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Implementation of IOT Technologies in an Autonomous Fire Detection and Control System

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Abstract—*This work expresses the idea of implementing IOT technologies for the development of an autonomous fire detection and control system which not only helps in early prediction of fire but it is also capable for fire detection and control in an automatic manner. Fire IOT belongs to the application of IOT technologies in firefighting industries. The proposed system is an intelligent control system integrating the functions of intelligent fire detection and automatic fire control. The system is designed using smoke sensor, temperature sensor and flame sensor. These sensors continuously monitor the parameters like smoke, temperature and flame. Whenever the output values of all sensors exceed the predetermined threshold values stored in the database of microcontroller, then a buzzer will be alarmed and a warning message, with all the values, will be displayed at LCD. Also, this information will be transmitted to the control server with the help of Zigbee module. Zigbee provides two way communications in this system. Firstly, it will send the information to control room if any fire accident is detected. Second, any authority from control room can also give the command in order to automatically ON a high pressure nitrogen pump and exhaust fan with the help of relay. Thus the proposed system can also work as an automatic fire extinguisher. When the fire hazards occur, the fire alert messages can be spread via web based notification system with IOT techniques. With this technique, the notifications are quickly transmitted over all nearby fire control stations and control rooms.*

Keywords- *Fire Detection, Internet of Things (IOT), Zigbee, Automatic Fire Extinguisher, Wireless Local Area Network (WLAN)*

1. INTRODUCTION

Since the very early age, the use of fire has been useful for the development of human society and it is also used in many applications i.e. cooking, manufacturing etc. But when fire is out of control it can create a serious threat to human life and property, and it is also harmful for our environment [1]. Thus in order to prevent fire accidents and to reduce fire losses, there is a requirement for development of an autonomous system which not only provides early fire prediction but also control the fire in an initial stage so that further disasters can be reduced. This paper describes the development of an autonomous fire detection and control system which is equipped with various sensors and microcontroller. This system not only deals with the detection of fire but it also provides controlling actions. For control purpose, controlling devices can be used which will be working as automatic fire extinguishers. Here, an exhaust fan and a high pressure nitrogen pump will be used as automatic fire extinguishers. This process is fully automated using a microcontroller system, executing the fire-detection algorithm and providing controlling action. As fire detection and extinguishment are the hazardous job that invariably put the life of a human being in danger. By putting these types of automatic devices to perform this task in a fire sensitive area, it can help in avoiding unwanted fire accidents [6].

This work is focused on applications of IOT techniques in fire detection and control field. With the help of internet, the people can be warned about the occurrence of fire disasters at an early level. Compared with traditional fire alarm system, the proposed system is based on multi sensor approach, thus there is less chance of missing detection. Also, with this system, the alert notifications are transmitted in a fast and intelligent manner with IOT techniques. This system is based on the idea of Fire IOT which belongs to the application of IOT in firefighting industries. The main characteristics of IOT like reliable transmission and information processing makes it a suitable choice for fire disaster detection and management [2].

The term IOT is defined as a network of objects carrying unique identity which are able to communicate together [7]. In the Internet of Things (IOT), many of the objects that surround us will be on the network in one form or another. Radio Frequency Identification (RFID) and sensor network technologies are widely used for the implementation of IOT techniques. The Internet of Things architecture requires a shared understanding of the situation of its users and their appliances, software architectures and communication networks to process and transmit the information and the analytics tools in the Internet of Things that aim for smart behavior. With these three fundamentals smart connectivity can be accomplished [8]. IOT relies on the interaction of smart

objects or things among each other and with physical resources through the Internet [9].

2. LITERATURE REVIEW

A lot of research work has been done in this field. Authors gave designed a fire pre-warning system in [1].This system adopts a single chip micro-computer with temperature sensor and smoke sensor as detective devices. In [2], authors have analyzed the development and advantages of fire IOT in several aspects. A study has been done on how IOT techniques can be implemented in the field of fire fighting safety. An automatic fire fighting robot has been designed by using adaptive fusion algorithm [3]. In [4], authors have studied how IOT can be used in public safety emergency management and early warning system. The concept of indoor fire fighting robot is developed in [5]. Authors have designed a fire fighting robot which can also communicate with injured victims at fire place and can send videos to the control unit. An autonomous fire fighting mobile platform is developed in [6] that can patrol through hazardous sites via a guiding track. It is equipped with fire fighting equipments. In [12], authors have designed an automatic fire detection system with GSM and alarm for alert notification. With the application of IOT and cloud servers, authors have designed an autonomous emergency warning system in [16]. A wireless system has been designed using wireless sensor network for smoke and fire detection in [17]. The research work is still going on the implementation of IOT techniques in the field of emergency management such as fire hazards etc.

3. SYSTEM OVERVIEW

The overall system architecture can be configured into two units i.e Transmitting Unit and Receiving Unit. The transmitting unit consists of MQ-2 smoke sensor, temperature sensor LM-35 and a flame detector at the input side. It also consists of a microcontroller unit Atmega-16 which takes the decisions with sensor values. At the output side, the system consists of LCD, buzzer, a high pressure nitrogen pump and an exhaust fan. The microcontroller establishes a two way communication with Zigbee module via Zigbee communication protocol. The receiving unit consists of a Zigbee receiver and a control server. The data is transmitted via Zigbee transmitter, which is received by Zigbee receiver at the control room on the receiving side. The Fig. describes the architecture of proposed system:

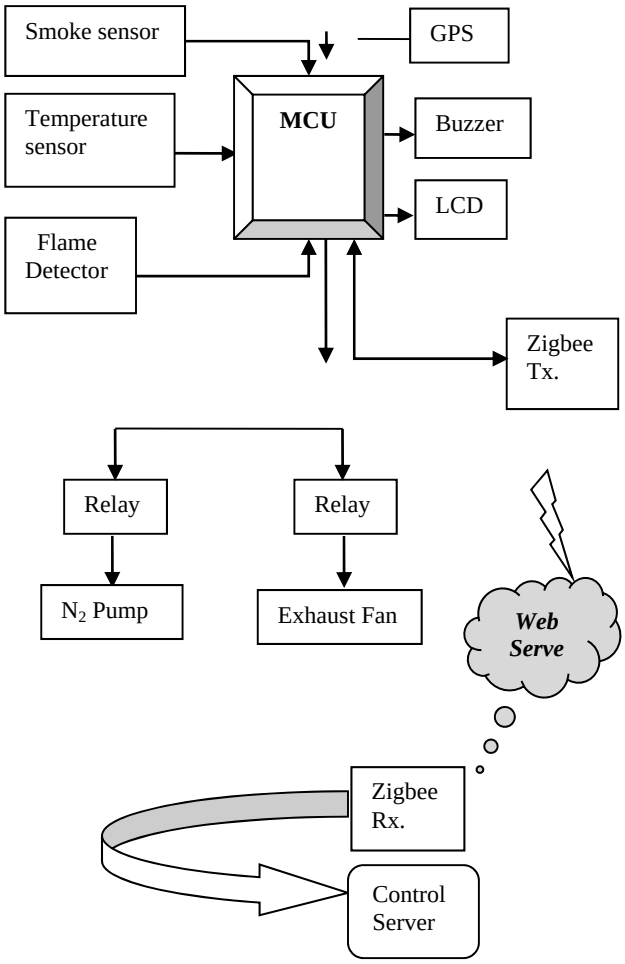

Fig. 1: Block diagram of system.

4. METHODOLOGY

The working of proposed system can be explained in two procedures. First, the data is collected from sensors and data processing is done by controller. Second is the integration of IOT techniques. Each Fire detector device is given a unique identity so that all of the devices can be configured to an interconnected network. The reliability of this system will depend on the integration of hardware components. Initially the data is converted into digital form via ADC. The microcontroller unit takes this data into digital format and compares the data with the threshold values stored in its database. Whenever these values exceed the threshold values, the controller then considers this situation as the occurrence of fire. At the same time a warning message with all the values are displayed at LCD. Now, the buzzer will be alarmed for alert notification. Whenever the controller detects the fire conditions, warning messages are transmitted via Zigbee transmitter. Zigbee is communication protocol which is the advanced version of Bluetooth technology with a large communication range of 30-70m in urban areas. It operates at

a frequency of 2.4 GHz. Now at the receiving side, this message is received by control server via Zigbee module. After receiving this information, the authorities from control room can check about fire occurrence and if there exists the fire conditions then a command can be given to controller. This command will automatically on the exhaust fan and a high pressure nitrogen pump. Exhaust fan will help to reduce the smoke level and N_2 pump will remove the flames.

Now, the second and main part of the system is the implementation of IOT techniques. For this purpose, fire detection device is given a unique address. Fire IOT is an interconnected network of various fire detection devices and each of those devices has a unique address. Whenever the fire conditions are detected, the messages are transmitted to all nearby fire station control rooms via web server. Now, with the help of unique IP addresses, it can be identified that the notifications are coming from which of the device. Also, with the help of GPS module, the location of each device can be determined. Thus, with all this notifications Fire control services can be reached to the exact location of fire accident. Since all these things are occurring in an automatic manner, this system will provide intelligent fire detection and control mechanism. Given Fig. represents the functional overview of the proposed methodology:

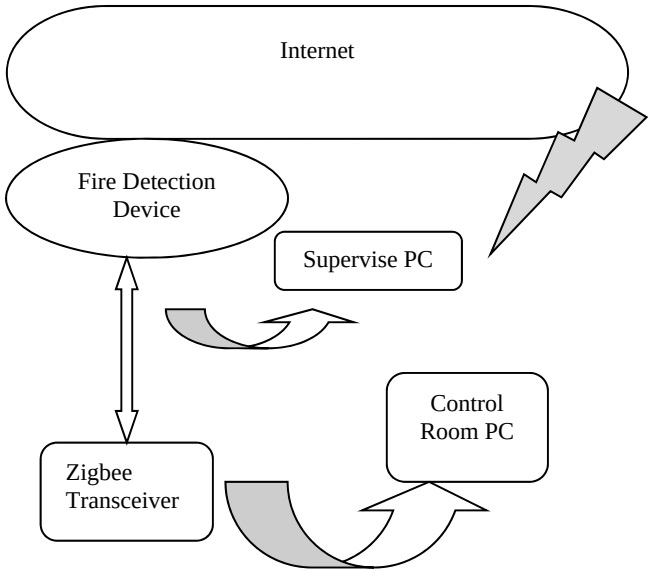

Fig. 2: Functional Overview of system.

4.1 Circuit simulation of the System

To analyze the performance of proposed system, we create a schematic diagram of this system in Proteus simulation software and simulate it for real time values. The schematic Fig. of proposed system is shown in following figure:

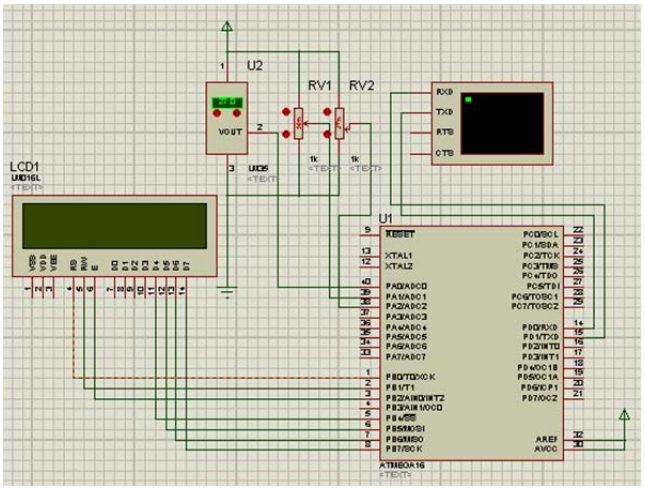

Fig. 3: Schematic diagram of system in Proteus simulation software.

4.2 Software Design of the System

The flow design of entire system represents the data flow direction through entire mechanism. The system needs to detect all parameters like smoke, temperature and flame. Whenever the values exceed the threshold values, fire alarm is executed by the control unit.

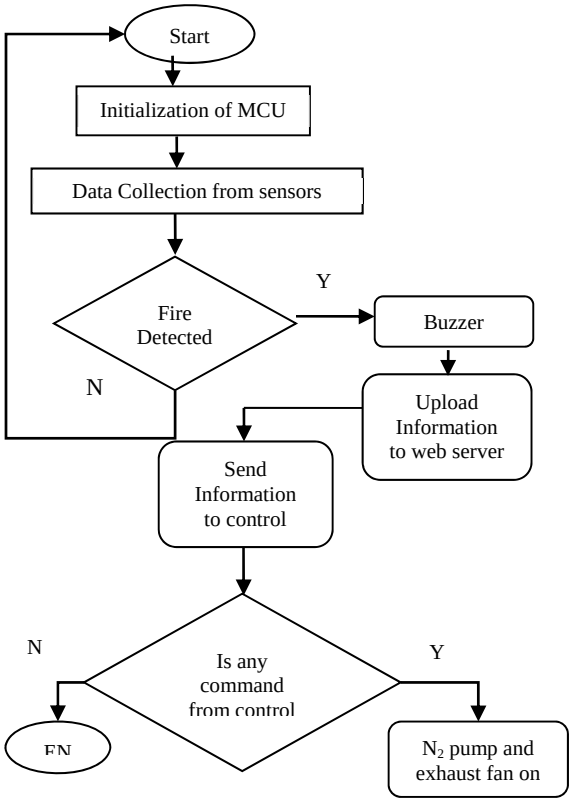

Fig. 4: Flow diagram of system.

5. SUMMARY AND CONCLUSIONS

Fire hazards are serious threat to human lives as well as property. Thus, pre- warning of these hazards has great importance for the safety of human lives. The fire detection systems must be reliable and accurate enough in order to identify the hazardous situations based on real time data. The proposed system will work as fire pre-warning system, which will predict the fire conditions at an early level. This system is different from traditional fire alarm devices as it does not always rely on a single sensor. Also, this system can provide an automatic mean for using fire extinguisher devices. The main characteristic of the proposed system is the implementation of IOT techniques in this field. With the use of IOT, the system is smart enough in order to spread the message using wireless internet. The proposed system will easily detect the fire conditions and also provide control mechanism in a reliable manner and can help in saving human lives.

6. FUTURE SCOPE

In this paper, the implementation of IOT techniques is proposed by designing a single fire fighting device but future research can be done in direction of designing a number of fire fighting devices and connected them via internet. Zigbee routers can be used in order to increase the coverage area.

REFERENCES

[1] Zeng, Y., Qian, J., "Designs of a Fire Detecting and Fire Pre-Warning System based on a Single Chip Microcomputer", Procedia Engineering 7 (2010), 360-365.

[2] Ying-Cong, Z., Jing, Y., U., "A Study on the Fire IOT Development Strategy", Procedia Engineering 52 (2013),314-319.

[3] Kuo, L., S., "Automatic Fire Detection System using Adaptive Fusion Algorithm for Fire Fighting Robot", IEEE International Conference on Systems, Man, and Cybernetics, October 8-11, Taipei, Taiwan, 2006.

[4] Chunquan, D.,U., Shunbing, Z., H., U., "Research on urban public safety emergency management early warning system based on technologies for the internet of things", International Symposium on Safety Science and Technology, Procedia Engineering 45 (2012), 748-754.

[5] AlHaza, T., Alsadoon, A., Alhusinan, Z., "New Concept for Indoor Fire Fighting Robot", World Conference on Technology, Innovation and Entrepreneurship, Procedia - Social and Behavioral Sciences 195 (2015) 2343 – 2352.

[6] Laranjo, I., Macedo, J., Santos, A., "Internet of Things for Medication Control: Service Implementation and Testing", CENTERIS 2012 - Conference on Enterprise Information Systems / HCIST 2012 - International Conference on Health and Social Care Information Systems and Technologies, Procedia Technology 5 (2012) 777 – 786.

[7] Gubbi, J., Buyya, R., Marusic, S., Palaniswami, M., " Internet of Things (IoT): A vision, architectural elements, and future directions" Future Generation Computer Systems 29 (2013) 1645–1660.

[8] Rathore, M., M., Ahmad A. , Paul, A., Rho, S., " Urban planning and building smart cities based on the Internet of Things using Big Data analytics", Computer networks, March 23, 2016.

[9] Cavalcante, E., Pereira, J., Alves, M., P., Maia, P., Moura, R., Batista, T., Delicato , F., C., Pires, P., F., " On the interplay of Internet of Things and Cloud Computing: A systematic mapping study", Computer Communications, March, 2016.

[10] Jean, J., H., Lian, F., L., "Implementation of a Security Micro-Aerial Vehicle Based on HT66FU50 Microcontroller", 4th International Congress on Advanced Applied Informatics, DOI 10.1109/IIAI-AAI.2015.292, 2015.

[11] Tang, Z., Shuai, W., Luojun, "Remote Alarm Monitor System Based On GSM and ARM", Advanced in Control Engineering and Information Science, Procedia Engineering (2011), 65-69.

[12] Patel, M., A., Patel, H., D., Patel, A., M., Bhatia, A., Gavit, K., H., " Automatic Fire Detection and Controlling System using GSM & Alarm", IJSRD - International Journal for Scientific Research & Development Vol. 2, Issue 02, ISSN (online): 2321-0613, 2014.

[13] Tan, L., Wang, N., "Future Internet: The Internet of Things", 3rd International Conference on Advanced Computer Theory and Engineering (ICACTE), 2010.

[14] Li, B., Yu, J., "Research and application on the smart home based on component technologies and Internet of Things", Advanced in Control Engineering and Information Science, Procedia Engineering (2011), 2087-2092.

[15] Bhide, V., H., "A Survey on the Smart Homes using IOT", International Journal of Advance Research in Computer Science and Management Studies, Volume 2, Issue 12, December 2014.

[16] Buribayeva, G., Miyachi , T., Yeshmukhametov, A., Mikami, Y., "An Autonomous Emergency Warning System based on Cloud Servers and SNS", 19th International Conference on Knowledge Based and Intelligent Information and Engineering Systems, Procedia Computer Science 60 (2015), 722-729.

[17] Islam, T., Abdullah, S., A., Sarowar, G., "Enhanced Wireless Control System for Smoke and Fire Detection" International Journal of Computer and Electrical Engineering, Vol. 5, No. 2, April 2013.