ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 4, Issue 10, October 2015

AUTOMATION OF FLEXIBLE CONTROL OF TEMPERATURE IMPLEMENTING SOFTWARE FUZZY WITH PID CONTROL

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***Abstract*— Processing provides the flexibility of integration of data acquisition software/hardware with the process control application software for automated test and measurement applications. Controlling the temperature changing range and achieving the desired temperature is a difficult process. Various controlling techniques are used to control the temperature changes of liquid heating system[1]. In this paper, an effort is made to control the design process of a temperature controlling system by implementing software fuzzy with PID controller, the parameters are adjusted to control the temperature .Design of controller by applying several methods in analyzing controlled parameters to tune parameter in order to obtain the best process response.**

***Keywords*— Arduino mega 2560 microcontroller, Fuzzy logic, PID controller,RTD, Temperature Control**

I. INTRODUCTION

Low cost temperature control using software programming of Fuzzy with PID controller. The work presents in this paper liquid temperature control system which is widely used process in the process industry[2].To design the phenomenon using PID control and Fuzzy logic for controlling the temperature value. The control objectives are to maintain the steady state temperature of the desired value and to reach the desired steady state temperature as quickly as possible, without overshooting the desired value.

II. PROCEDURE

Block diagram of Temperature control implementing software fuzzy with PID

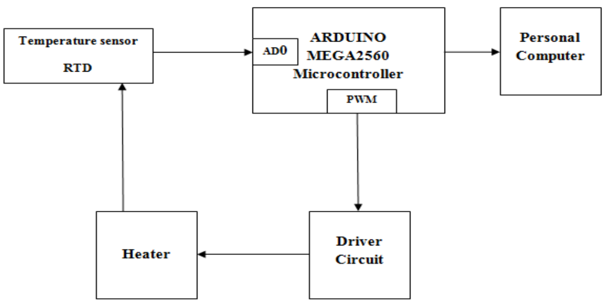


Fig 2

A. RTD

Every type of metal has a unique composition and has a different resistance to the flow of electric current. This is termed as the resistively constant for that metal. For most metals the change in electrical resistance is directly proportional to its change in temperature and is linear over a range of temperatures. In this work, RTD gives resistance for signal conditioning ,this resistance is connected to analog input which of Arduino Mega2560 microcontroller AD0 [3] which voltage is adjusted to 1.1V for improving the resolution of RTD output ,then analog voltage is converted in to digital data.

RTD Sensor

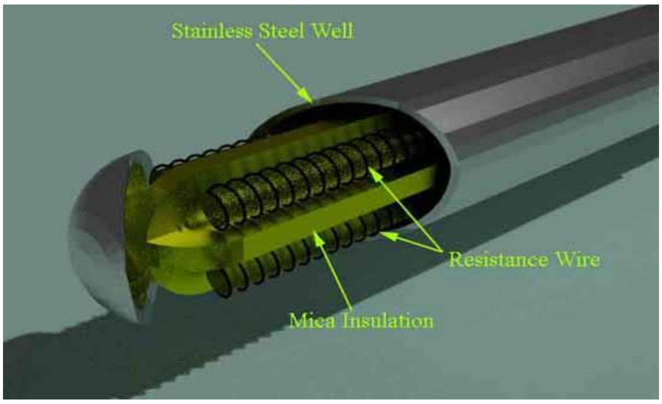


Fig 2

B. Pulse Width Modulation

The temperature system has a Heater. The heater placed in a liquid container. When current passes through the coil of the heater it gets heated and in turn raises the temperature of the liquid in a container. The amount of power which is to be delivered to heater can be assured by several methods. We are using the PWM technique. Modulation of the square wave which is in duty cycle is done by pulse width modulation action.

C. Driver circuit

Optocouplers enable you to control one circuit from another circuit with no electronic connection between the two circuits for example to control a device (switching it ON or OFF) from the Wiring harware. A TRIAC is an electronic switch capable of switching AC devices by applying a small current at the Gate, making possible to control high AC voltages.

Internally the Optocoupler has an LED , when the gate is to be HIGH the internal LED turns ON activating an internal light sensor that enables the flow of electricity between whatever is connected in the main terminal . There are different types of optocouplers but the functioning is very similar the MOC3021 is just one type and it is useful for using it with the TRIAC.

D. Arduino mega 2560 microcontroller

Microcontrollers are widely used in many commercial and industrial applications. In the present work we used Arduino mega 2560 microcontroller and it operates on +5V with 16 MHz and the final output of the level measurement after processing presented on pc. It has a number of facilities for communicating with a computer, another Arduino ,or other microcontrollers. It provides four hardware UARTs for TTL (5V) serial communication. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the board. The Arduino Mega can be powered via the USB connection or with an external power supply. The power source is selected automatically.Out of 54 Digital I/O pins 15 provide PWM output. Here the analog voltage of the ADC input can be adjusted by instruction given in the program for improving the resolution of the output of the RTD interms of digital values which are calculated the temperature and exact error for controlling the set temperature value. By giving instruction analogReference(INTERNAL1V1); in the program.

Circuit diagram of embedded based temperature control

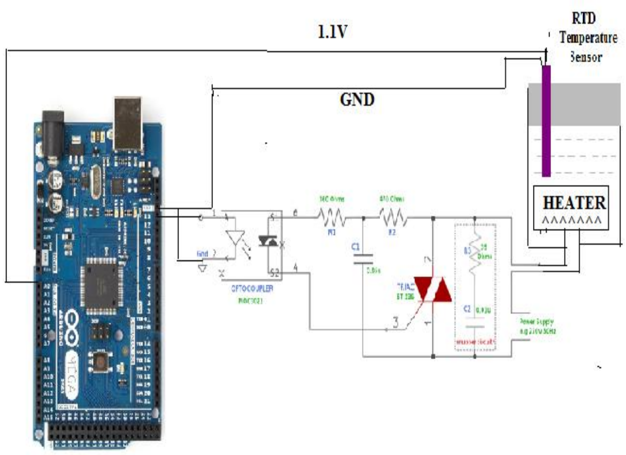


Fig 3

E. Algorithm:

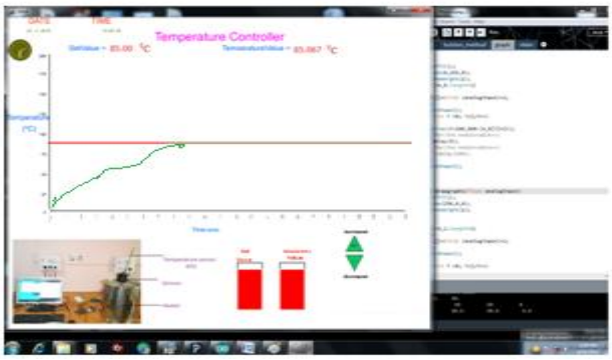
- Start
- Read the resistance from RTD
- Signal conditioning this resistance in to voltage
- Analog voltage is converted in to digital data by connecting pinAD0 of microcontroller
- Calculate the temperature value based on voltage
- If set temperature is reached, the heater will be off.
- Stop

Total Temperature control ystem

Photograph (a)

The photograph 1 shows the total system of temperature control with simple hardware and implementing Fuzzy with PID control algorithm.The graph can be represented in GUI which is developed by using java programming language in processing combined with the arduino software.

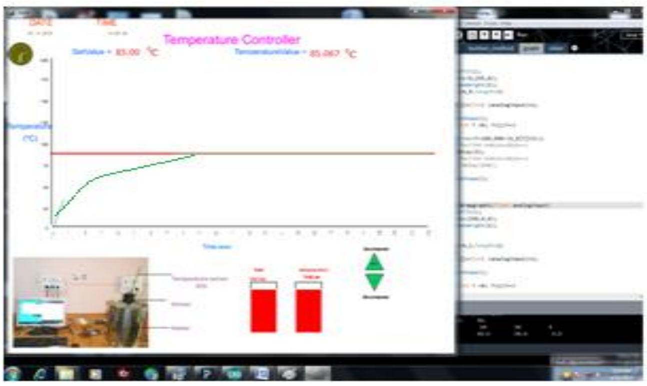
Screen Shot GUI Window for implenting PID



(a)

The GUI(a) represents the graph time vs temperature implenting only PID .It takes more response time without overshooting about set temperature value takesplace.Settling time also takes more with proper tuning.

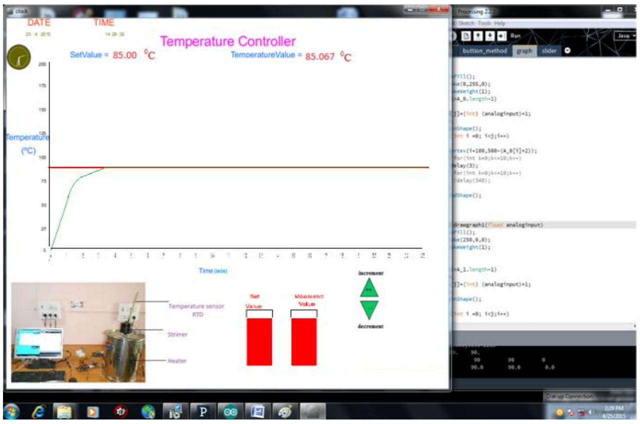
Screen Shot GUI Window for implenting Fuzzy



(b)

The GUI (b) represents the graph time vs temperature implenting only Fuzzy logic,it takes slightly less response time compared with proper tuning of proportional constants of PID but it does not accurate .

Screen Shot of GUI Window for implenting Fuzzy with PID



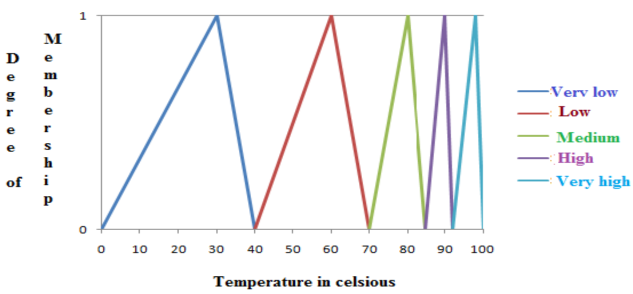
(c)

The GUI (c) represents the graph time vs temperature implanting Fuzzy with PID ,the response time and settling time is also decreases.

F. Fuzzy with PID

Fuzic logic has rapidly become one of the most successful of today's technologies for developing sophisticated control systems. Fuzzy controllers are more robust than PID controllers [4] because they can cover a much wider range of operating conditions than PID can ,and can operate with noise and disturbances of different nature. overcome this in this
It takes response time is slightly more than Fuzzy but much less than PID and settling time is much less than compared with simple PID and Fuzzy only.First we calculate the proportional constants by changing that values for proper tuning of PID.Fuzzification means writing variables or members of the range of the temperature.For this variables write a set of rules how to control the parameter at particular point,then the control process can be implented in defuzzification process.For the controlling of liquid temperature of range is 0-100(^{0}C) ,consider the four fuzzy sets of PID.Kp,Ki and Kd are the proportional constants for PID.For each fuzzy set the constants will be varied. By implementing this system we reduce the complexion of the automation of the one of the most important process parameter temperature.It is very inexpensive.

G. Fuzzification



Membership Functions for T(temperature) ={Very low, Low, Medium, High,Very high}

Matrix of the temperature control

Temperature in celsious	Very low	Low	Medium	High	Very high
Very low	No change	Heat	Heat	Heat	Heat
Low	Cool	No change	Heat	Heat	Heat
Medium	Cool	Cool	No change	Heat	Heat
High	Cool	Cool	Cool	No change	Heat
Very high	Cool	Cool	Cool	Cool	No change

Table (a)

H. Fuzzy Rule Set

- If temperature range is 0 to 40C, the FPID 1 is applied .i.e., the proportional constants K_p,K_i ,K_d of set 1 will be executed in the program.
- If temperature range is 40 to 70C, the FPID 2 is applied .i.e., the proportional constants K_p,K_i ,K_d of set 2 will be executed in the program.
- If temperature range is 70 to 85C, the FPID 3 is applied .i.e., the proportional constants K_p,K_i ,K_d of set 3 will be executed in the program.
- If temperature range is 85 to 92C, the FPID 4 is applied .i.e., the proportional constants K_p,K_i ,K_d of set 4 will be executed in the program.
- If temperature range is 92 to 100C, the FPID 5 is applied .i.e., the proportional constants K_p,K_i ,K_d of set 5 will be executed in the program.

I. Defuzzification

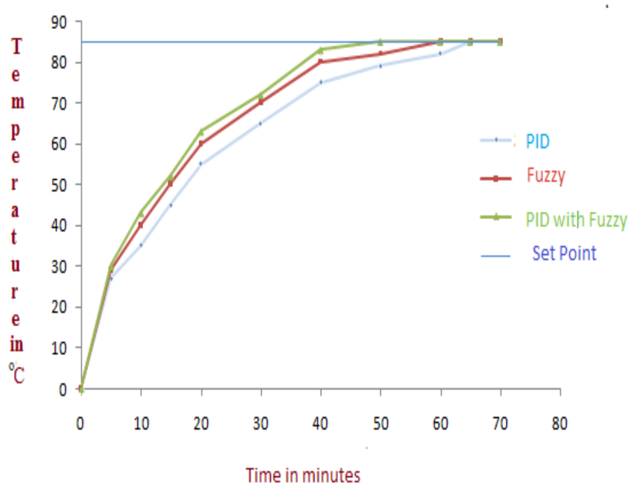
The procedure of producing a output variable in fuzzy logic given rule set of fuzzy and respective membership values can be described as term "Defuzzification". It requires basically fuzzy control matrix arrangement. It contain large number of conditions which will convert the linguistic variables of a final result taken from the fuzzy logic. To understand this ruleset of the fuzzylogic is to be determine how much PWM drive can be applied to the heater.

J. Pseudocode algorithm:

```
P = Error[Current] * Kp[fuzzy];
Error[Sum] = Error[Current] + Error[Last] +
Error[SecondToLast];
I = Error[Sum] * Ki[fuzzy];
Error[Delta] = Error[Current] - Error[Last];
D = Error[Delta] * Kd[fuzzy];
Drive = P + I + D;
Error[SecondToLast] = Error[Last];
Error[Last] = Error[Current];
```

III. CONCLUSION

Functioning of three different algorithms,



Graph (a)

The design of Fuzzy with PID temperature controller with active rule selection mechanism. The proposed system is tested in real time environment and the output performances are evaluated. In this system which is key point to reduce the cost by implementing software algorithm. We have successfully experiment this system in lab and therefore proposed a web based temperature monitoring and controlling network with flexibility, further extension of this system is to control from any place via internet even with different type of devices. This could have a substantial benefit from this research work for efficient management of liquid temperature.

REFERENCES

[1] Allahverdi, N., 2002. An application of artificial intelligence. In the proceedings of the XI International Conference on Computer Systems and Technologies and Workshop for PhD Students in Computing, pp:186-190.1

[2] Ignatyev, V.V., 2011. Syntheses method of hybrid controlsystem combining traditional and fuzzy Object tmodels. M. S.thesis, Don State Technical Univ. ,Rostov-on-Don.

[3] Barrett, Steven F. 2010. Arduino Microcontroller: Processing for Everyone. Morgan & Claypool, 325 pp. ISBN: 9781608454389. Available online at UCSD library.

[4] FarhadAslam and GagandeepKaur, March 2011 "Comparative Analysis of Conventional, P, PI, PID and Fuzzy Logic Controllers for the Efficient Control of Concentration in CSTR", *International Journal of Computer Applications*, Vol.17, No.6, pp.12-16.

ACKNOWLEDGMENT

We welcome this opportunity to express our heartfelt gratitude and regards to my partner G.Venkatesh, Weaver and my son, G.Adharsh , II-standard.They supporting me a lot for doing my Ph.D.Without their cooperation,the extensive work and preparing the paper for publication would not be possible.

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