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Fire detection and surveillance system with cloud-based alert to enhance safety in commercials and home

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ABSTRACT

This study presents a comprehensive internet of things (IoT) solution for improving home automation and fire safety. It describes the design and construction of an all-inclusive house fire extinguishing system using an ESP8266 microcontroller to supply water, detect fires in real time, and monitor them remotely. The IoT fire safety system is currently under investigation for its potential to prevent fires. The system includes a servo motor for precise water distribution, an ESP8266 microcontroller for smooth performance and networking, a water pump for timely fire suppression, and a fire sensor for detecting heat and flames. The system architecture, software integration, and hardware parts are detailed. Field testing has shown that fire detection and suppression systems can effectively detect fires, reducing risks and damages associated with fires. The discussion section discusses the pros and cons of the recommended strategy, implications for home fire safety and automation, and areas for further research and development. The IoT-based domestic fire extinguishing system combines modern technologies with quick response time, real-time monitoring, and fast action capacity, addressing the urgent need for increased home fire safety measures.

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1. INTRODUCTION

This study is aimed at developing a smart fire alarm system with networked sensors that are capable of recognizing fires and informing the owners of premises about them, besides contacting first responders [1]. The purpose of this project is to develop a new yet affordable fire alarm system using internet of things (IoT) and Arduino technologies. Another thing this has potential for lies in preventing accidents which can therefore lead to better safety rules [2]. In order to efficiently detect smoke and fire within defined areas, we suggest that wireless automated fire detection systems be built [3]. Among others, such systems should have global positioning system (GPS), global system for mobile (GSM) modules, ATmega328P microcontroller unit, temperature and ionization smoke detectors, as well as ZigBee technology [4]. Information signals from integrated detectors like heat, smoke and flame sensors can be accessed through application of machine learning algorithms [5]. GSM modems and IoT technologies when combined with these algorithms are

provided which enable the system to assess fire risk and disseminate this information to various stakeholders [6]. Therefore, in order to reduce false alarms, a system of such kind is capable of efficiently identifying fires, providing specific areas affected by a particular fire or confirming if the first alarm was genuine [7]. Designing a simple wireless network for fire detection as the core objective of this research is to make use of GSM technology in order to be able to send fire alerts quickly through cellular devices [8]. Instead, in order to keep track of personal properties without infringing on an individuals' privacy, the paper prefers using a unique vision-based approach for fire detection. This highly creative plan focuses on maintaining data privacy during fire alerting which had been ignored so long by employing imaging sensors [9].

2. LITERATURE REVIEW

In this study an intelligent fire detection and security system is proposed that's not only cost-effective but also presents comprehensive strategy for real time monitoring in the fire detection like emergency situation [10]. The system is equipment with wireless sensor network that consists of multiple sensors which detects house fire. For the effective management of any undesired events multiple sensors are provided. The objective of this system is to enhance the efficiency of intruder detection, measures and mitigate any unwanted occurrences [11]. The system harnesses GSM and ZigBee modems to monitor as well as detect any hazardous situations occurring within the structure, surroundings, or the city [12]. Three-tier system comprising of sensor nodes, local control rooms, and a central control room is recommended. Monitoring sensors permit the opening of gates to a certain extent while sensor data continues to be collected [13]. While it is local control rooms that comprise all the actions, the central control room administers all decision making; indeed, local control rooms have been provided with alarm systems to warn them when dangerous conditions or discrepancies above danger level are present [14]. The present study illustrates an application of the IoT which provides services of real time count of people and notifies the users by short message service (SMS) when the predefined maximum count has been reached. Such monitoring devices IoT based are significant to people living in distant places with the reassurance of safety [15]. Experimental results indicated the efficacy of an artificial intelligence based early flame recognition and alarm notification system based on vision. The device is designed for the rapid detection and recognition of terrorist fires both day and night [16]. An intelligent vision-based fire detection system is presented, utilizing infrared sensors and image processing to detect and provide advanced warnings to fire outbreaks [17]. The findings of the study present the favourable output of an artificial intelligence (AI-driven) early flame detection and alert system based on vision may be. Regardless of their size or shape, the device quickly and reliably detects catastrophic fires in both day and night situations. By utilizing infrared sensors and digital image processing technology, a computer vision-based fire detection system is presented to effectively identify and deliver early warnings of fire events [18].

3. FIRE DETECTION, SUPPRESSION SYSTEM, AND HARDWARE DEVELOPMENT

The block diagram of fire detection and suppression system (Figure 1) describes as follow for this project. The fire sensor stands out as the most critical component that is utilized in fire detection within the monitored area that is flame or heat-based. The ESP8266 microcontroller is a core processing unit used in th4e implementation of the fire detection by receiving fire data and linking through to external networks and applications using wireless fidelity (Wi-Fi). Mobile Blynk and ESP8266 microcontroller applications permit the use of a cell phone for supervising and controlling the operation of the fire extinguishing system. The end-user can learn of the prevailing condition of the system and perform action based on the requirements at the moment. The pump motor is employed as a water source and can operate at high-pressure levels in order to maintain an adequate supply of water for fire fighting purposes. Special nozzles that are coordinated with the help of a servo motor enable water spray to be accurately targeted at the burning fire. The effectiveness of controlling the fire is influenced by the efficiency of the functioning of the servo motor in supplying water at the required period. The essential components of the home fire suppression system in the IoT pertain to certain interconnections among the coordinating members and coordinated to fit in the whole system referred to as the ESP8266 microcontroller when a fire sensor is triggered. The fire sensor starts the system. When integrated with Blynk, remote monitoring and control is possible, thus making it easier for users to access their homes and offering a holistic approach towards fire prevention at home. To detect, respond to, and manage fires adequately, these components work together.

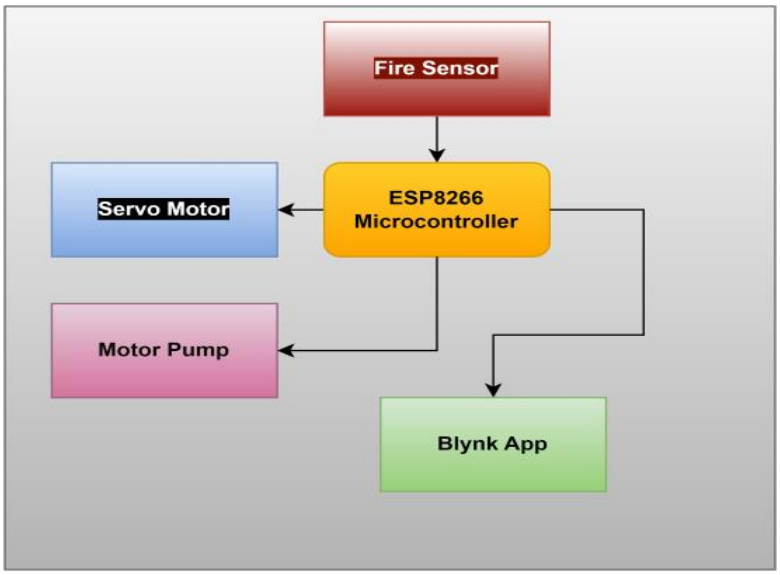

Figure 1. Block diagram of fire detection and suppression system

The hardware interfacing for the fire detection and suppression system are as (Figure 2):

- The ESP8266 board is the brain of the complete system where external power supply has been attached with the 5 V and ground pin.
- The ground pin of the fire sensor is connected to the ground and the voltage pin is connected to the voltage pin of the ESP8266 board and the data pin of the fire sensor is connected to the D2 pin of the ESP8266 board.
- The ground pin of the servo motor is connected to the ground and the voltage pin is connected to the voltage pin of the ESP8266 board and the data pin of the servo motor is connected to the D4 pin of the ESP8266 board.
- A motor pump was also used which was connected to the real body of the ESP8266 microcontroller, the realy ground was connected to the common ground, the data pin was connected to the D5 pin of the esp8266 and the motor pump was grounded by the power supply.

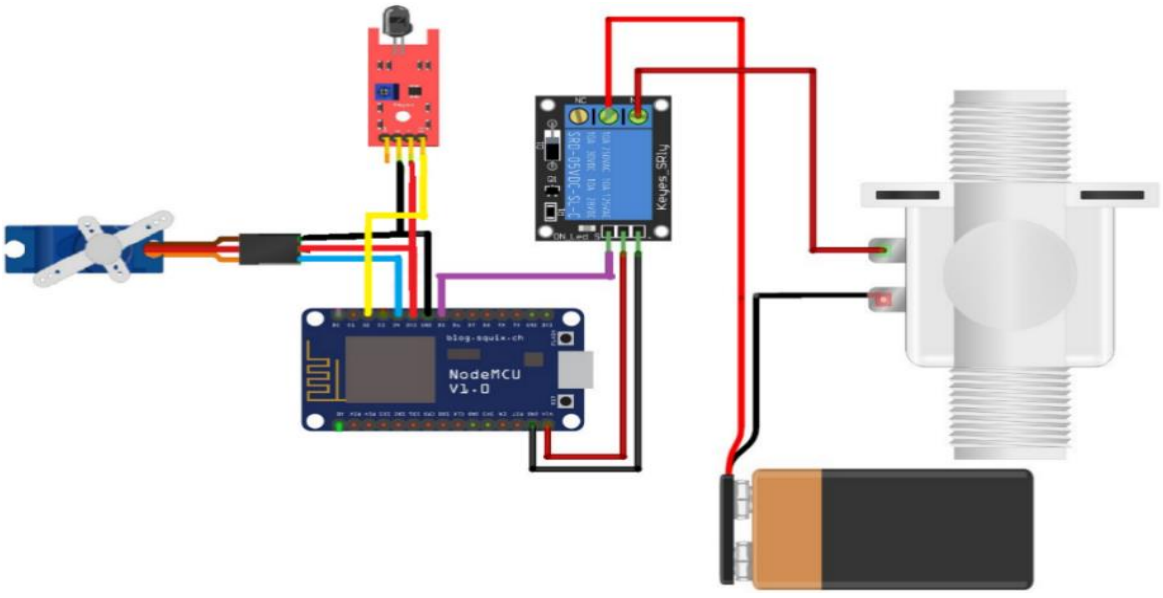

Figure 2. Hardware interfacing for the fire detection and suppression system

4. SYSTEM IMPLEMENTATION

All of the system's parts are powered on and verified to be ready during the initialization step. The fire sensor is used by the system to continuously monitor the surroundings because it is sensitive to heat and flames [19]. To find out if there has been a fire event, it waits for information from the fire sensor. The ESP8266 microcontroller receives a signal as shown in Figure 3 from the fire sensor informing it of a fire incident when it notices a substantial rise in temperature or the presence of flames [20].

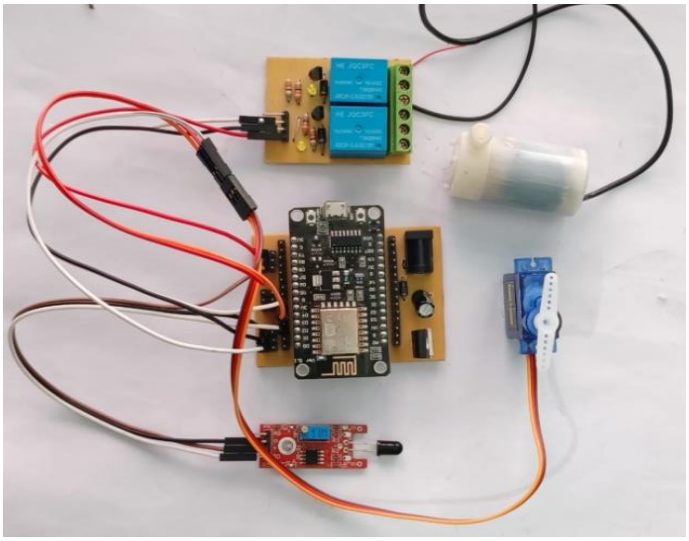

Figure 3. Connection diagram of fire detection and suppression system

The ESP8266 microcontroller starts an alert sequence when it receives the fire detection signal. It might sound an audible or visual alarm within the system and instantly notify the user of the detected fire via the Blynk app as shown in Figure 4. A simultaneous command from the ESP8266 activates the water pump motor [21]. By pressurizing the water supply, this motor gets it ready to combat fires. The ESP8266 controls the servo motor and sets the water nozzles' precise location and angle [22]. By doing this, it is certain that the water spray directly to the fires source. As the nozzles of the water pump are positioned by a servo motor, a fire extinguisher starts working while it is on. It will rapidly decrease temperature and put out fire with its focused water spray [23].

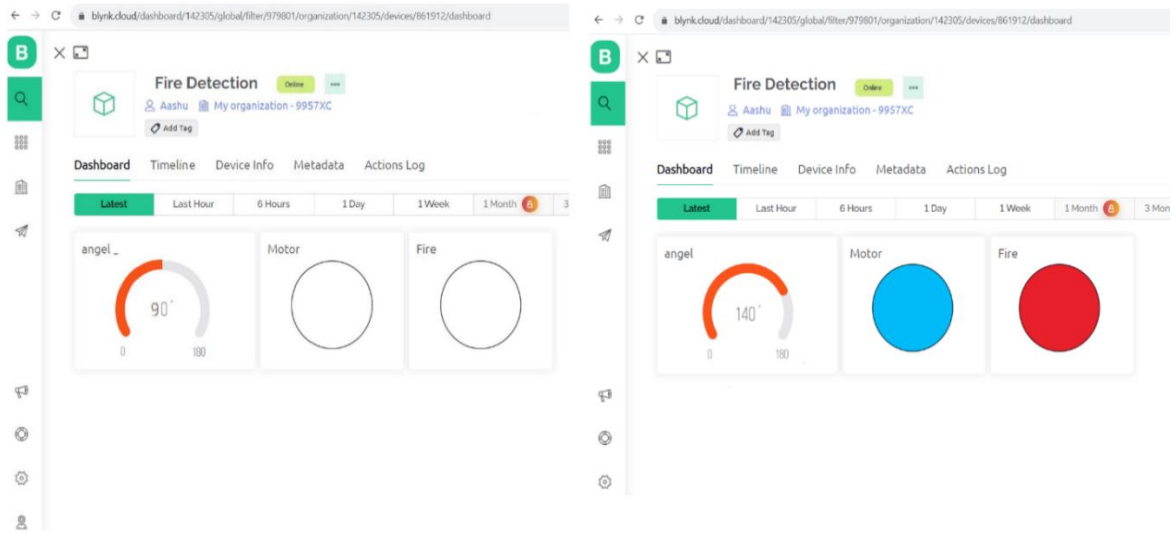

Figure 4. Blynk cloud dashboard

The fire sensor is active whether putting off the actual flames or not. ESP8266 obtains feedback information from sensors to evaluate how effective suppression of fires was [24]. Once there is no visible heat or flames detected by the fire sensor, ESP8266 commands that the water pump should stop running and servo motor shall be switched into sleep mode again [25]. The Blynk app plays a confirmation alert to the user as soon as the fire is out and machine is in standby mode. The system was ready for future fire situations and has returned back to its monitoring and standby mode. In case the alarm system detects a fire, then this algorithm explains how your domestic extinguishing unit works [26]. With an effective management of water flow, real time alerts against such elements and continuous observation, it is able to put off the flames while at the same time informing the individual on its movements [27].

5. CONCLUSION

This study presents internet-based fire fighting system controlled by ESP8266 microcontroller. This system is expected to introduce some added home automation improvements with a safer environmental occupancy by reducing fire accidents at homes. The mechanism consists of the ESP8266 microcontroller along with water pump, servo motor, fire sensor which makes the integrated working of all the components of the system possible. Non–user of these devices finds it difficult in monitoring or controlling inverted technology. The firefighting system burns the flame and immediately douses it using water within appropriate circumstances, thereby minimizing damage, and associated dangers. Such a system is the low minimizing fire handicap breathalyzer by mitochondrial response time and high manned response time accuracy and high operational response efficiency and so low damage. Fire is one of the most disastrous fires in which many losses occur. This system operates aiming at quick response to some emergency situations such as outbreak of a fire and it is acceptable for protecting homes and buildings. This approach will reduce the fire impact, save both lives and properties, and set the stage for more advanced and focused research on house-fire countermeasures.

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