INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN PROGRESSIVE EDUCATION & DEVELOPMENT

OPEN ACCESS JOURNAL

Vol 11, Issue 3, (2022) E-ISSN: 2226-6348

Alert Me! IoT Based Mobile Application Using Smoke Detector

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To Link this Article: http://dx.doi.org/10.6007/IJARPED/v11-i3/14471 DOI:10.6007/IJARPED/v11-i3/14471

Published Online: *23* September 2022

Abstract

The concept of smoke detector and mobile application integrated for fire emergency hazard systems is quite well known in the current era. Due to the serious health, safety, environmental and economic issues of the release of hazardous materials, the device that controls gas sensors, processes information, produces evacuation alarms and shuts down equipment and gas valves can be easy to use. Besides, most of death cause by fire incident is not by fire burn but by excessive smoke inhalation. Thus, this study serves to assist the public community to reduce the risk of having fire or smoke inhalation. This project aims; 1) to design the Alert Me! IoT Based Mobile Application Using Smoke Detector and 2) develop Alert Me! IoT Based Mobile Application Using Smoke Detector. This project will be using the android platform. Mobile Application Development Lifecycle (MADLC) is the approach employed to complete this task. The IoT Design Methodology will be used to develop the smoke detector device which utilizes the internet to connect with the mobile application. Findings show that the implementation of an IoT Based Mobile Application Using Smoke Detector can provide better monitoring and prevention from any potential situation turning into tragedy. In the future, this application can be used not just in house or shop premises, but also in the industrial sector.

Keywords: Mobile Application, Internet of Things, Smoke Detector

Introduction

Nowadays, security is very important, everybody wants to protect their belongings at home because fire hazards are unpredictable. Fire can pose a serious threat to human life and their property. The fire hazard can be significantly improved if an early alert can be detected (Ismail et al., 2016). In the case of Malaysia, residential area has led to a rise in fire incidents, in particular those related to the accidental fire caused by electrical sources, cooking devices, faulty or misuse of equipment, reckless handling of fire or hot liquids (Aziz et al., 2020). According to the statistic of investigated structural fire by premises for the year 2018 from official Fire and Rescue Department Malaysia's website, the number was dominated by blazes in residential property which is more than 60% followed by shops and workshops/factory in 6626 cases.

Furthermore, most fire deaths occur not by fire burns, but by smoke inhalation. Often smoke incapacitates so quickly that people are trapped and cannot make it to an otherwise available exit (National Fire Protection Association (nfpa.org), 2019). The primary cause of death indoor fire victims is smoke inhalation. Many smoke compounds from fires are extremely volatile and poisonous.

False alarm that causes by device malfunction also increase the amount false report. When referring to fire, a false alarm is a fire alarm when there is no real fire condition at all. Therefore, with the advancement of technology users can have fire safety devices such as smoke detectors that used to alert the inhabitants of a fire building before it reaches a rapidly spreading stage, inhibits escape or attempts to stop it and reduce false alarm by using multiple different ways to detect real situation.

According to the outcomes of the interview conducted to 5 house owners, 5 out of 5 house owners admitted that they have go through fire hazards whether a practice or real fire emergency. Most of them know the first thing to do if there is a fire emergency happen which is evacuate the building. Next, 4 out of 5 house owners stated that they do not own smoke detectors at their house but wanted to have it in the future. This shows that the smoke detector on the current market is not well known enough and some of the interviewee state that the smoke detector is expensive.

Moreover, 3 out of 5 house owners stated that they prefer a smoke detector with 2 power which is hard-wired, and battery powered. Battery powered is more for backup power and hard-wired would be the main power. Lastly, they prefer a few functions in the smoke detector application such as alarm, push notification and direct call to the fire and rescue department.

Therefore, the project is aimed to develop a mobile application with IoT technology to help house owners to have a better fire safety. By using this application house owner enable to receive a push notification for gas detection in the house that is connected to a smartphone. Users can respond to the alert and quickly act from the notification received before the smoke turns into a fire incident.

Literature Review

Internet of Things

The Internet of Things is a new light on the advancement of technology in the early stages of IT growth. IoT is a network of connected sensors, computing, and digital devices distributed across the globe, which can communicate with each other to communicate and transfer information using a unique ID assigned to each unit, such as UIDs (Unique Identifiers) (Yadav et al, 2018). It uses radio wave-based spectrum or frequency modulation technology to allow communication between devices in a limited region, also known as the basic service set. Efforts have therefore been made to provide a reliable and user-friendly application for easy use and control of electrical operation (Gupta & Johari, 2019).

IoT refers to the conceptual interconnectivity of our everyday devices, as well as device autonomy, sensing capability and contextual awareness. IoT products include personal computers, notebooks, tablets, smartphones and other mobile embedded devices. The interconnected device networks will result in many smart autonomous applications and services that can bring vital personal, professional and economic profits, leading to the emergence of a more data-centric industry (Hossain et al., 2015). Thus, the term Internet of Things typically refers to a phenomenon where network connectivity and computational

power connects to objects, sensors and ordinary items not generally known as machines, allowing such devices to generate, exchange and process data with minimal human interference.

One of the most apparent benefits of IoT is monitoring [7]. This can be achieved due to objects getting connected and controlled remotely with wireless support. IoT apps can greatly improve personal and home security. Remote home surveillance makes home security much easier to be control and get notification from anywhere in the world. If the user's phone receives a message saying, "your front door has just been opened," the user can access the live camera feed from the front door of the user instantly, so that users able to avoid a burglary and may have the evidence if anything happen while they are away from home (futureoftech.org). Lastly, according to Rathore et al (2016), based on the current traffic situation, smart management of the traffic system with the provision of real-time information has a major impact on the citizen life and enhances the performance of the authorities.

IoT Technologies

Most network-connected devices receive their IP addresses dynamically via Dynamic Host Configuration Protocol (DHCP). Devices and controllers in assembly lines and processing centers have static IP addresses. Different procedures are used by IoT Security to detect and track network behavior and correlate it to individual devices. There are several reasons why IP address is important for IoT such as IoT security. These added security features depend entirely on proper design and implementation of IP address, and the more complex, flexible infrastructure of IP address makes this process more difficult. According to a Gartner study (2020), 25 billion "things" will be connected to the internet. That is impressive prediction, given that 4.9 billion devices will be connected in 2015, the same study states. In just five years, this estimated 400 percent growth rise sheds some light on how much exponential IoT growth we can hope to see in the next 10, 20, or even 50 years. Given these numbers, it easy to understand why IP address is essential for IoT devices.

Smoke Detector

Smoke is a collection of tiny particles of solids, liquids and gas. While smoke may contain hundreds of different chemicals and fumes, most of the visible smoke is carbon, tar, oils, and ash. Each particle is too small to see through your eyes, but you see them as smoke as they come together (Science Learning Hub (sciencelearn.org), 2009). The diffusions of the smoke differ under different densities of fire load. When the density of the fire load is high, the plume of smoke is concentrated, and the rate of increase is faster. But, when the fire load intensity is small, the smoke travels more in the horizontal direction at the fire level (Chen et al., 2020).

These gases can come from different sources such as soil, furnace and fireplace and when household is constantly surrounded by certain gases it may be dangerous and inflammable. The first type of the gas commonly found or used in the household is Liquefied petroleum gas (LPG). LPG is a flammable mixture of hydrocarbon gases used as fuel in heating appliances, cooking equipment, and vehicles. If the usage of LPG is incorrect, it can lead to explosions, fires, loss of property and most importantly, loss of lives. Next, Carbon Monoxide is produced in fuel-burning gases from things like generators, furnaces, grills, and fireplaces. Carbon monoxide is toxic when breathed because it displaces oxygen in the blood and eliminates oxygen from the heart, brain and other vital organs (www.osha.gov). In addition, methane also included in the list. It is a colourless, odourless, non-toxic but flammable gas

(National Center for Biotechnology Information, 2020). Methane also is the chief constituent of natural gas, which contains from 50 to 90 percent methane. In summary, house owner should be expose to fire incident prevention. There are few ways that could prevent a fire incident from happening. There are some product or device specially designed to prevent fire incident.

A smoke detector is a device that senses smoke particles, usually used as a fire indicator. It plays an important role in reducing fire deaths and damages. Inside the kitchen, smoke detector should be place at least 10 feet away from household appliance to reduce the possibility of false alarm. The density of smoke is lighter than air at 20°C which means it will rise to higher place in the environment. Therefore, smoke detector should be placed high on the walls or ceilings. Bear in mind that smoke detector should not be placed near any ceiling fans, vents and window so that the smoke detector to work properly. Moreover, user is recommended to test the smoke detector every month and replace the smoke detector every 10 years.

Considering household situation, this project develops ionization smoke detector towards development of mobile application.

Methodology

The Mobile Application Development Life Cycle (MADLC) is implemented to develop Smoke: Alert Me! Smoke Detector Mobile Application. The Mobile Application Development Lifecycle (MADLC) is the most suitable framework for creating a mobile application. This method helps in achieving a smooth project's development and support an orderly approach throughout the mobile application development (Vithani & Kumar, 2014). The development of detector has been integrated in MADLC Therefore, there are few phases of MADLC such as the identification phase, design phase, development phase, prototyping phase, testing phase, implementation phase focusses on IoT and mobile application.

Identification Phase

In the first place, an interview has been conducted on 5 interviewees to gather information such as problems and significance for Smoke: Alert Me! Smoke Detector Mobile Application. The survey was conducted through WhatsApp mobile application. Apart from that, some of the literature information related to the project has been reviewed through online journals, conferences and research papers. The review focuses on mobile components that are related to the project. This phase includes IoT methodology step includes Purpose & Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification, Service Specifications, IoT Level Specification, Functional View Specification, Operational View Specification.

Design Phase

The concept that was reported from the identification stage is created into an original application model in this stage. The functions and features of the implementation are determined on all mobile platforms. The user interface for the application is designed during this phase in MADLC. The outcome of this activity is the storyboard for low fidelity. First, the user interface of Smoke: Alert Me! mobile application is designed using Marvelapp an prototyping design platform. Followed by the design of the actual circuit diagram for smoke

detector and video streaming components using online design tools named Fritzing. Lastly, Draw.io online software is used to design use case diagram and domain model diagram.

In IoT design phase is where the design of detector is created. In this phase, it covers Process Specification steps, Domain Model Specification steps, Information Model Specification steps, Service Specifications steps, IoT Level Specification steps, Functional View Specification steps and Operational View Specification steps. All the hardware, software and platform required for the IoT Design Phase activities are included.

Development Phase

The development phase is the phase in which the proposed mobile application is coded to follows the design that has been carried out during the design phase. Thus, all the intended features and functions are implemented in the application during this phase. In the development phase is where the Smoke: Alert Me mobile application is coded to follows the design that has been stated in the Design Phase. In this process, the Device Components Integration and Application Development steps were covered. Hence, during this process, all the intended features and functions were integrated in the application. The completion of this step means that part of the Smoke: Alert Me! and IoT methodology is achieved. All the hardware, software and platforms needed for activities in the development process were also included. To make the Smoke: Alert Me! mobile application more realistic, a kitchen room prototype was developed using box and toys. The smoke detector and video streaming device are glued together with the roof of the kitchen room prototype. The completion of this process means that the first part of the third goal of designing the Smoke: Alert Me! mobile application has been accomplished. All the hardware, software and platform required for the development phase activities are also included. Firstly, the application will be constructed by using Android Studio. smoke detector that will connect with the mobile application using Arduino IDE.

Prototyping Phase

In this stage the functional requirements for each prototype were analysed; the prototypes will be evaluated and forwarded for feedback from the customer. After receiving feedback from the user, the necessary modifications will be implemented through the development stage. When the second prototype is prepared, tested and then forwarded for input to the company, it is merged with the first prototype. Repeat the development, prototyping, and testing phases until the final prototype is ready. The final version was submitted to the user for one last consideration. The documentation of the tasks carried out at this stage is then forwarded to the test stage.

Testing Phase

The application is tested on the real environment on mobile device and is documented and delivered to the user for feedback as a result of the testing. The application is reviewed during this process to ensure the functions are workable and meet the requirements. The application able to display real time data and alert the user using push notification, user can stream on live video and data can be received without using the same internet connection during the testing phase. The targeted user is house owner and own mobile phone with internet connection. 2 house owners will be test Smoke: Alert Me! application. Users will test the Smoke: Alert Me! application, then provide feedback regarding the mobile application'

features and function. In addition, testing procedure was also added in this testing phase, which consists of a list of tasks and interview questions.

Result and Findings

Design Requirement

Based on Table 1, all the basic features of the mobile application such as location-based service, Realtime database, login and profile update were included in the Smoke: Alert Me! mobile application. To make this mobile application has its own added value, a video live streaming will be integrated in this mobile application which enable the user to monitor their house environment remotely (Figure 1).

Table 1

Design features of Smoke: Alert Me! mobile application

Requirements	**Description**
Location-Based Service	Allow the users to find nearby fire station.
Real-time Database	Users can view the past incident which retrieve from real-time database.
Login	User need to login and register before log into the application.
Profile Update	User can edit their account details
Direct Call to Fire Station	User can call 999 through the mobile application
Push Notification	For alerting purpose when user is not around the house
Live Streaming	Video streaming to monitoring purpose.

Developing the Smoke: Alert Me! mobile application is a critical step to ensure that it is compatible with the specification stated earlier. Figure 1 shows the high fidelity of the applications and Figure 2 shows the smoke detector that has been connected to the mobile application. To test the functionality of all component and features. An evaluation has been conducted during the testing phase and the feedback as show in Table 2.

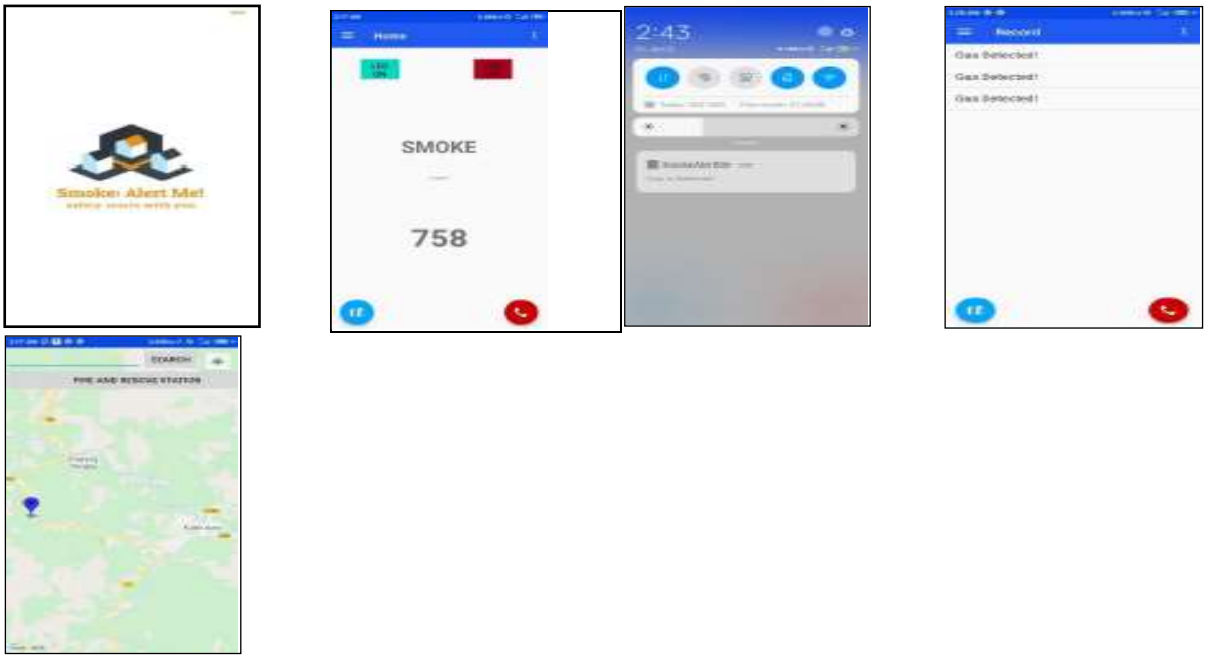

Figure 1. High Fidelity Prototype Smoke: Alert Me! Mobile Application

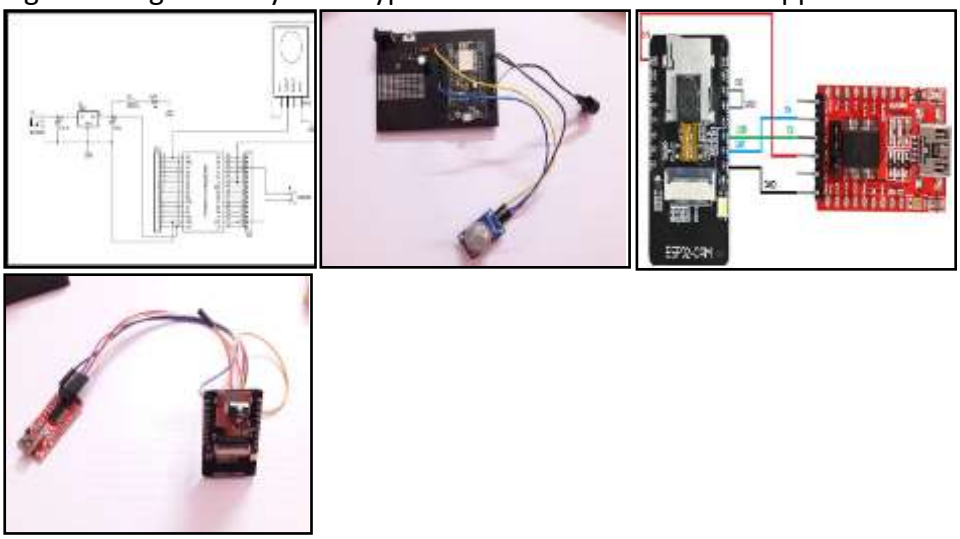

Figure 2. High Fidelity of Smoke Detector

For the testing phase, 3 household owners have been chosen to test the usability of the Smoke: Alert Me! mobile application. Therefore, a series of tasks have been outlined for the users when they were testing the mobile application. After the tasks have been executed, the user then will be interviewed regarding their opinions on the mobile application. These questions are crucial for improving this mobile application.

The result of user testing and interviews were recorded based on the testing procedures provided by the household owner as the testers. Based on the user testing result, all functionalities of Smoke: Alert Me! mobile application work as they are expected. One of the testers said that overall design looks great while other tester said the design was simple and straightforward. Both of the testes said it easy for them to navigate through the mobile application. Both of the tester said the application can be helpful for them to monitor their house as fire safety alarm. Both of the feedback by the user are positive toward the

effectiveness of the application. however, this application still has some weaknesses which is the integrated sensor is only one and might trigger false alarm easier. Therefore, the results have been collected and will be used for further improvement of this mobile application.

Conclusions

This project is executed to observe how Smoke: Alert Me! mobile application is able to ease the process as well as enhance the monitoring procedure of the users with the ability to detect smoke much faster than a traditional smoke detector. A standard smoke detector works by identifying environment situation when there is too much smoke in the room. Smoke: Alert Me! mobile application able to alert users from anywhere they are. However, the features of this mobile application still require some improvement to make it more precise and accurate by reducing the possibility of false alarm. Furthermore, defining the user requirements for the Smoke: Alert Me! IoT based mobile application, designing and developing the Smoke: Alert Me! mobile application is crucial for the development of this project.

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