Dual Heater Controller

Picture (Completed Dual Heater Controller)

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EET 2278 Capstone Spring 2015

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Acknowledgments

I would like to take this time to thank the people who have helped me the most with my capstone project.

Professor Bill Russo
Sinclair Community College

Professor Nick Reeder
Sinclair Community College

Donald Peters
Sinclair Community College

Kenzie Grogean
Sinclair Community College

Professor Jack Steinmetz
Sinclair Community College

Mr. Bill Bliss
Regional Sales Manager
 Advanced Circuits

Summary

The main purpose of the Dual Furnace Controller is to automatically alternate between two different furnaces. The secondary purpose of the Dual Furnace Controller is to record run times, inside and outside temperatures and with an operators input calculate which furnace is the most efficient at certain conditions.

Introduction

The Dual Furnace Controller was an idea that came to me about three years ago when I moved into my current home. When I move into my current location the home came with two heat sources. The first and main heat source was a #2 fuel oil burning boiler which would transfer heat though a system of baseboard radiators. The second heat source was a typical forced air propane furnace. The previous home owner had removed the secondary propane heat from the system and was only utilizing the boiler system for heating the home. Due to the sky rocketing fuel prices after the home was purchased I wanted a way to run both furnaces during the winter months. The first system I installed was a basic ON-OFF-ON switch that would allow me to manually turn either the main furnace or the secondary furnace on with the flip of a switch. This system worked well for the first year, the only down side of the this first system was that the switch was located in the basement and any time that I wanted to switch to a different furnace it had to be done manually.

So the idea came to me one day to use a microcontroller to control the switching of the two units. The more I thought about the idea of using a microcontroller to automatically alternate between the two units the more options I thought about putting in the system. One of the secondary ideas of the microcontroller was to record the run time of each furnace, the inside and outside temperatures, and the price of each of the fuels (entered by the operator) and use this information to calculate which furnace is the most efficient at different times of the winter season.

Principles of Design

That main factor that brought the Dual Furnace Controller to fruition was the Arduino microcontroller. Because I had been working with the Arduino on simple hobby projects made my decision to use this small versatile microcontroller a simple one. The Arduino could monitor the thermostat installed in the home then using a couple relay the Arduino could alternate the relays to fire the intended furnace. One of the main principles learned while doing this project was the process of using pull up or down resistors. In the beginning phases of testing the breadboard unit I was finding that the Arduino was not always seeing the thermostat change from a low signal to a high signal, however with a little research I found that the thermostat would need a pull down resistor so the microcontroller would constantly see the high signal from the thermostat.

Design Details

Circuit Diagram
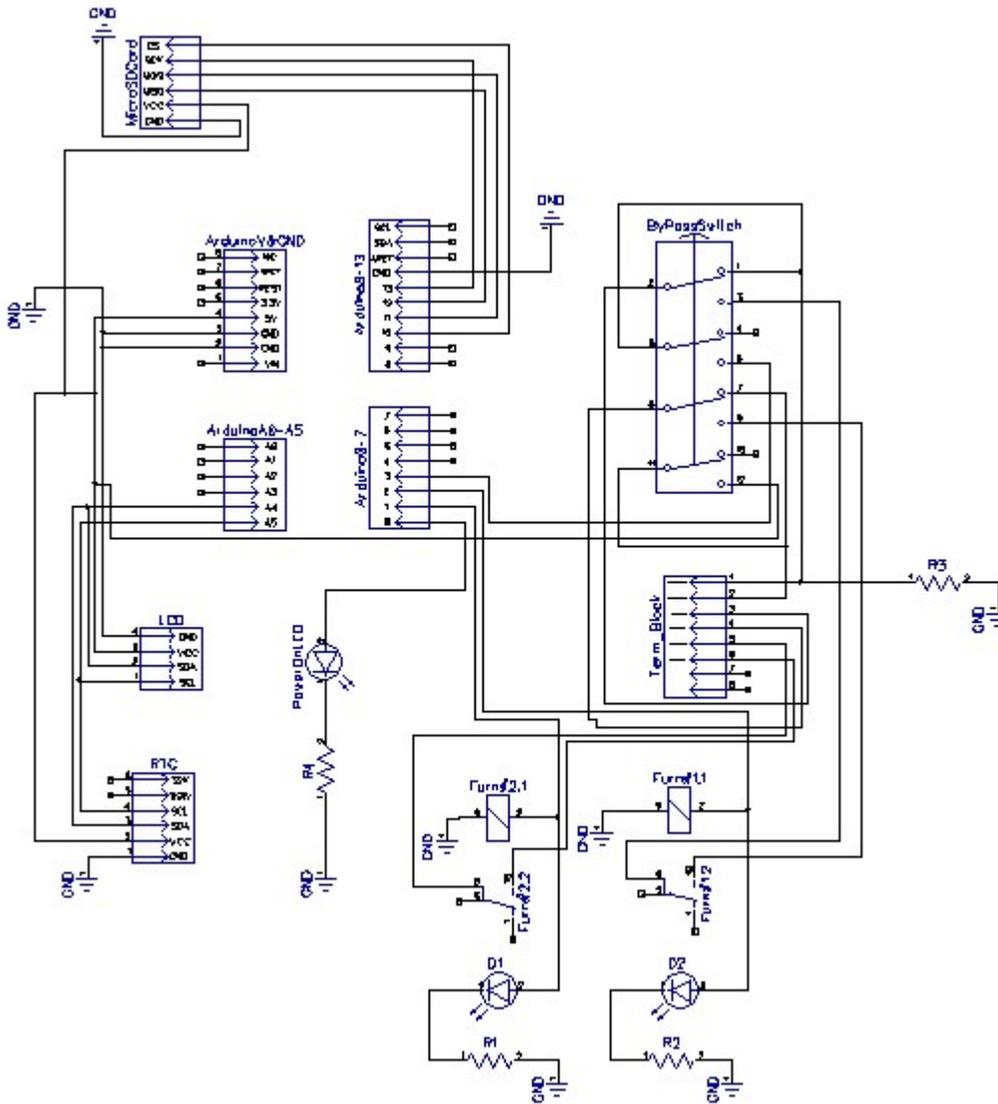
Construction

The construction of the project began with the main part of the circuit, the Arduino. The rest of the circuit was built around the Arduino and that is how it was bread boarded and tested. From the beginning of the project I knew that I would need two small relays so the Arduino could acquire a signal from the thermostat and then turn on the appropriate relay. A small 16 X 2 LCD screen was added so the system could output information quickly to the user. The next item to be added to the circuit was a small but complex "bypass" switch. The bypass switch would allow the user to completely bypass the controller in case of failure. Failure of the controller would disable the thermostat from turning on either of the two furnaces, so the bypass switch allows direct access from the thermostat to the main furnace when the switch is in the manual mode. The final piece of hardware for the main circuit that would be needed for the controllers' circuit was a connection point to the world. Some type of quick disconnect would be needed so the thermostat and the two furnaces could be connected to the controller. The next pieces of hardware added to the circuit was a real time clock and an SD slot adaptor, these units are both secondary in nature to the controller. Neither of these units are needed for the main function of the board but are "options" for future use. The real time clock will be used to record on and off run times of each of the two furnaces, so that efficiency can be calculated. The SD storage card unit was added in case any information needed to be stored by the Arduino. Both of these units are prebuilt units that only need four connection points on the future circuit board and were relatively inexpensive, so it was a cheap option to add more value to the controller. The circuit was built, programmed, tested, and improved on the breadboard. Once the system tested well on the breadboard the circuit schematic was designed using Dip Trace. Once the circuit schematic was finished that was used to design the final circuit board layout using Dip Traces PCB. The PCB board files were then sent to Advanced Circuits (4pcb.com). Advanced Circuits then used the top mask, lower mask, and the hole location file to produce the circuit board. Once the design of the circuit board was finalized the enclosure was started. The enclosure started out as a typical enclosure from Radio Shack, but since so much work and effort went into making the circuit board it would be a nice idea to show off the controller as much as possible so and new enclosure was designed and built. This new enclosure would mimic a more typical size of enclosure for the controller and it is made of 1/4" thick clear Polycarbonate or Lexan. The clear Polycarbonate lets anyone see the circuit board and components that are inside of the case instead of hiding all of the work that had been put into the project.

Construction update:

Due to mistakes with the circuit board and time constraints the circuit board portion of the project had to be put on hold so that the project could be presented on time.

Operation

The first thing that should be done when using the Dual Furnace Controller is to mount the controller in a location that will allow ease of access to the controller and ease of installation. The Dual Furnace controller will need to be located close to an outlet for power up. The unit will also need to be located somewhere close to the two furnaces to allow ease of installation. Once the controller is mounted the thermostat should be wired into the unit. Once the thermostat is wired into the unit then the two furnaces should be wired to the controller to allow the controller access to the furnaces. Once the controller is wired to the thermostat and the two furnaces the unit can be plugged in to the wall outlet. Once the unit is plugged in the unit will power up and the LCD screen will come on and go through a few setup screens. Once the unit goes through the first few set up screens the unit will be ready to go. Check the bypass switch to see if the switch is in manual mode or automatic mode. If the switch is in automatic mode then when the thermostat calls for heat the controller will turn on the main furnace (the main furnace is determined by which furnace is wired into the main location of the controller). The controller will then begin to alternate between the two furnaces with each time the thermostat calls for heat. If the bypass switch is set to manual mode the controller is in bypass mode and the thermostat will fire the main furnace every time. The bypass mode eliminates the controller from the system allowing the thermostat complete control of the main furnace. If the controller were to fail the user could switch the bypass switch into manual mode which will allow for original operation of the system.

Recommendations

My recommendations for future capstone projects would be if a circuit board is going to be part of the project, start working with the software immediately. Get to know the software as soon as possible. Also with using a circuit board check with online manufactures of circuit boards and their technical support. Some of the online company's technical support can help with manufacturing tips. Check with these online circuit board manufactures to get a circuit board produced as well. I found that if time is not an issue the price of low quantity circuit board production is quite reasonable.

My second recommendation for future capstone projects is to hit the ground running once the project is known. DONT PROCRASTINATE!!!!!

Addenda

Arduino Program used for the Dual Furnace Controller

```
/*
Dual Heater controller CapStone Project
*/

#include <Wire.h> // wire library allow arduino to comunicate using I2C
#include <LiquidCrystal_I2C.h> // LiquidCrystal library allows the Arduion to us I2C to comunicate with
the LCD

LiquidCrystal_I2C lcd(0x20, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE); // Sets the LCD I2C address

int LED = 13;  //Initializing pin 13 to LED.
int therm = 12;  //Initializing pin 12 to therm.
int furn1 = 11;  //Initializing pin 11 to furn1.
int furn2 = 10;  //Initializing pin 10 to furn1.
int disp = 9;
int disp1 = 8;
boolean prevtherm = 1;  //Seting up prevtherm = previous thermostat state.
boolean thermchoice = 0;  //Seting up thermchoice = which furnace to choose.

void setup ()
{
  pinMode (LED, OUTPUT);  //Seting up LED as an output.
  pinMode (therm, INPUT);  //Seting up therm as an input.
  pinMode (furn1, OUTPUT);  //Seting up furn1 as an output.
  pinMode (furn2, OUTPUT);  //Seting up furn2 as an output.
  pinMode (disp, OUTPUT);   //Seting up disp as an output.
  pinMode (disp1, OUTPUT);  //Seting up disp1 as an output.

  digitalWrite (LED, HIGH);  //Turns on LED for power on indication

  lcd.begin(20,4);  //Initializing the LCD as a 20 by 4 LCD screen.

  for (int i = 0; i< 3; i++)  // for loop for the blinking back light at start up.
  {
   lcd.backlight(); //Turns LCD backlight on.
   delay (250);  //Keeps LCD backlight on for 250ms.
   lcd.noBacklight();  //Turns LCD backlight off.
   delay(250); //Keeps LCD backlight off for 250ms.
  }
```

```
    lcd.backlight(); //finish with backlight on

    lcd.setCursor(0,0);  //Sets LCD cursor to positions.
    lcd.print("Dual Heat Control");  //LCD print.
    delay(1000);  //Holds the "Dual Heat Control" statement on for 1000ms.
    lcd.setCursor(0,1); //Sets LCD cursor.
    lcd.print("By Jeff Lipscomb");  //LCD print.
    delay(8000);  //delays LCD screen for 8000ms.
    lcd.noBacklight();  //turns backlight off.
    lcd.clear();  //clears LCD screen.


}

void loop ()
{

 if (digitalRead (therm) == HIGH && prevtherm == 0)
  {
    prevtherm = 1;

    if (thermchoice == 1)
     {
      digitalWrite (furn1, HIGH);
      lcd.backlight();
      lcd.setCursor (0,0);
      lcd.print ("Main Heater ON");
      delay (5000);
      lcd.clear();
      lcd.noBacklight();
     }
     else
     {
      digitalWrite (furn2, HIGH);
      lcd.backlight();
      lcd.setCursor (0,0);
      lcd.print("Heater #2 ON");
      delay(5000);
      lcd.clear();
      lcd.noBacklight();
     }
  }

 if (digitalRead (therm) == LOW && prevtherm == 1)
```

```
{
    //digitalWrite (disp, HIGH);
    //delay (500);
    //digitalWrite (disp, LOW);

 digitalWrite (furn1, LOW);
 digitalWrite (furn2, LOW);
 prevtherm = 0;
 thermchoice = !thermchoice;

}

    digitalWrite (disp1, HIGH);
    delay (500);
    digitalWrite (disp1, LOW);

    if (thermchoice == 1)
    {
     digitalWrite (disp, HIGH);
     delay (1000);
    }
    else
    {
     digitalWrite (disp, LOW);
     delay (1000);
    }


}
```