IoT-based Emergency Alert System Integrated with Telegram Bot

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***Abstract*— Fires and robberies are two of the most traumatic events that can happen in a person's life. Both situations can lead to the loss of precious objects, including jewelry, electronic gadgets, cash, and other important items that might have been acquired over the years. The impact of such events can be far-reaching and can leave an indelible mark on the victim's life for a long time after the event. Taking safety measures to protect against fire and theft can lessen the likelihood of loss in the event of a disaster. As a result of this, it is necessary to develop an updated warning system which is an upgrade on the one that is already in existence. The Emergency Alert System (EAS) is a system that is designed to provide the user with information regarding the condition of their home. This system was built with a NodeMCU, a gas sensor, a sound sensor, and typical alert devices like an emergency light and a siren. In the past, a standard alert would only notify the people in the general neighborhood, but now it could also notify the owner even when they are not at home. This project utilized the Internet of Things (IoT) and is integrated with Telegram Bot as a tool to expand the alert system's notification capabilities.**

Keywords—Emergency Alert, NodeMCU, Arduino, Telegram Bot, Internet of Things

I. INTRODUCTION

Fire alarms are an important piece of safety equipment found in homes, businesses, and other buildings. Fire alarms are designed to detect early warning signs of a fire and alert occupants to the danger. It is essential for fire alarms to be reliable and effective in order to protect the occupants and belongings of any building.

Apart from that, it is also important to prevent intruders or thieves from entering our residential areas including shop premises and office buildings. Security measures are implemented to protect people, property and assets from theft or intrusion. Although there are many different types of security measures, the most important are physical barriers, alarms, locks, surveillance systems and access control.

Many types of study on IoT-based fire detection systems have been conducted. The primary objective of each study is to develop prototypes for detecting fires at an early stage utilizing a variety of sensors and strategies to notify users. One of the research use raspberry pi as the controller and MQ-2 gas sensor for detection. One of the studies, is a cloud-based system that employs sensors (hardware) to detect fire and inform the user via the internet [1]. The system is maintained and monitored using a simple Android application. The FireNot system employs Raspberry Pi with Python programming and Google API for location detection. To avoid false alarms, [2] develop a prototype that can detect fire and indicate the location of the impacted area. A few sensors and a camera are integrated with Raspberry Pi 3 and several Arduino boards. The prototype was outfitted with a relay motor that rotates 360 degrees and is assembled with the camera. This allows the image to be captured from any angle, regardless of where the fire is detected. Both studies are developed for fire events in buildings, homes, or premises.

In addition, a prototype was developed to keep a monitor on a forest fire [3], [4]. The occurrence of forest fires is something that occurs frequently [5], [6], and they typically take place between the months of June and September, so the installation of a sensor and monitoring system can be used for early detection and prevention of forest fires. In addition to that, an emergency warning system has also been built to detect any kind of intrusion into your home. There is numerous research on that as well [7]–[12]. The common sensor used for intruder detection is Passive Infrared (PIR) sensor. The different between the cited research is the project aims, controller, output devices and notification method.

This study describes an enhancement to the project that was carried out using the integration of fire and intruder detection using a system called EAS (which stands for Emergency Alert System). Because the PIR sensor is subject to several restrictions, the PIR sensor is now being replaced with the sound sensor KY-037. A gas sensor designated as MQ-2 was employed to detect the presence of a fire. As incidents occur, the user will receive notifications about those incidents. In addition, the prototype was constructed in such a way that it gives the user the ability to switch ON the EAS event even if the detecting devices have not picked up any harmful signal. This feature helped the user in case an intruder broke into their house while user is at home. Hence, the activation of EAS manually can notify nearby neighbors, and the intruder may escape quickly.

II. Methodology

This project fundamentally has the same system flow as the standard fire alarm, however, this project additionally includes IoT so that the user will receive notification along when the alert system is turned on either automatically or manually. This project is well-suited not only for households, but also for workplaces and any other business sector that requires an alarm. With the present features of this project, users now have a more advanced level of control over the system. They are now able to operate it by the tip of their finger by using their own smartphone or any other gadgets that have the Telegram application. This gives them a significant advantage over previous versions of the system. Since this initiative can be controlled, society no longer has to worry about false alarms.

A. Project block diagram

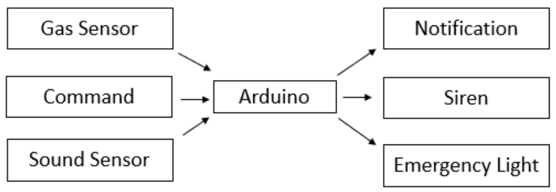

Fig. 1. EAS Project's Block Diagram.

A block diagram of Emergency Alert System is shown in Fig. 1. Gas sensors and sound sensors are the two types of sensors that are utilized as input devices. The Arduino software was used to create commands, which were then uploaded into the microcontroller. The emergency light and siren both function as output devices that respond whenever dangerous levels of gas or sound are detected outside of their normal range. Further, NodeMCU sent a notification to the user's smartphone through the Telegram app.

B. System Operation's Flowchart

To get started, this project relies on both sensors and a human command as shown in Fig. 2. When one or both sensors are triggered by gas, smoke, or sound, it immediately send signals to the Arduino. The Arduino would then process all of the data it received and transmit output to the relay and NodeMCU. After the relay was activated, both output components, the sirens as well as the emergency light, will become active for about 10 seconds. The user then will receive an alert notification via the Telegram app on their smartphone.

Simply by utilizing their phone, the user can control the connection that is being made by the relay. The user would merely utilize the commands that have been established to control and turn off the emergency light if it became necessary to do so. But, for the relay to be turned off, the user would need to provide the command to do so, and the sensors would need to indicate that there is no longer a threat present. To disengage the relay and switch off the components of the output, it is necessary to fulfill both of these conditions. Users are still able to manage the relay even in the absence of any sensor activity.

In the case that an unwanted incident occurs when the user is at home, like an intruder invading the house, the user can also employ this system to activate the EAS by sending a command over Telegram. With that, the user's nearest neighbors will notice and detect that something is wrong so they can seek help. It is also possible that the intruder will run instantly after hearing the siren.

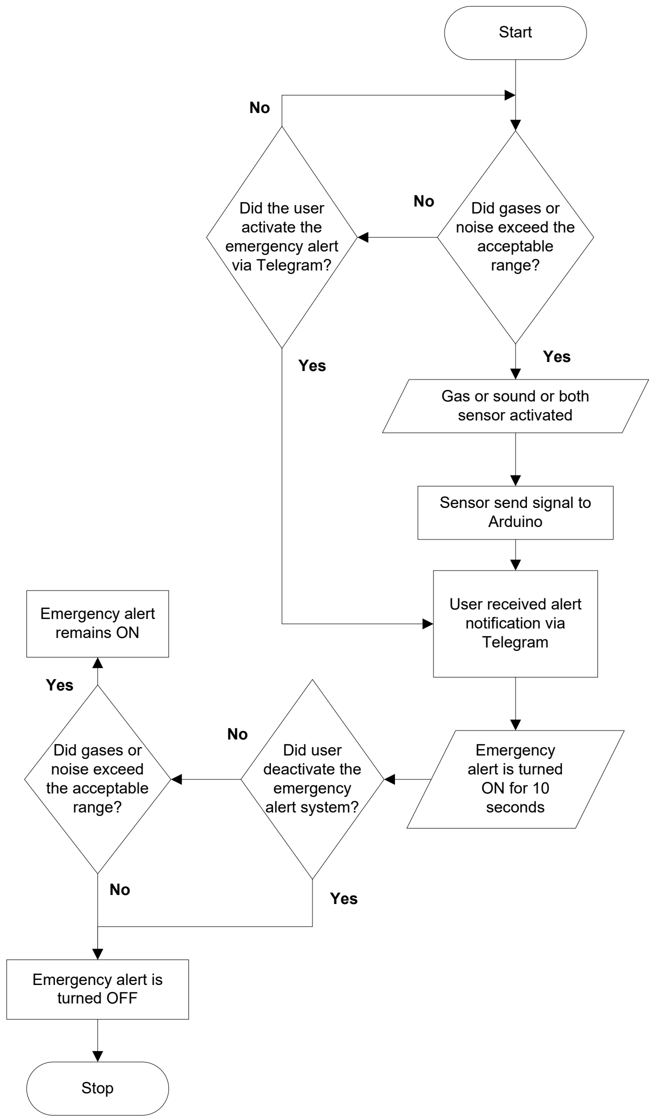

Fig. 2. EAS System Operation's Flow Chart

C. Schematic diagram

Fig. 3 depicts a schematic diagram generated with the Proteus 8 software. For the simulation, the following components are utilized: a gas sensor, a sound sensor, a lamp and a buzzer (to virtually replicate the use of an emergency light and siren), an Arduino as the primary controller, and two virtual terminals to represent the transmitter and receiver devices. In this EAS project, the purpose of the two terminals that were employed in the simulation phase was to practically reproduce the operation of the NodeMCU as a WIFI module. Both sensors were set to function like digital sensors during the simulation process and connected to the Arduino's digital pin. Both sensors are connected to the digital pin because the simulation's only primary objective is to verify that the circuit works.

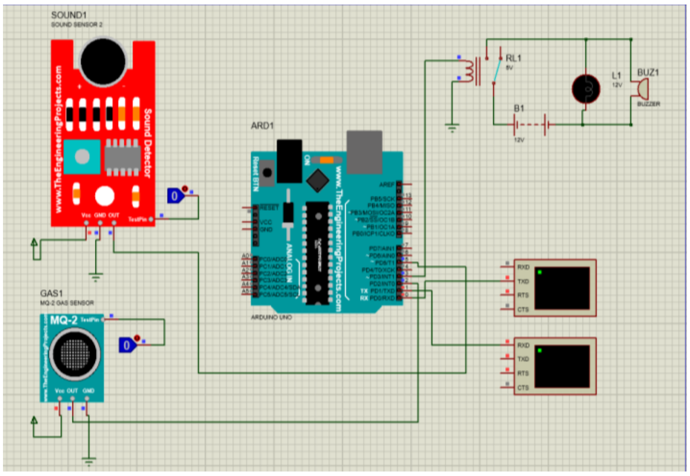

Fig. 3. Schematic diagram of EAS (simulation phase)

The schematic diagram of the projects' hardware is shown in Fig. 4 below. Initially, the gas sensor pin connected to A0, also known as analog pin 0. Meanwhile, the A3 or analog pin 3 would be connected to the sound sensor. The sensitivity of both sensors must be adjusted so that the emergency warning does not generate false alarms for users or neighbours. The relay is then attached to D4, also known as digital pin 4. Because a relay's primary function is to connect and disconnect the circuit around the output devices, there is no need to fine-tune the digital pin and relay to get the desired "HIGH" or "LOW" output. Lastly, the NodeMCU would link the RX and TX pins accordingly to the RX and TX pins of the Arduino, allowing both microcontrollers to transmit and receive signals. All of the sensors and relays as well as NodeMCU are powered by the Arduino's 5V and share the same ground.

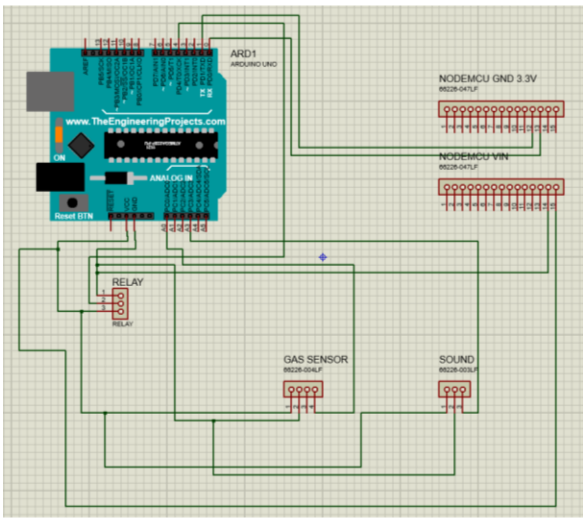

Fig. 4. Schematic diagram of EAS (hardware implementation phase)

D. *Sensor setting*

Data was analyzed and compared to get the best value of what level would be the best for the sensors to be triggered. Ky-037 was the most sensitive sensor, but it could be interrupted by none hazard noise, so data was collected in decibel value to compare the level of noises in different situations as listed in Table 1.

TABLE I. DECIBEL LEVELS FOR DIFFERENT SITUATION

Decibel (dB)	Situation
120 dB	Thunder
110 dB	Concert and screaming child
100 dB	Motorcycle, Blow dryer
90 dB	Diesel truck, Power Mower
80 dB	Loud music
70 dB	Busy traffic
60 dB	Normal conversation
50 dB	Quite office, Rainfall
40 dB	Quite Library
30 dB	Whisper
20 dB	Ticking watch
10 dB	Almost Quiet, Breathing

As this project is supposedly to be placed inside the house when the users are away from home or on vacation, it means that nobody is at home, so the house should be quiet. The measurement was taken directly by using the sound sensor (KY-037) with the help of an Arduino to compare the sound wave or spectrum in a quiet room or house, as shown in Fig. 5. As could be observed, the sound wave would be peak to peak at around 54 or -54 in analog measurement. This measurement was taken when the area that was tested was quiet and only had the sound of fans and winds. Small sounds like talking do not vary much when measured. Thus, it means that talking and normal human activity do not trigger much around this value. The spectrum wave is depicted in Fig. 6 when the sound sensor is configured to activate when it detects a decibel level of more than 200. The explosion, which occurred during the fire event, must have produced an extremely loud noise that is greater than 200 ADC. Yet, more specifically, when the user is not at home, the assumption is made that the house is quiet. The sound sensor's setting value ought to be adjusted down to a more reasonable level. When there is an intruder in your house, they will be more careful and will not make any noise, hence the EAS should be very sensitive to any undesirable sound created by the intruder. The EAS will perform less effectively if the value that is set is too high.

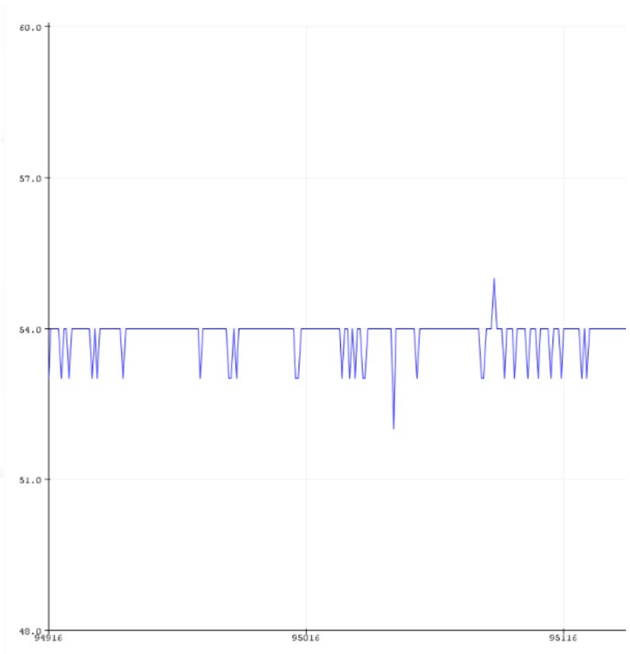

Fig. 5. Spectrum wave obtained at quiet condition.

Fig. 6. Spectrum wave obtained at loud condition.

MQ-2 sensor also been tested. From the observation made, when the gasses or smoke are detected by the sensor, the reading continue to rise and does not go any lower as shown in Fig. 7. The set point for the MQ-2 is 300ADC. If the sensor detect the gasses or smoke level up more than 300ADC, the EAS will trigger instantly. The spectrum waveform will slowly decreased when the level of gasses reduced and the EAS stop if the value dropped below 300ADC as shown in Fig. 8.

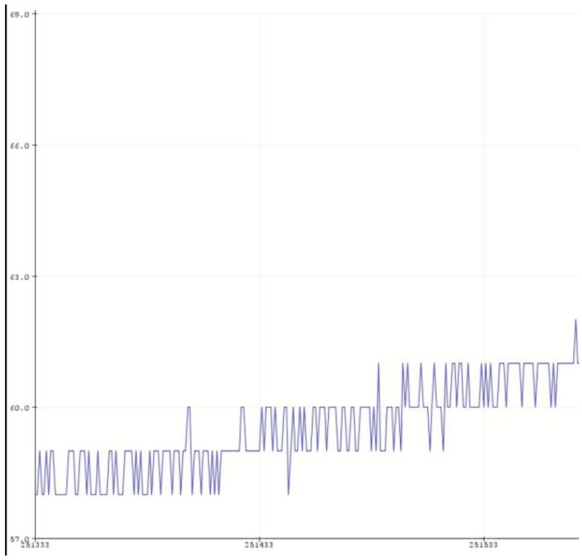

Fig. 7. MQ-2 working signal based on the gasses or smoke detection (increased).

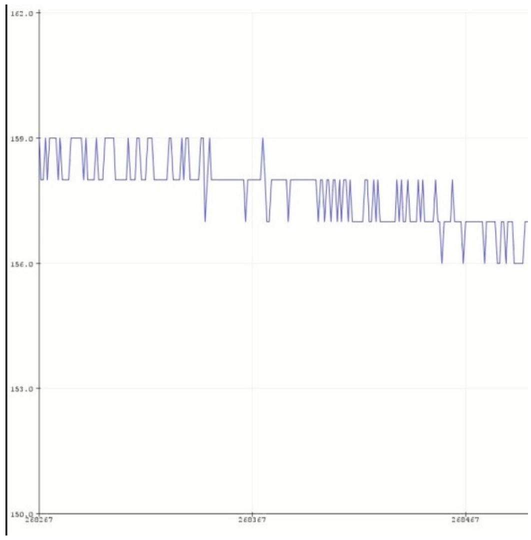

Fig. 8. MQ-2 working signal based on the gasses or smoke detection.(decreased).

E. Prototype

The final prototype of the project is depicted in Fig. 9. House are modeled in the final prototype. The emergency alarm, which serves to notify the neighborhood of the threat inside the home, is, as one might expect, situated outside the house as shown in Fig. 10. Meanwhile, the sensors are positioned inside the house, ensuring that the sensors only identify hazards within the house and not those outside, which could result in a false alarm.

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Fig. 9. Final prototype of Security Alert System.

Fig. 10. Emergency alarm positioned outside the prototype.

III. RESULT AND DISCUSSION

The result section is divided into 2 parts. The notification command and setting were discussed first and then followed by the analysis done from the prototype testing.

A. *EAS notification command and setting*

The two commands used in EAS project were 'alertonn' and alertoff. Fig. 11 shows the example of correct commands showed 'alertonn' using virtual terminal. Whenever the user entered the right command with correct capitalization and spelling, it will be considered as the right input and being understand by the microcontroller to proceed with the signal and send an output to turn on the relay. As result, it can be observed in the Fig. 12, that the relay is now connected, and the lamp and buzzer is now turned on. At the same moment, the EAS system delivered a status message to the user as shown in Fig. 13. Indicating to user that the command works fine, and the emergency alert is now turned on following the user's command of which is "alertonn".

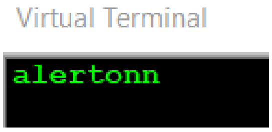

Fig. 11. Alertonn command shown in virtual terminal.

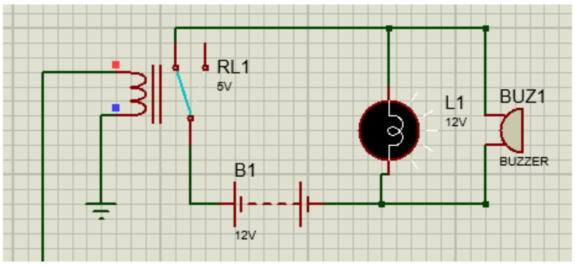

Fig. 12. Lamp and buzzer activated by the 'alertonn command'.

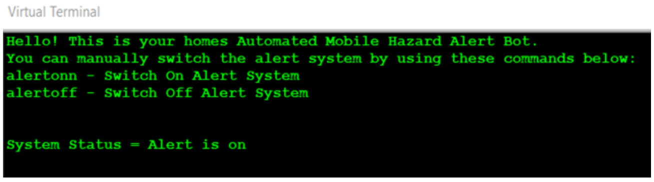

Fig. 13. Status message delivered to the user via virtual terminal.

When the user entered the command "alertoff," it was also regarded as the correct command to turn off the emergency alarm. The command is sent by the user to the microcontroller, and it will turn off the emergency light. But, this condition is true in the event that no sensing devices are triggered and in an inactive state. The command cannot override the EAS system if the emergency alarm is activated by the sensing devices. Fig. 14 shows the notification received by the user that the alert was turned off. If the user submits an invalid command, they will receive a message as shown in Fig. 15, and the relay cannot be activated, preventing the activation of the emergency alarm.

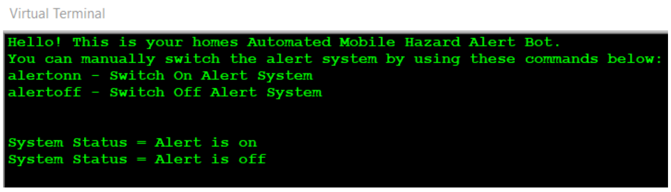

Fig. 14. Status message delivered to the user via virtual terminal.

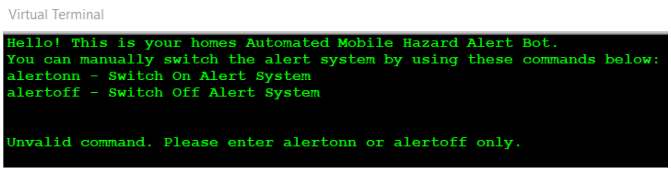

Fig. 15. Status message delivered to the user via virtual terminal.(invalid).

B. *Data Analysis*

Table 2 below shows the summary of the results of sensing devices using Proteus 8 software. This result considered four different conditions of the sensors and how the relay would respond to them. Table 1 shows the results from the prototype testing for both conditions of sensor. The output relay can also be controlled by sending a command or instruction via Telegram apps. Table 3 depicts the summary result of the output relay status from the 4 conditions of command with the sensing device status.

TABLE II. SENSING DEVICES ACTIVATION VS OUTPUT RELAY STATUS

Condition	**Result**
Both sensors INACTIVE	Relay OFF
ONLY gas sensor ACTIVE	Relay ON
ONLY sound sensor ACTIVE	Relay ON
Both sensors ACTIVE	Relay ON

TABLE III. COMMAND CONDITION VS. OUTPUT RELAY STAUS AND NOTIFICATION

Condition	Result
'alertonn'command	Relay ON Receive notification 'Alert is on'
alertoff command Both sensor INACTIVE	Relay OFF Receive notification 'Alert is off'
'alertoff' command Any sensor ACTIVE	Relay ON -cannot override the EAS
Invalid command	Relay remains Get notification

The Telegram bot that has been developed specifically for use with this project can be seen in Fig. 16. In the simulation, the user had to enter the command. With the Telegram bot, the command was already made, and the user just had to click the command. It is more convenient for the system. In the emergency, it is not practical if the user needs to type the command, so this feature is more suitable

Fig. 16. Notification and command via Telegram.

IV. CONCLUSION

The prototype IoT-based Emergency Alert System using Arduino and NodeMCU with telegram alarm notification is illustrated in the paper with adequate results. The developed system is capable of being put into action in a real-time setting such as a restricted public area, a private property, or a small home or office. This project is advantageous to the owner of the home since it has the potential to give the user a greater favorable impact than a conventional alarm system does. This project has also been demonstrated to be a success, as the final outcomes were nearly identical to those anticipated and could assist alleviate the problem currently facing society. Further improvements are possible in the future, such as the installation of a camera within the home that is integrated into the security system. As a result, it may capture the thief's face and pinpoint the exact location of the fire in the house.

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