UCSC Extension Silicon Valley

Embedded Firmware Essentials

EMBD.X415.(1) Spring 2018

Final Project Presentation: Temperature Monitoring System For A Microclimate Or Greenhouse

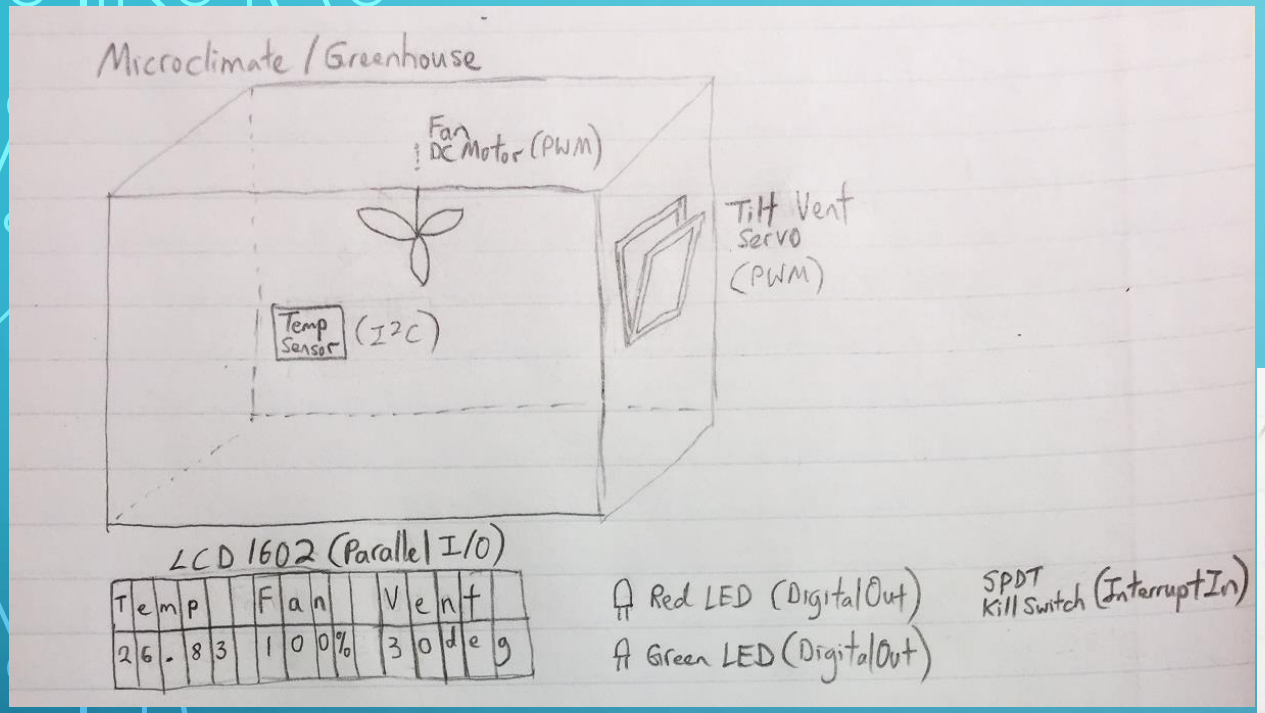
Student: Kam-Mun Foo

Instructor: David Wachenschwanz

Date: June 16, 2018

Final Project Proposal

Temperature Monitoring System For A Microclimate Or Greenhouse

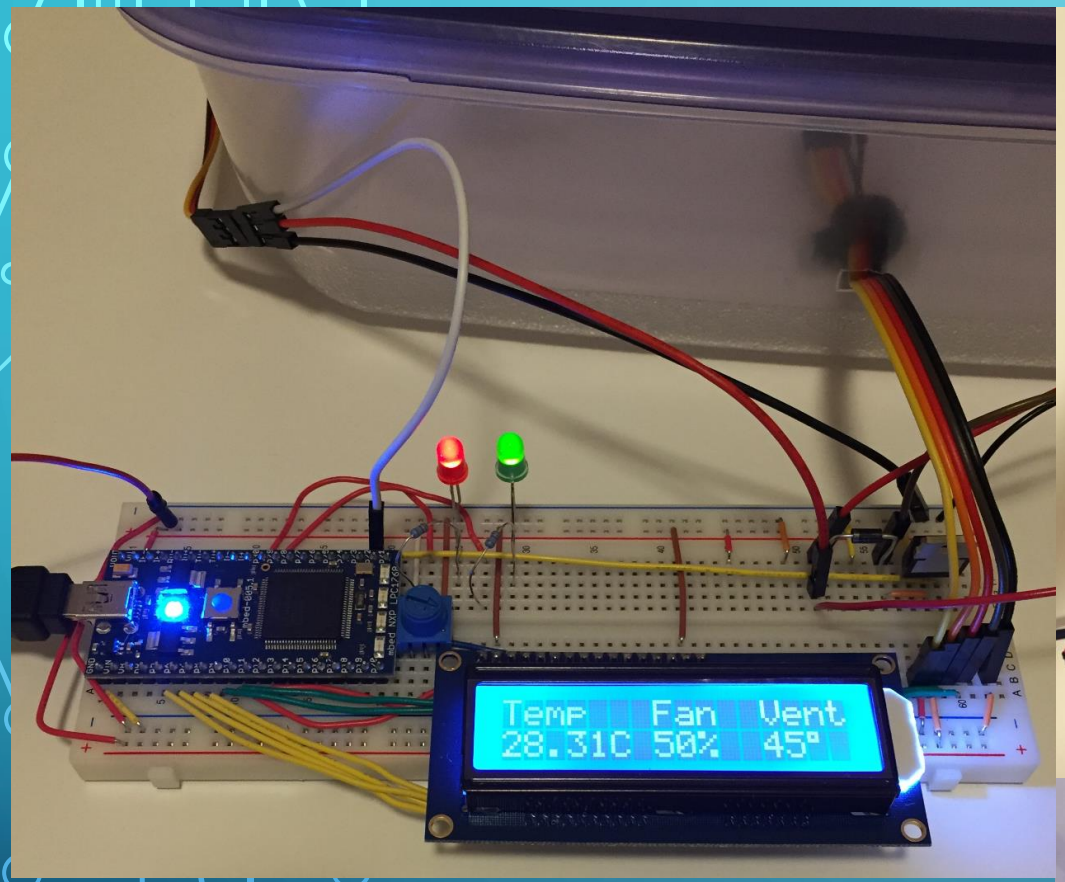


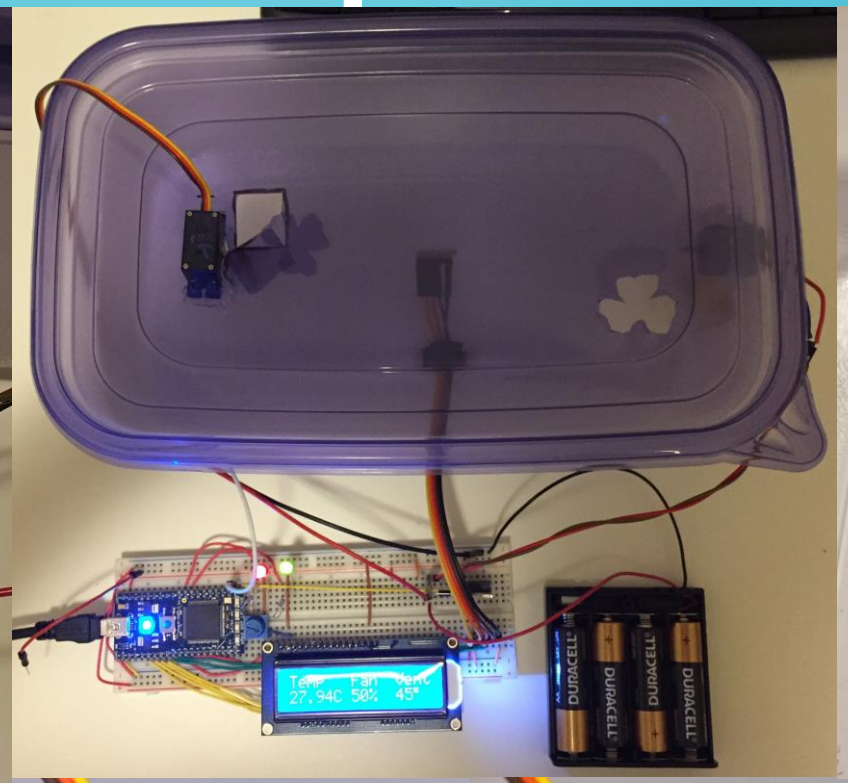
Program Pseudocodes:

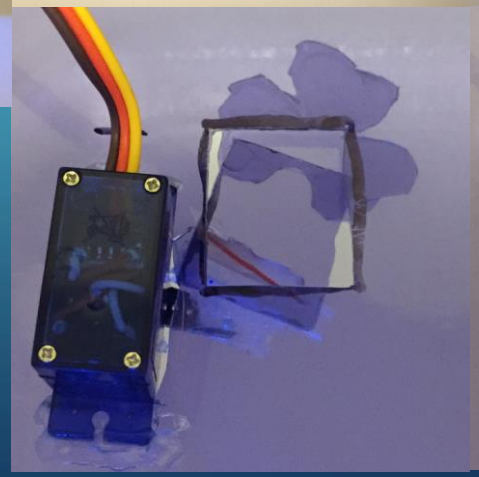
Interrupt Triggered
Fan OFF; Vent 0°;
Green LED 0.1s 0.1s
Red LED 0.1s 0.1s

Temp < 20
Fan OFF; Vent 0°; Green LED 0.1s 0.1s
Temp >= 20 && Temp < 25
Fan 25% DC; Vent 15°; Green LED 1s 1s
Temp >= 25 && Temp < 30
Fan 50% DC; Vent 30°
Temp >= 30 && Temp < 35
Fan 75% DC; Vent 45°; Red LED 1s 1s
Temp > 35
Fan 100% DC; Vent 60°; Red LED 0.1s 0.1s

Hardware Setup







Aspects of Embedded Systems Design

- I^2C: TMP102 Temperature Sensor
- InterruptIn: Kill Switch For Emergency Shutdown
- DigitalOut 6x: Status LEDs
- PwmOut 2x: Servo (Vent), DC Motor (Cooling Fan)
- Serial: Emulation Terminal Status Display
- TextLCD (parallel): Status Display

Firmware Components

- **Modular Codes, Modular Functions, Multiple Files:**
- **Debounce:** Timer, Debounce_Setup()
- **I²C:** TMP102_Setup(), TMP102_Sample()
- **InterruptIn:** ISR_Setup(), ISR_rise(), ISR_fall()
- **LED:** LED_Reset()
- **OperationStates:** StateInit(), StateTooCold(), StateCold(), StateNormal(), StateHot(), StateTooHot(), StateEmergency(), StateResume()
- **PWM:** Fan_Setup(), Servo_Setup()
- **Serial:** Serial_Setup(), Serial_Print()
- **TextLCD:** TextLCD_Print()

Main Function

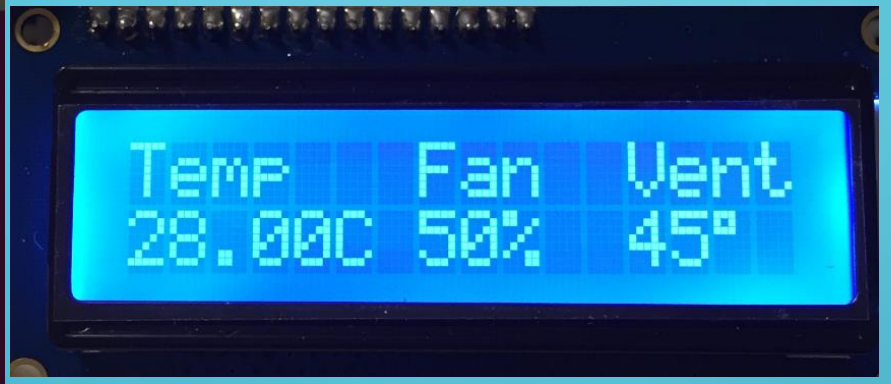
```
int main()
{
    StateInit();

    while (1)
    {
        if (!emergency_flag)
        {
            Red_Green_LED_Reset();
            while (!emergency_flag && temp < 20.0)
                StateTooCold();
            Red_Green_LED_Reset();

            while (!emergency_flag && temp >= 19.0 && temp < 25.0)
                StateCold();
            Red_Green_LED_Reset();

            while (!emergency_flag && temp >= 24.0 && temp < 30.0)
                StateNormal();
            Red_Green_LED_Reset();

            while (!emergency_flag && temp >= 29.0 && temp < 35.0)
                StateHot();
            Red_Green_LED_Reset();

            while (!emergency_flag && temp >= 34.0)
                StateTooHot();
            Red_Green_LED_Reset();
        }

        else
        {
            while (emergency_flag)
                StateEmergency();
            StateResume();
        }
    }
}
```

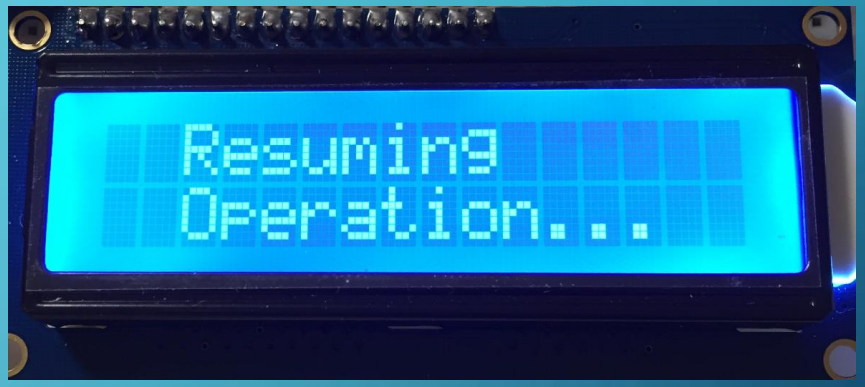
Terminal and LCD Displays

kfoo@kfoo-VirtualBox: ~

File Edit View Search Terminal Help

```
Temperature = 32.75 degC
Fan Duty Cycle = 75 %
Vent Angle = 60 deg

Temperature = 32.94 degC
Fan Duty Cycle = 75 %
Vent Angle = 60 deg

Temperature = 33.00 degC
Fan Duty Cycle = 75 %
Vent Angle = 60 deg

Temperature = 33.12 degC
Fan Duty Cycle = 75 %
Vent Angle = 60 deg

Temperature = 32.50 degC
Fan Duty Cycle = 75 %
Vent Angle = 60 deg

Temperature = 32.31 degC
Fan Duty Cycle = 75 %
Vent Angle = 60 deg
```





Challenges

- DC motor interference with InterruptIn
- Causes InterruptIn to be triggered on rising edge when DC motor is running
- Wire on InterruptIn acts as antenna, picking up noise from DC motor (induced voltage on wire)
- Capacitors, tin foil shielding on wire and dc motor did not work
- Video demonstration

Challenges: Video Demos

- Without DC motor running to prove InterruptIn is working:
- <video to be shown in class>
- With DC motor running:
- <video to be shown in class>
- With DC motor running, wire hanging on InterruptIn:
- <video to be shown in class>
- With DC motor running, wire hanging on wiper of switch:
- <video to be shown in class>

To not use a switch to eliminate interference on wire.
Assert and de-assert a 3.3V wire manually the InterruptIn pin to simulate closing (trigger rising edge) and opening (trigger falling edge) of a switch.

Final Project Demonstration

Questions and Answers

Thank You