Preliminary Design Review

525.743
David Sorber
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Project Concept

- Brewing control system
  - Different types of beer require different fermentation temperatures:
    - Ales: 68°F to 72°F
    - Lagers: 45°F to 55°F
  - Active fermentation can raise beer temperature 10-15 degrees F
  - Use a mini refrigerator to control temperature of beer during fermentation
  - Develop control system to monitor the temperature of the beer and control power to the mini refrigerator thereby regulating the temperature

System Capabilities

- Monitor temperature
  - 2 sensors inside the fermentor
  - 2 sensors inside the refrigerator outside the fermentor
- Enable/disable refrigerator
- Provide a method for locally monitoring system status
  - Walk up to refrigerator and see what's going on
- Provide a method for remotely monitoring system status
  - Sit at my desk at work and see what's going on

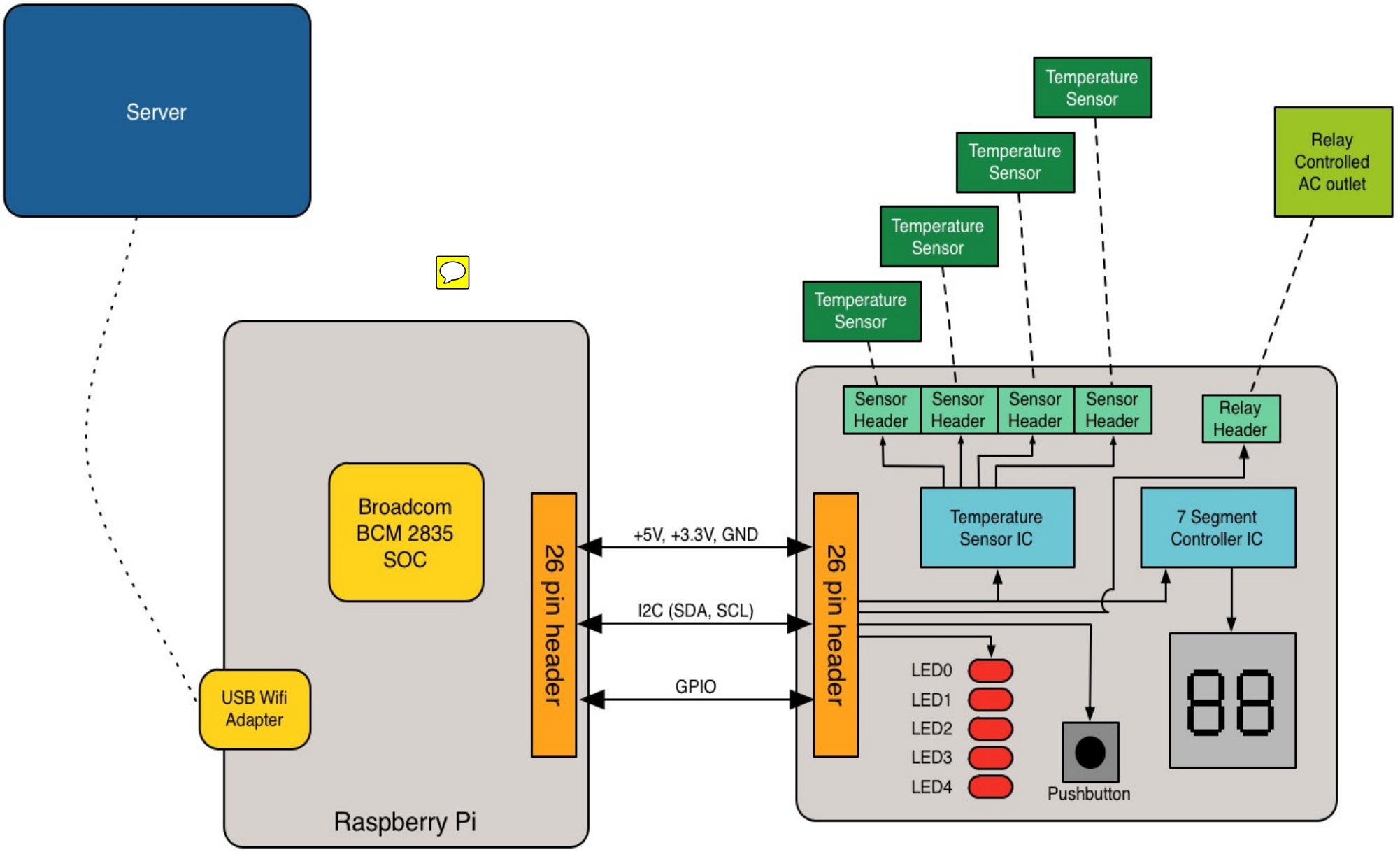
Approach

- Use Raspberry Pi development board
- Develop a daughtercard for the Raspberry Pi
  - Temperature sensor IC
    - Connectors to remote temperature probes
  - 2 digit 7-segment LED
  - 7-segment LED controller
  - Push button to select which temperature sensor is displayed
  - 4 LEDs to indicate which sensor is being displayed
  - 1 LED to indicate if the refrigerator is active
  - Connector to relay controlled AC power outlet
- Use relay controlled AC power outlet to control power to the refrigerator
- Monitor temperature data and send to remote server

References

- http://www.raspberrypi.org/
- http://elinux.org/RPi_Low-level_peripherals
- http://www.raspbian.org/
- http://www.ti.com/product/lm95234
- http://www.nxp.com/products/interface_and_connectivity/i2c/i2c_led_display_control/SAA1064T.html
- http://www.lumex.com/en/products/detail/leds7/led_displays2/thru-hole2/numeric5/dual_digit7/standard30/5610/rounded_segments4/

Block Diagram



Interfaces

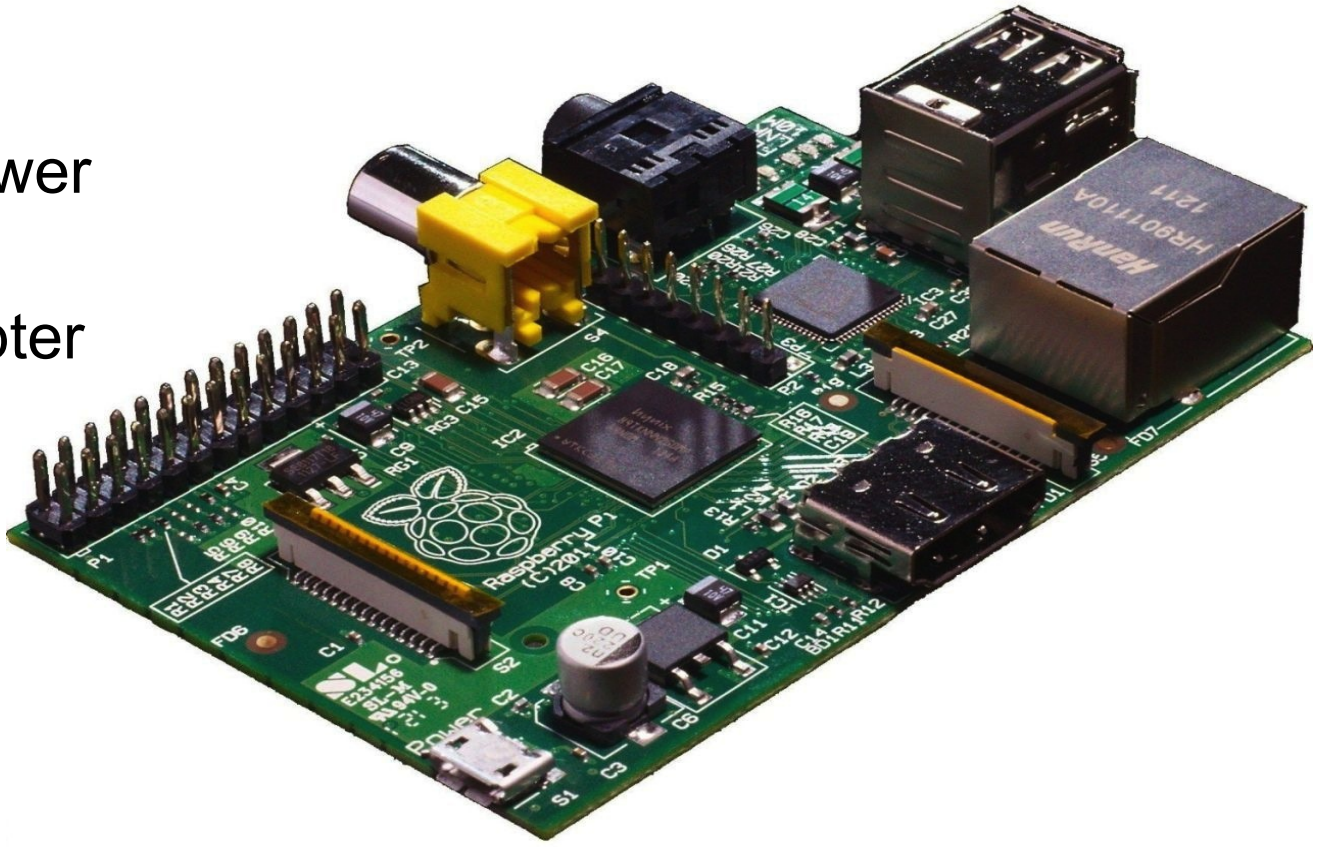
- Raspberry Pi to Server
  - custom protocol on top of TCP/IP via Wifi
- Raspberry Pi to daughtercard
  - 26 pin header (includes +5V, +3.3V, GND, I2C, and GPIO)
- Raspberry Pi to Temperature Sensor IC and 7 segment controller IC
  - I2C
- Raspberry Pi to LEDs, pushbutton, and relay header
  - GPIO
- Temperature sensor header to temperature sensor
  - physical wire
- Relay header to relay
  - physical wire

Software

- Client side
  - Raspberry Pi will run Raspbian Linux
    - Version of Debian Linux created to support the Raspberry Pi
    - Includes Python modules for accessing I2C and GPIO
    - Develop daemon in Python to read temperature sensors, send output to server, control relay, respond to pushbutton, light up appropriate LEDs
- Server side
  - Server runs Ubuntu Linux 12.04 Server
    - Write Python server app to receive and store daemon output data
    - Write WSGI web app to display status

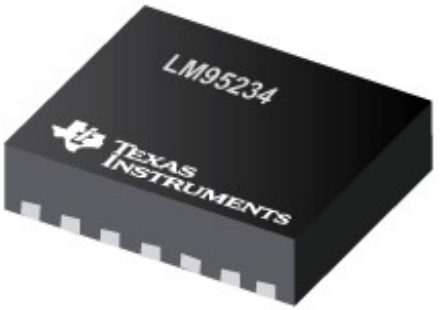
Materials

- Raspberry Pi
  - Status: already own
  - Peripherals:
    - SD card
    - Micro USB power adapter
    - USB Wifi adapter

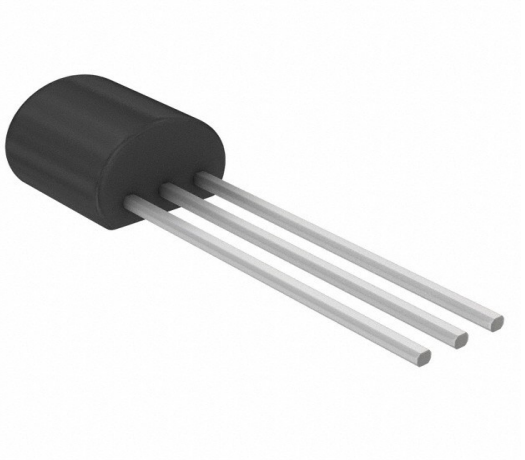


Materials continued

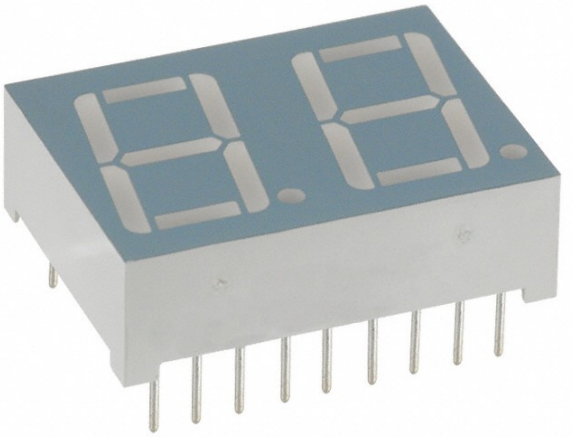
- Daughtercard
  - Status: will design and have fabricated



- Temperature Sensor IC
  - TI LM95234 Quad Remote Diode and Local Temperature Sensor w/ SMBus Interface
    - Status: samples ordered from TI
- Remote Temperature Sensors
  - 3904 NPN BJT Transistors
    - Status: will purchase



Materials continued



- 7 Segment Display
  - Lumex Opto LDD-A516RI
    - Status: samples requested;
      will purchase if necessary
- 7 Seg Display Controller IC
  - NXP SAA1064T LED Driver w/ I2C Bus
    - Status: will attempt to get samples;
      otherwise will purchase
- Relay controlled AC Outlet
  - PowerSwitch Tail II
    - Status: will purchase

Materials continued

- LEDs, pushbutton switch, miscellaneous passive components, headers, wire, etc.
  - Status: will use whatever I already have, purchase the rest as needed
- Test equipment, solder station
  - Status: will use resources at work

Development Plan

- Design daughtercard and have it fabricated; estimated turnaround time for PCB fab is ~2 weeks (design 2 weeks, fab 2 weeks)
- Develop server application and sample client daemon for testing (2 weeks, occurs during PCB fab delay)
- Assemble daughtercard and perform electrical testing (1 week)
- Develop test programs, in Python, for daughtercard: (2 weeks)
  - Read and debounce pushbutton
  - Activate relay GPIO
  - Turn on and off all standalone LEDs
  - Display digits on the 7 segment display
  - Read temperature values from all four sensors
- Integrate all test programs and sample client daemon into final client daemon (1 week)
- Assemble and test entire system (1 week)
- Brew some beer!

Risk

- I have never designed a PCB before
  - Mitigation: have very experienced coworker to go to for CAD tool introduction and questions
- I have done very little surface mount soldering
  - Mitigation: bribe one of the technicians at work to give me some pointers; practice using junk PCBs at work
- Component availability
  - Mitigation: use several distributors if necessary