An IoT based Fire Alarming and Authentication System for Industrial Sector using Deep Learning

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DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
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LIST OF ABBREVIATIONS

Abbreviations:

MQ2	:	The Grove - Gas Sensor
LPG	:	Liquefied petroleum gas
LDR	:	Light Dependent Resistor
GSM	:	Global System for Mobile Communications
TDMA	:	Time Division Multiple Access
FDMA	:	Frequency division multiple access
SOC	:	System on a Chip
TCP	:	Transmission Control Protocol
IP	:	Internet Protocol
AT	:	Asynchronous Transmission
GPIO	:	General Purpose Input/Output
PCB	:	Printed circuit boards
APSD	:	Automatic Power Save Delivery
RF	:	Radio frequency

1. INTRODUCTION

Many properties destroyed by fire are not rebuilt. Fires harm property, inflict injury or death, and can even result in the loss of jobs. The only method to prevent these fatal tragedies is to receive proper fire safety training. Learning about fire hazards is essential for preventing a fire. The importance of early fire detection in protecting and preserving lives and property cannot be overstated. A fire detection system can help to minimize damage and maximize firefighting operations. It's also one of the most important fire safety precautions one can take. Even while resting or working, early fire detection will alert and assist people in responding swiftly.

1.1 Importance of the Proposed Research

Providing minimal rights and safety for garment workers has become a burning issue in recent years. Fire is undoubtedly one of the labyrinths that garment factory workers are confronted with. Investors are losing interest in this area, and its prominence is diminishing. Fires have the ability to spread swiftly. In a matter of minutes, a little flame has grown into a gigantic firestorm. As a result, business enterprises, as well as residential properties, should have an emergency plan in place, which should include fire safety and protection protocols. While flames can spread swiftly in most cases, other fires begin as a result of long periods of latent burning. In such situations, very sensitive fire detection systems are required. The truth is that the more quickly a fire is detected, the more expensive the fire detection system becomes. But nothing is more important than the safety of the people. Thus, this invest is reliable and effective for fire detection system for protecting life, property and safety.

1.2 Limitation of this research

Fire detection systems are intended to offer fire warnings, they do not guarantee fire protection. The following research gaps in the relevant subject are revealed by a careful and sophisticated examination of the material gathered from literature:

1. This proposal is exclusively for industrial usage; it is not suitable for use in the house or in the wild.
2. This proposal is only appropriate for accidental fires; it is not appropriate for human-caused fire.
3. This is a rather expensive undertaking that a small or developing business may not be able to complete.

1.3 Problem Statement

The issues discovered in the existing systems accessible on the market:

1. It would be an issue if the setup sensor ceased working.
2. If a fire occurs out in the current system, it will burn out and be unable to detect an actual fire.
3. Because the camera in the present system rotates 180 degrees, if a fire occurs only rearward, above, or below from the camera, the system will not detect a false alert.
4. Detecting whether it is a false alarm or not using a camera at night or in any other situation when a sufficient quantity of light is not entering is extremely challenging.
5. In the existing project, whether or not there was a false alarm was determined by a person, which was not automated nor safe because the designated human being may be distracted at any time.

1.4 Research Questions

To resolve the issue explanation as referenced it is split into the following individual research questions:

1. How will the system function if the setup sensor fails?
2. If The cameras are damaged how would the system will verify if it is an actual fire?
3. How would the system identify false detection if the fire happened directly behind, above, or below the camera?
4. How can a false alarm be detected at night or in any other condition where enough light is not entering?
5. Is it feasible to rely on human beings for continuous 24 hours supervision?

Table 1: Link between the research problem, research questions, and research objectives

Research Problem	Research Questions (RQ)	Research Objectives (RO)
An issue would be generated, if the setup sensor ceased working. If a fire occurs out in the current system, it will burn out and be unable to detect an actual fire. Because the camera in the present system rotates 180 degrees, if a fire occurs only rearward, above, or below from the camera, the system will not detect a false alert. Detecting whether it is a false alarm or not using a camera at night or in any other situation when a sufficient quantity of light is not	**RQ-1 :** How will the system function if the setup sensor fails?	**RO-1 :** To assure that the sensors function properly, we may use automation testing to ensure that if any of the sensors have a problem, the system will automatically alert the system manager through text message.
	RQ-2 : If The cameras are damaged how would the system will verify if it is an actual fire?	**RO-2 :** To ensure that a fire is detected, we may utilize a drone from which the entire system can view over the damaged camera, as if it were the system's third eye.
	RQ-3 : How would the system identify false detection if the fire happened directly behind, above, or below the camera?	**RO-3 :** A 360-degree drone can address the problem of ensuring a real fire behind or above a 180-degree camera.
	RQ-4 : How can a false alarm be detected at night or in any other condition where enough light is not entering?	**RO-4 :** A night vision camera can be utilized to identify a false alert at night or when there is insufficient light.
	RQ-5 :	**RO-5 :** Deep learning may be utilized in this system for automatic verification to assure the identification of false alarms 24/7.

entering is extremely challenging. In the existing project, whether or not there was a false alarm was determined by a person, which was not automated nor safe because the designated human being may be distracted at any time.	Is it feasible to rely on human beings for continuous 24 hours supervision?	

1.5 Research Objectives

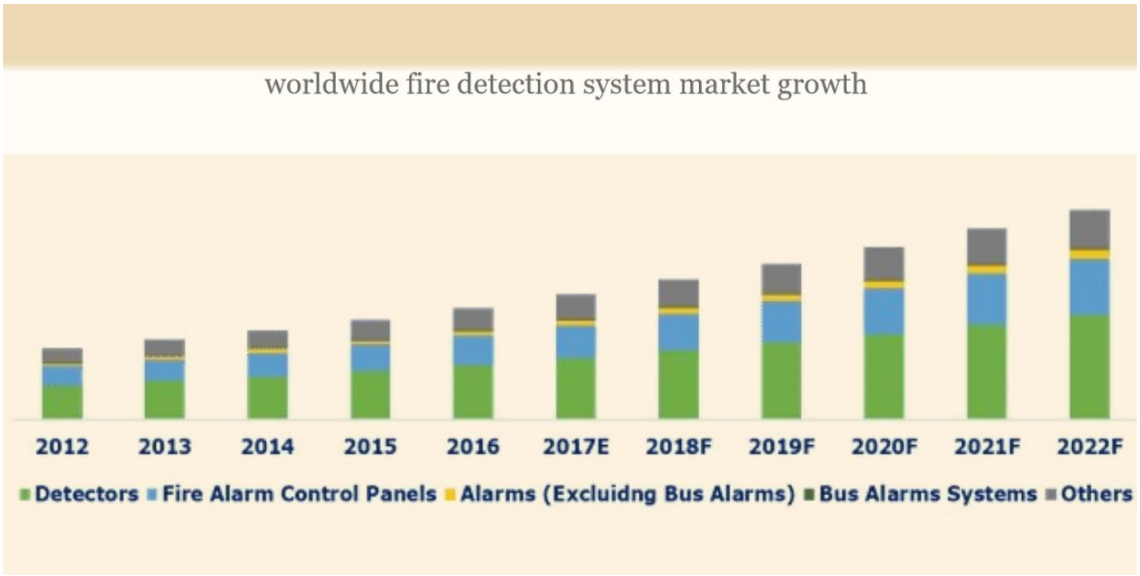
Based on the above-mentioned research questions, the following study objectives have been defined:

1. To assure that the sensors function properly, we may use automation testing to ensure that if any of the sensors have a problem, the system will automatically alert the system manager through text message.
2. To ensure that a fire is detected, we may utilize an autonomous drone from which the entire system can view over the damaged camera, as if it were the system's third eye.
3. A 360-degree drone can address the problem of ensuring a real fire behind or above a 180-degree camera.
4. A night vision camera can be utilized to identify a false alert at night or when there is insufficient light.

5. Deep learning may be utilized in this system for automatic verification to assure the identification of false alarms 24/7.

1.6 Scope of the Research

The aim of the present research proposal is to develop a fire detection system to minimize the risk of lives and property. Fire alarm system technology has been slow to innovate in comparison towards other greater smart items. Manufacturers all across the world are putting their efforts on high-return products. While fire alarm systems aren't exactly cutting-edge technology, enterprising organizations are coming up with novel ways to deal with fire and gas-related hazards. Accessing to a diverse spectrum of cutting-edge technology that help save hundreds of thousands of lives every day. Preventive technologies work to stop a fire from starting in the first place. Smoke, heat, and flame detectors are examples of these devices, which can assist offer early warning of fires. To assist prevent fires from spreading, a variety of sprinkler systems are now available. To get the most out of technology while maintaining the highest level of safety, need to assess not just existing technology and its application, but also rules, policies, and enforcement on a weekly basis and make changes in these areas. Artificial intelligence, networked systems, and the smart city program, as well as the promise of a creative revolution in fire alarm systems, will lead to further out-of-the-box technical innovation.



Today, we have access to a diverse spectrum of cutting-edge technology that help save hundreds of thousands of lives every day. Preventive technologies work to stop a fire from starting in the first place.

2. BACKGROUND

Early discovery of a fire is critical in preventing it from spreading and extinguishing. As a result of a succession of major fire accidents that resulted in significant material losses and much higher deaths, fire detection equipment was developed. New York City paid workers to patrol the streets looking for fires while carrying buckets on ladders in the 17th century. Philadelphia constructed its Independence Hall bell spire in the 1800s with this purpose in mind, even developing distinctive ringing patterns to notify firefighters to the broad area of the city the fire was raging in. Several developments in the nineteenth century revolutionized the fire detection landscape. In 1837, Samuel Morse created the telegraph, and it wasn't long before people began to use the first kind of long-distance communication. Other detecting devices, such as smoke detectors and gas detectors, were created around the turn of the century and have since become vital components of conventional fire alarm systems. While the technology existed over a century ago, the devices were either too costly to produce or too large to be feasible for use in a home or business. In the perspective of Bangladesh, it’s the nation's fastest garment producer after China, has a long history of factory fires and abuses, including employees trapped behind sealed doors. Due to low enforcement of safety laws and harsh living conditions in its facilities, fires are a tragedy of the commons in the garment sector, which accounts for over 80% of something like the country's exports [2]. The incidence of fires has grown fourfold in Bangladesh over the last two decades as the country's urban regions develop without basic infrastructure such as fire stations. According to data given by the Fire Service and Civil Defense, there were roughly 285,000 fires in the country between January 1, 1999, and December 31, 2020. The country suffered a financial loss of roughly Tk6,900 crore as a result of the fires. Furthermore, according to fire service data, at least 2,308 persons were died in fires across the country between 2004 and 2020. With 24,074 fire events in 2019, 2019 was the year with the most, followed by 2020 with 21,073. There were 383 industrial fires in Bangladesh in 2020, according to the Bangladesh Emergency Services and Civil Protection, with 273 of them happening in garment industries. Between 2012 and 2019, there were over 150 fires and other safety hazards associated to Bangladesh's garment business, according to the Solidarity Center, killing around 1,300 people and injuring nearly 3,800 others. In the previous two decades, at least 2,000 industrial workers and other personnel have perished in at least 26 fires, according to the International Labor Organization. There have been 5,834 industrial fires

within last five years, resulting in an economic damage of Tk250 crore. Dhaka division had the most industrial fires, while Sylhet had the least, as per the Bangladesh Fire Brigade and Civil Protection. A fire at an industrial facility in Narayanganj on July 15, 2021 killed at least 52 persons, making it the country's latest industrial calamity. Six employees of a spinning mill in Gazipur were murdered in a workplace fire in July 2019, while 13 were killed in a boiler explosion in the same location in 2017. In January 2015, an explosion at a plastics plant in Dhaka killed nearly 13 people. A boiler accident at Tampaco Foils Ltd in Tongi in 2016 triggered a fire that killed at least 25 people. A massive fire out in a knitwear factory in Gazipur the same year, killing at least four persons. A fire ravaged the Tazreen Fashion plant in 2012, killing 117 workers. The following January, eight laborers died in an accident at Smart Export Garments, and eight more tragically died at another garment factory in the city the following May. A fire at Garib & Garib Garments killed 21 people in 2010, and a fire at Ha-Meem Group's sportswear facility killed 26 people [1]. Following each incident, Bangladesh's industrial safety has come under close inspection. Despite public outrage in the aftermath of each disaster and tragedy, labor conditions in garment manufacturers have generally remained unaltered. Detection of fire is difficult to in the event of sensor failure or malfunction. When compared to other approaches, it takes a long time to identify and investigate a fire incident. It cannot be deployed in specialized areas such as severe heating spots or vibrations, and the consequences are difficult to predict.

3. METHODOLOGY

In this study, a combination of simulation and experimental investigation was used as the research methodology. The major research activities are covered in the following sections:

To begin, an automated test would be developed to verify that if any of the sensors fail, the system would automatically send a text message to the system manager, who will dispatch a technician to repair the issue. Then an autonomous drone will be used to confirm a fire alarm which will monitor the entire system as if it were the system's third eye and after when it's work done it will be automatically connected to the charging port. After that, a 360-degree webcam is employed to examine the entire business to determine whether or not there is an actual fire. A night vision camera can be used to identify a false alarm during nighttime monitoring or when there is inadequate light. For 24/7 automatic verification of false alarm, deep learning can be utilized in this system. After the confirmation of an actual fire, the system will automatically sprinkle water only in that particular location to ensure minimizing the wastage of water. If large fire incident occurs, then the system will directly notify the fire brigade and also the authority. Furthermore, system will ring the alarm.

3.1 Flammable Gas & Smoke Sensor

A gas sensor is a piece of equipment that enables the detection or amount of substances in the atmosphere. By altering the resistance of the material inside the sensor, the sensor creates a corresponding potential difference dependent on the gas concentration, which may be recognized as output voltage. The MQ2 gas sensor detects gases such as LPG, propane, methane, hydrogen, alcohol, smoke, and carbon monoxide in the air. Another term for the MQ2 gas sensor is chemiresistor. When it comes into contact with the gas, the resistance of the sensing material changes. A change in resistance value is often used to detect the presence of fuel. MQ2 is an oxide - based transistor gas sensor. A voltage divider network in the sensor is used to monitor gas concentrations in the gas. This sensor runs on a 5V DC power supply. Gases with concentrations ranging from 200 to 10,000 parts per million can be identified. This sensor has a detecting element made primarily of aluminum oxide-based ceramic that has been coated with Tin dioxide and is surrounded in a stainless steel mesh. The sensing element is connected by six connecting legs. The sensing element is heated by two leads, one on each side [5].

3.2 LDR Sensor

A light-dependent resistor (LDR) is indeed known like a photo resistor, photocell, or photoconductor. It's a matter of contention varies according on the intensity of light that strikes its surface. [reference dea lagbe] The resistance changes when light shines on the resistor. These resistors are commonly employed in many circuits that need the detection of light. These resistors are comes in a multitude of forms, sizes, and resistance values. When the LDR is in the dark, it must be used to switch on a light, and it can also be used to shut off a light while it is in the light. In the dark, a conventional light-dependent resistance has a difficulty of 1MOhm and then in the light, it has a resistance of a few KOhm. This resistor is controlled by photo conductivity. When light reaches the device's surface, the material conductivity drops, and electrons in the device's valence band are driven to migrate into the conduction band.[reference dea lagbe] The energy of these photons in the incident light must be larger than the semiconductor material's band gap. Electrons shift from either the valence band to conduction band band as a result. The resistance of these devices is light-dependent; when lighting falls below a Certain level, it reduces, but in the dark, it rises. When an LDR is kept in the dark, it has a high resistance, and when it is maintained in the light, it has a lower resistance. The light intensity and current both rise when a constant "V" is supplied to the LDR [6].

3.3 ESP8266 Programme Adapter

The ESP8266 WiFi System is self SOC with an inbuilt TCP/IP internet protocol suite that allows any microcontroller to connect to your Wireless router. The ESP8266 may either run a program or delegate all WiFi networking to a separate application processor. Each ESP8266 module is pre-programmed with AT instruction step, so all you have to do is put it into your Arduino and you'll have approximately as much WiFi capabilities as a WiFi Bridge. The ESP8266 module is a low-cost board with a large, and rapidly increasing, community. This module seems to have enough on-board processing capabilities to connect to sensors as well as other software devices through its GPIOs with minimum development and load during runtime. Its excellent on-chip integration means that external circuitry is kept to a minimum, and the front-end module is designed to take up as little PCB space as possible. The ESP8266 offers APSD support for Services and applications and Bluetooth founder connections, as well as an identity RF that allows it to function in any environment and doesn't require any additional RF parts [7].

3.4 Autonomous Drone

There is virtually nothing that can stop technology from thriving in the mechanical drone sector. Drones have evolved so much over these past few years that today they can even be commanded autonomously. Unmanned aircraft electronic machines with single integrated circuit and software that employ artificial intelligence and data vision for identity and aerial operations are referred to as autonomous drones. Autonomous industrial drones are changing the way industrial and critical infrastructure sites conduct routine maintenance, oversee safe and secure operations, ensure business continuity after severe weather and other incidents, and maintain compliance by eliminating the human error factor and the overhead of piloted drone systems. For more closer, frequent and precise monitoring of large-scale facilities or risky equipment is possible using on-site autonomous industrial drone systems. Autonomous drone can easily access areas that human crews can't, enabling for close-up visual and thermal investigations for incident response and continuous maintenance. Furthermore, the data collected by the autonomous drone operation serves as a baseline for more effective anomaly identification and maintenance planning. Employees are at danger from manual inspections, which can take a long time and involve shutting down equipment, and occasional checks can result in even more costly downtime. On a regular and consistent basis, autonomous drones acquire visual data on crucial site assets. Trends and insights are gathered using large amounts of current data, and failures are discovered early on. Machine vision detects anomalies, leaks, fires, and other hazards on the spot, allowing you to take immediate action and avoid potentially disastrous failures. With no reliance on ground transportation, timely deployment to emergency situations provides for rapid situational awareness while keeping staff out of harm's way. Thermal imaging and computer vision detect fires and leaks, as well as potential hazards, swiftly and autonomously.

3.5 GSM

GSM stands for global mobile communication and is a mobile communication modem (GSM). It is the world's most commonly utilized mobile communication system. GSM is an accessible and electronic cellphone system that uses the 850MHz, 900MHz, 1800MHz, and 1900MHz frequency bands to provide standard for mobile. TDMA, FDMA and frequency hopping are all used in GSM. Initially, GSM used two 25-MHz-wide radio frequencies for up-link and down-link: 890 to 915 MHz for up-link and 935 to 960 MHz for down-link. Two 75 MHz bands were later added. Up-link frequencies are 1710 to 1785 MHz, and down-link frequencies are 1805 to 1880 MHz. Up-link refers to the combination between a ground station and a satellite, whereas down-link refers to the communication between a satellite and one or even more ground stations or receivers [4].

3.6 Omnidirectional camera

An omnidirectional camera has a horizontal field of vision of 360 degrees, or a visual field that encompasses a hemisphere or the whole sphere. Two lenses are located on opposite sides of the camera body in a typical consumer 360 camera. Some more professional 360 cameras have more than two lenses, but I'll stick to two lens setups to make things easy. Fish eye lenses are used in 360 cameras to capture roughly 200 degrees of image per lens. Each lens will catch roughly 400 degrees when used together, which will certainly involve some overlap. Following the collection of the clip, software will determine where the overlap occurs and strive to make the image smooth. This can be done automatically in the camera, but it can also be done with PC software or a phone app.

4. COST ESTIMATE

Sl. No.	Name and specification	Quantity	Unit price (BDT)	Total price (BDT)	Remarks
1	Arduino Uno R3 With USB cable for Arduino	1	790	790	
2	MQ-2 Flammable Gas & Smoke Sensor For Arduino	1	199	199	
3	LDR Light Sensor Module For Arduino	1	53	53	
4	1 Channel DC 5V Relay Module for Arduino Raspberry Pi DSP AVR PIC ARM	1	75	75	
5	ESP8266 Programme Adapter UART GPIO0 Serial Wireless Wifi Development Board Module	1	260	260	
6	V380 ptz IP Camera 360 Degree	1	1189	1189	
7	GSM Development Board Module Kit for Arduino	1	1748	1748	
8	Mi_WiFi Router 4C Global Version 300Mbps 4 Antennas Smart APP Control	1	979	979	

9	Raspberry Pi 3 Model B+ Motherboard	1	5950	5950	
10	2.4GHz GPS Professional WiFi FPV Autonomous Drone with 2-Axis Gimbal 4K Wide angle HD camera	1	11579	11579	

5. WORK SCHEDULE

Task	Status	Oct -30- 31	Nov -01- 06	Nov -07- 10	Nov -11- 16	Nov -17- 19	Nov -20- 23	Nov -24- 26	Nov -27- 30	Dec 01 - 09	Dec -10
Topic Selection											
Defining Problem											
Review Literature											
Formulate Hypothesis											
Writing Research Proposal											
Submission of Research Proposal to Course Teacher											

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