A SMART METHOD FOR AUTOMATIC TEMPERATURE CONTROL

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ABSTRACT

The main challenge and aim of the present work is to monitor and control the temperature in a limited environment i.e, to maintain the living room temperature at a predefined specific level with the use of the present method. A ON/OFF controller is designed to measure temperature and the LABVIEW virtual instrument is used to control the temperature and ensure that the temperature does not go beyond a certain set point. Feedback control is used by industry to regulate a variety of processes and systems. This paper describes the design and development of a feedback control system that maintains the temperature of a process at a desired set point given by user. The present system consists of a PC-based data acquisition unit using NI LABVIEW software that provides input and output interfaces between the PC and the sensor circuit and hardware. The paper consists of the sensor module, detail signal conditioning, the data acquisition unit, shows the implementation of the controller and the result of the on-off controller.

Keywords : Data Acquisition, NI -LABVIEW, Resistance Temperature Detector,Temperature-Monitoring, Temperature -Control, , Temperature Control Loop.

I INTRODUCTION

In the recent time, several work has been done on temperature control. Temperature monitoring and control is an important part in home automation. A various technique has already been established for temperature monitoring and controlling. In the present work a modern technique has been adopted for this purpose. There are several temperature sensors used in temperature measurement. They are RTD, Thermocouple, Thermistors etc. For the present temperature monitoring purpose Resistance Temperature Detector has been used due to some advantageous features such as its linearity, ease to assemble, high range etc.

The operating range of the RTD'S is from -250^0C to 1000^0C [1], and their accuracy is very high. Thermistors have the negative temperature coefficient. Their sensitivity is very high. The resistance versus temperature characteristics of the thermistors is highly non-linear. Resistance of the Thermistor is very high as compared to the RTD's, so error due to lead resistance in Thermistors is small. Thermocouple is a temperature measuring device, which is based on the principle of Seeback effect. According to the Seeback effect " when the two

dissimilar metals are joined together, an emf will exist between the two points A and B which is a function of the junction temperature," Thermocouples are typically used up to a temperature of about 1400^0C.

Order of sensitivity: Thermistors ›RTDs › Thermocouple

Order of linearity: RTDs › Thermocouples › Thermistors

For the present work platinum RTD has been chosen because of its good linearity, resistivity, chemically inertness, accuracy. Here for controlling and monitoring purpose NI LABVIEW has been used which is more advantageous than others. By using NI LABVIEW it is very much easier to implement the comparator circuit, display circuit in place of electronic circuitry. A ON/OFF controller has been designed to measure temperature and the NI LABVIEW has been used to control the temperature and ensure that the temperature does not go beyond a certain set point.

II DETAIL OF NI LABVIEW AND DATA ACQUISITION

NI LabVIEW TM (Laboratory Virtual Instrument Engineering Workbench), a product of National Instruments TM, is a versatile powerful software system that accommodates data acquisition, instrument control, data processing and data presentation. LabVIEW graphical programs, called Virtual Instruments, contains a Front Panel and a Block Diagram. Front Panel has various controls and indicators while the Block Diagram consists of a variety of functions. It manages data acquisition, analysis and presentation into one system. Data acquisition is the process of acquiring an electrical or physical phenomenon such as voltage, current, temperature, Accoustic energy, pressure with a computer. A DAQ system consists of a DAQ card or sensor module , hardware from which data is to be acquired and a computer with associated software. NI USB-6363 DAQ can be used to get data related to impulse voltage which require very high accuracy. Sampling rate of this card is 2MS/s[2]

III BLOCK DIAGRAM

3.1 Temperature control loop (closed loop control)

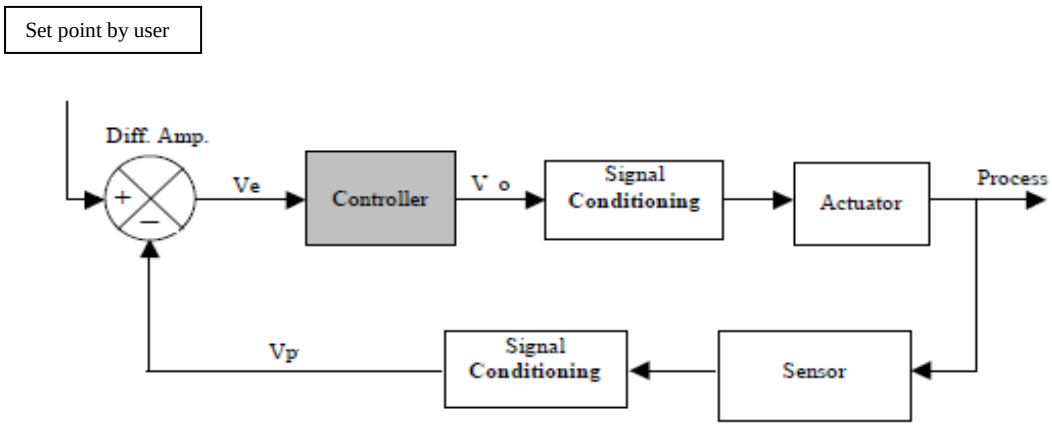


Fig.1. Simplified Block Diagram of The Temperature Control Loop

3.2 System Hardware block diagram

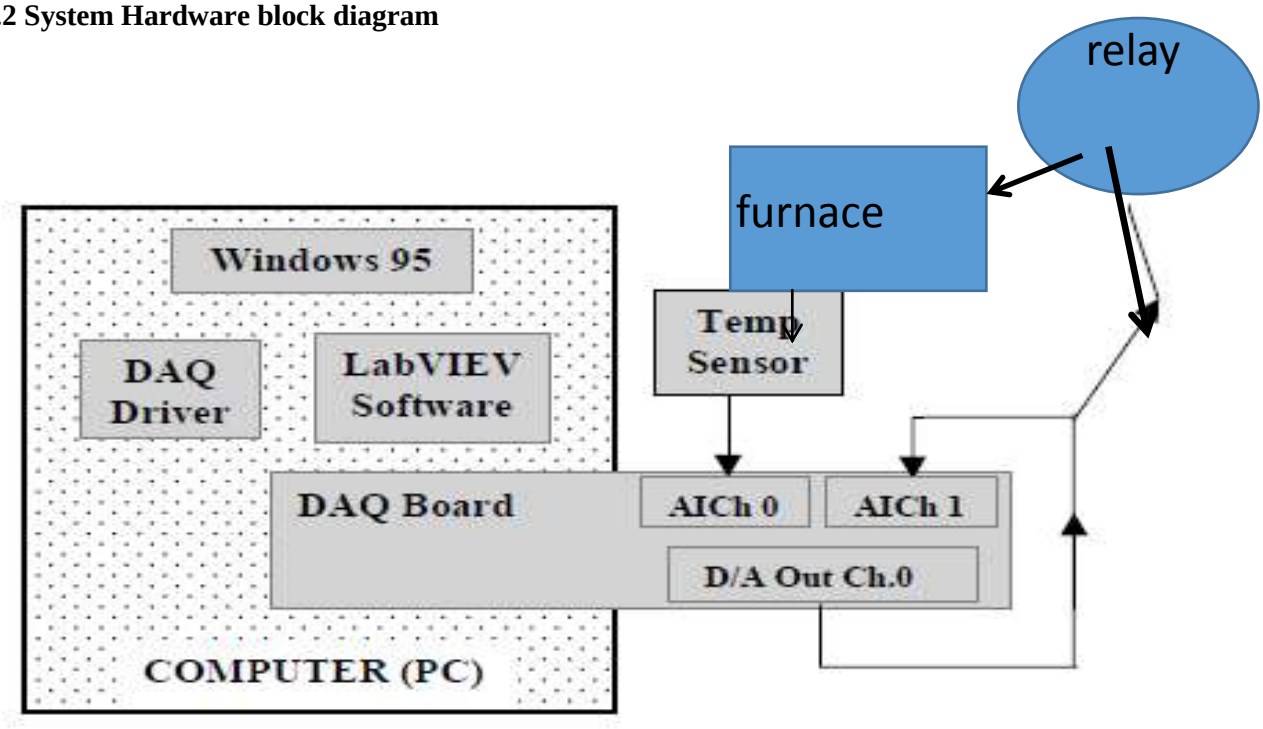


Fig2. System Hardware Block Diagram

The blocks of the above figure is described below

Process:-Furnace Temperature is being controlled and monitored here, so furnace is the process of our project.

RTD:-Resistance Temperature Detector or RTD is used as a temperature sensor. It senses the temperature according to that gives the output voltage.

DAQ:-DAQ acts as a media between the physical circuit and virtual circuit. It has several input and output ports through which it communicates between physical circuit and virtual circuit (NI LABVIEW software)

NI LABVIEW Software:- It is a software which acts like a virtual instrument. With the help of this software we can make a circuit virtually and also apply it physically. In our project we will make our comparator ON-OFF controller with help of this software.

Relay:- Here relay acts as a final control element

LED:- We use LED as a indicator.

RTD:Resistance temperature detector is one of the most accurate temperature sensors. Where precise temperature control and small temperature differences are needed, RTDs are the only solutions. Generally, three/four types of RTDs are generally used in terms of choosing materials. They are nickel, platinum, copper, tungsten. Among them platinum RTDs are mostly used because of its good linearity and inertness. Material of RTD should be pure otherwise it will deviate the conventional temperature graph. The variation of resistance of a metal with temperature can represented by the following relationship.

$R_t = R_0 (1+At +Bt^2 +Ct^3+…..)$ (1)

R_0 = Resistance at 0^0C, R_t = Resistance at t^0C, A, B, C are the constants.

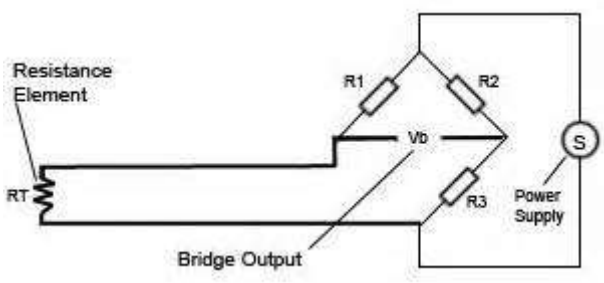
The significant characteristic of metals used as resistive elements is the linear approximation of the resistance versus temperature relationship between 0 and 100 °C. This temperature coefficient of resistance is called alpha, α. The equation below defines α; its units are ohm/ohm/°C.

$$\alpha = \frac{R_{100} - R_0}{100 R_0}$$

$R_0 =$ the resistance of the sensor at 0°C

$R_{100} =$ the resistance of the sensor at 100°C

In RTD circuits resistance changes with the change of temperature. Resistance is calibrated in terms of temperature. Here, some bridge balance circuits are used for measurement. Simple Wheatstone bridge circuit can't be used as RTD is a very sensitive element. So contact resistance of POT, temperature variations, heating effect have to be taken care of and some modifications are needed. Basically we use 3 wire RTD.

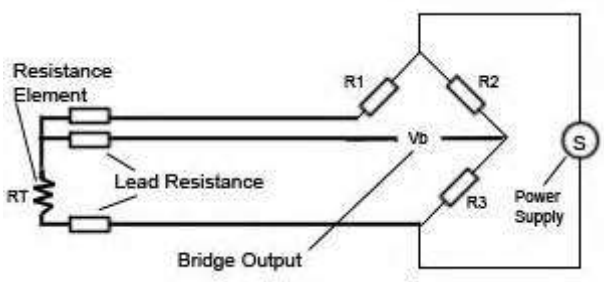


At balance condition, $R_t = (R_1/R_2) * R_3$

If $R_2=R_1$, then $R_t=R_3$

R_3 is an adjustable Potentiometer. All resistors are made of manganin in order to avoid any effect due to ambient temperature change as manganin has the lowest temperature co-efficient. Disadvantages of 2-wire RTD:

1. There is an I^2R heat loss in the RTD.
2. It's self-heating effect makes the reading erroneous. Current through RTD must be low to avoid 3-wire RTD



Three wire method is used to compensate for variable lead wire resistance. Balance bridge is obtained by adjusting the POT resistance which is calibrated in terms of temperature. The effect of contact resistance is avoided here. Each lead wire made of copper wire of the same diameter and length so that each has equal resistance.

RELAY:- Electromechanical Relay is a simple device that use magnetic field to control a switch. When a input voltage applied to the input coil, the resulting current creates a magnetic field. The magnetic field pulls a metal switch (or reed) towards it and the contacts touch closing the switch. The contact that closes when the coil is energized is called normally open(NO). The normally closed (NC) contacts close when the coil is not energized and open when input coil is energized. Normally open contacts are shown as two lines and will be open (non-conducting) when the input is not energized. Normally closed contacts are shown with two lines with a diagonal line through them. When the input coil is not energized, the normally closed contacts will be closed (conducting). Relay is used in DC source. Now days many other type of relay is used in industry like solid state relay, digital control protective relay etc. In case of solid state relay Thyristiors, Transistors are used as a switch controller and in case of digital protective relay microcontroller programming is use.

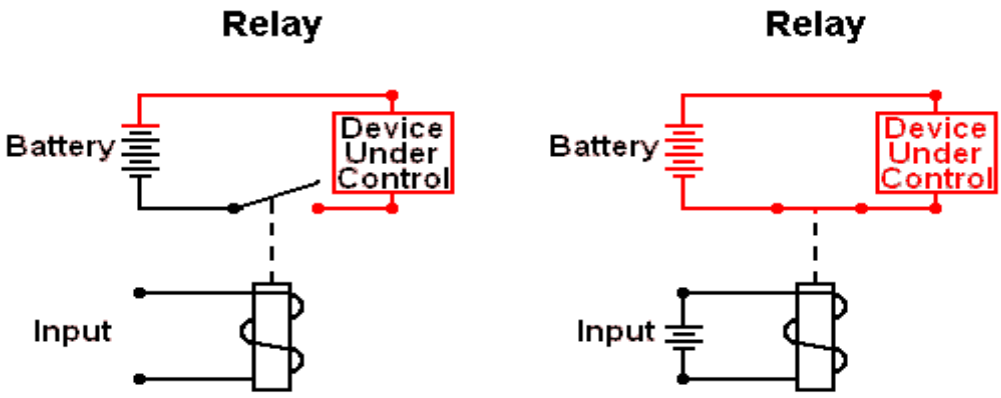


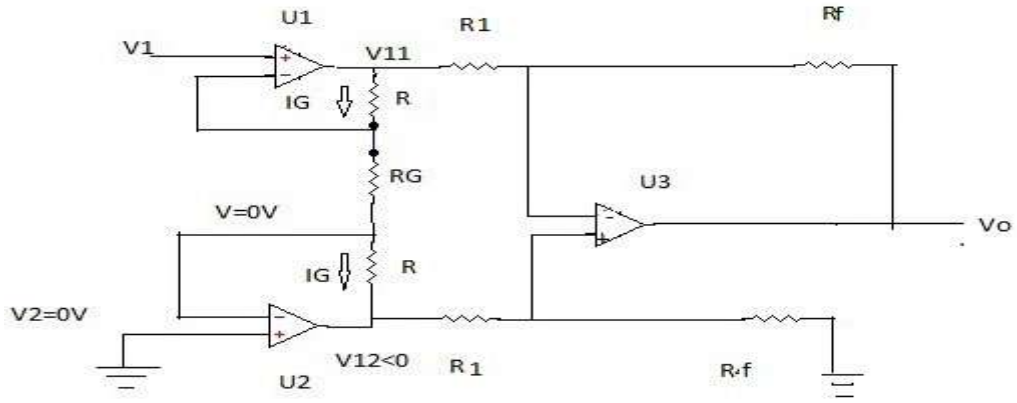
Fig.4. Relay Circuits

Instrumentation Amplifier: Instrumentation amplifiers are commonly used in environment with high common-mode noise such as in data acquisition systems where remote sensing of input variables are required.An instrumentation amplifier is a differential voltage-gain device that amplifiers the difference between voltages existing at its two input terminals . The main purpose of an instrumentation amplifier is to amplify small signals that are riding on large common-mode voltages.The key characteristics are high input impedance, high common –mode rejection , low output offset , and low output impedance . A basic instrumentation amplifier is made up of three operational amplifiers and several resistors. The voltage gain is set with an external resistor.Amplifier A_1 and amplifier A_2 are non-inverting configurations that provide high input impedance and voltage gain. A_3 is used as a unity gain differential amplifier.

$V0 = R_f / R_1 (V_2 – V_1) (1+ 2R/R_g)$

$Ad= V0/ (V_2- V_1) = R_f/R_1(1+ 2R/R_g)$

For gain 10, R_g = 220 ohm , considering all other resistances are of equal values.



IV WORKING PROCEDURE

Step 1 : The RTD has been connected to a balanced Wheatstone bridge circuit.

Step 2: When the temperature changes there will be an unbalanced voltage from the Wheatstone bridge circuit.

Step 3 : The unbalanced voltage is amplified by using an Instrumentation amplifier.

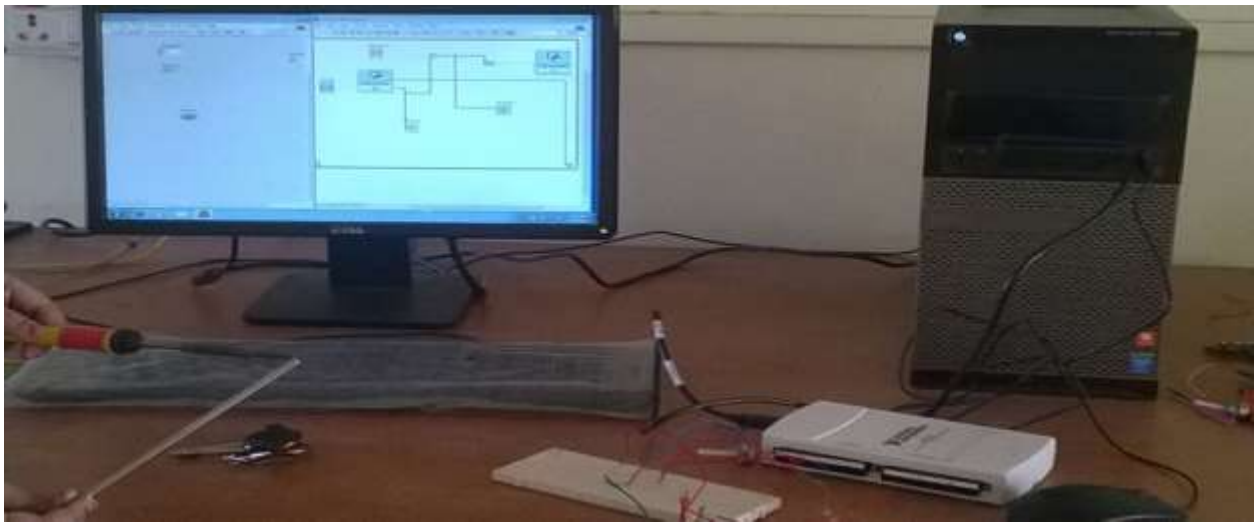
Step 4 : The output of the Instrumentation amplifier is connected to the DAQ card to the PC.

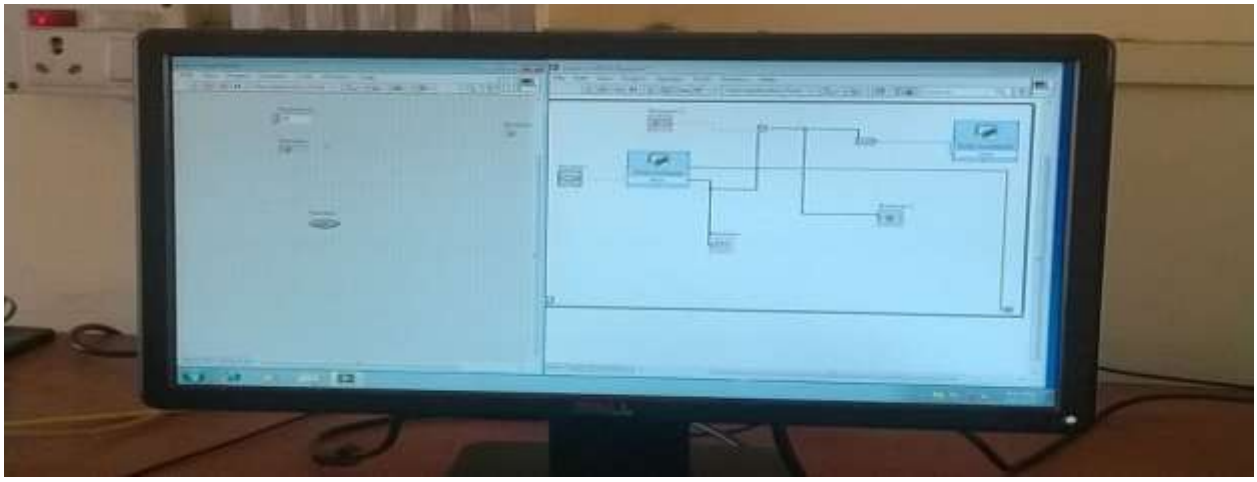
Step 5 : When the temperature was beyond the set point value then the comparator o/p in NI LABVIEW is very high.

Step 6: An LED has been connected to the o/p of the DAQ card. When comparator o/p is high , LED will be ON and when comparator o/p is low, LED will be OFF.

Step 7 : When the LED was ON, the comparator o/p has been fed back to the final control element, here an relay has been used. When relay was normally open, the power source has been cut off.

V SOME PHOTOGRAPHS OF THE PRESENT WORK





VI CONCLUSION

It was a very useful one and completed successfully. By using the NI LABVIEW virtual instrumentation temperature control has been done fruitfully.

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[2] *DESIGN OF TEMPERATURE CONTROLLERS USING LABVIEW* A Thesis Submitted for Partial Fulfillment Of the Requirement for the Award of the Degree of **Bachelor of Technology In Electronics and Instrumentation Engineering** By **ABHILASH MISHRA** Roll No: 109EI0329 & **PINAKI MISHRA** Roll No: 109EI0330 DEPARTMENT **IEEE Transaction and Journals.**