International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
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IJEMR Transactions, online available on 1st Jun 2019. Link :http://www.ijiemr.org/downloads.php?vol=Volume-08&issue=ISSUE-06

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Volume 08, Issue 06, Pages: 259–266.

Paper Authors

ANJUM RUKSANA, HITHA VENKATESH PRASANNA, AKSHARA TRICKANNAD, DR. MOHAN H.S
SJB Institute of Technology, Bangalore,India

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AUTOMATED FIRE AND HAZARDOUS GAS DETECTION AND ALERT SYSTEM USING IOT TECHNOLOGY

[1]ANJUM RUKSANA, [2]HITHA VENKATESH PRASANNA, [3]AKSHARA TRICKANNAD, [4]DR. MOHAN H.S
[1,2,3]Dept. of ISE,SJB Institute of Technology, Bangalore, India
[4]Head of the Dept. Dept. of ISE, SJB Institute of Technology, Bangalore, India
[1]anjumkurashi02@gmail.com, [2]hithaprasanna@gmail.com, [3]akshutrickannad@gmail.com, [4]hsmohan@sjbit.edu.in

Abstract— Industries and homes are susceptible to a wide range of fire and gas leak accidents due to various reasons such as faulty wiring, defective equipment, flammable appliances left turned on for a long duration of time, carelessness of users, and smoke detectors that fail to activate. Fire accidents can cause havoc and lead to injury to human lives and damage to property. Fires and gas leaks must be detected and mitigated immediately in order to prevent mishap. Instantaneous notification of a fire is crucial in fire detection and alert systems. The Internet of Things is a technology which gaining immense popularity in the modern era as it pertains to associating unconnected objects(things) with each other in order for them to communicate and coordinate events and operations without the manual interference of humans. IoT enables the use of an automated system which is more efficient than the traditional systems. In case of situations in which immediate response is required manual operations will cause a significant delay to response and recovery leading to catastrophe. To enable real time response in case of a fire or gas leak accident an IoT system can be employed as it provides a better response mechanism and emergency management strategies with the necessary up-to-date information and communication to ensure quick response and rescue. In our system we propose an automated fire and hazardous gas detection and alert system supported by IoT. Furthermore, the Global System for Mobile Communications(GSM) is used alleviate the possibility of false alarms for the smart factory system.

Keywords— Smart factory, GSM.

I.INTRODUCTION

Fire detection is a major issue in factories and homes, resulting in adverse damage to lives and property. Incidents such as these are more calamitous when the fire or gas leak spreads to the surroundings which aggravates the damage as the time to respond to the accident increases. Therefore, detection of a fire or gas-leak event at its initial stage is crucial. Usually most of the homes and factories these days are equipped with a fire alarm system which performs the basic functionality of detecting a fire once a change in temperature is sensed. The alarm can however be triggered manually or automatically each of which have their own advantages. If the alarm system is manual, then it becomes largely dependent on the user who may not be able to turn on the alarm when required if not present or already under risk in the fire-triggered environment. Manual alarm systems are less prone to false alarm in comparison to automated alarm systems. Although automated fire detection and alert systems have the advantage of being more reliable and quick, they may provoke false alarms. False alarms are in fact the most prevalent problem in the existing fire alarm systems. False alarms may be triggered by a variety of reasons such as:

Installation defects- An alarm system should be properly installed and configured in a manner that is appropriate to the area in which it is situated. Regular maintenance of the system is also an essential aspect of consideration. The failure of components in the underlying system or incorrect fitting which leads to loose connections will definitely lead to improper functionality. Improper installation or defects of the components being installed will largely affect the system.

Improper Location- The activation of a fire alarm is also affected by the location. Placing the fire detection system near heat igniting areas such as ovens or furnaces or machinery that generate combustion substances will cause the alert system to predict the occurrence of a fire accident. Areas that have high temperatures or drastic changes in surrounding temperature will ploy the alarm system into presuming the occurrence of a casualty.

Environmental factors- Sensors are used in fire alarm systems to detect the presence of smoke which will signal a fire alert. However, smoke sensors will not be able to differentiate between light smoke particles and dense moisture particles. Humid locations will encompass highly dense moisture particles which will prompt the alert system and give rise to an alarm. Another cause may be the dust in the environment. Dust specks present in the surroundings may settle down on the fire alarm sensors over a course of time which will also provoke a false alarm.

Power Breaches- When the power supply to the system is not constant the components may be impacted which can result in inaccurate functioning of the system. The systems that are widely impacted in case of inconsistent power supply are the ones which contain components of AC or AC/DC. The alarm system which requires constant power supply in order to function, if persistently turned off and on due to power breaches will malfunction.

Interference of chemical substances- Using sensors that are highly susceptible to even a small change in the environment may seem like the most effective choice when it comes to precise detection of fire events. On the other hand, these acute sensors will set off an alarm if encountered with paint fumes or chemical odors. The detector units will sense the presence of these strong chemical substances which will cause the system to identify the situation as an anomaly. In

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factories which use detergents, ethanol, ammonia, chlorine, phosphoric acid and other chemicals pertain to surroundings that may be affected by false alarms due to interference of chemical substances. False alarms not only cause inconveniences but also result in excessive economic setbacks. Fire alarms cost several thousand dollars which is mainly due to the possibility of having to reconfigure, reinstall or potentially replace the entire system. It is evident that a system which is fault tolerant to the above mentioned defects is needed. It is possible to overcome these challenges and arrive at system which is considerably more efficient. We propose an automated fire detection and alarm system which gives an effective solution to the problem of false alarms and late detection of fires or gas leaks. Using a method that detects fires efficiently and reduces false alarms, it also alerts users through the Global System for Mobile Communications.Our system uses temperature and gas detection sensors which will detect changes in temperature, humidity, and keep a constant check on the smoke level as well as gas leaks. Users will be alerted at the very initial stage of a fire or gas leak via the GSM communication system. The system uses a confirmatory technique which ensures that the alarm will not be triggered unless it is assured by the user or other sensors.The alarm will be triggered only after the confirmation by the user on receipt of the GSM alert message or if it receives alert signals from one or more other sensors. Finally, the details of the values such as smoke, humidity and temperature is updated to ThingSpeak. ThingSpeak is an open-source IoT application and API which can be used to store and retrieve data from smart objects over the Internet. This will enable the users to monitor the values through a dashboard which will extract the graphical representation of the temperature, humidity and smoke levels in the required environment.

II. RELATED WORK

A.Paper-1

CH recovery procedure is facilitated by the static cluster formation technique which this paper represents. Secondly, the reduction in the cost of fault tolerance and conservation of the entire energy consumption of the network is brought about by the recognition and enforcement of the RN to maintain a sleep state. Thirdly, it talks about a mechanism for the recovery of failed CH member nodes and how the RNs that are in sleep state can be activated by CH. The rest of the paper is a summary of the affiliated work. It also demonstrates FTTT and gives its arithmetical evaluation of the proposed protocol. Demonstration of the proposed protocol is done through simulation by providing parameters and metrics for it.

B.Paper-2

It utilizes WSN to employ a similar system. Wireless sensor networks (WSN) are made up small, inexpensive, and low power sensor devices that provide high accuracy, real-time fire detection and have the potential to sense the surroundings. This paper, helped us in the evaluation and design of a wireless

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sensor network using a number of sensors for early detection of fire.

C.Paper-3

The analysis is influenced by the RSSI ranging error in accuracy of positioning in greater depth. Hence, based on the RSSI ranging scope we propose a robust localization algorithm. This algorithm creates a one-to-one mapping between the RSSI value and the distance scope which is based on the value scope of the parameter in the signal propagation model to remove the error induced by the usage of the same and fixed parameters of the signal propagation model. They also performed simulations to evaluate the algorithm extensively. The proposed algorithm is largely flexible to a dynamic environment based on the results obtained.

D.Paper-4

A Real-time Medical Emergency Response System based on IoT medical sensors deployed on the surface of the human body was proposed. This system includes data analysis building, called "Intelligent Building," represented by the implementation model and layered architecture, and it is responsible for making decisions and analysis. The collection of data from millions of body-attached sensors is sent to Intelligent Building for processing and for performing necessary actions using various units such as collection, Hadoop Processing (HPU), and analysis and decision.

III. SYSTEM ARCHITECTURE

The biggest challenge is the triggering of false alarms. The system that we have proposed has four essential portions: (i) sensor; (ii) processing unit (iii) GSM (iv) alarm. Smoke, gas and heat sensors together, make the sensor unit. These sensors have their own event detection mechanism. The processing unit consists of the WiFi Controller(node-MCU) and Atmega-328. On consideration of the information obtained from the sensors as well as the user's response, a decision regarding the detection of fire is taken. The GSM communication system gets automatically activated and an alert message is sent to the user, even if the processing unit receives a fire alert message from just one sensor node. The user's response to the notifications obtained from the sensors is key to the decisions being made. The alarm is generated on obtaining the confirmation from the user. The event information is shared with the cloud and the local server simultaneously which in turn ensures that the information is spread throughout.

A. Sensors

Fire produces various things such as smoke, heat, gas and different radiations. The sensors that we have used can detect at least one of the above mentioned products of the fire. In our system, we have used DHT-11 temperature and humidity sensor and MQ-2 gas sensor to detect changes in temperature and concentrations of hazardous gases.

B.Processing Unit

- WiFi Controller(Node-MCU)

Node-MCU is an IoT platform which is open source. It contains both firmware and hardware, where the former is based on the ESP8266 WiFi SoC provided by Espressif,

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and the latter runs on the ESP-12 module. The term "NodeMcu" alludes to the firmware used. Lua scripting language is utilized by the ESP8266 firmware. Lua-cjson and spiffs are some of the open source projects that it uses.The Node-MCU is easily powered by the micro USB port and helps use the breadboard with ease.

- Atmega-328

The Atmega-328 was created by the company Atmel which is a microcontroller having a single-chip . The processor core is made up of an 8-bit RISC having a modified Harvard architecture. The microcontroller helps merge EEPROM of 1KB ,ISP flash memory having read-while-write capabilities of 32KB, , 2KB SRAM, , 32 general purpose working registers, 23 general purpose I/O lines ,three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, 2-wire serial interface which is byte-oriented, SPI serial port, 10-bit A/D converter with 6-channels, a programmable watchdog timer with an internal oscillator, and five software selectable power saving modes. The device is operational between 1.8-5.5 volts.

C.GSM (Global system for mobile communications)

To outline the protocols required by devices like tablets and mobiles for utilizing the second-generation digital cellular networks the European Telecommunications Standards Institute (ETSI) developed the GSM. It was initially used for full-duplex voice telephony. The GSM compresses the digitized data, and then sends it through the channel with two streams of user data in time slots of its own. SIM800L is a cellular module of miniature size which makes the GPRS transferal, sending and receiving messages , making and receiving calls possible.This model makes the long range connectivity required by most projects possible through reduced cost, tiny footprint and quad band frequency. The power module boots up, looks for the cellular network and logs in automatically after the connection is established.

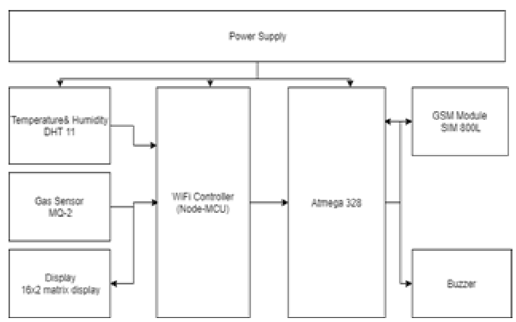
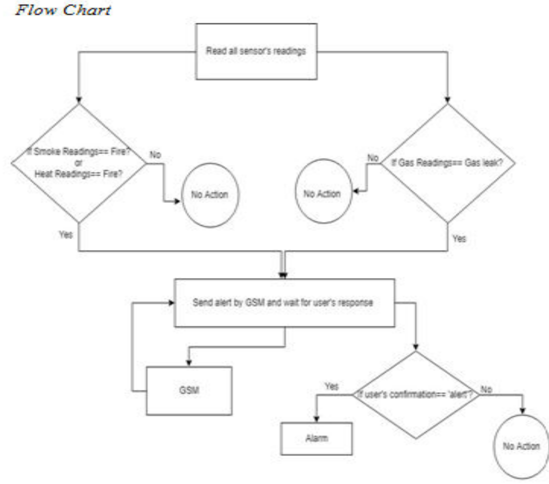


Fig 1: System Architecture

D.Alarm

The alarm system consists of the buzzer which maybe a electromechanical, mechanical or piezoelectric device that helps alert individuals of an emergency situation through audio.

Flow Chart



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IV. EXPERIMENTAL RESULTS

A threshold is set for all the sensors for certain values of temperature as well as permissible levels of smoke and gas in the environment. Once the observed values of temperature, humidity, smoke or gas level is greater than the threshold value that is set, the sensors will be triggered to send an alert to the processing unit.The operation of the processing unit basically two folds, one half will regularly collect the values of temperature, humidity and smoke from the sensors (i.e, continually monitoring the readings of the sensors used) and update ThingSpeak on the currently observed values. The other functionality performed by the processing unit is the verification of the fire or gas leak event. This verification is done using the GSM module which will be used to alert the user in order to prevent the occurrence of false alarms. The event of an alarm will be confirmed only if the user's response to the notification sent by the GSM module is 'alarm' or if other surrounding sensors are also triggered. The data that is collected by the gas sensor and temperature sensor is updated on to the cloud platform ThingSpeak which allows the user to monitor the instantaneous changes in the factory environment. The graphical representation of the readings is then extracted and projected onto a simple dashboard which can be accessed by multiple users. This system was tested several times and produced nearly zero percent of false alarms. The efficiency of our proposed work is significantly greater than the existing systems mainly because of its fault tolerance. Therefore, we found that our system is efficient as we have achieved automation and a quick response strategy to fire and hazardous gas detection equipped by a system that is resistant to false alarms.

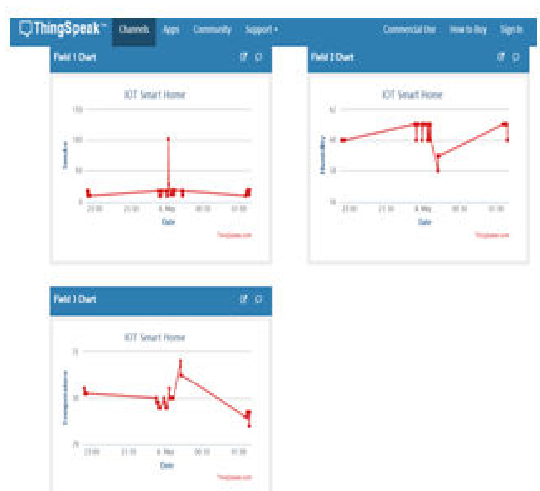

Fig 3: Sensor readings on ThingSpeak

V.CONCLUSION

The fundamental intent of the proposed work was to design an automated smart factory environment for fire and gas leak detection. This system is fault tolerant and efficient. On the whole, our system design provides a lucid solution to defects encountered in the existing systems. To mitigate false alarms, the two-way confirmation technique is used which alerts the user at the very initial stage in case a fire is detected. The processing unit is the brain of the system which makes the decision on whether there is a fire or gas leak event or if it was a false alarm. The goal of our system was achieved by connecting the sensors, processor and the cloud to the users with an automated system backed by the IoT technology.

Future Work

The future enhancement of this system can be to include predictive maintenance and avoidance of single point failure which will make the system more robust than it already is. Predictive maintenance is essential in systems which employ multiple sensor units in order to avoid failure of the system due to inefficiency or downtime of the sensor components. The most vital components in any IoT system are the sensor components which would have to be maintained to ensure that the system is working as it was devised to. Predictive maintenance enhances the uptime of an operational equipment and also aids in eliminating more than a quarter of the time-based maintenance routine, It is also said to pare the downtime of an equipment by approximately fifty percent. In addition to the effective recognition strategy which is covered by our system, a recovery and response strategy can also be added by using actuators and components such as water sprinklers which can be activated once the fire event is confirmed in order to find a temporary solution which may reduce the possible damage.

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