RASPBERRY PI BASED INDUSTRIAL SECURITY SURVEILLANCE SYSTEM USING IOT

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ABSTRACT:
The industrial environment presents unique fire protection and security challenges. The machinery used gases and the concentration of stored assets result in high risks. This system is capable of detecting fire and provides an alert to the workers. Raspberry Pi 3 has been used which is integrated with a couple of sensors and a camera. The system uses gas sensor to detect gas leakage, PIR sensor detects intrusion and the flame sensor detects fire. The sensors constantly sense and keep on transmitting values to the online web server over a Wi-Fi connection. If fire due to an intruder is detected, the camera captures the image and the system will immediately send an email alert along with the image of the affected spot to the industry owner. Once the fire is detected by the flame sensor, fire alarm will be generated to alert the workers, the sprinkler motor will be activated. The server can be viewed from anywhere for sensor information such as concentration of gases, fire and motion detection. With such intelligent information, safety managers, workers, and fire fighters will also be able to make better decisions for fire response.

Key points: I0T, Raspberry Pi, Sensors.

I. INTRODUCTION

IoT plays a major role in industrial safety and control. Technologies based on IoT make the industries smarter, safer and more environmentally sustainable. Fire accidents are a major threat to industries. It results in severe losses. IoT can help in intelligent fire monitoring and detection by integrating information from sensors to detect fires and take immediate response action. It helps in speeding up the response times and provides information for evacuation, rescue and fire suppression. It can also help to identify the cause for the fire. The notification devices such as alarm, hornand buzzer can be activated to provide alerts in case of fire. Several advanced features in mass notification systems including the capability to communicate alerts via email to targeted recipients, can thus help in creating quick and effective awareness. The sensor information is transmitted over the internet and can be viewed using laptops, mobile phones. This data can also be used for investigation purposes after the accident has occurred.

Fire accidents result in huge loss of personnel, equipment, and customer trust. The management of the fire alarm system is usually outsourced and it is not possible to know the current status even if event logs from the fire alarm panel are present. The industry owners are at the mercy of their chosen maintenance company but if something does go wrong, they will have to face the 3 consequences. Therefore an intelligentfire monitoring and alerting approach needs to be used which can be monitored by the personnel in the industry itself. In some other cases, fire can also be caused by intruders or criminals, thus using cameras can help to capture the intruder causing fire and alert the owner.

II. LITERATURE SURVEY:

The reference papers used in the development of the system are described in this paper. The existing technologies used and how the proposed system overcomes such limitations are given.

TAXONOMY OF AN IoT BASED FIRE MONITORING AND ALERTING SYSTEM: The literature survey with respect to automatic fire detection processing, email alert, different sensors used and the transmission of sensor values to the web server is analyzed.

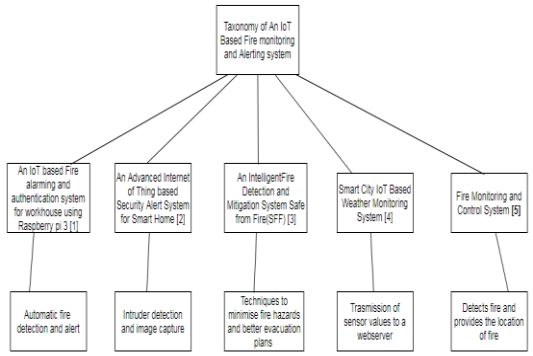

Fig (a) Taxonomy of An IoT based FMAS

An IoT based Fire alarming and authentication system for workhouse using Raspberry Pi 3: Ahmed Imteaj et. al. [1] 2017, proposed a fire alarming system for garment factories where the growth of the industry is challenged by frequent fire outbreaks and uses a master slave approach where a single Raspberry Pi controls several Arduino microcontrollers coupled with temperature and light intensity sensors. The sensors collect data and send it to the Arduino microcontrollers which will then process the data. All the microcontrollers will be controlled centrally by Raspberry Pi.A relay motor is assembled with the camera so that it can snap the image in whatever angle the fire is detected. The system will stop electricity on the outbreak of fire and start fire suppression. In our proposed system, flame sensor, gas sensor and Passive Infrared (PIR) sensor are used and the sensor values are constantly transmitted to a web server for periodical monitoring. The server can be accessed from anywhere to view sensor information.

An Advanced Internet of Thing based Security Alert System for Smart Home: Tanwar et. al. [2] 2017, proposed a low cost home security system which allows to monitor the house from a remote location. Several home security systems exist but it has issues like delay in transfer of alert by phone, text or email during unfavourable situations. Thus an advanced system is proposed which detects an intruder or any unusual event when nobody is there at home. This system makes use of a PIR sensor which detects an intruder and a camera which captures image of the intruder. The Raspberry Pi is used for minimizing the delay in the processing of email alert along with the captured image of the intruder. This enables the user to monitor the home more effectively and efficiently from a remote location. The paper confirms the flexibility of Raspberry pi and broad probability of its usage.

An Intelligent Fire Detection and Mitigation System: Safe from Fire (SFF) - Mobin et. al. [3] 2016, proposed a smart fire extinguisher system with multiple sensors, actuators and operated by micro-controller unit. The input signals from various sensors are taken and uses integrated fuzzy logic to identify the location of fire breakout. It provides messages and call notifications. It presents techniques that can minimize fire hazards. It also announces the location of fire and its severity in addition to the fire alarm which helps in situations where people do not realize the intensity of the fire and are not willing to evacuate the fire affected building quickly. It breaks the electric circuit in case of fire and releases extinguishing gas. The overall performance of the system is evaluated in this paper and its efficiency is demonstrated. The system does not capture image and the sensor values cannot be monitored in real time.

Smart City IoT Based Weather Monitoring System: Adil Hamid et. al. [4] 2017, presents a weather station based on IoT. It uses environmental sensors to monitor the weather at a particular place and uploads the data to a web server in real time. The weather parameters are uploaded and live reporting of weather is provided. The system also allows the user to set alerts for particular instances and the system provides alerts to the user if the weather parameters cross those values. This paper provides a clear idea about the sensors, data acquisition from the sensors, the fundamental decision making and controlling moves based on the conditions present and how the sensor data are uploaded to a server.

Fire Monitoring and Control System: K.M.Gaikwad et. al. [5] 2016, proposes a system which is able to detect fire and use Global positioning system to determine the location of fire. It also provides alert through message to the fire station and alert to the people through a fire alarm. This system uses some sensors to detect fire. The idea behind the use of sensors is because of quick response time, easy deployment and to equally save time and cost rather than using techniques like image processing. The system does not provide an email alert and there is no information available about the sensor values or the state of the sensors at the time of fire for future investigation after the fire accident has occurred

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III. SYSTEM ANALYSIS AND DESIGN

The system analysis and design gives the overall description of the existing systems and the design of the proposed system.

a) Problem Definition:

The complex environment of an industry presents unique fire protection and industrial security challenges. The high concentration of equipment and stored goods and assets mean high fire risks with huge losses. We present a system which is capable to detect fire and provide alert. Raspberry Pi 3 has been used to control which are integrated with a couple of sensors and camera. The system includes smoke sensor for detecting gas leakage, PIR sensor detects intrusion and flame sensor detects fire. The sensors constantly sense and keep

on transmitting values to the online web server over a Wi-Fi connection. If fire due to an intruder is detected, the camera captures the image and the system will immediately send a message along with the image of the affected spot. Once the fire is detected by the flame sensor, fire alarm will be generated and sprinkler motor will be activated. The server can be viewed for sensor information.

b) Need Analysis:

The Bull diagram describes the purpose of the system and all the actors involved in the system. The system is used by the industry and it acts upon fire, smoke and intruders. The purpose of the system is to detect fire, smoke and intruders and provide an alert

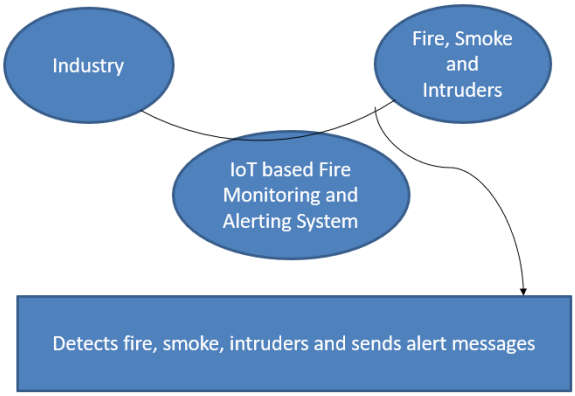
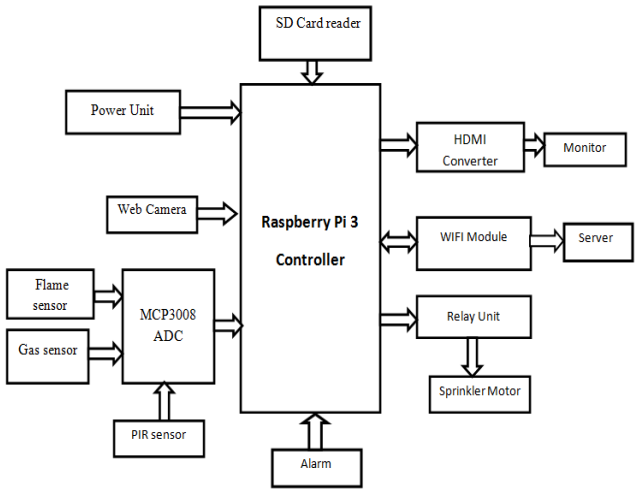


Fig (b) Bull diagram for An IoT based FMAS

IV. SYSTEM ARCHITECTURE:

The system architecture consists of the central Raspberry Pi controller to which, the Fire alarm and camera are connected. The flame sensor, gas sensor and PIR sensor used are analog sensors, so an Analog to Digital Converter is used to convert the Analog values into digital values since the Raspberry pi can accept only digital input.



The relay acts as a switch to activate the sprinkler motor when the fire sensor detects fire. If fire is detected, a fire alarm will be generated. When motion is detected by the PIR sensor, the camera captures an image and sends an email alert to the industry owner. The sensor values are transmitted to the web server through the inbuilt Wi-Fi module in the RaspberryPi.

a) Raspberry pi:

The Raspberry PI-3 Model B is a credit card sized computer with inbuilt Wi-Fi and Bluetooth connectivity.

- **SoC:** Broadcom BCM2837
- **CPU:** 4×ARM Cortex-A53, 1.4GHz
- **GPU:** Broadcom VideoCore IV
- **RAM:** 1GB LPDDR2 (900 MHz)
- **Networking:** 10/100 Ethernet, 2.4GHz 802.11n wireless
- **Bluetooth:** Bluetooth 4.1 Classic, Bluetooth Low Energy
- **Storage:** micro SD
- **GPIO:** 40-pin header, populated
- **Ports:** HDMI, 3.5mm analogue audio-video jack,
- 4×USB 2.0, Ethernet, Camera Serial Interface (CSI), Display Serial Interface (DSI).

b) **Flame Sensor:** A flame detector is a sensor designed to observe and respond to the presence of a flame as well as fire.It also can detect ordinary light source in the range of wavelength 760nm-1100nm. The detection distance is up to 100cm.

c) **Gas Sensor:** The MQ2 gas sensor is useful for gas leakage detection. It can detect H2, LPG, CH4, CO, Alcohol, Smoke or Propane. Due to its high responsiveness and fast response time measurement can be taken as soon as possible.

d) **PIR sensor:** A passive infrared sensor (PIR sensor) is an electronic sensor that estimates infrared (IR) radiation being released from objects in its field of view.

e) **MCP3008- ADC Converter:** The MCP3008 is a low cost,8-channel, 10-bit analog to digital converter.It can read the analog input from the sensors and convert it into digital signals.

f) **Relay:** A relay is an electrically operated switch. It takes some amount of power and distributes it to allow other devices to be powered in certain circumstances.

g) **Motor:** A water sprinkler mechanism can be connected to the shaft of the dc motor, which will sprinkle the water when the fire is detected by the sensor.

h) **Camera:** A rotatable web camera is used which captures the image of the intruder when motion is detected.

V. MECHANISM

a) Configuring the Raspberry Pi and interfacing the sensors

The Raspbian OS should be downloaded and installed in the Raspberry Pi 3. The Raspberry Pi 3 should then be configured. The flame, gas and PIR sensors are analog sensors and need to be interfaced with the GPIO pins of the Pi using an Analog to Digital Converter as the Raspberry Pi can accept only digital input. The programming is done using Python Idle and the connected input and output pins for the sensors are declared.

b) Automatic fire detection and fire alarm

The flame sensor is sensitive to flame and radiation. If the flame sensor detects fire, it is programmed to activate the fire alarm which alerts the workers and the relay switches on the sprinkler motor. It prints Fire detected on the terminal screen and the same information is updated to the server.

c) Gas detection

The MQ-2 gas sensor has high sensitivity to LPG, Propane and Hydrogen and can also detect Methane and combustible steam. The gas sensor readings are taken and the gas level is displayed and updated to the server.

d) Intruder detection

A passive infrared (PIR) sensor measures infrared (IR) radiation being emitted from objects in its field of view. If fire is caused due to an intruder, this sensor is programmed to capture image of the intruder using the camera. This image is stored in the Raspberry Pi.

e) Email and message alert

The email alert is coded and captured image is attached to the email message and sent to the already stored email address of the industry owner using the inbuilt Wi-Fi module.

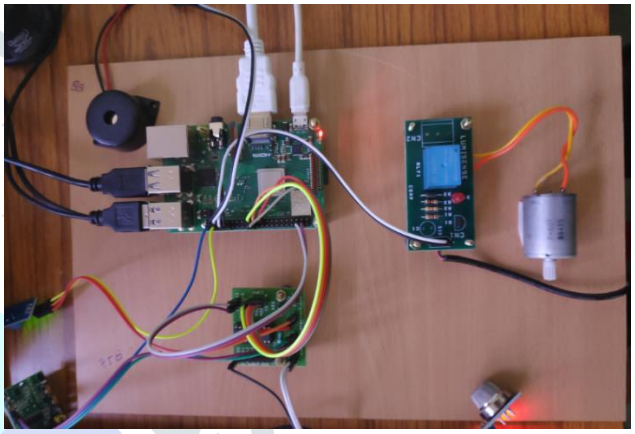
f) Transmission of sensor values to the web server

The sensor information is uploaded to the server which is created using php and uses the MySQL database. The server is accessed using the username and password for information such as concentration level of gases and fire and motion detection. The server can be viewed from anywhere using the URL and information can be periodically monitored.

RESULT:

Thus, the limitations in the performance of the existing systems can be overcome. The proposed system has better performance and accurate response to fire at critical situations. This shows that the proposed IoT based Fire Monitoring and Alerting system is an efficient and reliable system.

The challenges faced by the existing systems such as the delay in automatic fire detection processing and alert have been overcome in this system. It shows an immediate response to fire and provides quick and reliable alerts. The sensor information are also updated accurately. This will help in future investigationregarding the time and conditions under which the fire has occurred.



VI. CONCLUSION AND FUTURE WORKS

The proposed Fire Monitoring and Alerting system is described with the drawbacks of the existing system. The requirements and the implementation methodologies of the system are clearly explained. Industrial safety is a major concern and therefore this system can help in emergency situations with immediate response and quick action.

The system can further be enhanced by adding more sensors and using face recognition and image processing to identify the intruder. An android application can be developed to provide confirmation on the decision to be taken on the outbreak of a fire. The sensor data can be combined with algorithm and big data analytics to develop better emergency evacuation strategies and analyse the entire system.

VII. REFERENCES

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