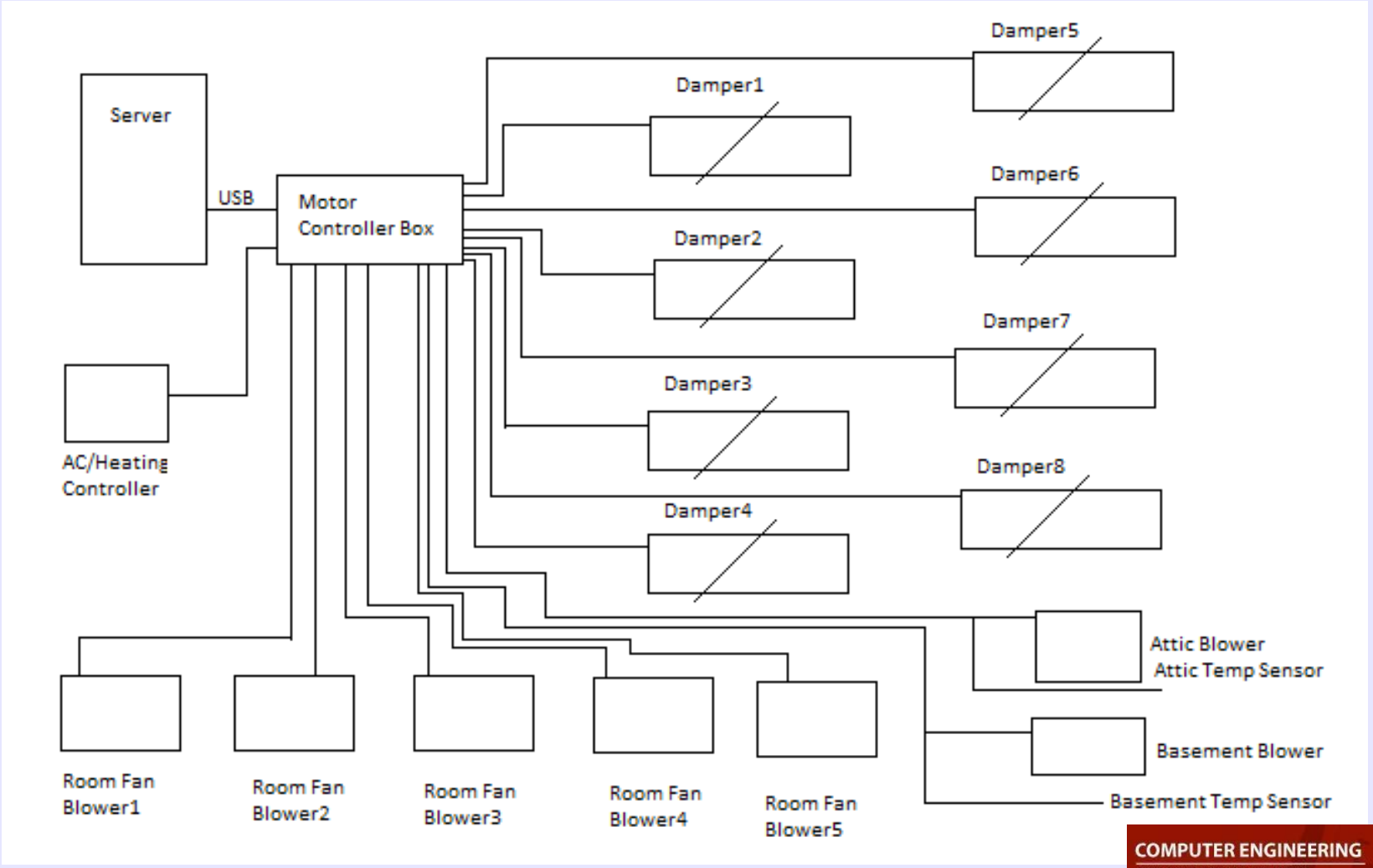
- Control individual Room Temperature.
- Take advantage of outside weather conditions.
- control a set of dampers so that the system will optimize house temperature comfort levels.



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.

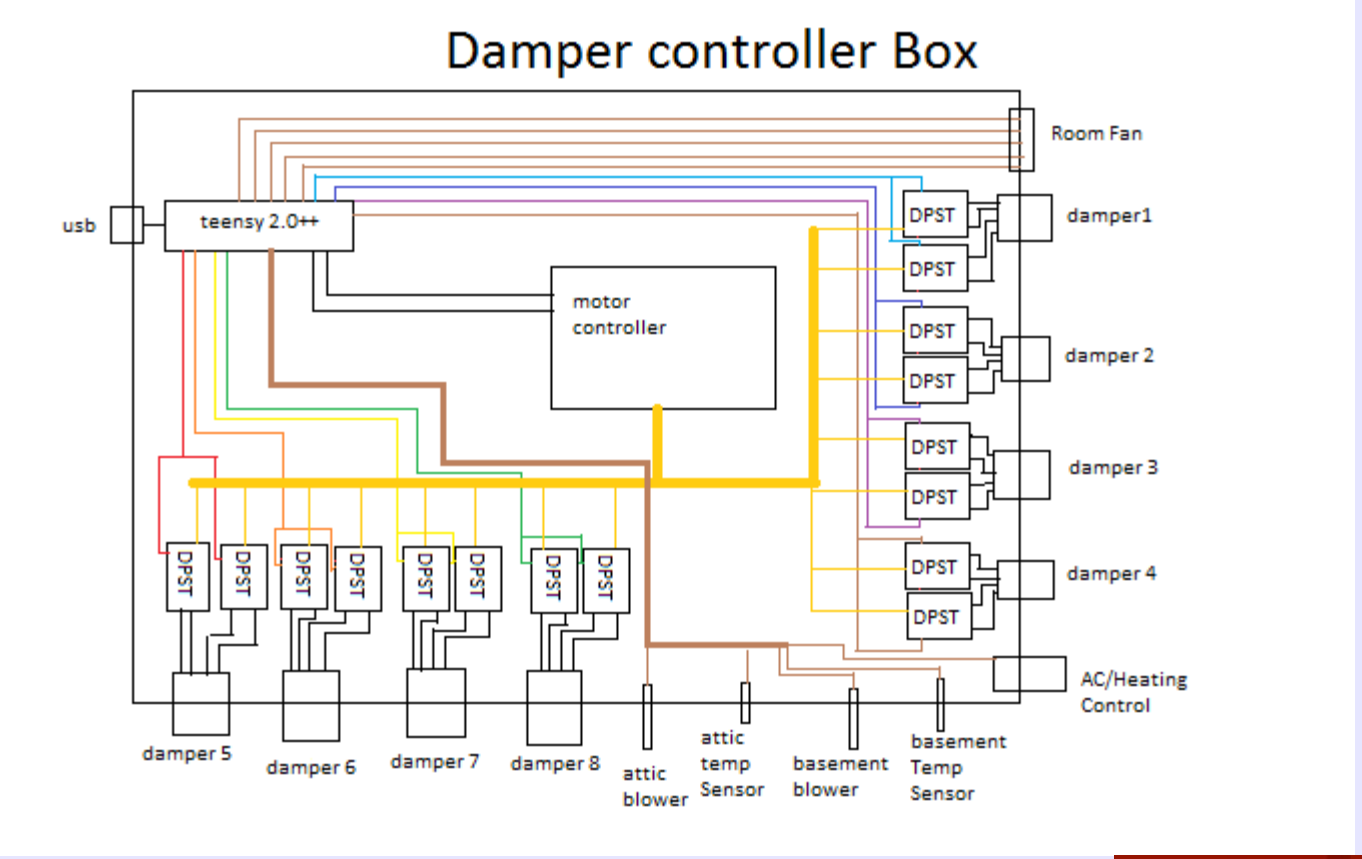


Temperature Control

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

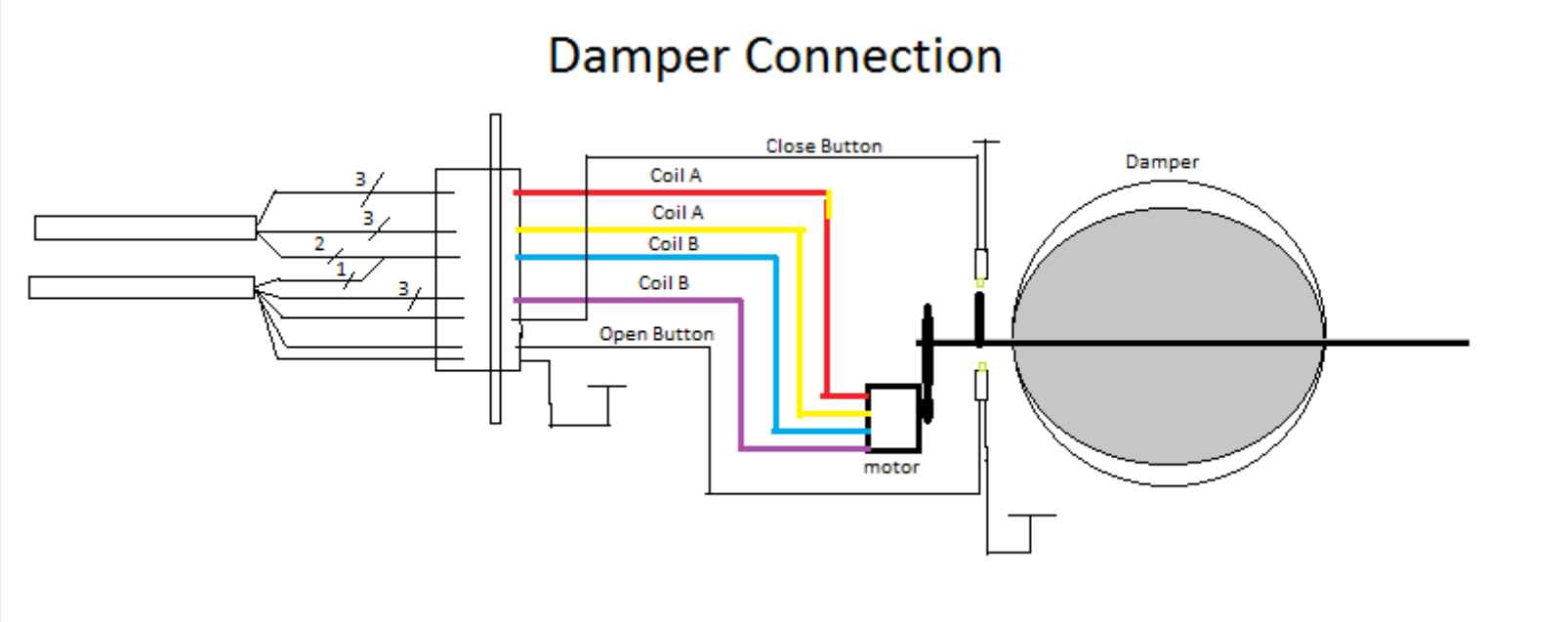


Temperature Control

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

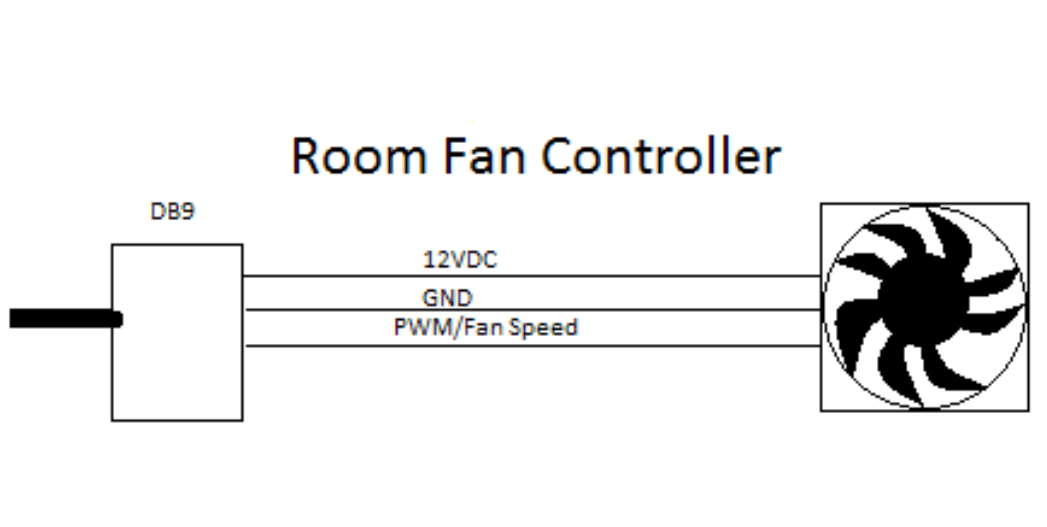


Temperature Control

Interfaces

Room Fan Controller

- 1 Delta AFC1212DE Fan
- 100Hz PWM signal

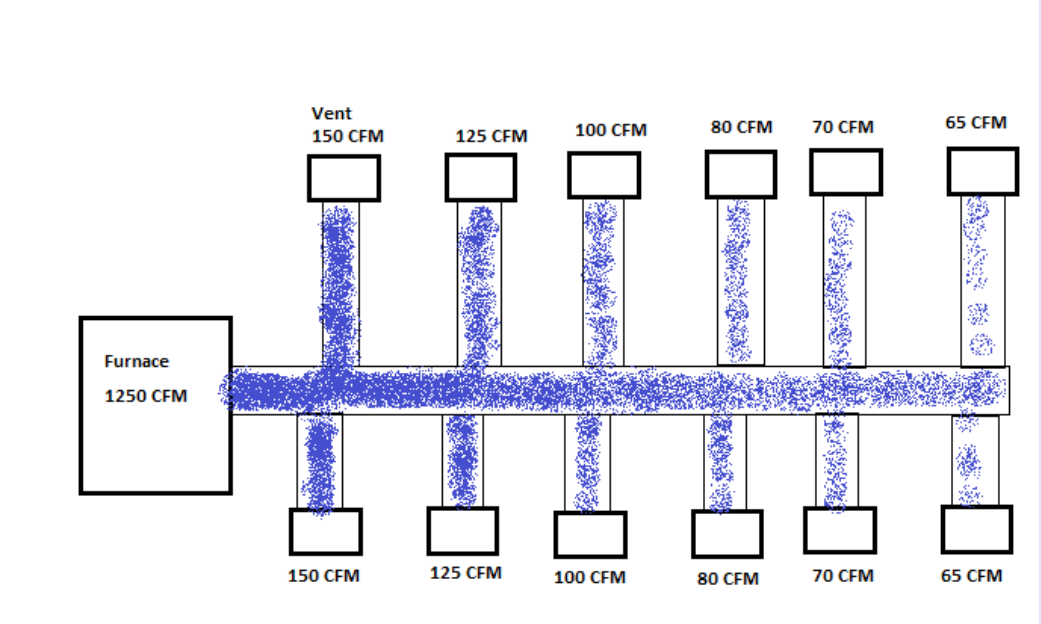


Temperature Control

Interfaces

Air Distribution

- Main Furnance blower ~1250 CFM(Cubic Feet/Min)
- Small room blowers 148 CFM
- 11 Vents = ~150 - ~85
- Air Flow Factors: Duct Size, Air Pressure, Humidity, and Air Temperature



Temperature Control

Interfaces

- A/C and Heating controller
- Relays to turn on and off
- Transistor to determine if already in use

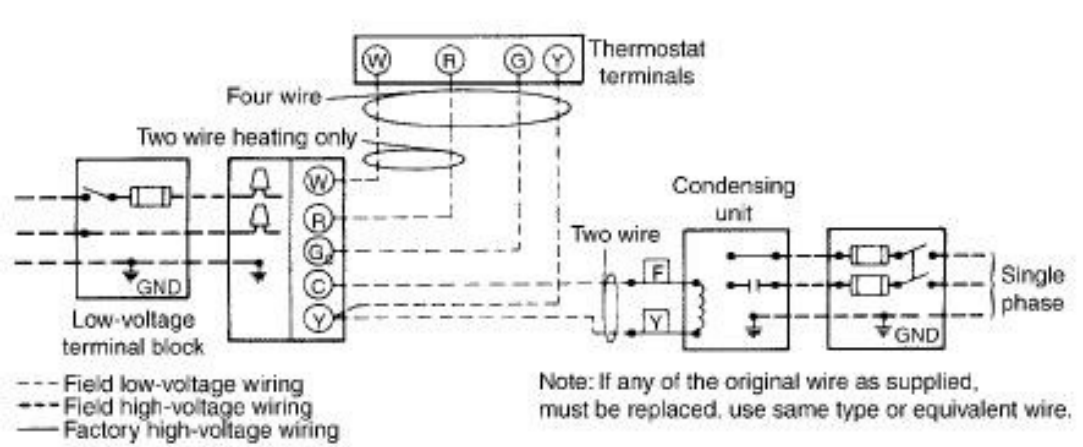


Figure 2-7 Heating and cool application wiring diagram. (*Courtesy of Carrier.*)

Wire diagram: http://www.hvactroubleshootingguides.com/hot-air-furnace-low-voltage-wiring.html

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
1 | 24V 4.2amp Power supply
1 | Heat Sink
1 | CPU fan

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

A/C Heating Controller

Outlet Control

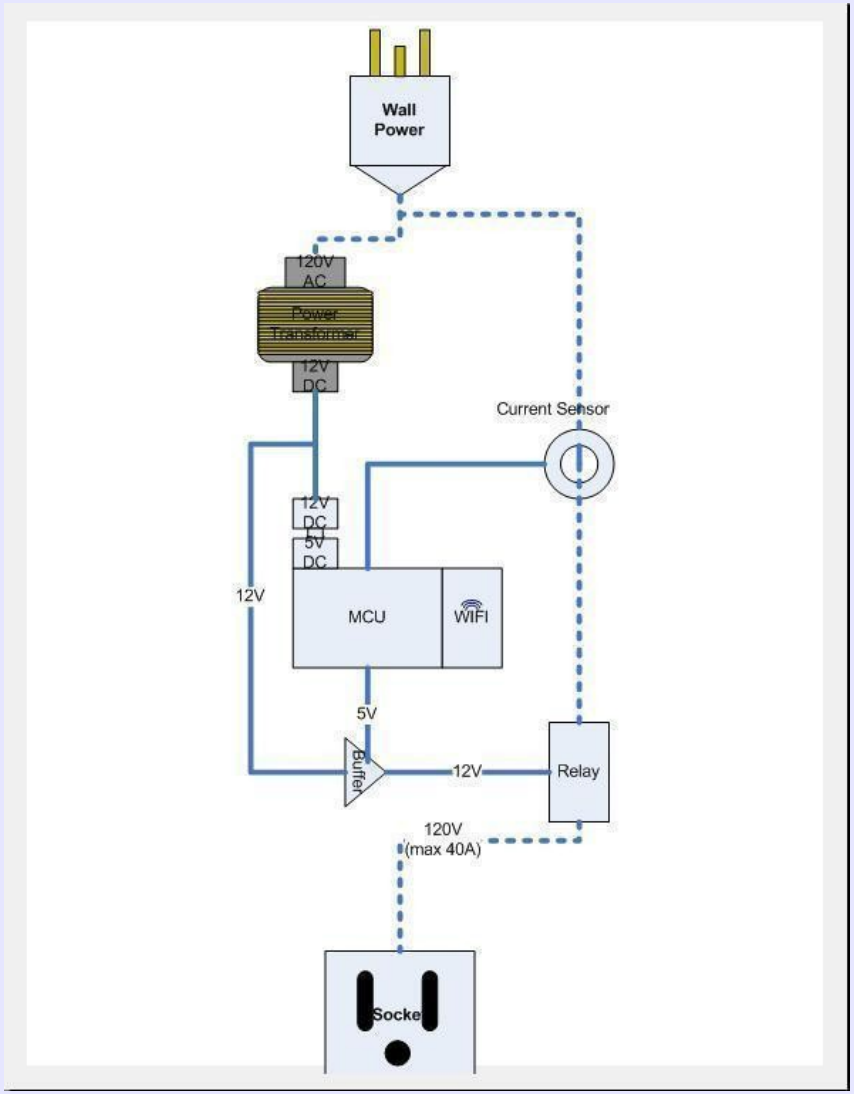
Review

- Switch power from wall on/off to 5 individual sockets.
- Monitor power consumption.
- Mobility of a power strip.
- MCU Controlled via commands from server over WIFI.

+

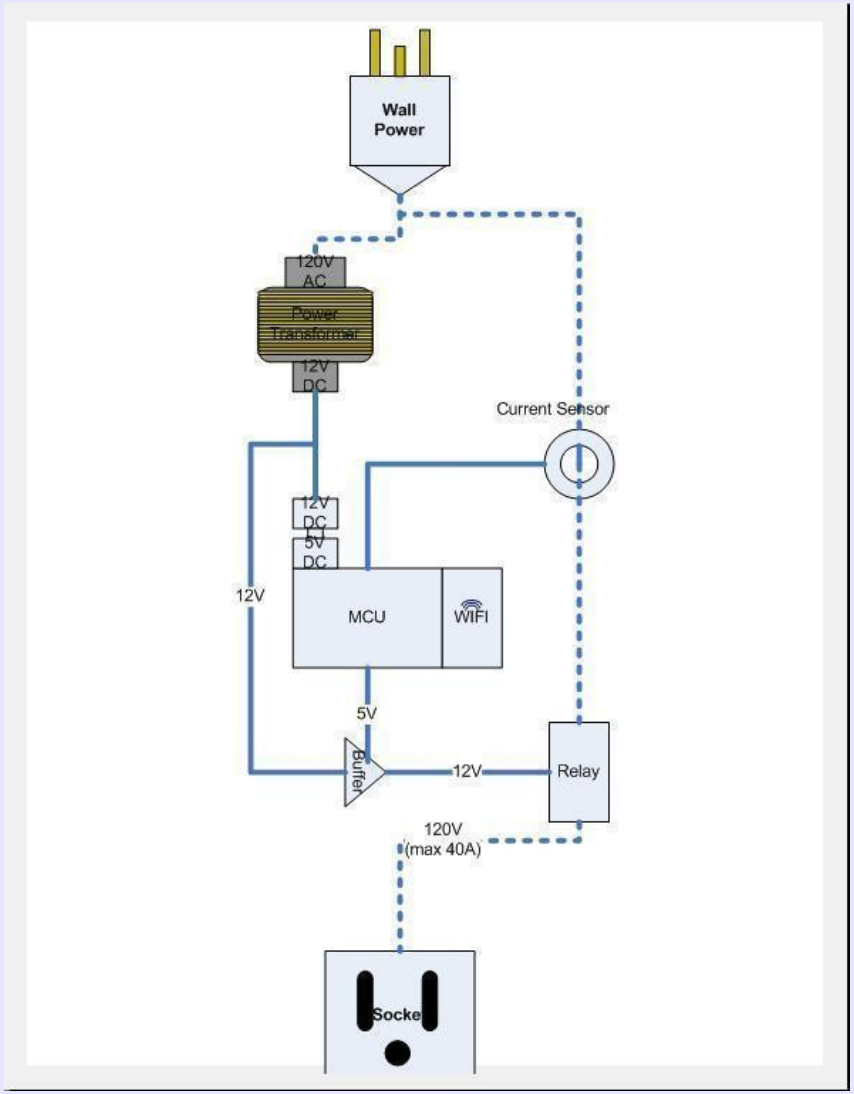
Outlet Control

- Relays used to switch on 120V 60Hz power.
  - Automotive relay used for its high contact current, low cost.
- Onboard power supply will drive the circuitry and the microcontroller/WIFI.
  - ~ 3 amps



Outlet Control

- Current Sensors will monitor power at each socket, values read into ADCs.
- Power consumption values available on web interface and LEDs near socket.



Outlet Control

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

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

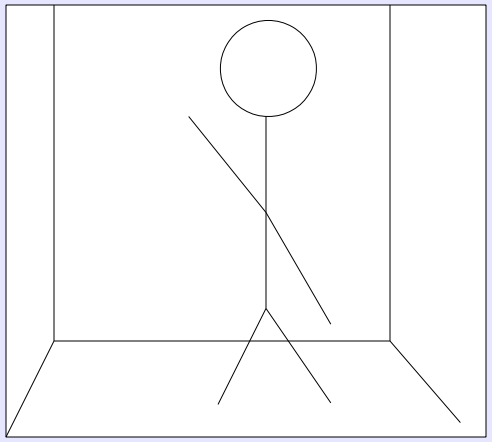
1 Arduino Demilanove Board

1 Wifi Shield

1 Power supply

Occupancy Detection

Why is room-based occupancy detection important?



Leads to

- convenience
- energy conservation and cost savings
- improved security

Occupancy Detection

Much of occupancy detection performed using

PIR motion sensors with timers.

Suspected reasons:

- cheap
- well-established technology
- savings are better than no occupancy detection

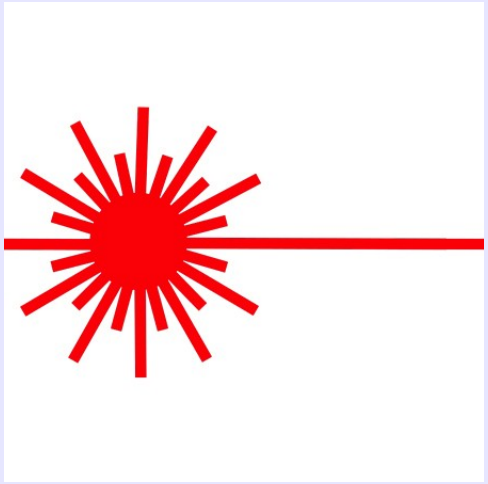
Occupancy Detection

Principal characteristic of motion detectors:

- *perpetual, periodic motion required to preserve occupied state*

Leads to compromises adjusting the timer.

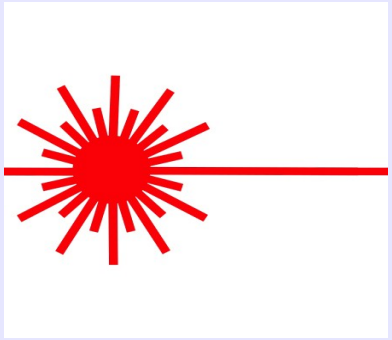
Occupancy Detection



Enter light beam interruption detectors!

- use a laser or other light source to shine a beam of light
- detect when persons pass through a doorway, breaking beam

Occupancy Detection



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Light beam interruption detectors, when added to motion sensors and timers:

- free motion sensors from perpetual motion requirement
- allow motion sensors to detect vacancy in as little as 5-10 seconds
- increase both efficiency and reliability

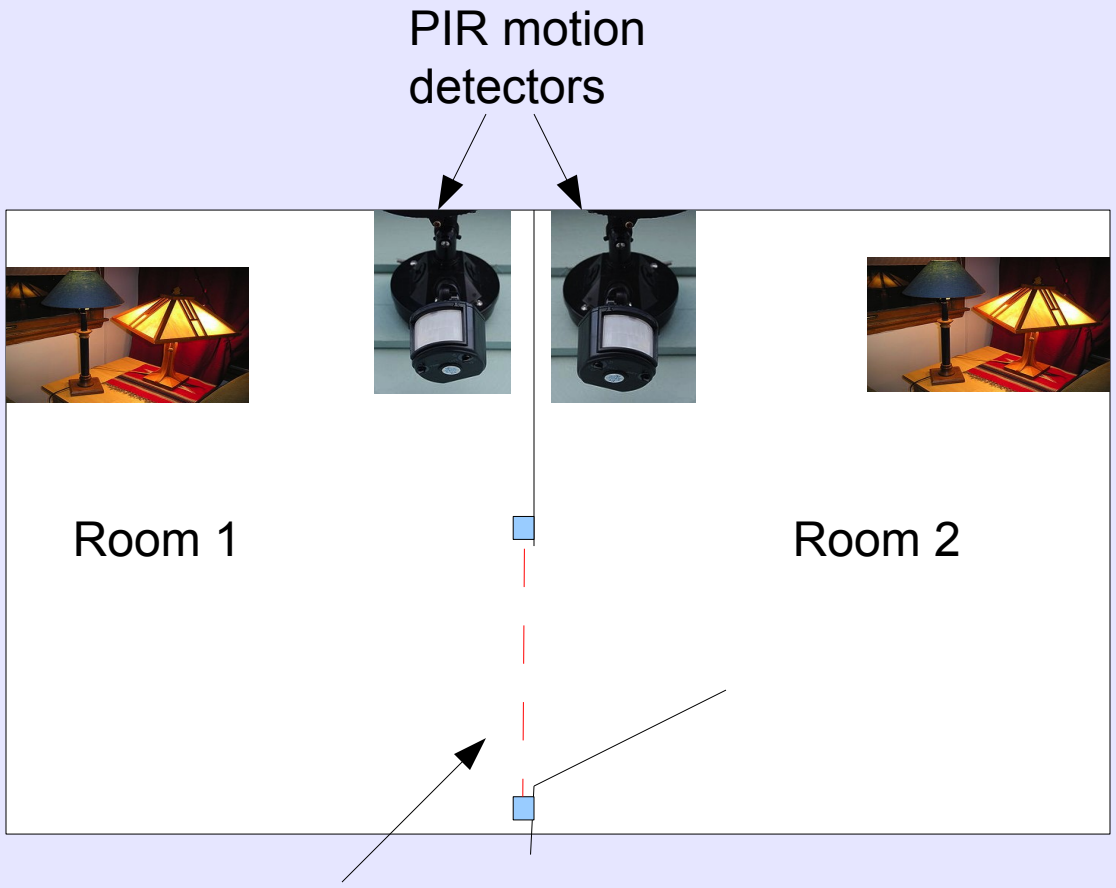
Occupancy Detection

Combining occupancy detection with lighting

- lights turned on in both rooms adjoining a room boundary after beam broken
- lights turn on when the room is deemed occupied
- lights go out when the room is deemed vacant
- switches on touch screen panels allow forcing of lights to on or off to override occupancy

Occupancy Detection

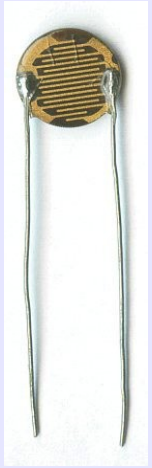
demonstration setup



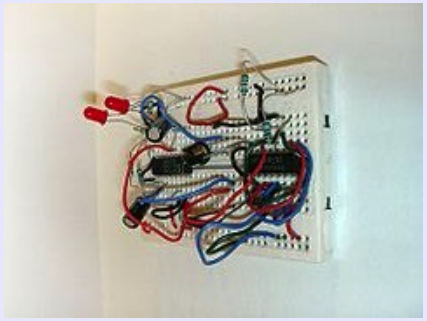
Occupancy Detection

Materials

- light beam interruption detector
  - laser pointer
  - CdS light-sensitive resistor



- DYP-ME003DD-H low voltage PIR motion detector
- miscellaneous other circuitry to connect sensors to Arduino



Occupancy Detection

Schedule of Completion

Time	Risk	Task
week 1	|1|	verify motion sensor shipped right, test LBID
week 2	|3|	test motion sensor, design circuit to connect it to control board
week 3	|2|	test motion sensor digital output, design
week 3	|2|	assemble circuitry to connect LBID to control board
week 4	|2|	test digital output for LBID with laser

Wi-Fi and networking

Review

- Arduino MCU with Wi-Fi shield collect data from sensors and send to server
- Bi-Directional communication
- Control power outlets, lights.
- Store information on Apache server
- Accessible from anywhere where there is internet connection
- WEP secured
- Web based presentation of data

Wi-Fi and networking

WiShield 2.0

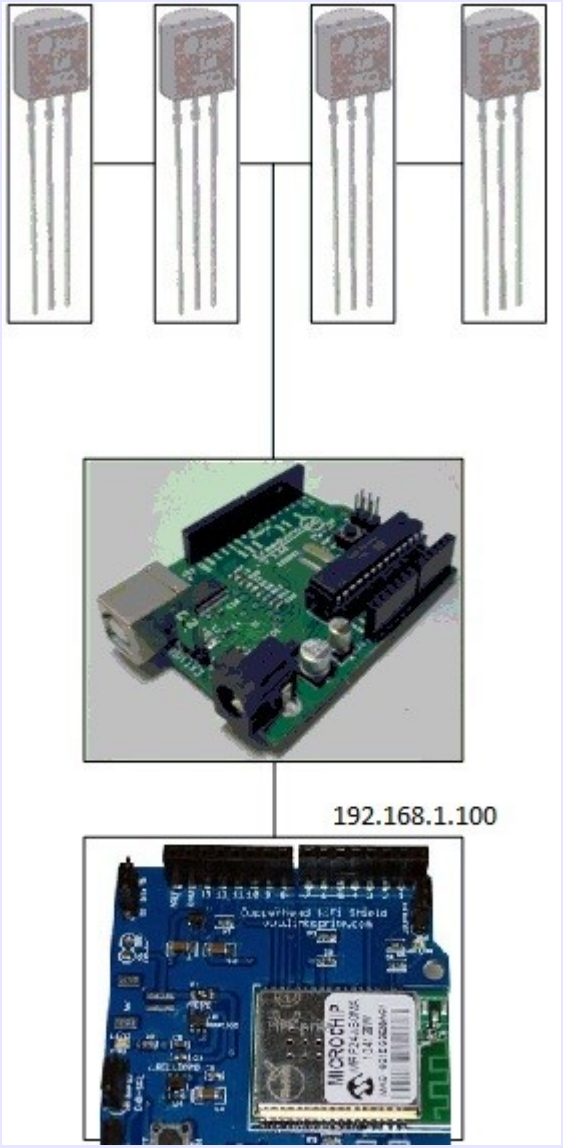
- WiShield 2.0 from async_labs
- 802.11b Wi-Fi certified
  - 1Mbps and 2Mbps throughput speeds
- Supports both infrastructure (BSS) and ad hoc (IBSS) wireless networks
- Ability to create secured and unsecured networks
  - WEP (64-bit and 128-bit)
  - WPA/WPA2 (TKIP and AES) PSK
- Low power usage
  - Sleep mode: 250μA
  - Transmit: 230mA
  - Receive: 85mA

Wi-Fi and networking

Interfaces

- Temperature Sensors will be connected to Arduino MCU
- Room occupancy sensor 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)
- Commands will be sent through HTTP from server to Arduino MCU

Wi-Fi and networking



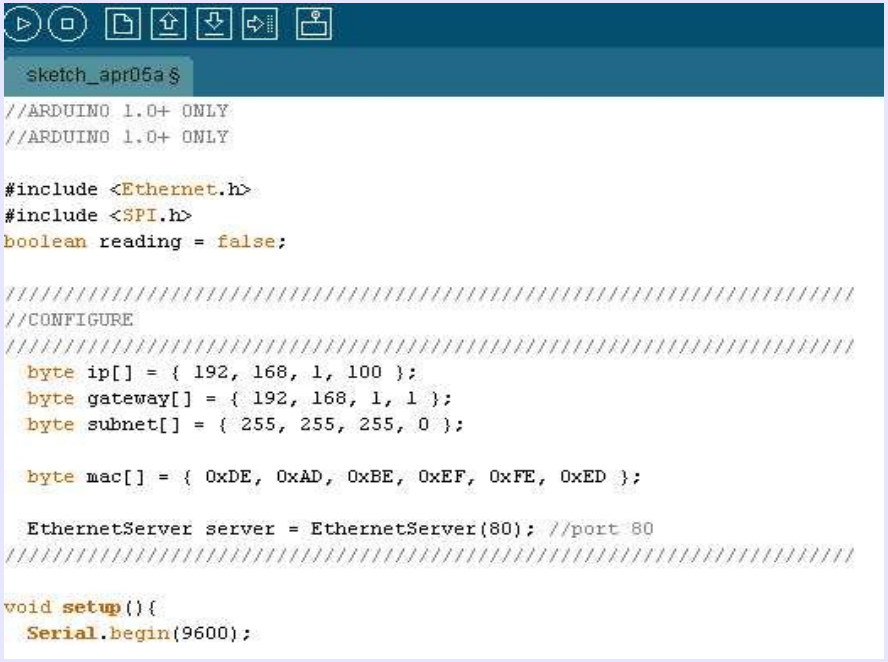
Interfaces

- Static IP Address
- Room 1 IP(192.168.1.100) Arduino MCU
- Data from room 1 sent to server over 192.168.1.100 IP
- Commands sent over HTTP (http://192.168.1.167/?2345) turn pins 2345 on
  Lights connected to those pins will turn.
- Depending on command received through http arduino will run a specific block of code to execute command
- WEP encrypted communication between Arduino and server
- Communication available from any internet based location

Wi-Fi and networking

Interfaces

- Add Ethernet.h arduino library for communication with wifi
- PHP codding available for grabbing the information from sensors
- Data collected from arduino can be stored in database for future planing



Wi-Fi and networking

Schedule of completion

Time	Risk	Task
week 1	2	Communicate with the sensors
week 2-3	3	WIFI shields interfacing assign specific IP addresses
week 4-6	6	Wi-Fi shields communicate with Server
week 7-9	5	Server communication - store gathered data from sensors
week 10-11	5	Send commands back to the Arduino MCU
week 12-13	7	Testing
week 14-15	1	Demo Setup

Wi-Fi and Networking

Interfaces

Bill of Materials

Qty|Part

1 Netgear Wi-Fi router

1 Computer running Apache server

3 Arduino Demilanove Board

3 Wifi Shield (WiShield 2.0)

3 Power supply's

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

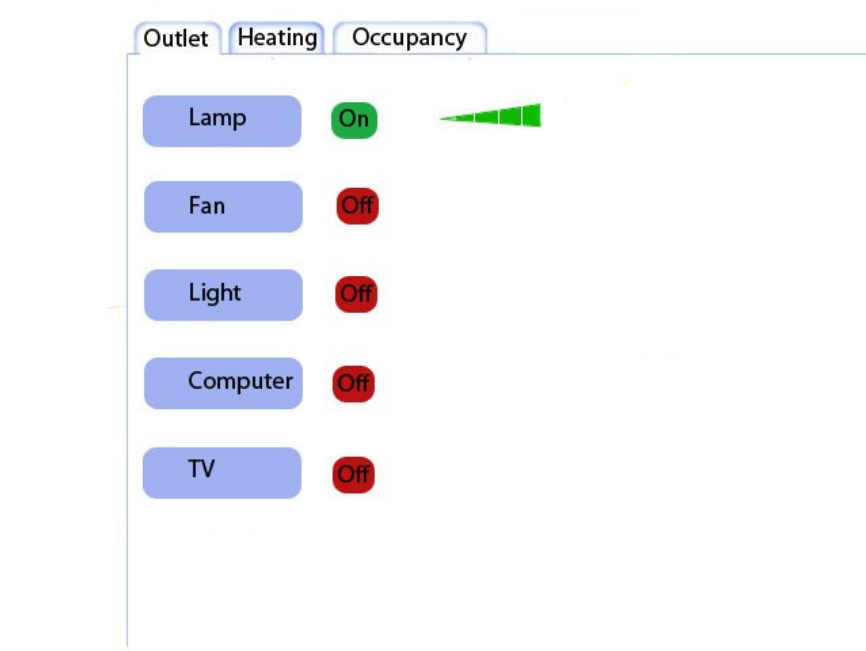
WIFI

WiFi Shield WiShield V2.0

1| PC (Dell Precision 380)

Web Interface

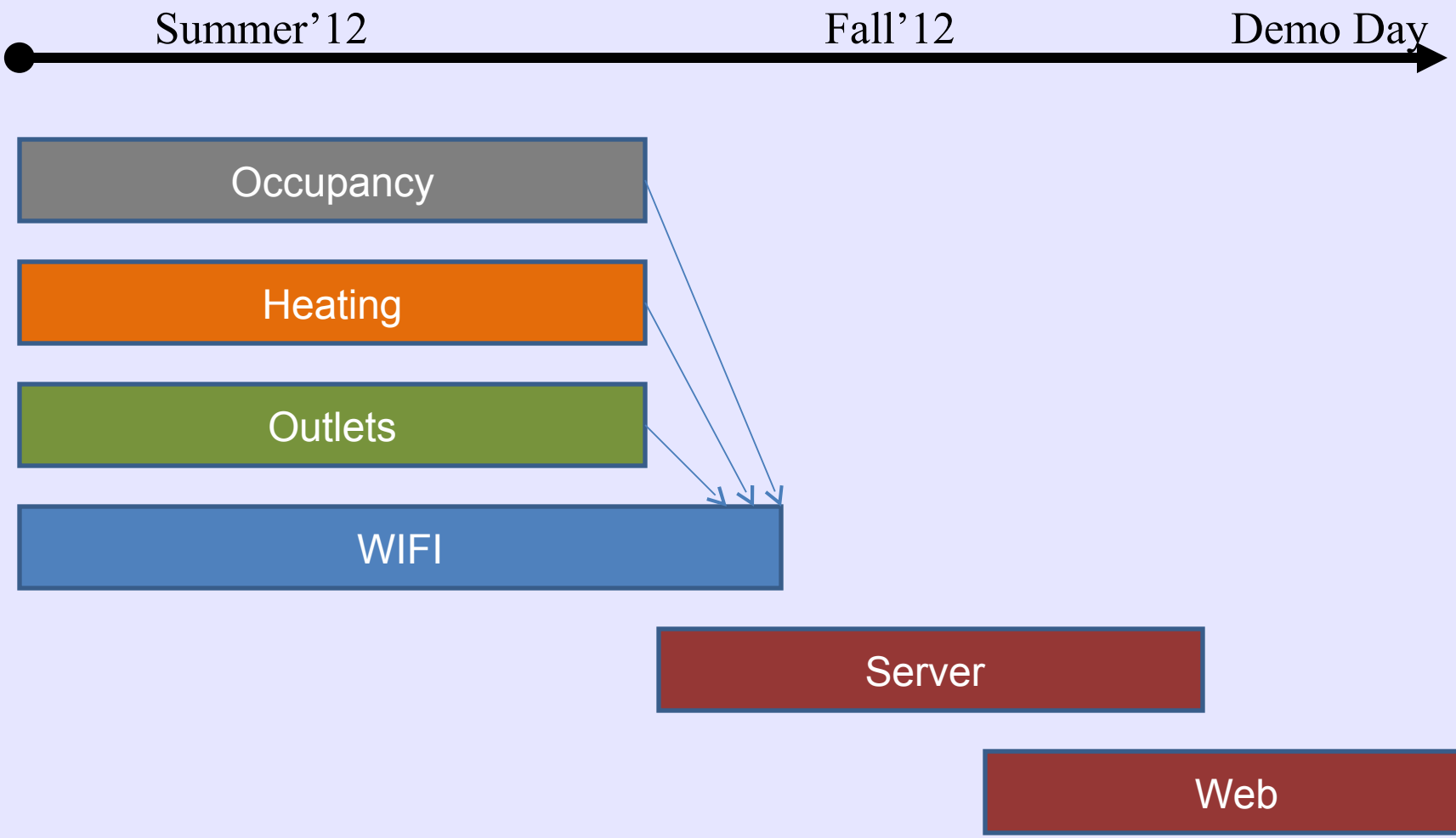
- Users will control house systems via web interface.
- Controls for outlets, heating, and occupancy.
- Statistics, routines, and timers.
- Simple and useful.



Tasking

Christopher Johnson:	Occupancy
Dario Bosnjak:	WIFI
Levi Balling:	Heating
Todd Rogers:	Outlets
All:	Wifi to Server interfacing
All:	Web interface

Time Line


Summer'12
Fall'12
Demo Day
Occupancy
Heating
Outlets
WIFI
Server
Web

Questions?