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Detection and Monitoring a Forest Fire using GSM Module

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Abstract: *In the present arena, wildlife and forest departments are facing the problem of movement of animals from forest area to residential area. The number of trees has reduced drastically from the forest that creates an unhealthy environment for animals to survive in the forest. It has been found in a survey that 80% losses are caused due to fire. This could have been avoided if the fire was detected in the early stages. This project proposes a system for tracking and alarming for the protection of trees against forest fires. Nowadays IOT (Internet of Things) devices and sensors allow the monitoring of different environmental variables, such as temperature, humidity, moisture etc. Arduino platform based IOT enabled fire detector and monitoring system is the solution to this problem. In this project we have built fire detector using ESP32 which is interfaced with a fire sensor and a buzzer. In order to implement this project, we will be using GSM which is used to provide the final SMS to the user through the given number in the simulation program. The sensor data is displayed on LCD. Whenever a fire occurs, the system automatically senses and alerts the user by sending an alert to an app installed on user's android mobile.*

Keywords: *IOT, Fire Sensor, GSM, ESP32, ThingSpeak and Forest Fires*

I. INTRODUCTION

Forest is a large area where it is dominated by trees and animals. Forest covers an area of around four billion hectares or approximately around 30% of world's land area. Forest is one of the huge supports for a country economic. Forest normally contains various species of trees and animals. Even human beings receive a huge profit from the forest. Some medical materials, house-hold requirements and other human requirements are got from the forest. Forest also has a huge impact on the environment which prevents the earth from over heading. Pollution made by the humans are reduced in a greater extent by the forest. So, the fire in the forest causes a great impact in the world. Forest fires are unnoticed and spread very quickly, causing millions of acres in damage and claiming many human lives every year in many countries. This forest fire can lead to a huge disaster in the environment. The losses in the forest fire are huge which affects both animals and trees. Forest fire in the world is increasing in recent times. This fire in the forest is due to natural or man-made disasters. Lightning is one of the reasons for natural forest fire. It occurs due to combustion of dry fuel in the forest like leaves. Fire caused due to man-made are more like smoking, due to any miscellaneous activities. The fires caused due to man-made are more than natural forest fire. But large area damage is caused by natural forest fire because it cannot be predicted. The damage cause due to forest fires are more in recent years. The survey taken by National Interagency Centre says that in 2016, there more than 65,575 wildlife are affected due to forest fire. In 2017, the damage has increased to around 71,499 and around 10 million acres were burned in the fire. By taking a awareness schemes, the damage has reduced to 55,911 wildlife and about 8.6 million acres of were burned which is less compared to the year 2017. The survey also suggests that the forest fire is more in northern countries. USA has a huge number of forest fires. Early detection of hot spots and the initiation of appropriate measures can prevent, or, at least minimize damage and casualties. So, to reduce the damages in the forest area due to forest fires a device can be used where the device is built with some modern technologies. In the modern world immediate information are send and received in a quick time. Even normal activities are informed through these technologies; it is possible and important to inform this kind of information in a quicker time. This information helps the government to reduce the damage in the forest by fire. To avoid huge damage of forest from the natural fire precautions are taken by the government and forest departments by having some emergency equipment to reduce the fire like fire extinguisher and some rangers are appointed in the forest areas to give immediate information about the fire in the forest so that immediate necessary actions can be taken.

A. Problem Statement

Forest fire is also called as wild fire or wild land fire is an uncontrolled fire occurring in forest areas it is essential to distinguish these sorts of flames as ahead of schedule as conceivable in order to keep the harm from it to biological framework. Consistently a large number of sections of land of timberland are burned to the ground. The land were woods is singed it winds up plainly difficult to develop vegetation over yonder. This is on account of soil moves toward becoming water repellent and acknowledges no more water, prompting lessening in ground water level. So such system would help in detecting and alerting so that proper actions could be taken. Putting this problem in mind, we are designing a system which helps us to achieve our goal i.e. To Protect Nature.

B. Objectives

The objective is to detect the forest fire as early as possible by measuring the level of temperature and carbon dioxide level.

- 1) Apart from the preventive measures, early detection and suppression of the fire is the only way to maintain the damage and casualties.
- 2) IOT-based forest fire detection system is proposed to detect the fire by monitoring the values of carbon dioxide level and temperature. To limit such fire to save the forests around the earth some preventive actions need to be done. To avoid the forest fire we are developing such a system which can be used in forest.
- 3) In this system tree will be having one small electronic unit including of Controller, Fire Sensor, buzzer, GSM and ThingSpeak Server.
- 4) Forest fire will be sensed by Fire sensor and this information will be displayed on LCD in main server unit like as Fire name and area simultaneously buzzer will be ON and also message will be transmitted to mobile application officer using ThingSpeak app in mobile. Communication between tree unit and main unit is done by Arduino Uno microcontroller.

C. Proposed System

This section of the paper will include the proposed work carried out showing the Hardware used, Software's utilized, Algorithms used with respect to deep learning part of the project and working of the project.

In this system we have given an idea to detect the fire in the forest by using modern equipment. The system is proposed to detect the fire in the forest and also to alert the forest officer about the fire in the forest. Here a microcontroller is used to control the system activities, fire sensor is used to detect the fire in the forest, and module which are GSM module and Relay module. So, the system is a complete IOT based system where the activities of the system are continuously monitored and the monitoring details are stored in online pages which is viewed by the officer regularly. The details are stored as a data and this data can be viewed at any time. The sensor senses the data if getting values is above the threshold value the fire alarm gets ON. If fire is detected then water pump & buzzer gets ON. All this information send to microcontroller & it upload into webpage, and SMS is sent to owner & fire station.

II. LITERATURE SURVEY

In 2014 Alkhatib, A.A.A. summaries all the technologies that have been used for forest fire detection with exhaustive surveys of their techniques/methods used in this application. A lot of methods and systems are available in the market and for research. The paper reviews all the methods and discusses examples of research experiment results and some market product methods for better understanding. Result. Each technique has its own advantages and disadvantages. A full discussion provided after each type.

Vicente, F.B., Carbajal, N., Felipe, L. and Martínez, P. in 2014 estimates the total yearly CO₂ emissions by Wildfires in Mexico during the Period 1999-2010. Fire identification in homes is important to prevent property loss due to both natural and triggered fire events. Fire identification will prove to be very critical since the difference between life and death may mean it. Fires will come from anywhere and at any moment, but the existence of a fire alarm device helps to keep the family safe. The need to get a fire alarm device isn't seen by certain people. They just think they're going to smell the fire and sprint out of time. The typical time for a building to burn down is just 60 seconds today. So the fire has probably consumed the house by the time you smell the fire and decide to run inside.

In 2008, Zhang et al. presented a forest fire detection system based on ZigBee wireless sensor network. The topology structure of the system is an adaptation of a cluster-tree in order for the information path to take less memory space. The hardware circuitry of the network node is based on a CC2430 chip. The environmental parameters detected are temperature and humidity. Communication between gateway and monitoring centre is done through GPRS module. Processor chip used at the gateway is PXA255 from Intel Company. The downside of this system is requirement of internet within forest areas all the time for it to function.

A lot of studies based on wireless sensor networks have been done by researchers worldwide in order to come up with systems capable of monitoring and detecting wildfire. Bolourchi & Uysal in 2013 came up with a research work that proposes the use of wireless sensor network (WSN) for data harvesting to be used as raw input data into a control system that they developed. They choose fire detection to illustrate the Intelligent Decision Making (IDM) capability of the system and developed Fuzzy Logic algorithm using temperature, smoke, light, humidity and distance as functions. Probability of fire based on fuzzy rules using the status of the functions is presented by simulating the developed system on the Matlab software. The weakness in this research is that it is merely a theoretical work based on simulation on the Matlab software for the purpose of finding the probability of occurrence of fire. The system is not tested in the really environment to give out a clue on how it will behave.

A research work by Lloret et al. in 2009 recommended a wireless sensor network deployment for rural and forest fire detection and verification. This system uses IP (Internet Protocol) cameras in a wireless network in order to detect and verify fire in rural and forest areas. The system consists of multiple sensors and access points to detect fire and send a sensor alarm through the wireless network to a central server. The central server selects the closest wireless cameras to the multi-sensor, based on a software application, which are rotated to the sensor that raised the alarm, and sends them a message in order to receive real-time images from the zone. This system requires better internet coverage in rural and forest areas. In Tanzania the forests and rural areas don't have good coverage of internet and thus if this system is deployed it won't function effectively and efficiently as intended.

Chauhan et al. in 2013 came up with artificial neural network-based forest fire detection system using wireless sensor network. The proposed framework in this research mainly describes the data collection from designed data acquisition system and then its classification. The wireless transmission of sensor node data is done using BT module and also artificial neural network approach i.e. support vector machine (SVM) is applied for classification of collected data. For someone to be able to deploy and implement this system has to be equipped with a lot of skills such as knowledge on support vector machine, multilayer perception polynomial and quadratic and radial basis function.

III. SYSTEM DESIGN

System design thought as the application of theory of the systems for the development of the project. System design defines the architecture, data flow, use case, class, sequence and activity diagrams of the project development.

A. System Architecture

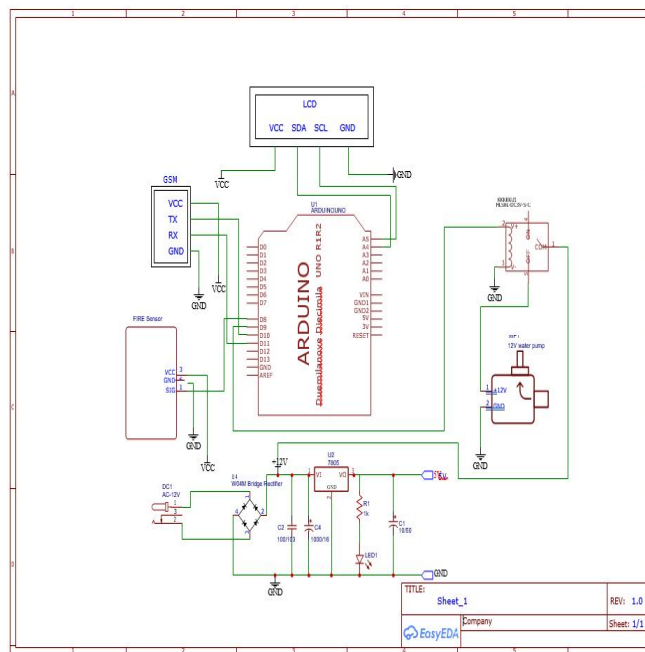


Fig. 1 Architecture Diagram

Here a microcontroller is used to control the system activities, fire sensor is used to detect the fire in the forest, and module which are GSM module and Relay module. So, the system is a complete IOT based system where the activities of the system are continuously monitored and the monitoring details are stored in online pages which is viewed by the officer regularly. The details are stored as a data and this data can be viewed at any time. The sensor senses the data if getting values is above the threshold value the fire alarm gets ON. If fire is detected then water pump & buzzer gets ON. All this information sends to microcontroller & it upload into webpage, and SMS is sent to owner & fire station.

Fire alert system comprises of three important stages: sensing, routing and communication. For sensing the physical change in environment, a sensor is used namely fire sensor. The fire sensor, which is highly sensitive and responsive in the presence of a fire and it helps to detect a fire in the forest and transmit the data to the microcontroller. If there is a fire at the forest, the LCD display turns ON and displays "FIRE ALERT", then it will immediately communicate with the base station using GSM modem.

B. Dataflow Diagram

Data flow diagram also referred as bubble graph. This diagram is useful for representing the system for all degree of constructions. The figure is differentiated into parts which show maximizing data path & practical aspect. The below figure 2 shows the dataflow of the proposed system.

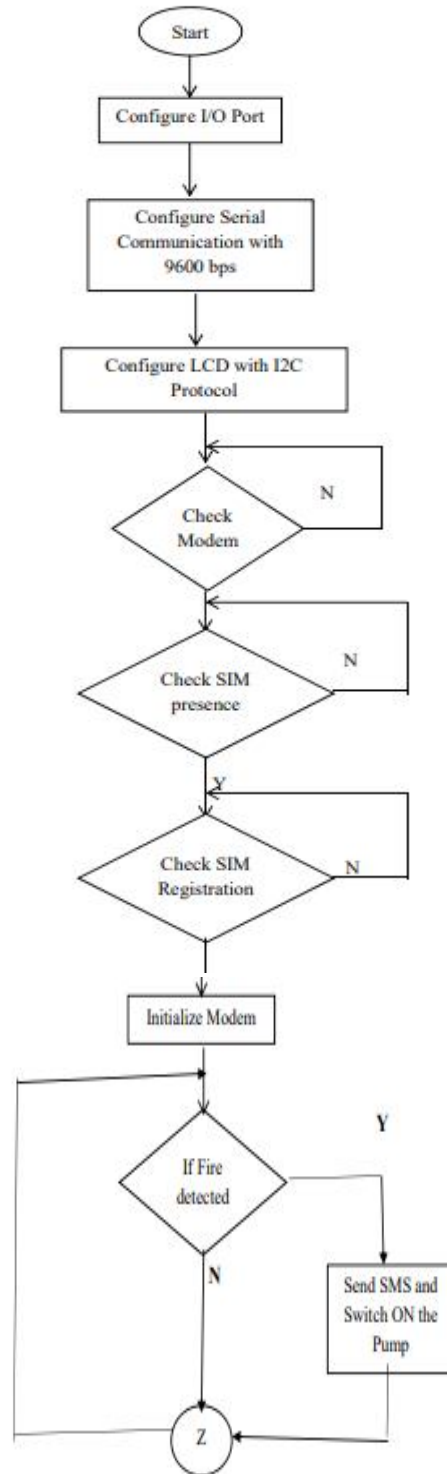


Fig. 2 Dataflow Diagram

C. Sequence Diagram

A sequence diagram simply depicts interaction between objects in a sequential order i.e. the order in which these interactions take place. We can also use the terms event diagrams or event scenarios to refer to a sequence diagram. Sequence diagrams describe how and in what order the objects in a system function.

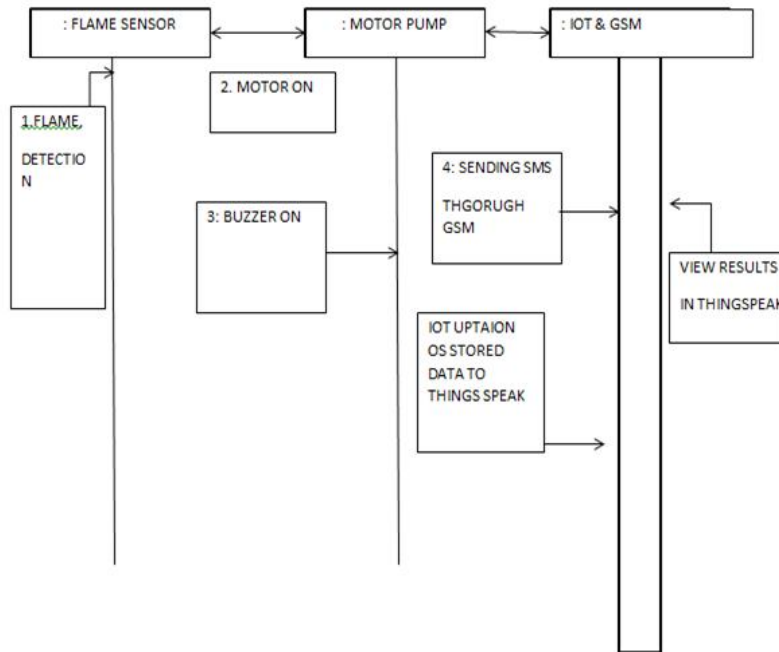


Fig. 3 Sequence Diagram

D. Block Diagram

The below figure 4 shows the block diagram of the proposed system. In this system one of the main components is Arduino where the entire controlling operation takes place. It is interconnected with fire sensor which detects the fire in the forest. So, the sensed data is continuously monitored by the microcontroller where the sensor is interconnected. When the fire is detected, the microcontroller operates its function to transmit the information about the fire in the forest to the officers through cloud and through SMS mode.

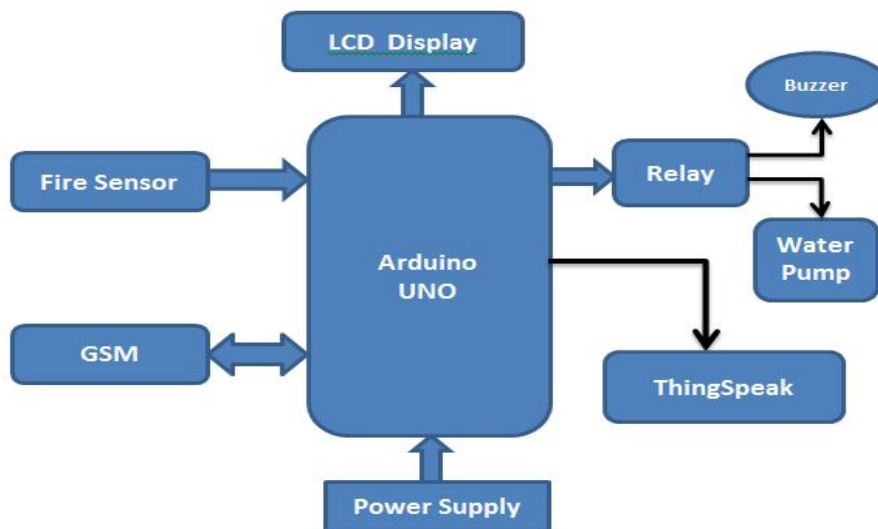


Fig. 4 Block Diagram

IV. RESULTS

The processing of data is carried out in the Arduino to get the desired output. Fire is monitored by flame sensor and displayed in the LCD display unit whenever the fire is detected and data is updated in cloud. The sensors data are stored in the web page automatically. This data can be accessed from anywhere irrespective of time through internet by using ThingSpeak channel.

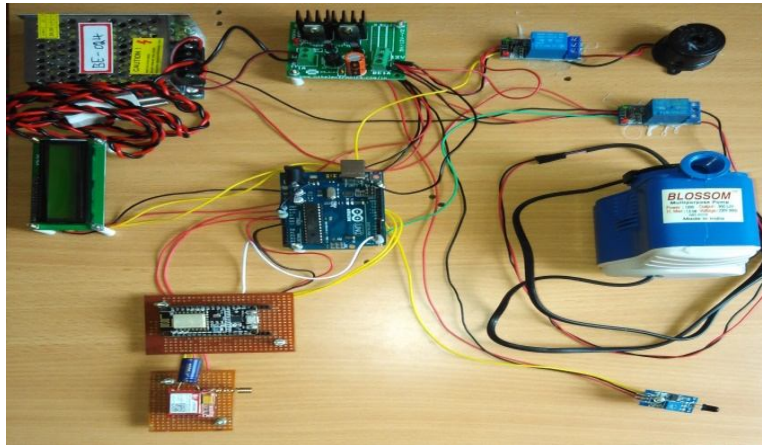


Fig. 5 Top view of fully developed Forest Fire Detection Model



Fig. 6 Model when the fire is detected

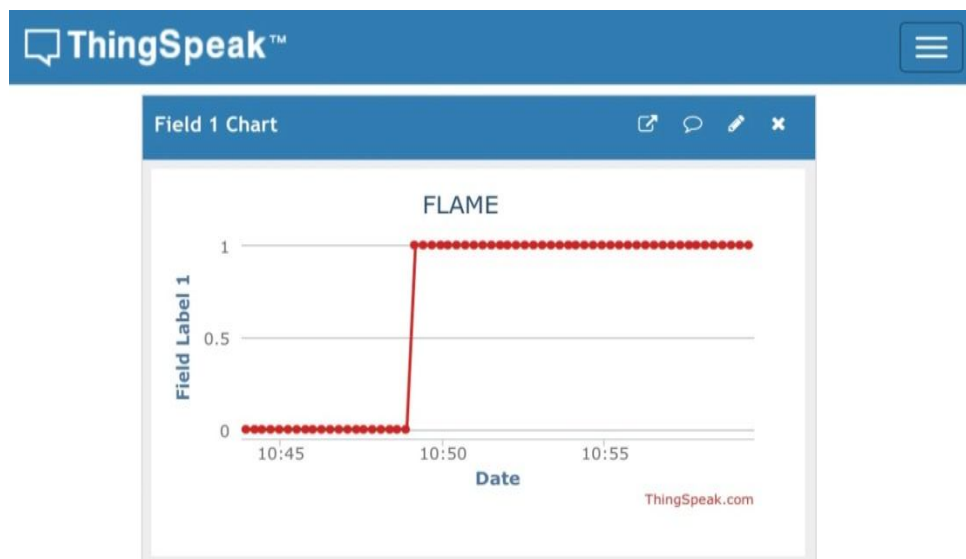


Fig. 7 Flame Chart of Field 1

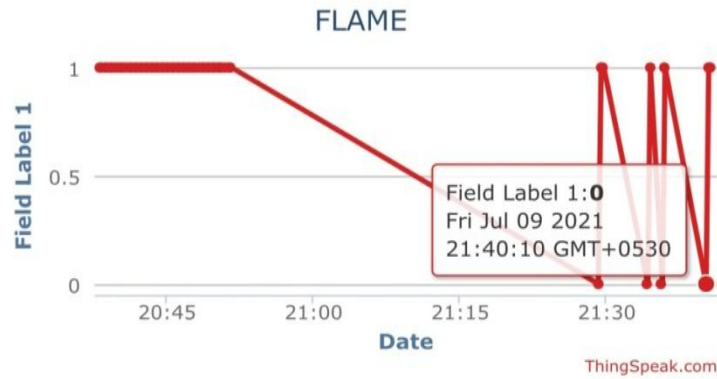


Fig. 8 Flame detected Graph with Date and Timings

Figure 7 and 8 shows the flame sensor monitoring data which in simple graph format. Whenever fire is detected the graph is pointed to value 1 and when it is extinguished it is again move to value 0. We can also get the date and timing of data updated in thingsSpeak cloud application

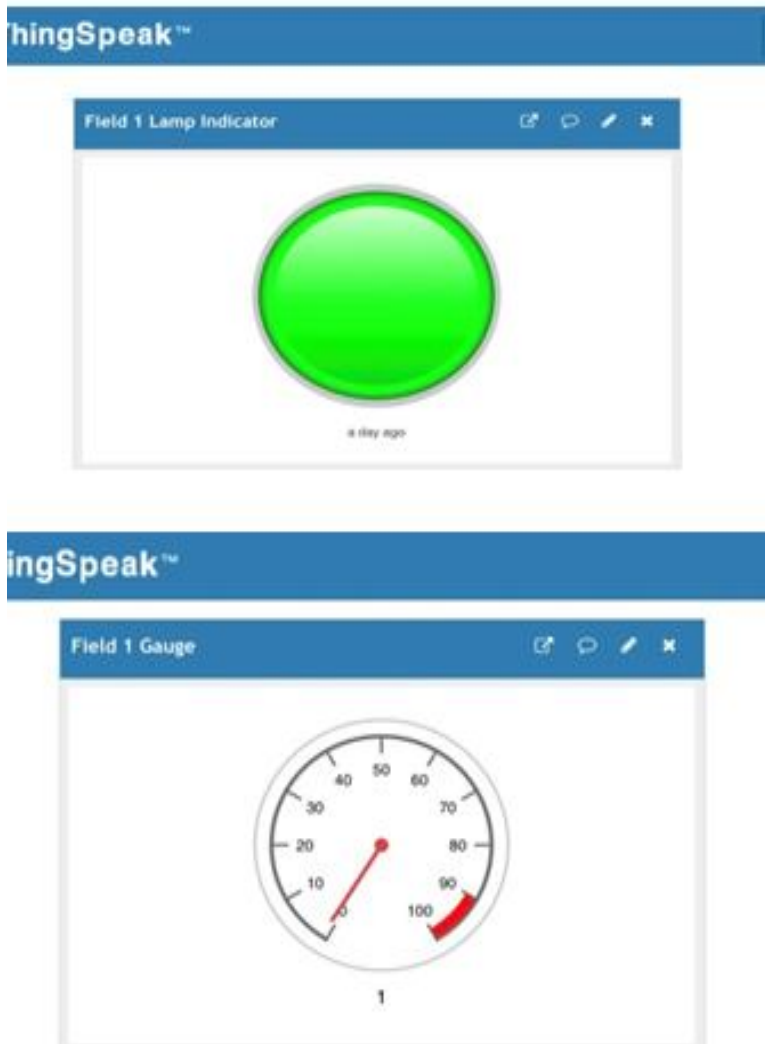


Fig. 9: Lamd indictator and Gauge of field 1



Fig. 10 Fire Detected Message on LCD

The LCD display unit displays the title of the project as a sign of initiation of the functioning of the program. LCD reads the data from arduino board which is directly interfaced with the Node Module in the system. The data regarding the fire levels measured by the sensors is updated in the “Thingspeak” application and displayed through LCD display as shown in Fig. 10.



Fig. 11 SMS received by GSM

V. CONCLUSION

We discussed the latest technology that can help to reduce catastrophic accidents caused by fire. We designed the whole system and evaluated its effectiveness as well as scalability. With the improvement of sensor technology, the system will become more efficient and useful. If this system can be successfully integrated in every factory, then it is hoped that the loss of life and property due to the fire accidents will reduce remarkably and the country’s economy will not be stumbled by such tragic accidents. It can further extend this project by adding some more features which can make it more efficient and security oriented. The camcorder can also be used to track all the activities of the unknown person or intruders.

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