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Development of Smart Fire Detection System for Household Kitchen

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Abstract

An important development in home safety technology is the home safety technologyis the smart fire detection system for home kitchen which makes use of MQ-2 and DHT11 sensors combined with an Internet of Things (IoT) architecture. With an intuitive mobile application, this project seeks to improve the accuracy and response times of fire detection while offering real-time monitoring and notifications. While the DHT11 sensor keeps an eye on humidity and temperature, the MQ-2 sensor detects a variety of gases, including smoke. For seamless IoT connectivity, the system is based on an Arduino ATmega2560 microcontroller equipped with

Wi Fi ESP8266. The device instantly notifies the user through the Blynk app on their smartphone when it detects abnormal levels of smoke or temperature allowing for quick response. Furthermore, the extensive testing in a standard residential kitchen setting proved the system's dependability and efficiency in identifying fires. Opens source technologies and reasonably priced sensors work together to make this system feasible and approachable for broad use. In addition to addressing the shortcomings of conventional fire detection techniques, this project makes advantage of Internet of Thingscapabilities to improve user awareness and safety in residential settings. According to the findings, installing a smart fire detection system can increase kitchen safety and perhapssave lives at a reasonable cost.
Keywords: MQ-2, DHT11, fire detection, IoT system.

Introduction

Fires are unfavorable occurrences that cause real harm to both human life and property. In a matter of seconds, a fire can ignite, destroy houses and property, inflict injuries, and claim lives. It can also rage uncontrollably until its fuel supply runs out. It might be difficult in circumstances where the building is empty or where conventional alarm sounds might not work, including in loud places or around people who have hearing impairments. Everything could be destroyed by a wildfire.

The creation of fire detection systems was the subject of research and invention in the early 1900s by 1960s, the commercial smoke detectors are initially made available for purchase. Since that, it has grown to be a crucial safety component in homes and buildings. The invention of smoke detectors which provide early warnings and enable occupants to take prompt action has dramatically decreased the number of fire-related injuries and fatalities.

The development of smart fire detection system for home kitchen a new technology with the concept of IoT (Internet of Things) by integrating a microcontroller device as an inputand the output data processor parts such as sensors that have smartphone communication capabilities. It is not only required a precise fire detection system but require for a clever solution. A smoke sensor, an Arduino board and the temperature sensor with addition of other components such as buzzer are some of the hardware and software parts to utilize for smart fire detection system project. When the sensor senses a smoke, the Blynk app on the smartphone is utilized to monitor media in real time.

Lastly, the system is made to make intelligent judgments based on the circumstances where it offers hardware controls and feature-updated alarms. The main goal of the project is to lower the risk of loss of life, reduce the cost of large losses and reduce property damage. This project wants to create a basic Smart Kitchen system that is reasonably priced, simple to operate, easy to install and modify, and reasonably reliable.

Despite technological progress and increased public knowledge of fire safety, the house kitchens remain popular locations for unintentional fires that frequently result in serious property damage, injuries and even fatalities. There are many key issues the fire detection happened at home kitchen for example frequent false alarms, delayed detection, lack of smart integration, maintenance issues or limited accessibility and awareness.

In Malaysia, one of the most frequent categories of home fires is caused by cooking Asizable fraction of residential fire events, according to the Fire and Rescue Department of Malaysia (Bomba) from kitchen fires. Therefore, kitchen fires accounted for almost 30% of allrecorded residential fire events between 2016 and 2020.

Besides, many injuries from home fires are caused by cooking fires in Malaysia. Whenlocals attempt to put out the fires themselves, many get hurt. While comparatively infrequent, kitchen fire deaths are nevertheless noteworthy where several incidents are documented each year. In addition, the fires in kitchens can seriously harm property. The tens of thousands of Malaysian Ringgit (MYR) worth of property damage can be caused by a single kitchen fire incident on average. In 2019, kitchen fires resulted in an estimated MYR 15 million in property damage.

In Malaysia, the hours of greatest kitchen fires coincide with meal preparation between from 6 to 9 p.m. Due to consistent with global trends, unattended cooking is the leading cause of kitchen fires. The frequency of kitchen fires is also influenced by the usage of outdated or malfunctioning cooking appliances.

Due to increasing the population densities, it increased usage of gas stoves and electric cooking appliances and higher rates of kitchen fires, Malaysian cities have higher ratesof kitchen fires. Although there may be fewer kitchen fires in rural regions, the usage of traditional cooking methods puts residents at serious risk. In other words, the lack of access to contemporary fire detection systems and often utilize older, less dependable cooking appliances, lower-income homes in Malaysia are more vulnerable. Kitchen fire incidents are more common in public housing communities which are home to many low-income households.

In Malaysia, a sizable portion of residences lack of kitchen smoke alarms whichcauses fire damage to increase and detection delays. The installation of smoke detectors in residential areas is generally not enforced or given enough awareness. However, a smoke detector was frequently neglected and not properly inspected by leaving it inoperable in the event of a fire.

According to the United Nations, to improve global health outcomes. 146 out of 200 countries or areas have already met or are on track to meet the under-5 mortality target. Besides that, effective HIV treatment has cut global aids-related deaths by 52% since 2010. Through this, at least one neglected tropical disease has been eliminated in 47 countries. According to statistics, 381 million people (4.9% of the population) have out of pocket payments for health pushed or further pushed into extreme poverty. Next, almost 25 millionchildren missed out on important routine immunizations in 2021 and 6 million more than in 2019. Every year starting from 2019, 2020 and 2021, the malaria cases have surged worldwide. The data from those years increases slowly. From those problems, a woman diesevery two minutes from preventable causes related to pregnancy and childbirth in 2020.

According to the United Nations too, to make cities and human settlements inclusive,safe, resilient and sustainable. Based on statistics, in 2020, 1.1 billion urban residents are living in slums and 2 billion more are expected in the next 30 years. Air pollution is no longer an exclusively urban problem because of towns experiencing poorer air quality according to cities in eastern and south-eastern Asia records in 2019. Global records in 2022, only one in two urban residents have convenient access to public transport. Not only that, 3 in 4 cities have less than 20% of their area dedicated to public spaces and streets, it is much lower thanthe target of 45-50% in 2020 globally.

Kitchen fires continue to be a major global and Malaysian problem with a few underlying concerns compounding the danger and consequences of these types of occurrences. The burgeoning prevalence of gas stoves and electrical appliances in Malaysian homes has resulted in an upsurge in kitchen fire accidents which are frequently ascribed to neglectful cooking, defective wiring and inadequate maintenance. The situation is made worse by the fact that installing smoke detectors and fire suppression equipment in domestic kitchens is not required. Similar patterns are seen throughout the world with kitchen fires accounting for most home fires and the deaths they cause. A major factor in thehigh frequency of kitchen fires in many developing nations is the lack of knowledge and instruction regarding fire safety precautions. Inadequate ventilation in kitchens and inappropriate handling and storage of combustible products are other frequent problems. Because of modern lifestyle habits and the dependence on high-power cooking appliances, kitchen fires remain a concern in developed nations despite improved infrastructure and more stringent regulations. Adopting cutting-edge fire detection and prevention technologies, enforcing regulations and educating the public are all necessary componentsof a comprehensive strategy to address these problems.

Literature Review

The construction of a comprehensive safety solution incorporating many sensors and networking features is explored in the thesis paper on home security and fire detection system design utilizing an IoT-based microcontroller, AT mega 2560. The ATmega2560 microcontroller is utilized by the system to establish connections between various sensors including temperature, gas and smoke detectors, to keep an eye out for any security breaches and fire threats. The system uses Internet of Things (IoT) technology to allow for real-time data transfer and remote monitoring using a mobile application, giving users immediate alerts and control. By enabling preventative actions and prompt emergency interventions, this integration improves home safety.

The system is not without its drawbacks, though. Technical difficulties may arise fromthe intricacy of combining several sensors and guaranteeing dependable IoT connectivity, especially when it comes to preserving steady network connections and averting false warnings. For some customers, the setup and maintenance costs of this kind of system could be too high, particularly when compared to more conventional fire and security systems. Furthermore, because the system depends on internet access, its efficacy may be harmed by network disruptions or outages, which could cause vital alerts and replies to be delayed.

The advantages and disadvantages of the Internet of Things-based AT mega 2560 microcontroller-based home security and fire detection system demonstrate how to strike a balance between cutting-edge capability and possible drawbacks. Positively, the system provides instant notifications and real-time monitoring, which greatly accelerates emergency reaction times. Several sensors can be integrated with the AT mega 2560 to provide a comprehensive solution for detecting different types of threats. By providing remote access and control through mobile applications, IoT connectivity improves user convenience over traditional systems. Its modular architecture also makes it easier to scale and customize, allowing it to be used in a variety of residential settings.

On the other hand, the intricacy of combining several sensors and guaranteeing dependable IoT connectivity can pose technological difficulties, like preserving steady connections and reducing false alarms. Some consumers may find it less accessible due to the greater setup and maintenance costs compared to traditional systems. Another disadvantage is that the system's reliance on Internet access puts it at risk of malfunctioning and delaying vital alerts. Even with these difficulties, the IoT-based system is still an appealing choice because of the overall advantages of increased safety and user control if these drawbacks are taken care of with thoughtful planning and strong design.

Methodology

A few research holes that must be filled to make further improvements are identified in the journal article on home security and fire detection system design employing an Internet of Things-based microcontroller, the AT mega 2560. First and foremost, to make sure the system can withstand a range of circumstances and situations, more through real- world testing and validation of its dependability and efficacy in varied residential environments are required. Second, there is a lack of research on the integration of sophisticated machine learning algorithms for anomaly detection and predictive analytics, which could improve the system's capacity to discern between genuine threats and false alarms.

Furthermore, there has been little research done on enhancing the energy efficiency of these systems, especially when it comes to battery-operated sensors and devices. The impact of network disruptions could be lessened by creating more robust offline features, as the current solutions frequently rely largely on constant internet connectivity. More research is still needed to determine how scalable the technology is in bigger, more complicated home setups. In conclusion, there exists a notable need in user education and the creation of user-friendly interfaces that enable non-technical users to use the system, hence guaranteeing wider adoption and efficient utilization. Closing these gaps could improve IoT-based home security and fire detection systems' usability, practicality and dependability considerably.

Results and Discussions

In delivering precise and timely alarms, the creation and application of a smart fire detection system for residential kitchens that make use of MQ-2 and DHT11 sensors coupledwith an IoT framework seeks to improve fie safety.

Figure 1 Smoke Sensor Result

This system uses the MQ-2 smoke sensor which measures the strength of the smoke produced by the fire, to make it sufficiently intelligent and to give people life support if the fire intensifies to the point where it could suffocate them. In addition, the microprocessor provides a 5V supply to power the sensor.

The DHT11 sensor precisely tracked temperature fluctuations, and the MQ-2 sensor efficiently identified different smoke concentration levels. The testing and calibration verified both sensor's dependability in various scenarios. In addition, the sensors in the system demonstrated fast reaction times to identify alterations in a matter of seconds and send out notifications. It is essential to notice kitchen fires quickly to stop them from getting worse. The test of continuous operation demonstrated that the system continued to operatesteadily for log stretches of time. There were no appreciable delays in data transfer or alerts thanks to the interaction with the IoT platform. Lastly, the test of continuous operation demonstrated that the system continued to operate steadily for long stretches of time. There were no appreciable delays in data or alerts thanks to the interaction with the IoT platform.

Conclusions

The assessment offers a path forward for future research by carefully examining existing solutions and pinpointing research gaps. The practical issues faced by present systems are addressed by highlighting topics like the need for real-world validation, integration of advanced machine learning for better threat detection and improvements in energy efficiency. Furthermore, highlighting the need for scalable offline features and adaptability across a range of residential situations highlights the necessity for flexible and durable solutions. The evaluation also emphasizes how important it is to have user-friendly interfaces and user education to make sure that technical developments are accessible and easy to use. The body of knowledge in academia is a useful tool for researchers working to create IoT-based home security and fire detection systems that are more dependable, efficient and user-friendly. It does this by highlighting research gaps and possible areas for improvement.Acknowledgements

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