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ROBODET: An IoT based Inspection Bot for a Total Safety thought

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Abstract: ***The present era has left humankind vulnerable to innumerable mishaps and we are prone to several industrial accidents. There are chances where life-threatening blasts can happen due to leakage of harmful and flammable gases. These accidents are triggered by the percolation of poisonous and flammable gases in various chemical industries. This brings us to the point that a survey is very important in the field of chemical industries, where a suspected gas leakage can take place. For this, an IoT based smart dynamic gas sensing robot is designed to detect hazardous gases and put the system on alert instantly to fix the issues and avoid chances of accidents. This ultimately ensures the safety of human lives. The objective of this paper is to come up with a suitable mechanism that can sense the presence of poisonous and flammable gases like Ammonia, Sulphur Dioxide, Nitrogen Dioxide, Carbon Dioxide, Methane, and LPG using IoT based smart gas sensing robots specially designed for field inspection. This dynamic gas sensing robot can be used for timely gas detection beneficial for remote areas inside a pipe or in an industrial laboratory etc. Generally, at such places, the source of the leakage is unknown therefore using automated or man-less apparatus will pave way for safety rather than sending a technical person with an inspection instrument who lacks an idea about the magnitude of contamination. This robot not only identifies gases but also give information about the overall air quality and also smoothens up the transfer of the same among devices using IOT technology so that immediate actions could be taken depending upon the contingency.***

Keywords: IOT, Robot, Gas Detector, Automation, Inspection, Safety.

I. INTRODUCTION

An Embedded system is the nexus of every compact handheld electronic device. This system is used for home automation systems, industrial robotics, advanced health care devices, personal weather station monitoring purposes, and other security systems, etc. The Embedded system is also important for the implementation of the Internet of Things (IoT) solutions such as for industrial robotics. An Embedded system serves as a link to bridge the gap between hardware and software for real-time operating systems (RTOS). It is anticipated that the overall embedded system market will grow at a CAGR of 22.5% to reach $226 billion through 2020.

Interestingly, an industrial robot is an intelligent and useful combination of sensors, automated controls, and a remotely operated system. The use of this type of robot can certainly improve productivity, security, safety, and curtail excess manpower. Robots have been developed to assist in several industries including that in the manufacture of other robots for packaging in the food and beverage industry, welding robots in the automobile industry, and mobile robots in space. In this paper, we are focusing on the development of a survey robot using IoT technology which is used as a sensor that warns us about harmful gas related mishaps.

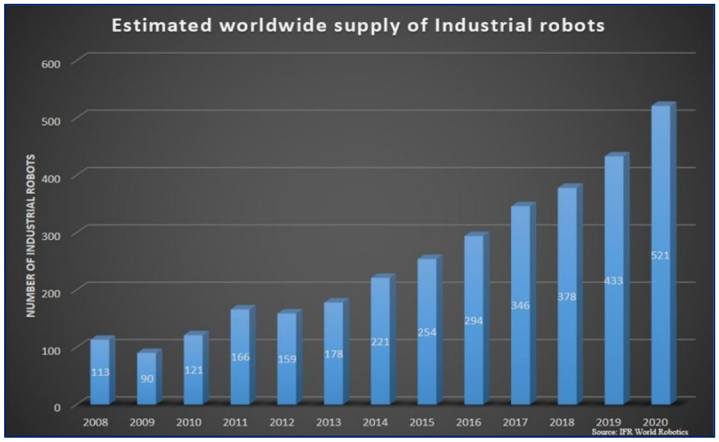

Fig. 1 Industrial Robot Evolution

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To address the growing industrial demands, inspection is a regular process in the industry to detect and identify foreign gas present inside the atmosphere including the overall air quality. As a convention, a technical person visits the suspected area and collects data using a detector. This process poses grave risks for health and also caters to serious health complications like respiratory problems, nausea, breathing difficulties, etc. Sometimes this practice can lead to even death of the survey inspector who happens to visit the site for inspection without having a proper idea about the air quality. In several cases, the harmful and hazardous gases present in the atmosphere can cause health hazards after being inhaled. Additionally, it can cause breathing problems for a considerable period of time.

The best solution to keep risks at bay is to inspect such an area, that is full of congestion due to unknown dangerous gases and temperature is Iot devices. This is also helpful as generally the contaminated areas possess a high temperature that makes it unreachable for human beings. The instrument is competent enough to move and reach the desired spots, collect real-time data, and send it through IoT based network. Thus, we can easily avoid any kind of risk related to health.

II. INTERNET OF THINGS

Internet of Things is a futuristic technology which is all set to connect billions of device around the globe over the World Wide Web. Nowadays, we wish to have everything at our fingertips such as shopping, healthcare, security, banking system, etc. IoT is omnipotent to turn “old” devices into “smarter” ones by giving them the ability to share data over the internet and communicate effectively with mankind. Tech analyst company IDC predicts that there will be around 41.6 billion IoT devices by 2025. Industrial, automotive, healthcare, agriculture, and survey devices offer brighter prospects for IoT technology.

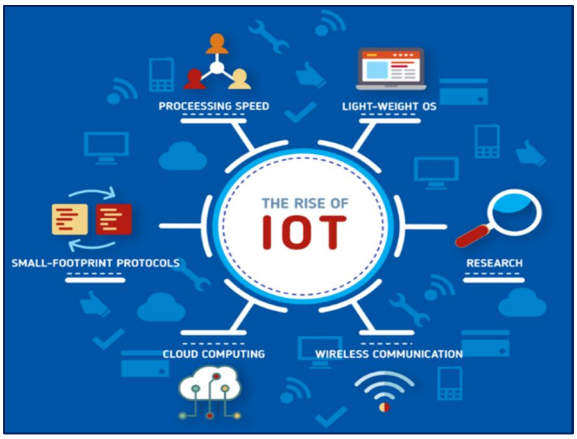

Fig. 2 Internet of Things

A. IoT Based Application

1) *Medical and Healthcare:* The IoT finds a wide range of applications in the healthcare sector as it is very useful to gather data about transmission and also gives an idea about the patient’s real-time health condition. In the COVID-19 situation, IoT technology is pretty much needed.
2) *Transportation:* IoT based systems can assist in the unification of communication and facilitates an exchange of information between various transportation systems. Smart traffic signal system, intelligent toll system, smart road assistance logistics, cargo and fleet management, etc. In upcoming days, we will be able to curtail road accidents and improve cargo management with the help of IoT technology.
3) *Manufacturing Industry:* IoT can be used to manufacture the latest devices equipped with advanced sensors, identification, communication, and networking capabilities. In several sectors like automobiles, packaging, food processing, or service industries, IoT based smart systems can be put to use for better efficiency.

III. SYSTEM ARCHITECTURE

A. Overview

IoT based gas detection robot is developed with a view to undertaking a survey of the area where the probability of gas leakage exists. This robot can be used to monitor a suspected contaminated area at regular intervals. This robot is lightweight, portable, and Wi-Fi compatible.

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This system has some advantages like it is made up of Arduino Uno and Node MCU microprocessor which can be programmed as per requirement and this robot runs on low power like 5-12 volts. There are some limitations like this system is made up of electronic components, hence it should be handled with care.

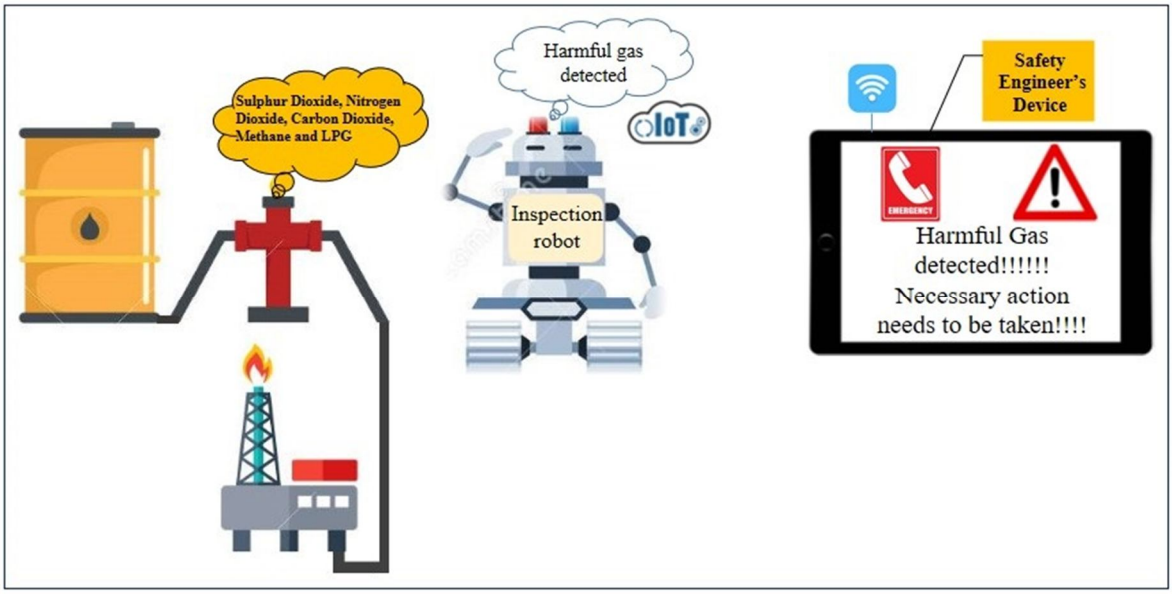

Fig. 3 The system framework on the engineers' side

B. Hardware Description

1) Arduino UNO: Arduino based scientific project started in 2005. More than 150,000 micro-controllers have been used worldwide to date. Arduino is a compact microcontroller that can be programmed to process inputs and outputs exchanged between the devices and external components that are connected to it.

Fig. 4 Arduino UNO

2) Node MCU ESP 8266-12E: Node MCU is an open-source IoT based Microcontroller Unit. This board is consists of ESP 8266 is a low-cost Wi-Fi Chip with TCP/IP protocol and it has Analog pin (a0) and Digital pin (D0-D8). It supports serial communication like UART, SPI, and I2C, etc.

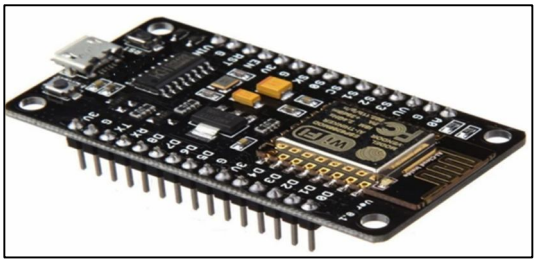

Fig. 5 Node MCU ESP8266-12E

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3) *MQ 135:* MQ 135 is an Air Quality assessment Sensor, which can able to detect various types of gases like NH3, alcohol, benzene steam, and CO2. This sensor is ideal for use in inspection service in office and factory, which have a fast response and quick recovery characteristic, adjustable sensitivity, and minimum power (5 volts) required to operate.

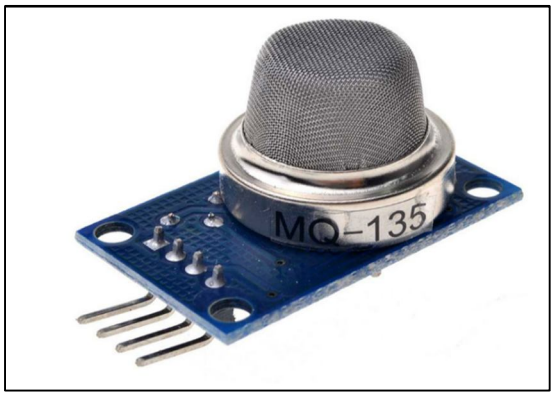

Fig. 6 MQ 135

4) *Bluetooth Module HC-05:* HC-05 is a Bluetooth based wireless module, which can be used as a communicating device between two micro-controllers or any device which have Bluetooth functionality like a mobile phone. This module communicates with the USART protocol (Universal Synchronous Asynchronous Receiver Transmitter) at a 9600 baud rate hence it is trouble-free to interface with microprocessors that support USART. This module is capable of transferring data as not only multimedia like pictures but as voice too.

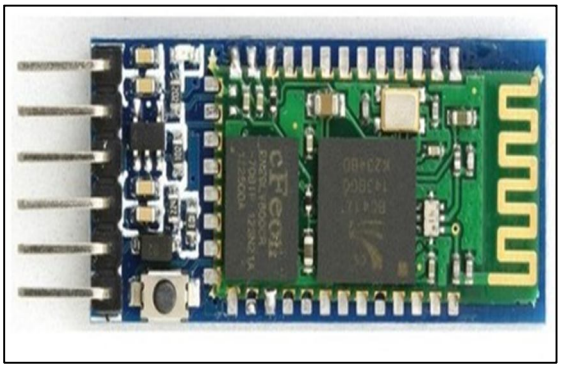

Fig. 7 HC - 05

In this Project we are use Bluetooth module HC-05 to run the robot and Node MCU ESP 8266-12E IoT module for transfer real time data of the MQ-135 gas sensor to the safety engineer. Elaborate circuit diagram and operating procedure will be discussed in next segment.

C. Software Specification

This project is executed with open source software and application which are easily available and accessible. The robot is controlled using Bluetooth technology-based Automatic Car Control android application. The transmission of Real time-based gas detection data is realized using ThingSpeak software. ThingSpeak is an IoT platform that gives us space to compose, visualize, and analyse the live data, and thereafter take necessary actions. In this system, there are multi-step vigilance features, to alert the safety engineers by the alarm and also to signals the fire & safety department's control room in-charge for taking the necessary steps without any delay.

D. Project Accomplishment

The "ROBODET" gas detection robot is embedded with the Arduino UNO microcontroller along with Bluetooth segment HC-05 for wireless control. For gas detection and live data transmission, MQ – 135 gas sensor and Node MCU Wi-Fi module is used here. We can see real-time data using Thing Speak Android app on a Mobile phone. The data is also shown in LCD and an ultrasonic

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sensor is placed in front of the robot to protect it from any collision. If some object comes in front of it then it gives an alarm and red light indication to the operator. The whole circuit diagram is designed using Fritzing software for a better understanding of the internal operation and corresponding sensors.

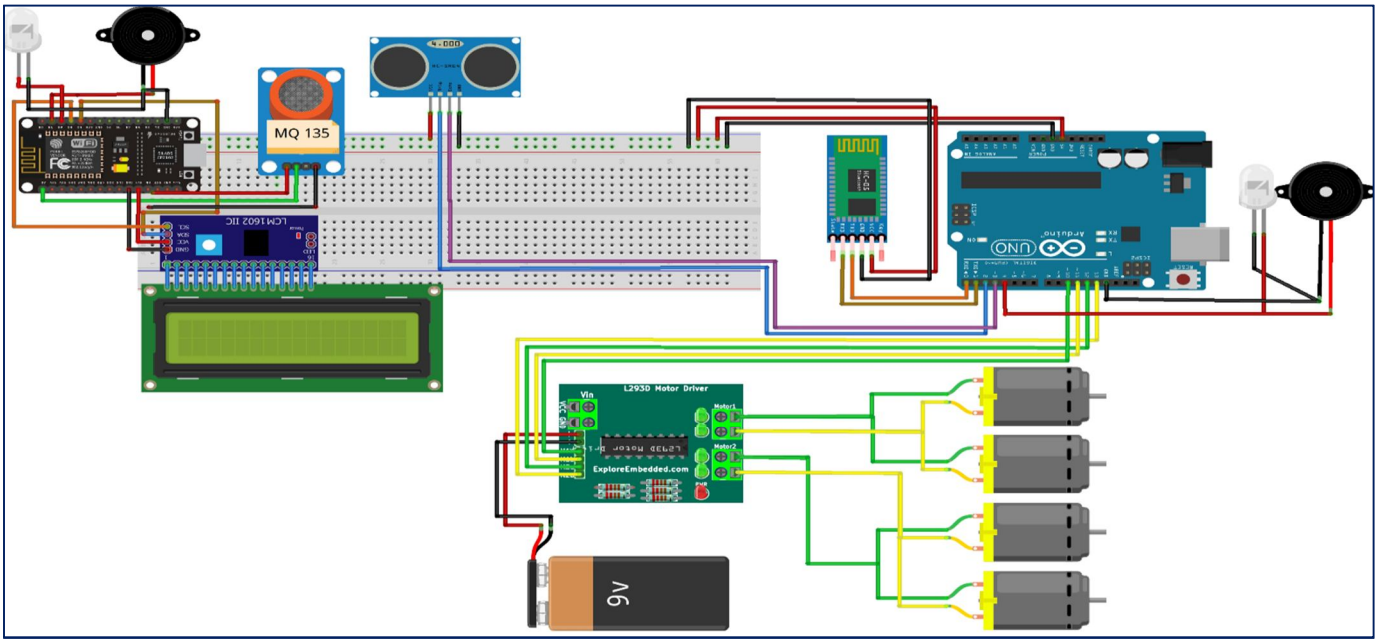

Fig. 8 Circuit Diagram representation

E. Flow Chart and execution

The operation of "ROBODET" is fully controlled through program execution. The program is written on the Arduino Uno microcontroller and Node MCU that how this robot operate. The flow chart is described below shows execution of program.

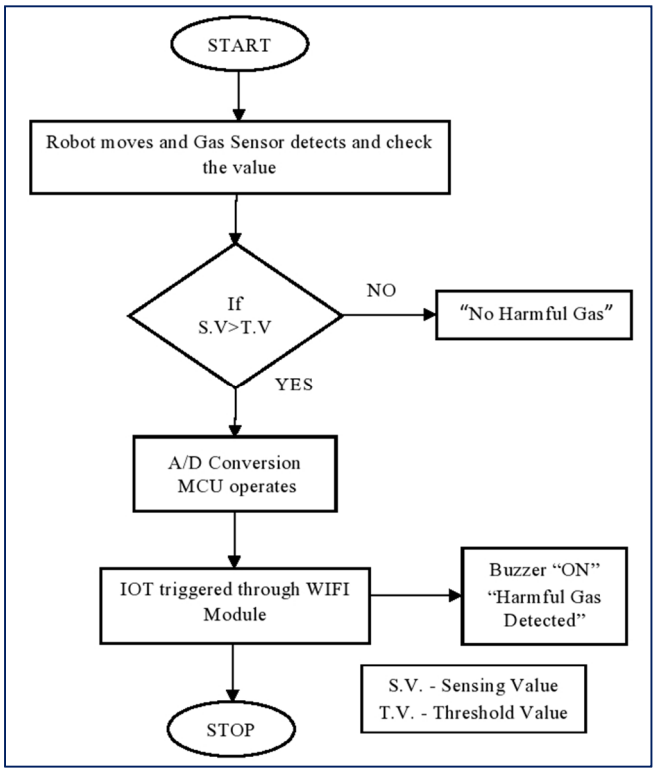

Fig.9 Gas detection process

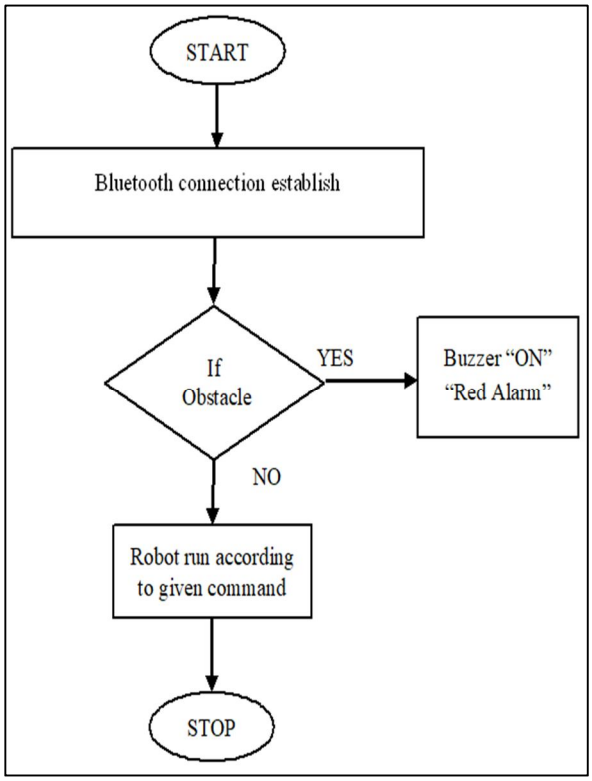

Fig.10 Robot Movement

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IV. RESULT AND DISCUSSION

In this section we are discussing about the corresponding values of the MQ-135 sensor on ThingSpeak platform.

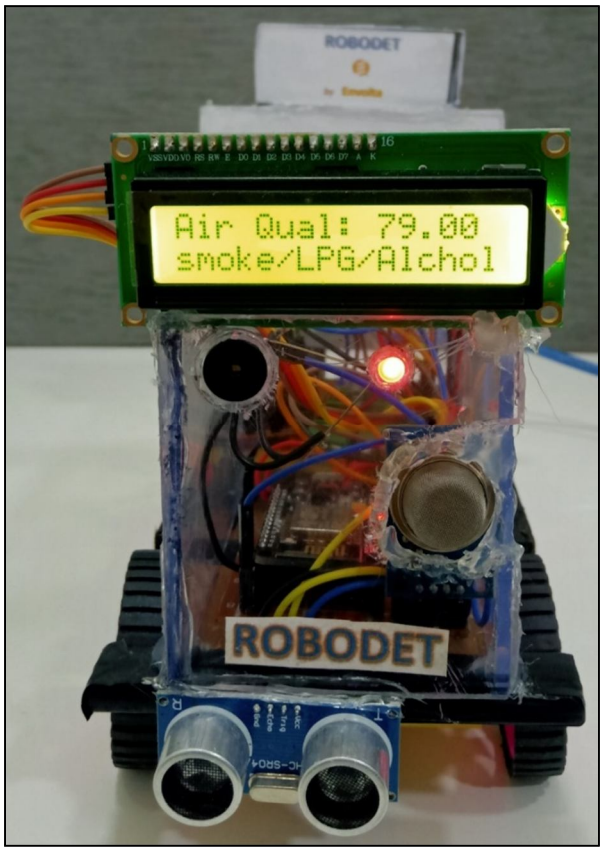

Fig.11 Real time project with alarm

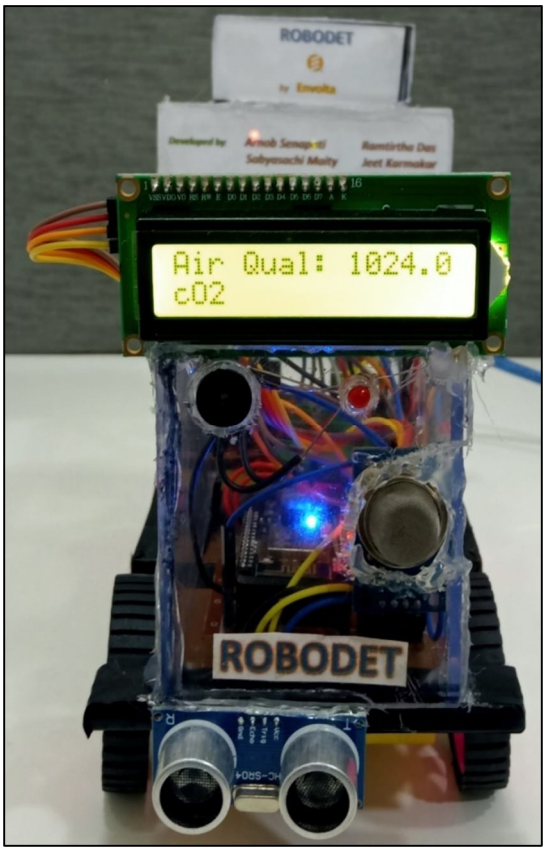

Fig.12 Real time project with alarm

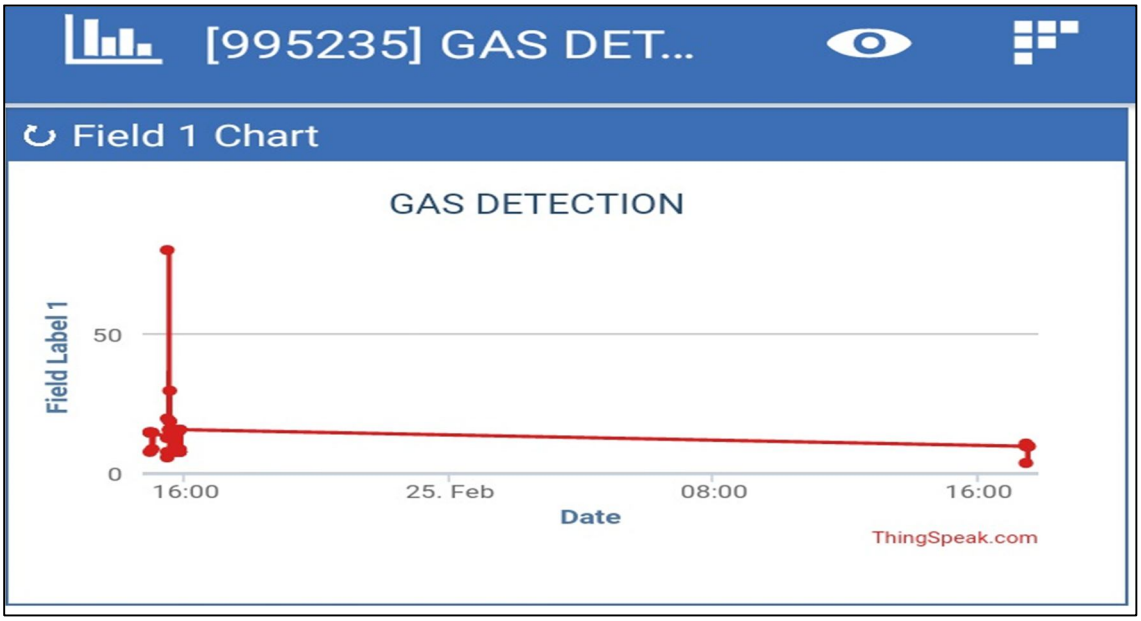

Fig.13 Real Time data from ThingSpeak Platform

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V. CONCLUSION

In this research paper, we have developed "ROBODET" an IoT based robotic gas detector for inspection cum safety operations. This robot will be used for a routine survey in an industry where the possibility of gas leakage or any unexpected gas leakage occurs. It can warn about the contaminated area and subsequently, the evacuation process could be started without delay. This system is less bulky as it can be handled by one person alone, as it is cost-effective hence it can be purchased by any small to medium industry. Further, it has low maintenance expenditure because it is built with electronics components. "ROBODET" is equipped with dual power source technology as it operates with 230-240 volt AC, 50 Hz also, it has four rechargeable 3.7-volt Li-ion batteries, suited for situations where power supply is not available. According to our observation and research, this robot will be very helpful for gas or chemical industries where unexpected gas leakage incidents might occur. However, this robot is a prototype model which has been made for provisional purposes only and cannot be used for commercial purposes. The commercial version of the product comes with technological up-gradation.

VI. FUTURE SCOPE

"ROBODET" will be developed by adding some more features and sensors. The next version of this robot is "ROBODET-PRO" which will be embedded with high definition gas detectors like features for instance it would identify the unknown gases as well. A camera will be installed in the front face of the robot to visualize the environment. A solar panel will be installed at the top surface of the robot so that it could store power and curtail the use of the same. In the "pro" version, we will try to make it both waterproof and dustproof as per IP 64 and it would be highly efficient.

VII. ACKNOWLEDGEMENT

We hereby express our deepest gratitude to the entire team of ENVOLTA for their valuable cooperation and kind assistance throughout the project. Especially, we extend our sincere thankfulness to Shri Chandan Kumar Bera, CEO ENVOLTA for being our guiding light and providing us with all the necessary equipment needed for the completion of this project. Without their valuable direction and support, the project would not have been a success. Also we hereby express our deepest gratitude to the editor Mrs. Bharati Banerjee for helping us. We thank them for the goodwill and encouragement. Last but not least we thank our teachers and parents for their best wishes.

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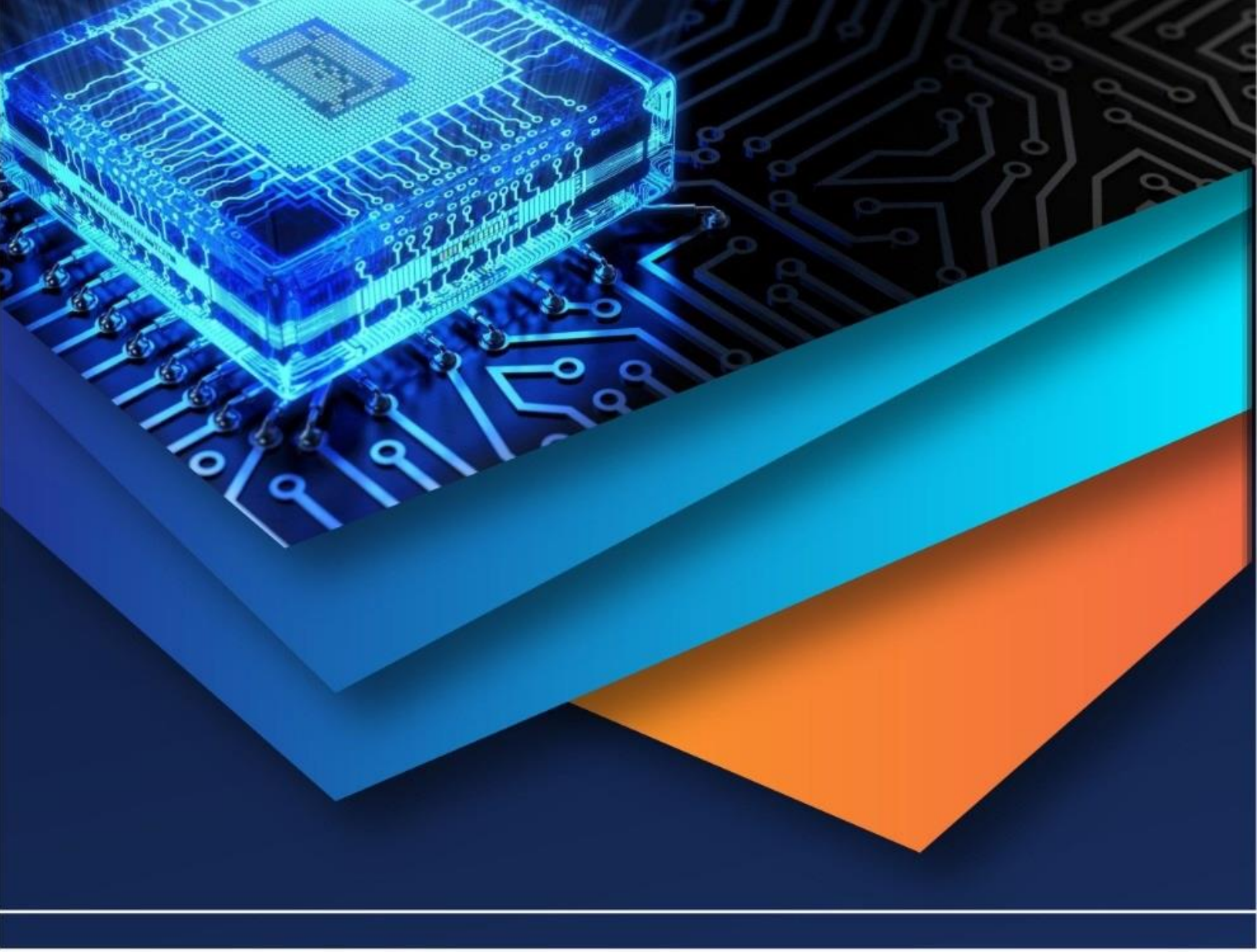

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