2012 12th International Conference on Control, Automation and Systems
Oct. 17-21, 2012 in ICC, Jeju Island, Korea

Hardware based Automatic Fire Extinguisher Robot

B. Swetha Sampath[1]
[1] Department of Electronics and Communication Engineering, JNT University, Hyderabad, India
(Tel : +91-8341671687; E-mail: swetha04cyndrilla@gmail.com)

Abstract: A Robot suitable for automatically extinguishing the fire during fire accidents is presented in this paper. The Robot moves in the direction with respect to the fire intensity and avoids self-destruction using calcium silicate boards shielded with, that are capable of withstanding very high temperatures. The principle used, was designed and experimented at a temperature of 300°C. The temperature sensing capability of the robot is varied by heating the Thermocouple ends to a cut-off temperature, above which the robot starts responding to the fire. The Robot finds its applications in Rescue operations during fire accidents, in closed loops such as hospitals and shopping malls, where the possibility for service men to enter the fire prone areas is very less and also during wars to perform rescue functions. The most added advantage of this Robot is that it turns ON automatically as it detects the fire within a distance of 5-10cms, using Thermocouple, and tries to extinguish it by moving in the direction with respect to the fire intensity. The temperature sensor provides a backup to the Thermocouple, if needed in vast circumstances.

Keywords: Non-Inverting Amplifier, Comparator, Obstacle Avoider, IC 741 Specifications, Thermocouple.

1. INTRODUCTION

With the expansion of Robotic Applications [1], some tasks may require quick and efficient action to be performed. A Robot is a re-programmable, multifunction manipulator designed to move materials, parts, tools or special devices through variable programmed motions also be defined as an automatic device that performs functions normally ascribed to humans or a machine in the form of a human. The Robot in this paper is an Automatic Fire Extinguisher which detects and extinguishes the fire sensed by a Thermocouple.

2. CONSTRUCTION

The Robot in this paper detects the temperature of about 300°C from the furnace, using a Thermocouple. The detailed specifications of the Thermocouple are given in Table I. IC 741 has been used both as a Comparator and an Amplifier. The amplified DC voltage has been converted into AC using a DC to AC Convertor. The AC voltage thus generated supplies power to the water pump. Generally Water, or other substitutes like foam and carbon dioxide can also be used to extinguish the fire. Obstacle Avoider and Motion Sensor have been used to avoid the obstacles and move in all directions as per the fire intensity. The Robot is shielded with calcium silicate boards to withstand very high temperatures.

The thermocouple shown in Fig.1 has been initially heated to a cut-off temperature at the junction end to make it resistant and sensitive to all temperatures above the cut-off temperature. The difference between the temperature sensed from the furnace at the junction end to that of the temperature generated at the tail end measures a voltage difference between the two thermo-elements at the tail end. The voltage from Thermocouple [2] is being amplified and compared using IC 741[5] and the output DC voltage of the order 10~12V is converted to 230V AC by using DC to AC Convertor which is being supplied to the water pump. Water pumps widely used in water coolers are incorporated in the Robot whose specifications are given in Table II. The input supply to the IC is being given from an external 5V battery connected to its pin.

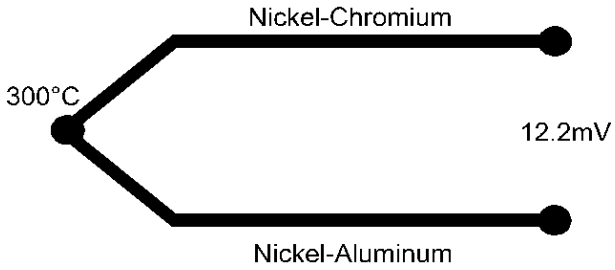

Fig 1: Thermocouple (RTD)

TABLE I

THERMOCOUPLE SPECIFICATIONS

TC TYPE	TEMPERATURE RANGE F	TEMPERATURE RANGE C	ACCURACY
J	0 TO 530 530 to 1400	-17 TO 277 277 to 760	2 DEGREES F 3/8%
K	0 TO 530 530 TO 2300	-17 TO 277 277 TO 1260	2 DEGREES F 3/8%
T	-300 TO -75 -75 TO 200 200 TO 700	-184 TO -60 -60 TO 93 93 TO 371	1% 3/4% 3/8%
E	0 to 600 600 TO 1600	-17 TO 315 315 TO 871	3 DEGREES F 1/2%

TABLE II Water Pump Specifications

Voltage: 165-250V/50Hz

Power(W)	12	15	19	40
Output(L/h)	900	1000	1100	3800

3. ROBOT DESIGN

The process flowchart used in Robot control is mentioned in Fig.2.

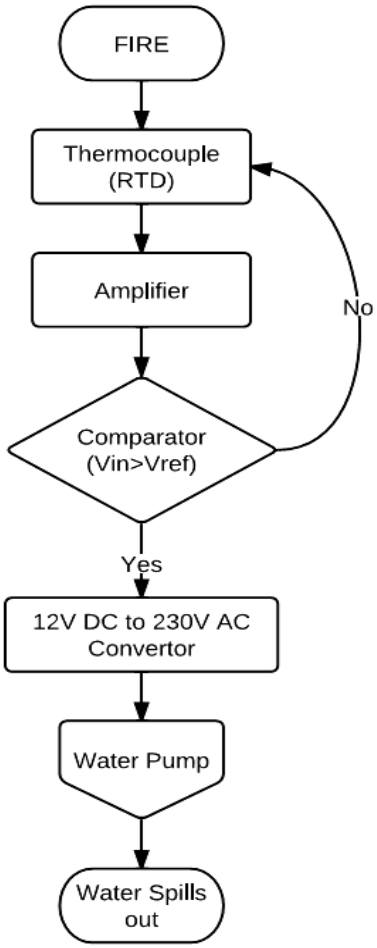

Fig. 2 Robot Control Flowchart

Temperature sensed by the thermocouple at the junction end (from a furnace of 300° C) is measured as Voltage at the tail end. Generation of voltage at one end as a result of temperature difference between two ends of a Thermocouple is defined by Seebeck Effect [1] as,

$$EMF = \int_{T1}^{T2} (S1 - S2) . dT \qquad (1)$$

NON-INVERTING AMPLIFIER USING IC741: In a non-inverting amplifier, the output voltage changes in the same direction as the input voltage. The gain of the non-inverting amplifier is given by,

$$A = (R1 + Rf) / R1 \qquad (2)$$

Where R1 – Input Resistance
Rf – feedback Resistance

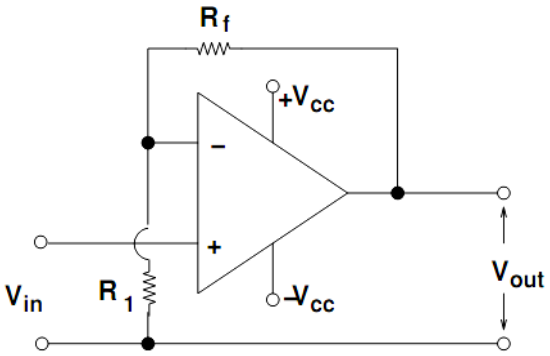

Fig 3: IC 741 Non-Inverting Amplifier circuit

The EMF (1) or voltage thus produced, in the range of few mV is amplified and the output voltage is calculated using

$$Vout = Vin \times A \qquad (3)$$

Where, A – Gain of Op-Amp

COMPARATOR USING IC 741: A 'comparator' is an circuit that compares two input voltages. One voltage is called the reference voltage (Vref) and the other is called the input voltage (Vin). When Vin rises above or falls below Vref the output changes polarity (+ becomes -).

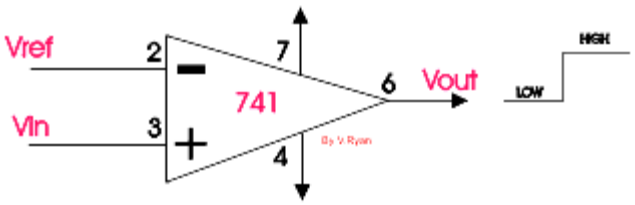

Fig 4: IC741 Comparator circuit

The non-inverting amplified voltage thus compares it with the reference voltage using the condition,

Vin>Vref, Vout=Vin (4)
Vin<Vref, Vout=0 (5)

Where Vref - Reference Voltage
Vin - Input Voltage
Vout - Output Voltage

Vout (of range ~mV) of the comparator is directed to DC to AC convertor thus supplying power to switch ON the water pump. Fig 5 figures out the circuit of Amplifier and Comparator built using IC 741.

OBSTACLE AVOIDER: A mobile robot must be able to avoid both static and moving obstacles in its path. This essential task often relies on GP2Y0A21YK0F which is a distance measuring sensor unit, composed of an integrated combination of PSD (position sensitive detector), IRED (infrared emitting diode) and signal processing circuit. The variety of the reflectivity of the object, the environmental temperature and the operating duration are not influenced easily to the distance detection because of adopting the triangulation method. This device outputs the voltage corresponding to the detection distance. So this sensor can also be used as a proximity sensor. DC motors of the robot are controlled by the information obtained from GP2Y0A21YK0F, programmed into an on-board Picaxe 28×1 CPU, using Picaxe basic. The on-board CPU is powered using 3 AA cells. The entire arrangement of Obstacle Avoider is figured out in Fig 6.

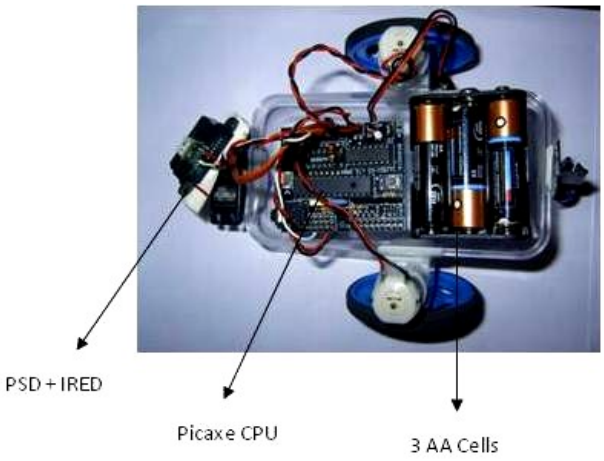

Fig 6. Obstacle Avoider

4. SIMULATION RESULTS

The simulation results of the circuit in Fig 7 are stated in Fig 8. XSC2 CRO generates an amplified voltage of 11.2V from Thermocouple voltage of 12.2mV. The o/p DC voltage of the Comparator is directed to a 11V DC to 230V AC Convertor, which produces ~220V to run the water pump.

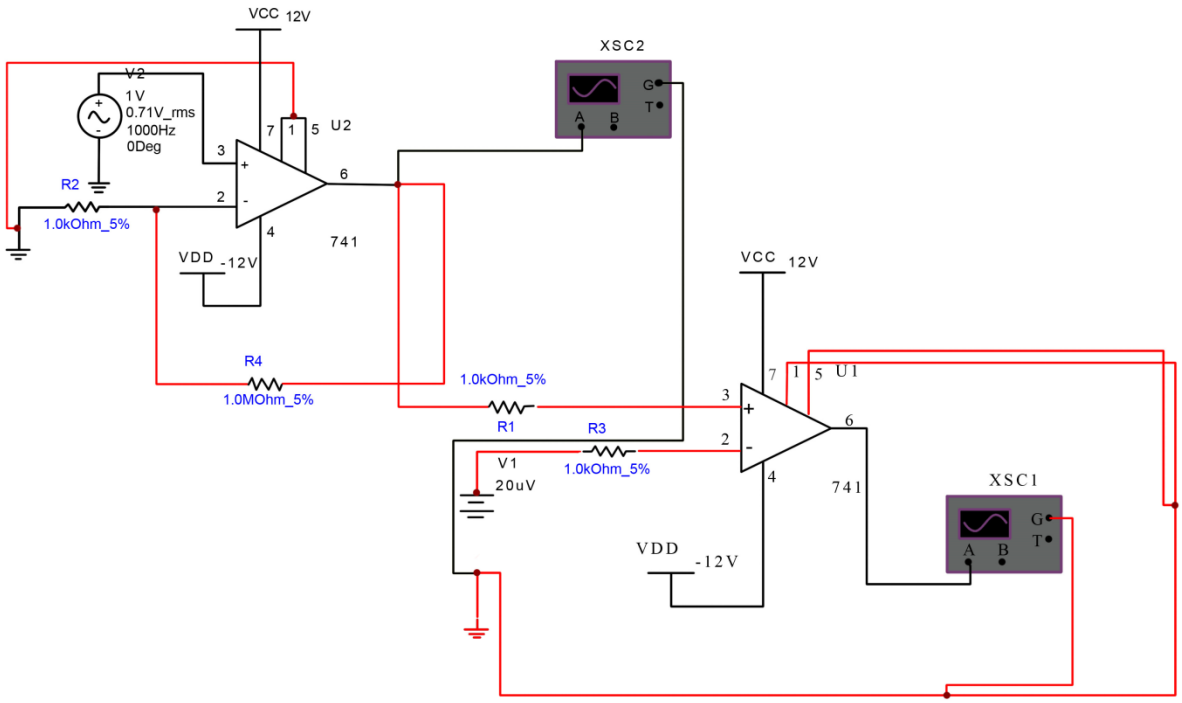

Fig. 7 Circuit Diagram of Amplifier and Comparator using IC 741 (MULTISIM)

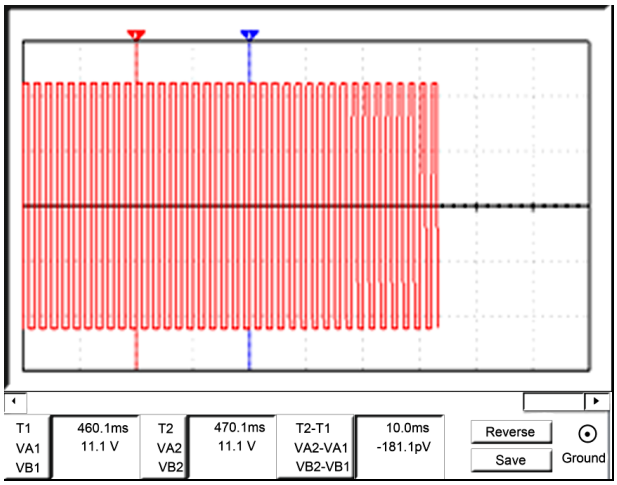

Fig.8 11V at the Comparator o/p

5. CONCLUSION

This section gives a concise summary with applications related to the proposed system described above. The system used an IC741 as both Amplifier and Comparator with Thermocouple and water pump, to pump out the water automatically when the robot is in fire. The Robot's movement is predicted using obstacle avoider.

6. FUTURE WORK

The aim in future would be to implement this syste m and its principle on a Humanoid Robot to avoid human loss during vast fire accidents and wars, wh ere the human rescue operations cannot be performe d.

REFERENCES

1) J. Casper and R. Murphy, "Human-robot interaction during the robotassisted urban search and rescue effort at the world trade center," IEEE Transactions on Systems, Man and Cybernetics Part B, vol. 33, no. 3, pp.
367–385, 2003
2) M. Micire, "Analysis of robotic platforms used at the world trade center disaster," Ph.D. dissertation, MS thesis, Department of Computer Science and Engineering, University of South Florida, 2002.
3) C. Breazeal, Designing Sociable Robots. The MIT Press, Cambridge, MA, 2002
4) K.Severinson-Eklundh and A. G. H. Huttenrauch, "Social and collaborative aspects of interaction with a service robot," Robotics and Autonomous Systems, vol. 42, no. 3-4, pp. 223–234, 2003.H. Jones, S. Rock, D. Burns, and S. Morris, "Autonomous robots in swat applications: Research, design, and operations challenges," in Proceedings of the 2002 Symposium for the Association of Unmanned Vehicle Systems International (AUVSI '02), 2002.
5) J. Casper and R. Murphy, "Human-robot interaction during the robotassisted urban search and rescue effort at the world trade center," IEEE Transactions on Systems, Man and Cybernetics Part B, vol. 33, no. 3, pp.
367–385, 2003
6) M. Micire, "Analysis of robotic platforms used at the world trade center disaster," Ph.D. dissertation, MS thesis, Department of Computer Science and Engineering, University of South Florida, 2002.
7) C. Breazeal, Designing Sociable Robots. The MIT Press, Cambridge, MA, 2002
8) K.Severinson-Eklundh and A. G. H. Huttenrauch, "Social and collaborative aspects of interaction with a service robot," Robotics and Autonomous Systems, vol. 42, no. 3-4, pp. 223–234, 2003.
9) H. Jones, S. Rock, D. Burns, and S. Morris, "Autonomous robots in swat applications: Research, design, and operations challenges," in Proceedings of the 2002 Symposium for the Association of Unmanned Vehicle Systems International (AUVSI '02), 2002.
M. Diffler, F. Huber, C. Culbert, R. Ambrose, and W. Bluethmann, "Human-robot control strategies for the nasa darpa robonaut," in Proceedings of 2003 IEEE Aerospace Conference, vol. 8, 2003, pp. 3939–3947.
10) T. Takahashi and Tadokoro, "Working with robots in disasters," IEEE Robotics and Automation Magazine, vol. 9, no. 3, pp. 34 –39, 2002.
11) I. Erkmen, A. Erkmen, F. Matsuno, R. Chatterjee, and T. Kamegawa, "Snake robots to the rescue!" IEEE Robotics and Automation Magazine,16 vol. 9, no. 3, pp. 17– 25, 2002, propose snake robots and show simulations.
12) J. Casper, R. Murphy, and M. Micire, "Issues in intelligent robots for search and rescue," in SPIE Ground Vehicle Technology II, 2000.
13) V.M. Bove, Discrete Fourier transform based depth-from-focus, image understanding and machine vision, 1989, Technical Digest Series Vol. 14 (Optical Society of America and Air Force Office of Scientific Research, June 1989.