# IoT And Fuzzy Logic Based Smart Robot System For The Detection Of Groundmines

**V.Praveen, A.Saran Kumar, G.Sivapriya, S.Priyanka**

**Abstract:** The main purpose of this paper is detection of landmines in the war field for saving the human life. For this purpose an autonomous robot is designed which can reach the destination without any human intervention. With the help of this designed robot the bombs which are buried inside the land can be easily found and the location of the bomb can be immediately transmitted to the control room with the help of Internet of things. Fuzzy logic controller has been used for the autonomous movement of the robot. The inputs to the fuzzy control are speed error and variation in speed error. The designed controller is implemented using raspberry pi processor. Ultrasonic sensors are used for the detection of obstacles and for the detection of landmines a metal detector sensor has been used and at the same time if any metal is detected the image of that location is captured and sent through IoT. Thing speak website is used for visualising the data obtained from the sensor unit.

**Keywords:** Fuzzy logic controller, Internet of Things, Rasberry pi

## 1. INTRODUCTION

The advancement in robotics has produced a massive change in human's life. Users can make it to do all the works which we are capable to do. Main challenge is design of an autonomous robot which can be operated in any environment. With the help of the sensors attached to it and high processing speed the robot can do any complex task without any human intervention. The intelligence of the designed robot depends on the type algorithm used and accuracy of the sensors. If more sensors are used then the processing complexity increases. For this purpose modular approach can be implemented which can handle multiple tasks at a time. There are nearly 100 million unexploded landmines all around the world. These landmines might kill or injure the people and the number is increasing and many portions of the land go unused due to the fear of landmines. There are three strategies for determining the landmines. First is manual detection, Manual detection of those mines is very difficult and dangerous process and it takes several years to locate all these mines. Plastics and composites are used for manufacturing of mines and also low metal content in mines makes detection a difficult one. The second method is determining with the help of mechanical equipment. The third one is by using advanced robotic technologies. Fully autonomous robot can be used for the detection of landmines.


- *V.Praveen is currently working as Assistant Professor at Bannari Amman Institute of Technology, Sathy, India. Email: praveen@bitsathy.ac.in*
- *A.Saran Kumar is currently working as Assistant Professor at Bannari Amman Institute of Technology, Sathy, India. Email: sarankumar@bitsathy.ac.in*
- *G.Sivapriya is currently working as Assistant Professor at M.Kumarasamy College of Engineering, Karur, India. Email: gsivapriya21@gmail.com*
- *S.Priyanka is currently working as Assistant Professor at Bannari Amman Institute of Technology, Sathy, India. Email: priyanka@bitsathy.ac.in*


*Fig 1. Location of landmine*

## 2. BACKGROUND AND RELATED WORKS

Model of Fuzzy Regulator of Mobile Robot Motion Control System: A method is designed to find the landmines with the help of swarm robot which moves autonomously and shares the location of the landmines [1]. Probability based fuzzy logic is used for the movement of the robot. Based on the obstacle on the path the movement of the robot is decided [2]. Wireless Robo-pi for landmine detection: A low cost automatic mine detector has been designed and implemented which replaces current manual method [3]. The device communicates the information gathered with the server wirelessly. Here the robot is controlled remotely which gets the commands and moves accordingly [5]. Autonomous Landmine Detecting Robot: Many landmines have to be detected across the world. So an autonomous robot is designed for identifying the landmines. Detected information is sent to the control room with the help of zigbee [6]. Sensors For Landmine Detection &Techniques A Review: This paper gives an overview of the technologies available for the detection of buried landmines. Various sensors and its features were explained [7]. Technologies used for detecting the landmines are X-ray, Electrical Impedance Tomography (EIT), Explosives vapours detection (EVD) [8]. An Efficient Detection and Classification Method for Landmine Types Based on IR Images Using Neural Network: Preliminary results for the detection of buried anti-personnel landmines have been presented in this paper. Here different algorithms have been introduced which sets different threshold levels to select the group of pixels corresponding to an object from background. Mine Detection robot is designed with fuzzy logic controller which makes the autonomous movement of robot [8]. With the help of this robot and the sensors attached to

it, the landmines can be easily detected. LABVIEW is used for both client system and for the robot.

## 3. METHODOLOGY

The proposed method involves designing of an autonomous robot which can automatically move without any human intervention and it detects the landmines with the help of the sensors attached to it and if any landmine if detected it captures the location of the landmines and the information can be transmitted with the help of IoT.

### 3.1 Fuzzy Logic Controller

Fuzzy logic controller (FLC) is used in many industrial applications. First high speed fuzzy controller was used for underground railways which stops at predetermined place. FLC autonomously decreases the speed of the train once it enters the station [10]. It also provides a comfortable ride by suitable acceleration and braking system. Many products have been introduced which uses fuzzy logic controller. The four main parts in fuzzy logic controller are Fuzzifier (transformation 1), Knowledge base, Inference engine, Defuzzifier (transformation 2)

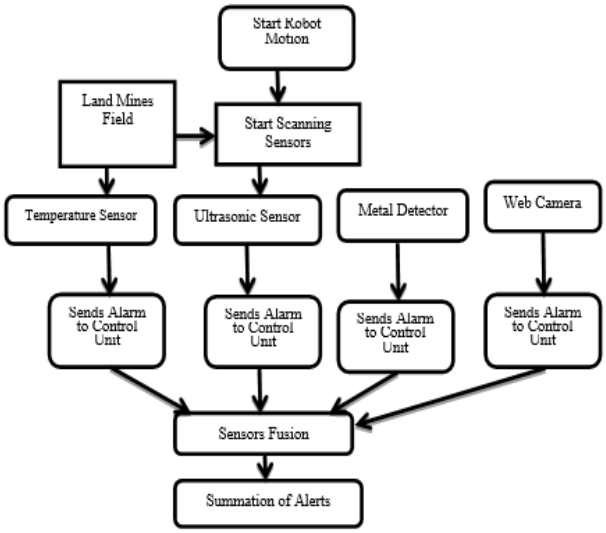



***Fig 2.*** *Flow graph for determining mines*

### 3.2 Movement of Robot

The motor can be controlled with the help of four switches for the speed control switches 1 and 4 are used which makes the robot to move in forward and reverse direction at same speed. If both the switches are turned on then the motor runs at full speed. The motor can be run in half speed if any one of the switch is on. Frequency and duty cycle are the two main factors have to be considered to implement this system.

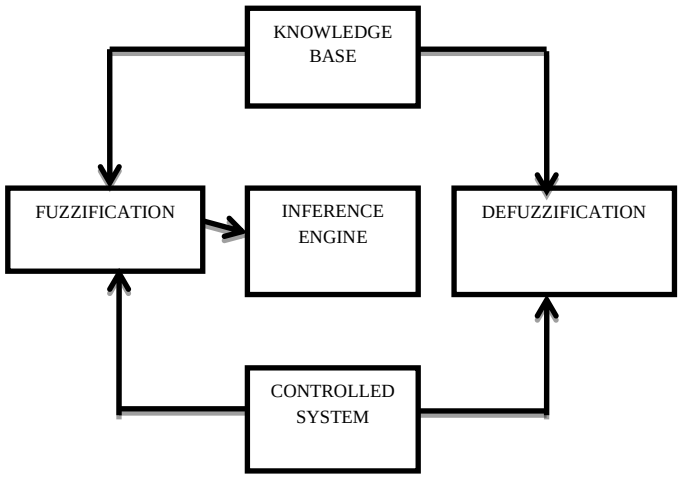



***Fig.3*** *Block Diagram of Fuzzy Logic Controller*

### 3.3 Fuzzification

The fuzzy logic controller works with two inputs which are speed error and the variation in speed error. The first step is to design a fuzzy controller which determines the states responsible for the performance of the system. Linguistic variables are used in fuzzy logic controller. Fuzzification is the process of converting the input data set to crisp set. For conversion of input data three kinds of fuzzifiers are used which are singleton fuzzifier, Gaussian fuzzifier and Triangular fuzzifier. Gaussain and Triangular fuzzifiers are used at the input and output data sets.

### 3.4 Rule Base

Linguistic fuzzy rules are framed in 'IF THEN' format. The conditions and the conclusion of the problem are set in the IF and THEN format. The rules are executed and control signals are produced based on the input conditions. Natural language is used for rule based algorithm, hence it is easy to understand and modify.

### 3.5 Inference Engine

Inference engine is nothing but a software code which is used for executing the rules framed for the problem defined. The inference engine works like a computer program which run continuously like our human brain. The program is executed with the rules framed and the inputs given. It is an information processing engine which uses max-min and max-product methods.

### 3.6 FLC in DC Motor

The error signal is continuously monitored and the controller output is updated so that it matches the reference set speed. Two input signals are given as input to the fuzzy controller. Error is calculated by finding the difference between set speed and actual speed. Linguistic values are set for the error, error rate, control action and output variable. The parameters like input and output variables, error rate are specified with the help of linguistic values Z = Zero, PS =Positive Small, PM =Positive Medium, PB=Positive Big,NS =Negative Small, NM = Negative Medium,NB =Negative Big. For the selected linguistic value membership function has to be drawn. There are seven

membership functions for inputs and CE signals, also there are seven membership functions for the output. All the MFs are identical for both positive and negative variables. Depending on these input variable values, the output variable value has to be decided from the experience encoded in the form of rules. For calculating the fuzzy output two types of methods were used which are Mamdani's method and or Takagi–Sugeno–Kang method. For DC machines, Mamdani method is mostly used.

### 3.7 Defuzzification

Defuzzification is the inverse of fuzzification method. Fuzzification converts the real world input to the linguistic variables. For the real world application the linguistics set has to converted to the crisp sets. Different defuzzification methods are available whereas centre of gravity is the most common defuzzification method. Centre of Area (COA) de-Fuzzification logic is used for obtaining the accurate value of the result. First, the centre point value for every membership function is evaluated. Then the final output is evaluated with the help of average of each centroids and degree of membership functions [14]. The output of this fuzzy system will be applied to the PWM. PWM generally helps in running the motor at desired speed. For the exchange of data between files, applications and web services data socket can be used.

## 4. SYSTEM IMPLEMENTATION

### 4.1 Metal Detector

Nearby metal objects can be detected with the help of metal sensors. With the help of these metal detectors we can detect the buried landmines and a signal will be sent to the processor on board for further processing. The distance that the sensor covers depends on the nominal range.

***TABLE 1.*** *TYPES OF METAL DETECTORS*

| Types | Uses |
|---|---|
| Inductive type | Metallic objects detection |
| Capacitive type | Metallic and non-metallic objects detection |
| Photoelectric type | Use light sensitive elements to detect objects |
| Magnetic type | Presence of permanent magnets detection |

### 4.2 Temperature Sensor

Temperature sensor is used which can detect the change in temperature. With the help of this sensor forest fire can be easily detected and can be reported immediately. Temperature sensor used here is LM35 which can measure temperature and produces corresponding electrical signals at the output. It is controlled by raspberry pi-3 and the information is sent through IoT to the PC. Temperature sensor is connected to the A0 pin in the raspberry pi 3. If the sensor detects the temperature range 40 degree and above the processor sends an indication.

### 4.3 Ultrasonic Sensor

For the autonomous movement of the robot, obstacles in its path have to be detected. Obstacles can be detected with the help of this ultrasonic sensor. This ultrasonic sensor will be placed at the front end of the robot [14]. If the sensor detects the obstacle in the predefined distance then it gives an indication to the processor, so that the processor can make movement in other directions.

### 4.4 RASPBERRY PI

Several versions of the processor have emerged which has feature variations in memory storage value, peripheral devices support. This block diagram shows Models A, B, A+, and B+.

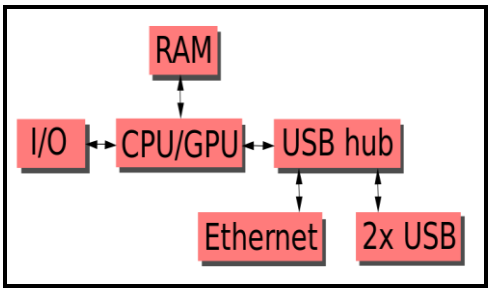
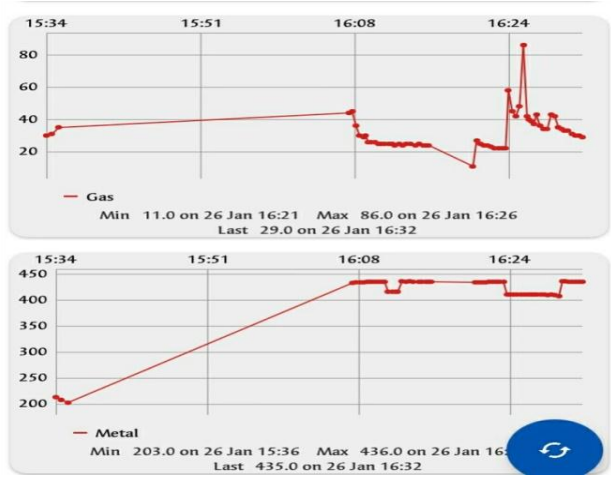



***Fig 4.*** *Raspberry PI*

The Broadcom BCM2835 SoC is the first Raspberry Pi which is similar to the IC used in many mobile devices, in which 700 MHz ARM1176JZF-S processor is added. It has various storage levels of 16 kilo bytes and 128 kilo bytes. The second level of storage is used by the GPU. The SoC is stacked underneath the RAM chip, so simply its edge is self-evident. Rasberry pi 2 uses BCM2836 system on chip with a frequency of 900MHz and uses a 32 bit ARM Cortex – A7 processor.

### 4.5 Internet of Things

Large number of embedded devices can be connected together with the help of internet of things. These embedded devices often communicate with the environment or with the people and sends data to the cloud for storing and for further processing of data [15].



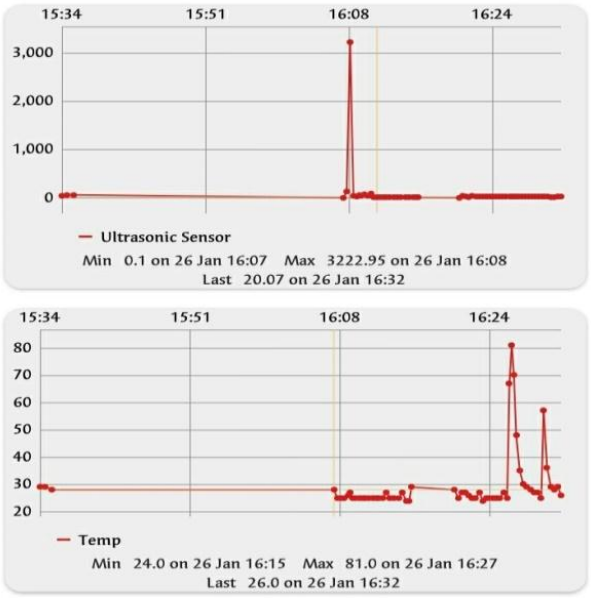



***Fig.5.*** *Senor values viwed through Thingspeak website*

For viewing the stored data from the IoT, Thing speak website can be used. The following graph shows the values of the sensors detected and it can be seen through thing speak website. Fig.5 shows the values measured from the temperature sensor, ultrasonic sensor and metal detectors. Fig.6 shows the thing speak web page through which values gathered from sensor units can be viewed and analysed.

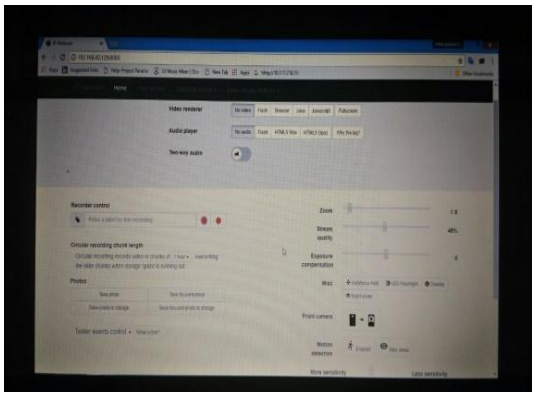


***Fig.6.*** *Thing speak web page*

## 5. EXPERIMENTAL RESULT

The results of the implemented system are shown in the fig. 7. The rasperry pi is programmed with the help of python landuage.

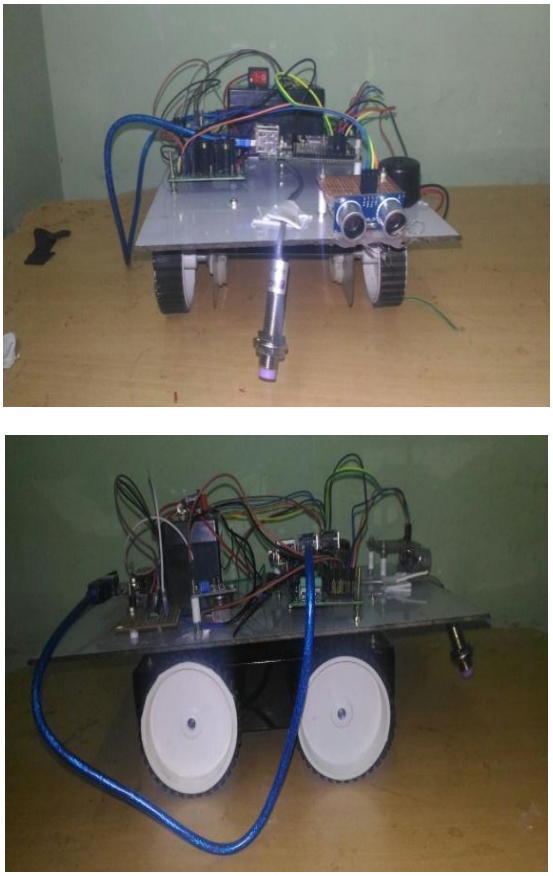


***Fig.7*** *Proposed Outcome*

Sensors are connected through the different ports of the processor. Ultrasonic sensor, temperature sensor and metal detectors are attached to the robot. Ultrasonic sensor is used for detecting the obstacles in the path. Based on the values obtained from the ultrasonic sensors, the speed and the direction of the robot is decided with the help of fuzzy controller. The metal detecteor output goes high if the landmine is detected then the location of that particular area is sent through IoT.

## 6. CONCLUSION

To achieve the autonomous movement of the robot, fuzzy logic controller is used. By using the fuzzy controller the system performance can be improved. It provides better performance on both steady state and transient responses. Rasberry pi processor helps in detecting and transmitting the information. The system designed helps in reducing the human work and the risk for loosing the life.

## REFERENCES

[1] Artem Vinogradov, Alexey Terentev, “Model of Fuzzy Regulator of Mobile Robot Motion Control System”, IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering (EIConRus), 2019.

[2] B. K. Patle , D. R. K. Parhi, “Application of Probability to Enhance the Performance of Fuzzy based Mobile Robot Navigation”, Applied Soft Computing Journal, 2018.

[3] Maid Ghareeb, AliBazzi, Mohamad Raad, Samih Abdul Nabi, “Wireless Robo-pi For Landmine Detection”, IEEE Xplore Digital Library, 2017.

[4] Rajesh Kannan Megalingam, Deepak Nagalla, "Swarm based Autonomous Landmine Detecting Robots, International Conference on Inventive Computing and Informatics", 2017
[5] KishanMalaviya, Mihir Vyas, Ashish Vara, "Autonomous Landmine Detecting Robot", International Journal of Innovative Research in Computer and Communication Engineering , vol.3, Issue 2, 2015.
[6] Arbnor Pajaziti1, Ka C Cheok,"Semi-autonomous mobile robot for mine detection" , IEEE Xplore Digital Library, 2015.
[7] M.G.KaleV, R.Ratnaparkhe,A. S.Bhalchandra, "Sensor For Landmine Detection And Techniques: A Review", International Journal of Engineering Research and Technology, Vol 2, Issue 1, 2013.
[8] A.Mahmoud and H. Farouk, "An Efficient Detection and Classification Method for Landmine Types Based on IR Images Using Neural Network", International Journal of Geology, Vol 4, Issue 4, 2010.
[9] Prema.K, Senthilkumar.N, Dash.S.S, Siva chandran.S, "Online Control of Fuzzy Based Mine Detecting Robot Using Virtual Instrumentation", IEEE Xplore Digital Library, 2012.
[10] L. Robledo, M. Carrasco and D. Mery, "A survey of land mine detection technology", International Journal of Remote Sensing, Vol 30, Issue 9, 2009.
[11] Przemyslawklesk, Andrzejgodziuk, Mariuszkapruziak, and Bogdanolech, "Fast Analysis Of C-Scans From Ground Penetrating Radar Via 3-D Haar-like Features With Application To The Landmine Detection", IEEE Xplore Digital Library,2015.
[12] Seniha Esen Yuskel,Jeremy Bolton, Paul D.Gadef, "landmine detection with multiple instance hidden markov models", IEEE Xplore Digital Library, 2012.
[13] Iraklis Giannakis, Antonious Giannopoulos, Craig Warren, "Numerical Modelling And Neural Networks For Landmine Detection Using Ground Penetrating Radar", IEEE Xplore Digital Library, 2015.
[14] V.abilash, j.paul Chandra kumar, "Ardunio Controlled Landmine Detection Robot", IEEE Xplore Digital Library 2017.
[15] NaqarFarooq,Nehal Butt, Samedshukat, nouman Ali Baig, Sheikh Muhammad Ahmed, "Wirelessly Controlled Mines Detection Robot", IEEE Xplore Digital Library, 2016.
[16] Seong Pal Kang, JunhoChoi,Seung-Beum Suh, Sungchul Kang, "Design Of Mine Detection Robot", IEEE Xplore Digital Library, 2010.
[17] N.Saravanan, R.Kaviyarasi, P.Malini, "Wireless LandMine Detection And Surveillance Robot", International Journal of Advance Engineering and Research Development, vol 4, Issue 3,march-2017.
[18] Andrew Karem and Hichem Frigui, "A Multiple Instance Learning Approach For Landmine Detection Using Ground Penetrating Radar", IEEE Xplore Digital Library, 2011.