Mechatronics Final Project

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Boiler Room Early Warning
Motoring system
&
Hand Held Boiler Diagnostic Temperature Sensor
Boiler Room
Hot water Boiler
Early Warning System

• The BS2 will be used to monitor some of the common problems that plague boiler rooms across the country
  • Pilot light failure
  • Dirty boiler Water
  • Pressure Problem /Leaking valves
  • Human tampering
Making Sure the Heat Stays on

• Boilers are complicated systems that often break down
• Many problems are mechanical in nature
• While others are do to human tampering
The Pilot Assembly Problem

• The most common problem with a Gas boilers is a broken thermocouple in the pilot assembly
• If the Thermocouple does not sense a pilot light the boiler cant turn on and there will be no heat
• There is no way to know the pilot is out until the house is cold
Thermocouple
The Solution

• To insure that a faulty thermocouple can be replaced in a timely manner an early warning system must be used

• Therefore we propose using a photo resistor to monitor the pilot light

• Early detection of the problem reduces the chance of greater problems
Pilot Assembly
'Pilot assembly check
HIGH 15
PAUSE 100
RCTIME 15, 1, Inputtime
DEBUG HOME, "Light = ", DEC4 Inputtime
IF (200<Inputtime) THEN
HIGH 5
HIGH 1
    GOSUB A
ENDIF
The Dirty Water Problem

- Another common problem is rusty water in the boiler
- This cuts down boiler efficiency
- This means that you have to pay more to heat your house
- Therefore clean water in your boiler saves you money
Dirty Water

• Over time the water in your boiler collects rust

• This rusty water is harder to heat than clean water
The Dirty Water Solution

• We will use a Photo resistor and an LED to monitor the water color in the boiler

• When the water is dirty a motor will be used to open the drain valve and change water

• The Photo resistor LED combination will be attached to the Gauge glass of the boiler to monitor the water
Gauge glass
Solenoid Valve

Grainger Item
Price $ $125.39
24V control
Normally closed valve
Only open when power is supplied
Drives Closed when power if turned off
Solenoid Valve Hook up

- Normally open Switching relay
- Therefore the BS2 could control the high load 24V Motor
Water Monitoring Code

```
'Water Check
'LED ON

HIGH  13
HIGH  2
PAUSE 100
RCTIME 2, 1, Inputtime
IF (50<Inputtime) THEN

|SUB A
DEBUG HOME, CR
DEBUG "Light = ", DEC4 Inputtime
IF number <2 THEN
HIGH  6
FOR i=0 TO 90
PULSOUT 14,500
PAUSE 20
NEXT
PAUSE 1000
FOR i=0 TO 90
PULSOUT 14,1000
PAUSE 20
NEXT
PAUSE 100
number=number+1
ELSE
HIGH  9
ENDIF
LOW  6
ENDIF

DEBUG HOME, CR
DEBUG "light = ", DEC4 Inputtime
```
The Pressure Problem

• A Pressure problem in the boiler is usually a symptom of a larger problem
• Early Detection of a pressure problem can prevent unnecessary wear on your system
• Pressure Problems are tricky because most people don’t know there is a problem until there is big problem
Expansion Tank

- Compensates for the fact that water expands as its heated.
- Once the bladder in the tank breaks there will be a pressure problem.
- A faulty expansion tank will eventually lead to greater problems.
- Causes the pressure relief valve to open.
Pressure Relief Valve

- The Pressure Relief valve is a safety valve
- It is spring loaded
- Above a certain pressure the valve opens
- This prevents the boiler from exploding if there is too much pressure
Solution to the Pressure Problem

- Use a Humidity sensor to monitor the humidity at the pressure relieve valve.
- If the Pressure Relief valve is blowing water than the expansion tank may have ruptured.
HS1101- Humidity Sensor

'Humidity
RHconstant CON 12169
HIGH 0
PAUSE 1
RCTIME 0,1, Inputtime
Inputtime=Inputtime*100
Inputtime = (Inputtime-RHconstant)/24
IF (Inputtime >60) THEN
HIGH 8
HIGH 1
GOSUB A
ENDIF

DEBUG HOME, CR ,CR
DEBUG "relative Humidity = ", DEC Inputtime, "%"
PAUSE 1000
The Human tempering problem

• Many tenants like to temper with the thermostat to try to get more heat
• This often ends up back firing and causing the house to become too hot
• Also raising the heat very high during the winter months costs a lot of money
• This can also cause unnecessary wear and tear on your system
Thermostat lock box

- Many landlords use lock boxes to try to secure the thermostat
- However the lock box key is universal and easily obtained
The Solution

- A simple alarm system using the BS2 to try to catch a person in the act
- Using a normally close button on the inside of a lock box as a simple alarm
- When the box is opened a signal is sent to the landlord
Lock Box with Alarm
Alarm Code and Circuit

'Alarm Box

IF IN12=0 THEN
HIGH 7
FREQOUT 11 ,1500, 2000
ELSEIF IN12=1 THEN
ENDIF

\[ \text{Diagram of alarm circuit} \]
The display panel consists of a series of LEDs, speakers and two buttons. The LED will light according to which alarm has been tripped in the system. The LED will stay on until the reset button has been pressed by the user. Also the Speakers will sound until the mute button is pressed by the user.
Hand Held Digital Sensor
Hand Held Boiler tester

• Temperature can tell you a lot about how your boiler is running

• Temperature drops in certain places can help you understand what is going wrong with your boiler
Diagnostic Temperature Sensor Components

- Infrared Temperature Sensor
- LCD Display
- BS2 Homework Board
- Bread board
- Sensors
The boiler header

- The boiler header is the pipe that comes out of the boiler and supplies the hot water to the system
- The header can be broken into two parts
- Before the flow control
- After the flow control
Flow Control
Flow Control

- Flow Control only opens when the circulator pump is on.
- Therefore you can check if the circulator is running by checking the flow control.
Circulator pump
Circulator pump

- On the left is a picture of the most commonly used residential circulator pump
- They run extremely quite
- They are completely sealed
- Therefore it is almost impossible to tell if they are running
Testing the Circulator

- Use the BS2 and a temperature sensor to take non-contact temperature measurements.
- Reading one is taken between the outlet of the boiler and the flow control.
- Reading two is taken after the flow control.
- By comparing the two values, you can know if the circulator is working.
Testing the Circulator

- Reading one is taken between the outlet of the boiler and the flow control
- Reading two is taken after the flow control
- By comparing the two values you can know if the circulator is working
The three possible Outcomes

• Temp1 = Temp 2
• This means the circulator and flow control are working correctly
• Temp1 > Temp2
• This means either the circulator or flow control are not working correctly
• Temp1 < Temp2
• The readings are faulty and you must try again
Circulator Tester code

- IF (temperature < temperature2-2) THEN
  - PAUSE 100 ' Pause for Serial LCD to initialize
  - SEROUT 12, Baud19200, [$0C] ' clear
  - SEROUT 12, Baud19200, ["error TEST Again"]
  - 'SEROUT 12, Baud19200,[$94]
  - 'SEROUT 12, Baud19200, ["test again"]
  - PAUSE 6000
  - LOW 4
  - GOTO Main
- ELSEIF (temperature > temperature2+2) THEN
  - PAUSE 100 ' Pause for Serial LCD to initialize
  - SEROUT 12, Baud19200, [$0C] ' clear
  - SEROUT 12, Baud19200, [" Circulator OFF"]
  - 'SEROUT 12, Baud19200,[$94]
  - 'SEROUT 12, Baud19200, ["Check FC"]
  - PAUSE 6000
  - LOW 4
  - GOTO Main
- ELSE
  - PAUSE 100 ' Pause for Serial LCD to initialize
  - SEROUT 12, Baud19200, [$0C] ' clear
  - SEROUT 12, Baud19200, [" CIRCULATOR WORKING"]
  - 'SEROUT 12, Baud19200,[$94]
  - 'SEROUT 12, Baud19200, [" Check elsewhere"]
Steam Trap

- Keeps Steam in your heater and out of your return lines
- Hot steam causes the trap to close
- Cooler steam will cause the trap to open
- When the trap malfunctions the efficiency of your system drops significantly
Testing a Steam Trap

- Testing Input and output temperatures of the steam trap
- The temperatures will tell you if the steam trap is functioning
The three possible Outcomes

• Temp1 = Temp 2
• This means that the steam trap is malfunctioning
• Temp1 > Temp 2
• This means the steam trap is working correctly
• Temp1 < Temp 2
• The reading are faulty and you must try again
Steam Trap Code

- IF (temperature < temperature2-2) THEN
- PAUSE 100 ' Pause for Serial LCD to initialize
- SEROUT 12, Baud19200, [$0C] ' clear
- SEROUT 12, Baud19200, ["error"]
- SEROUT 12, Baud19200, [$94]
- SEROUT 12, Baud19200, ["test again"]
- PAUSE 6000
- LOW 4
- GOTO Main

- ELSEIF (temperature > temperature2+2) THEN
- PAUSE 100 ' Pause for Serial LCD to initialize
- SEROUT 12, Baud19200, [$0C] ' clear
- SEROUT 12, Baud19200, ["Steam Trap good"]
- PAUSE 6000
- LOW 4
- GOTO Main
- ELSE
- PAUSE 100 ' Pause for Serial LCD to initialize
- SEROUT 12, Baud19200, [$0C] ' clear
- SEROUT 12, Baud19200, ["Steam Trap Fail "]
- PAUSE 6000
- LOW 4
- GOTO Main
- ENDIF
Testing a Zone Value

- This same test can be used to test zone values as well
- Zone values work on the same concept as the flow control
- However they are opened and closed by a motor
Humidity Sensor

- Take readings of humidity around the boiler room can expose potential problems
- For Example a leaking hot water heater
Taking Temperature Readings

• Taking Temperature readings inside and outside of the boiler room can be very useful

• Taking temperature reading at all the radiators can tell you how the system is working

• Also taking temperature readings at the hot water heater can prevent scalding
Continuity Tester

• Can Be used to test all the Safety switches on your boiler
• Can also be used to Check for Proper Thermostat operation
• Thermostat test
Boiler Control Loop
Diagnostic  Temperature Sensor

Main:
DO
LOW 4
LOOP UNTIL IN11=0 AND IN10=0
DIRL = $11111111
TxPin CON 0
Baud19200 CON 32

DO
HIGH TxPin ' Set pin high to be a serial port
PAUSE 100 ' Pause for Serial LCD to initialize
SEROUT 12, Baud19200, [$0C] ' clear
SEROUT 12, Baud19200, [" Check Boiler B1"]
SEROUT 12, Baud19200, [$94]
SEROUT 12, Baud19200, ["next option B2."]

PAUSE 10
IF IN11=1 THEN 'Check Boiler B1
GOTOC A
ELSEIF IN10=1 THEN 'NEXT opition
GOTOC B
ENDIF

LOOP 'UNTIL IN11=1 OR IN10=1 ' Waits FOR the ON BUTTON TO be pushed'

A: 'Check Boiler Ciculator

DO
LOOP UNTIL IN11=0 AND IN10=0
SEROUT 12, Baud19200, [$0C] ' clear
SEROUT 12, Baud19200, ["Ti U FC T2 O FC."]
SEROUT 12, Baud19200, [$94]
SEROUT 12, Baud19200, ["Press Button 1 ."]
DO
LOOP UNTIL IN11 =1

'GOSUB M
# Price List

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<th>SERIAL NO.</th>
<th>ITEM NAME</th>
<th>QTY</th>
<th>UNIT PRICE</th>
<th>AMOUNT</th>
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Conclusion

We utilized the BS2 to achieve the purpose of our project. We made use of the available low cost sensors and circuits to monitor a Boiler system.