Fuzzy Logic Algorithm and GSM IoT Based Fire Fighting Robot

P Vasanthkumar¹, P V Arunraj¹, N Mohammed Bilal Khan ², A V Akash², R. Mukunthan², R. Harish Babu²

¹Assistant Professor, ²UG Student
Department of Mechanical Engineering, SRM Institute of Science and Technology, Ramapuram, Chennai, Tamil Nadu, India.
E-mail: pvasanthme@gmail.com

Abstract. Artificial Intelligence (AI) covers many areas related to mechanical, electrical, psychology and philosophy. GSM IoT is the new method and idea in a simple application of fire detection. In our project, we are using IR sensor to detect a fire and it sends the information to a microcontroller, which is programed based on a fuzzy logic algorithm that helps to detect the fire and moves the nozzle head of the Fire Fighting Robot. The stepper motor is used for a 360 degree clockwise and anticlockwise rotation. The D.C motor controls the valve opens of the nozzle. The fuzzy logic algorithm is helps to detect the fire and to turn the nozzle in the direction of fire.

Key words: Fire Fighting Robot (FFR), Fuzzy Logic Algorithm, Internet of Things (IoT), Global System for Mobile Communication (GSM)

1. Introduction

In our day-to-day life, we hear news about many fire disasters in flats, textile shops and some chemical industries. To overcome these disasters, we invented a fire fighting robot using GSM and IOT based. We introduced GSM and IOT in our project to make our project more efficient. Whenever, the fire occurs in the flat or industries in the absence of the property owner our robot helps to detect the fire and extinguish the fire. Simultaneously, the GSM sends a message to the concern owner of the property and to the fire-station. So that, the fire can be extinguished before it gets complicated. Many textile shop and manufacturing companies doesn’t have proper fire extinguisher to extinguish the fire in the absence of people.

To overcome this, we replace our fire fighting robot in the place of the fire extinguisher. By replacing this, we can avoid the 95% of the fire accident occurring across the city. We use fuzzy logic algorithm to detect the fire and instruct the robot’s nozzle to turn in the correct direction. Our project also reduces the human risk. The presence of a IR alerts the robot when the
temperature exceeds the threshold temperature and the robot will sprays the water available in its tank.

A fire fighting robot is a preprogrammed device that performs tasks normally performed by humans or machines that are programmed to perform repetitive or repetitive tasks. After so many studies we analyse that the fire fighting robot can be useful in medical purpose [1], reawakening [2-6], rescue-function [7, 8] and sector [9]. In various industries robot have been introduced many years ago. Commercial robots are versatile controlled designed for specific objects, partitions, devices with several system gesticulations to perform numerous functions [10]. Mechanical study has also aroused attentiveness in robotics, but only a fraction of the latest developments in robots can be connected with machine intellects. A recent project for the growth of robots has incorporated machine intellects algorithms [11-15] to improve intellect in robots.

Due to this, it reduces electricity waste over time and cost, at the same time the productivity also increases in the industries. Research into the use of humanoid-like robots is actively conducted to reduce the wound and demise of fire-fighters and to improve productivity, security, efficiency and quality of a given job [16]. The design includes a range of sensors and a two-node MCU. The fire fighting robot is wirelessly connected to the node MCU. If the node fires, it notifies the central node to the MCU. The Central Node MCU sends information to fire safety officers and launches a robot to carry out fire fighting operations and launches pumps to extinguish fires. MHZ-14 CO2 sensor values are analysed using graphs. If the CO2 value is in the lower limit on the graph, the robot will start pumping CO2. Otherwise, it uses a water pump. At the receiving end, the interface for the two-motor L293D motor driver. For the movement of robots in all direction these two motors are used. Batteries are used to supply power. The storage system is used to store the values of the graphs analysed by the sensors. The node MCU receives all values from the various sensors and commands the robot to start the pump.

1.1 Fuzzy Logic Algorithm

Fuzzy from is a new technology that enhances traditional system models of engineering expert and using fuzzy logic we can reduce the need of rigorous mathematical modelling. Fuzzy logic is a real explanation of traditional logic, and fuzzy logic controller is a real explanation to the resembling control model. The point to successful use of fuzzy logic is intelligent combination of traditional methods. In addition, the fuzzy system is time-unchanging and decisive. Therefore any validation and fuzzy logic can also perform stability analysis method.

The rapid increase of numbers have seen in last few years and applications of fuzzy logic. There are some major uses that was increasingly visible from the field of user products, control techniques and industry systems. Uses for information processing, accusatory, human machine interfaces, cross check and decision support systems are less visible, but of increasing importance.

1.2 Development Tools

A software development tool suitable for fuzzy logic must meet the following criteria:
- Support all development stages (design, emulation, optimization, validation, and implementation)
- Industry standard interfaces (using MS-Windows, standard fuzzy logic programming language support, DLL / DDE / OLE and interfaces to control simulated software tools).
- Using fuzzy logic is a good approach. These recompiles basically translate the text of a fuzzy logic system into a standard programming language such as ANSICC.
1.3. Hardware Platform for Fuzzy Logic Systems

Fuzzy logic is a universal technique; its applications cover the entire spectrum of electronic control. Therefore the target hardware platforms are different. The Todd tool allows you to run fuzzy logic systems on almost any hardware, from 8-bit AT89C52 to process control systems that use distributed 64-bit RISC processors.

1.4 Third Generation Integrated Fuzzy Processors

Integrated dimmer processors overcome second-generation errors by integrating dimmer processor functionality into standard AT89C52. The functionality that processes fuzzy logic systems can be implemented in a variety of ways. One way is to integrate complete fuzzy logic coprocessor units on a chip with a AT89C52 so that the two work together. Its advantage is that the communication overhead is much smaller than the two over chip solutions, because the dimmer logic coprocessor can use the same registers that handle data exchange.

Expanding the teaching set of a standard MCU is a different solution. The easiest way is to expand the micro code and use the same ALU architecture. It speeds up the calculation of fuzzy logic three times and compresses the code twice based on MCU architecture and fuzzy logic system size. Common sense, greed for human thought and judgment fuzzy logic, ultimately brings fuzzy logic to the party. This is a question that has been under discussion for the past few years and will be disputed quite soon.

2. Methodology

The design includes a range of sensors and a two-node MCU. The fire fighting robot is wirelessly connected to the node MCU. If the node fires, it notifies the central node to the MCU. The Central Node MCU sends information to fire safety officers and launches a robot to carry out fire fighting operations and launches pumps to extinguish fires. MHZ-14 CO2 sensor values are analysed using graphs. If the CO2 value is in the lower limit on the graph, the robot will start pumping CO2. Otherwise, it uses a water pump.

2.1 Materials Required

The design includes a range of sensors and a two-node MCU. The fire fighting robot is wirelessly connected to the node MCU. If the node fires, it notifies the central node to the MCU. The Central Node MCU sends information to fire safety officers and launches a robot to carry out fire fighting operations and launches pumps to extinguish fires. MHZ-14 CO2 sensor values are analysed using graphs. If the CO2 value is in the lower limit on the graph, the robot will start pumping CO2. Otherwise, it uses a water pump.

Table:1 is listed the required of components, material and quantity for fabricating and assembling of GSM IoT Based Fire Fighting Robot.

| Components        | Material       | Quantity |
|-------------------|----------------|----------|
| L-Angle           | Mild steel C 40| 1        |
| Ball Bearing      | HSS            | 2        |
| LDR Sensor Unit   | Electronics    | 1        |
| Gear wheel        | Cast iron      | 2        |
| D.C motor         | Aluminium      | 1        |
| Front Wheels      | Nylon          | 2        |
| Rear Wheels       | Rubber         | 2        |
| Microcontroller   | Electronics    | 16F84 IC |
| Battery           | Lead-acid      | 12V D.C -1|
| Water D.C pump    | Mild Steel     | 1        |
Due to light intensity the LDR light has different resistance. It is much simpler for light intensity.

Resistance to LDR during dark burns up to Meg Ohm ranges. When sunlight falls on LDR it illuminated then the resistance of the LDR decreases abruptly (less than 10 kPa). White stone bridge is connected with LDR as shown in figure 1. The resistance is converted to different voltage and voltage is amplified and fed to comparator.

Angle steel is steel which is in 'L' shape and its angles are at 90 degree. It is one of the most common types of steel. The Shape of the 'L' angle can be equal to unequal at the bottom of the legs as shown in Figure 2. Ball bearings use to separate two different "races" or bearing rings to reduce surface contact and friction. Gears of different sizes change torque by their gear ratios, creating mechanical advantages and can be considered a simple machine. Rotational speed and two-mesh gears vary in proportion to their diameter as shown in figure 3.

The batteries are the only storage device that is technically and economically available as shown in figure 4. Since both the photovoltaic system and the battery are high in cost. The DC machine can perform as generator or motor as shown in figure 5. While running the generator, it works mechanically and develops a voltage and it has ability to send electricity through voltage load resistance. Motor action develops a torque. Figure 6 is a 12 volt DC water pump will be used. Microcontroller d. C. Provides water supply so that during firing, D.C. Run the water pump directly.

The 89C52 microcontroller will be used as the control unit in our project. Since the sensor unit is giving the control signal to the microcontroller unit, the microcontroller d. C. Pump and rotating permanent magnet D.C. Give a signal to the motor. Block of memory is a Program memory which is continues program codes (using specialized erasable programmable read-only memory. / Programmable read-only memory programmers). It is not possible to read and write only under normal operating conditions.

Input storage known as read / write memory. So, that can perform, read and written programs. The Microcontroller (AT-89c52) have 128 pixel of inner input storage and 64K outward input storage. The Microcontroller has four 8-bit parallel ports (so 8 * 4 = 32 I / O lines are available). Each line contains the latch, the production driver and the Data buffer.
Port 0 (PO), Port 1 (P1), Port 2 (P2) and Port 3 (P3) were designated as four ports. External memory is used to access four ports, port 0 and port 2. Multifunctional process takes place in all port 3 pins. 8-binary digit is a port 3 pin of two-way with internal pull-ups.

2.2 Flame Detector
Flame Detector includes,
- Flame detector circuit
- Voltage divider
- Comparator
- The circuit is changing

2.2.1 Voltage divider
The potential or voltage divider provides a convenient way to obtain variable voltage from a constant voltage supply. In general, if the passive two-terminal electrical component of R1 and R2 are connected in sequence across a supply voltage V and the voltages developed in each are V1 and V2 respectively, I can say that the current is:

\[ I \times R_1 (1) = V_1 \]
\[ I \times R_2 (2) = V_1 \]
\[ V_1 + V_2 = I (R_1 + R_2) = V \] ... (3)

Divided by (1) by (3) we get:

\[ \frac{V_1}{V} = \frac{I \times R_1}{I \times (R_1 + R_2)} \]

Multiplying both sides by V:

\[ V_1 = \frac{(R_1 \times V)}{(R_1 + R_2)} \]

Similarly from (2) and (3) we get:

\[ V_2 = \frac{(R_2 \times V)}{(R_1 + R_2)} \]

2.2.2 Comparator
The comparator is a device used when different signal reaches a certain input range and this comparator output is used to drive the logic circuit. OPAMP is used to construct a comparison. This is a open-loop op-amp of output (Vsat (= Vcc) as (A) Ideal transfer properties. However, in commercial op-amp, have transition characteristics. Following types of comparators are available, there are
- Non-inverter comparator
- Comparator
3. Design and Fabrication

The Fire Fighting intelligence can detect fires in an area of one foot square. The Fire detection limit in all directions is 360°. Nozzle adjustments i.e. for extinguish the fires water and any type of chemicals are used here. The project is based upon the AT89C52, it is composed and fast and responsive. No outward device is used for control this. This setup is very compact and easy to move.

IR sensor is used to detect flames. And it helps to find the direction of the fire area. Microcontroller receives the signal which is sent to the sensor it was basic information for the amplifier. Later having the signal of amplifier the microcontroller runs a program based on a signal, Such as permanent DC motor on stage to stage and D.C Pump Activation.

The rotary motion of the sensor and nozzle is fixed by a DC motor on rotating shaft of the fire fighting robot. The current is supplied by the electrochemical cells. D.C. motor control circuit receives power which is already stored in the electrochemical cells. DC motor operates
according to a program written on the microcontroller chip. (I.e.) Rotating motor ON and D.C water pump in off position.

4. Results and Discussion

Here we have successfully developed a fire fighting robot. The robot detects temperature, smoke and flame in the area where the robot is located. The movement of this robotic vehicle is controlled by IoT according to the program. The robot assists in areas where natural disasters have occurred and fire explosions have occurred. If a fire is detected with the help of a sensor, the MCU operates the water pumping system through the relay circuit. A fire is detected with the help of sensors.

5. Conclusions

Therefore the firefighting robot can be used to avoid the human damage and helps to take precautionary actions to avoid the complication of fire. Fabrication and assemble of fire fighting robot using GSM and IOT based, which helps to extinguish the fire and simultaneously alerts the fire station before it gets complicated in the absence of the people.

References

[1] Jeelani, S., et al., Robotics and medicine: A scientific rainbow in hospital, Journal of Pharmacy & Bioallied Sciences, 2015. Vol. 7, pp. S381-S383.

[2] Aliff, M., S. Dohta, and T. Akagi, Simple Trajectory Control Method of Robot Arm Using Flexible Pneumatic Cylinders, Journal of Robotics and Mechatronics, 2015. Vol 27, pp. 698-705.

[3] Aliff, M. D.S., and Akagi T, Control and analysis of simple-structured robot arm using flexible pneumatic cylinders. International Journal of Advanced and Applied Sciences, 2017. Vol. 4, pp. 151-157.

[4] Aliff, M., S. Dohta, and T. Akagi, Control and analysis of robot arm using flexible pneumatic cylinder. Mechanical Engineering Journal, 2014. Vol. 1, pp. DR0051-DR0051.

[5] M. Aliff, S. Dohta and T. Akagi, Trajectory controls and its analysis for robot arm using flexible pneumatic cylinders,” IEEE International Symposium on Robotics and Intelligent Sensors (IRIS), 2015, pp. 48-54.

[6] M. Aliff, S. Dohta and T. Akagi, Trajectory control of robot arm using flexible pneumatic cylinders and embedded controller, IEEE International Conference on Advanced Mechatronics (AIM), 2015, pp. 1120-1125.

[7] C. Xin, D. Qiao, S. Hongjie, L. Chunhe and Z. Haikuan, Design and Implementation of Debris Search and Rescue Robot System Based on Internet of Things, International Conference on Smart Grid and Electrical Automation (ICSGEA), 2018, pp. 303-307.

[8] Yusof, M., and Dodd, T., Pangolin: A Variable Geometry Tracked Vehicle With Independent Track Control, Field Robotics, pp. 917-924.

[9] Day, C.-P., Robotics in Industry—Their Role in Intelligent Manufacturing. Engineering, 2018. Vol. 4 pp. 440-445.
[10] J. Lee, G. Park, J. Shin and J. Woo, Industrial robot calibration method using denavit — Hatenberg parameters, *17th International Conference on Control, Automation and Systems (ICCAS)*, 2017, pp. 1834-1837.

[11] Sani, N. S., Shamsuddin, I. I. S., Sahran, S., Rahman, A. H. A and Muzaffar, E. N, Redefining selection of features and classification algorithms for room occupancy detection, *International Journal on Advanced Science, Engineering and Information Technology*, 2018, *Vol.* 8, pp. 1486-1493.

[12] Holliday, J. D., Sani, N., and Willett, P., Calculation of substructural analysis weights using a genetic algorithm, *Journal of Chemical Information and Modelling*, 2015, *Vol.* 55(2), pp. 214-221.

[13] Holliday, J. D., N. Sani, and P. Willett, Ligand-based virtual screening using a genetic algorithm with data fusion, *Match: Communications in Mathematical and in Computer Chemistry*, *Vol.* 80, pp. 623-638.

[14] Samsiah Sani, N., Shlash, I., Hassan, M., Hadi, A., and Aliff, M, Enhancing malaysia rainfall prediction using classification techniques, *J. Appl. Environ. Biol. Sci*, 2017, *Vol.* 7, pp. 20-29.

[15] Sani, N.S., Rahman, M.A., Bakar, A.A., Sahran, S. and Sarim, H.M, Machine learning approach for bottom 40 percent households (B40) poverty classification, *International Journal on Advanced Science, Engineering and Information Technology*, 2018, *Vol.* 8, pp.1698-1705.

[16] Kim, J.-H., S. Jo, and B.Y. Lattimer, Feature Selection for Intelligent Firefighting Robot Classification of Fire, Smoke, and Thermal Reflections Using Thermal Infrared Images. *Journal of Sensors*, 2016. pp. 13