TRENDSAFE: Intrusion Alarm System for Smart Home Protection and Security Using Arduino with SMS Notification

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Abstract

Security has become an essential part of our everyday lives, especially at home. The likelihood of an increase in intrusions may rise, posing a threat to everyone. The researchers proposed a home intrusion alarm system that aims to keep the house safe and secure at all times. An ESP32 board, two sensors (a PIR sensor and a magnetic door sensor), an LED, a sound buzzer, and a camera comprise the majority of the system. With the utilization of GSM, the user will receive an SMS notification and will be able to disarm and re-arm the system via the mobile application. Arduino IDE and Android Studio were used in the development of hardware and mobile application. PIR sensors were placed in a specific spot where they might detect unwanted movement. The system was tested by an experimental approach and trial-and-error basis. The researchers ran the system several times to test the device's functionality. The results were discussed, and the system has been demonstrated to be successful and efficient. The study indicates that the intrusion alarm system is an effective technique to give extra protection in addition to the physical security that you have inside your home.

Keywords
alarm, home security, motion sensor, intrusion, and SMS notification.

1. Introduction

Security has become an important aspect of our daily lives wherein home security is a must, and the possibility of increasing intruders may increase and becomes commination to everyone (Kumar and Mittal, 2019). As technology advances quickly, combining with smart technology to provide customers with the ability to protect the computers, homes, and lives on a budget of almost any size. When there's an issue at home, several smart devices send you a warning or notifications no matter where you are (New Security Tech for Your Life & Home, 2019). When cameras, alarms, detectors, and various sensors are installed and used in homes, the said system will automatically be used if there will be an intrusion or unexpected event happens. Most humans have their place in which they keep their properties with locks to restrict the invasion that might happen in the personal property or even in privacy. However, these days, locking the door is not secured enough and can be easily circumvented (Alghamdi, 2020).

The present study aims to develop an intrusion alarm system for home security that will include the ability to make a sound alarm and notify the user on his or her mobile phone via SMS when the motion sensor detects any movement or when the magnetic door sensor detects an open door. The system is mainly composed of an ESP32 board, two sensors namely PIR sensor and Magnetic door sensor, LED, sound buzzer, and camera. This will be programmed through Arduino IDE. Arduino is an open-source platform used for developing electronic projects. It has a microcontroller and software that runs on a computer that is used to upload code to the physical board. The GSM is also connected to the Arduino using digital signals to transmit messages and alerts to the pre-programmed mobile number via SMS. It also aims to develop a mobile app and it will be connected to the intrusion alarm system to control,

monitor, and provide information for the reference of the user. The study will be beneficial to the residential owners when it comes to the betterment of their security and the safety of all the members of the family.

2. Literature Review

2.1 Home Automation

Automation is a methodology, procedure, or framework for using electronic devices to operate or monitor a process while minimizing human interference. The ability to develop an automation system for homes and offices is growing day by day with huge advantages. Industries and researchers are working to develop cost-effective and reliable automated systems to track and operate various devices such as lights, fans, and air conditioners (Gunge and Yalagi 2016). Home automation allows a person to monitor their home remotely or automatically. A home appliance is designed to serve a specific function in the home, commonly an electrical device (David et al. 2015). The use of home automation technologies will improve the comfort of a person's living space. When the user is away from home, such as at work or on holiday, home automation is designed to alert the user to the current condition of the home surroundings and to take necessary emergency measures (Mahindrakar and Biradar 2017).

2.2 Security in Home

As technology advances, numerous home-based security systems are designed and introduced to protect our homes from unauthorized entry (Viswanatha et al. 2018). According to a study by Bautista et al. (2016) the typical goal of installing CCTV in preventing crime and disorder utilizing deterrence. The CCTVs in the Philippines can be mostly found in commercial establishments like malls, gasoline stations, convenience stores as well as in privately owned areas or condominiums, subdivisions, and especially in houses.

2.3 IoT devices in Smart Homes

Internet of Things (IoT) allows us to access useful information from any location, at any time, by any individual, as well as control and track various devices any time, from any location, on any network, and by any person that has authorized access (Mahindrakar and Biradar 2017). The way that innovation has advanced as the years grew by, is the real reason behind a noticeable and quick transformation in the various devices and equipment's shape, size and limit, its parts and mechanisms, and the products used in day-by-day life. The IoT offers us a chance to develop an effective organization, applications for assembling, lifesaving keys, appropriate development, and many more (Subramanian et al. 2019). The use of sharp and keen sensors in smart homes in which each is proficient in recognizing specific detects, conditions, and movements complement the acknowledgment of the most exceptional situations of dealing with the utilization of building energy (Fleury et al. 2016).

Three factors, according to the author's study, have a major influence on smart home service acceptance behavior: controllability, interconnectedness, and reliability. It is fascinating to note that automation has had no major effects. This can be translated as follows: people prefer remote management services that are considerably safer and more efficient than extremely advanced automated services. People may prefer to have control over their smart home's devices rather than having them completely automated because their home is secure and reflects their space and privacy which they can relax (Yang et al. 2018).

2.4 Microcontroller-based and mobile-based home automation and home security system

Naing and Hlaing (2019) present a simple and cost-effective smart home automation using the microcontroller board for control and monitoring of lights, temperature, and smoke. Different sensors such as temperature sensors, smoke sensors, motion sensors, and LDR have been incorporated with the automation. Two Arduino NANO are used to attach all of the components. To detect a movement, the passive infrared sensor (PIR) is used. The status of the door, light, temperature value, and fire condition are all shown on the LCD. In terms of security, the microcontroller will send an SMS text message to the owner via the GSM module. RFID technology and a servo motor are used in the door lock security system.

In the study of Odegwo et al. (2020) they used the idea of the Internet of Things in developing smart security automation systems. It was then integrated into Arduino Board, which can house various electronic components and also has a WIFI interface that allows it to connect to the internet. The WIFI interface also came with an App that establishes communication between the device and a mobile phone, where the house owner has the mobile app installed on his or her phone. In addition to that, the system included an SMS module that will handle instances wherein the owner of the house does not have access to the internet.

A PIR sensor, LCD screen, GSM module, and a burglar alarm were all used to build the system. The study is being recommended because it is low-cost and highly adaptable. The Arduino ATmega2560 microcontroller was used to simulate a physical home security system then in programing the microcontroller, the Arduino IDE and the C programming language were used. Moreover, in developing the Android mobile application to control and interact with the physical home security system, Android Studio and the Java programming language were applied. According to the conclusions of the study, this method must be implemented as a means of successfully securing residences against unauthorized access (Ehioghae and Ogunlere 2020).

Safety in the household is a key worry all around the world. As technology advances with a growing number of home-based security systems are being developed and offered to secure our houses against intruders. Such capacity to create an automation system for houses and other businesses is likely to boost the convenience of a person's living environment by notifying the user of the present state of the house environment and allowing the user to perform required precautionary actions. People preferred having total control over their smart home's equipment over having them fully automated since their house is safe and represents their personal space, allowing individuals to simply unwind. Considering technology is never-ending and innovation advances, modern tech could contribute to constructing a system that can inform the owner of the house whenever anyone attempted to obtain unlawful entrance to a property as well as other establishments especially particular houses.

3. Methods

The RAD or Rapid Application Development is the methodology that will be used. The researchers presume that this method will be the best and most applicable for this project. Rapid Application Development (RAD) is an agile development methodology that emphasizes prototype releases and implementations as quickly as possible. This methodology prioritizes software usage and user reviews over comprehensive preparation and requirements documentation.

The following steps will help in determining and analyzing the process of constructing the system:

Step 1. Defining and Finalizing
The first part will be gathering all the necessary data to define and finalize the scope and the project’s requirements.

Step 2: Building the Prototype
The process is where the researchers will be able to start in creating and improving the planned prototype.

Step 3: Gathering of Feedbacks
In this phase, the researchers will be able to gather user feedback to manage and help in improving the project.
Step 4: Testing
The researchers will test the system to ensure that the client's expectations are met.

Step 5: Presenting
Presenting the final system will be the final step before the release and deployment of it.

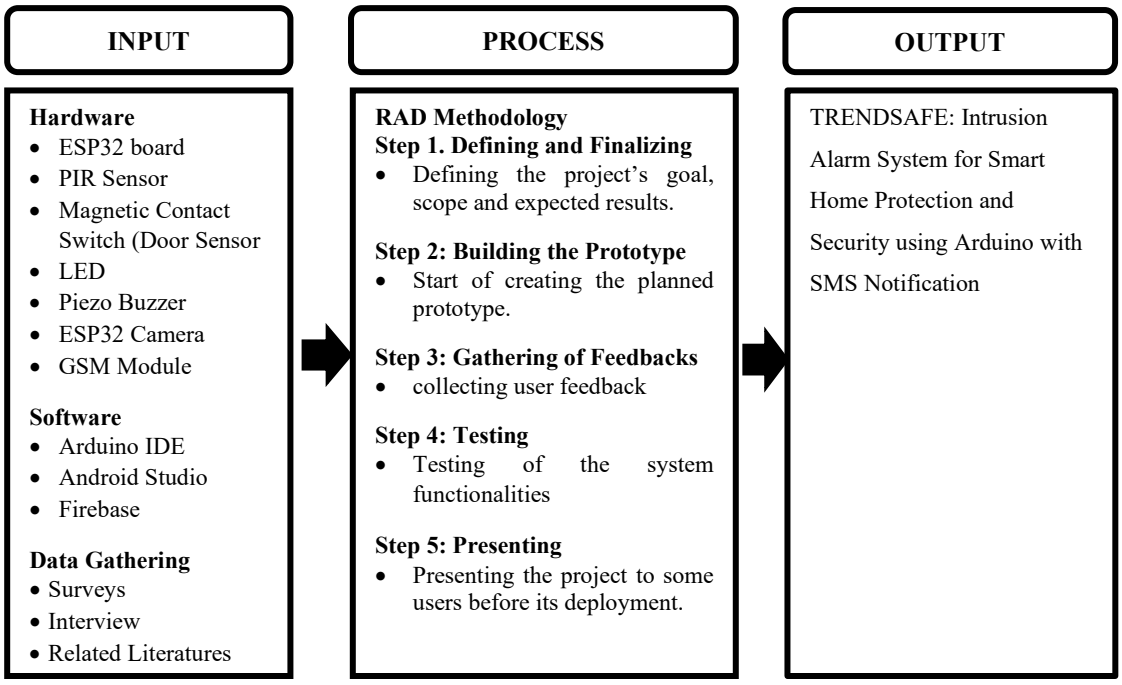

Figure 1. Conceptual Framework

Figure 1 shows the conceptual framework of the study which will serve as a guideline on how the system will be developed and come up with the expected output.

4. Data Collection

This study will be more of an experimental approach. The researchers conducted a recorded interview with the client via Google Meet. Moreover, additional surveys were conducted for the system's validity. The questionnaire consists of several questions the client needs to answer. The researchers continuously worked and communicated with the client in the development of the home security system processes. The data needed were gathered through the process of trial and error to see the effectiveness of using sensors; the motion and magnetic door sensors, buzzer alarm, LED, camera, and GSM module, and to be able to evaluate the performance and competence of the home security alarm system.

The researchers gathered additional information through the use of a survey that would be useful in the creation of the project. Fifteen people responded to the survey before we began the project. The main target of the researchers in information gathering are people who are residing in the area, and in this case, the researchers will gather data about the security in their homes. The participation of the respondents in the survey will have a great basis on this research.

4.1 FURPS Model

The researchers also used the FURPS Model to assess the device or the hardware and mobile application's functionality, usability, reliability, performance, and supportability.

FUNCTIONALITY- The user can register, log in easily, and can able to arm and disarm the system. The device will function whenever the motion sensor can detect any kind of movement. The door sensor can detect open doors and the buzzer will sound when the sensors are triggered.

USABILITY- The main users of the system and device are those who require security in the privacy of their own homes. The user can navigate easily whereas the application and device are user-friendly.

RELIABILITY– The reliability of this is that it provides accurate information to the user. As for the device, it can send a notification to the user with the date and time as well as it can send real-time alert notifications to the user.

PERFORMANCE- The developers considered the design to ensure a better user experience, and its device should function as long as it is internet-connected.

SUPPORTABILITY- This supports the installation of the program. The application can be installed and used on any android phone. Also, the device can be used as long as there is a power supply and can be controlled the arming and disarming of the system.

5. Results and Discussion

5.1 Survey Results

Table 1. The results of the first section of the survey

	Always	Often	Sometimes	Rarely	Never
How often do you have guests?	0%	20%	53.3%	26.7%	0%
How often do you leave the house /take a vacation?	0%	20%	40%	40%	0%
How often do you check your locks?	80%	20%	0%	0%	0%

The survey was answered by a total of 15 respondents. As shown in Table 1, half of the respondents said that they sometimes have a visitor or guest in their house. 40% of the total, answered Sometimes when they asked how often they leave their house and another 40% said that they rarely leave their house. 80% of the respondents said that they always check their locks so that no one can trespass.

Table 2. The results of the second section of the survey

	Yes	No	Maybe
Do you have or previously use any security system?	13.3%	73.3%	13.3%
Any cases of trespassers/thefts in the area?	46.7%	53.3%	0%
Is there good lighting on the property or around the area	46.7%	40%	13.3%

Table 2 shows the result of the survey when respondents ask about the security in their homes. 73.3% of the answers said that they don't have any security system in their home. 13.3% said that they are using a home security system. The respondents said that there are no cases of trespassers in their area, while, others said that there are some cases in other areas.

Table 3. The results of the third section of the survey

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Are do-it-yourself home security systems effective?	33.3%	46.7%	20%	0%	0%

The researchers also provide a question regarding the effectiveness of a home security system. Table 3 shows the result of their answers to that question. Respondents have different answers, mostly were agreed, some are strongly agreed, while others stay Neutral.

5.2 Discussion

Researchers designed and implemented an intrusion alarm system to provide additional security for your home. With a PIR motion sensor and door sensor in place, the intrusion alarm system is designed to boost smart home security and inhibit attackers from invading home residences. The buzzer automatically sounded as well as the LED light-up whenever the sensors were triggered. The camera automatically captured and saved an image only when the motion sensor recognizes unwanted or suspicious movement. The user received an SMS notification with the use of GSM and disarm and re-arm the system using the mobile application.

The researchers used the Arduino IDE to program the hardware device and the Android Studio to program the mobile application upon the development of the system. The ESP32 board is a microcontroller that allows sensors, buzzers, LEDs, GSM, and cameras to be connected. Firebase was used as the database, and it surprisingly played an important part in data interchange between the device and the mobile app.

The system was installed in a house miniature whose design was inspired by the actual home layout. The device was placed in a specified location where it may detect unwanted movements. The system runs several times to ensure that it is working properly. The power supply is needed for them to operate continuously. If the power supply fails, the connection will be halted and the SMS alarm will not be able to function.

5.3 System Evaluation Results

The system will also evaluate using the FURPS model to achieve the goal of this study and also to meet the user's expectations of the system. The researchers conducted another survey and got 12 respondents who evaluated the system. The overall functionality of the system has been demonstrated to be successful and efficient according to the survey results.

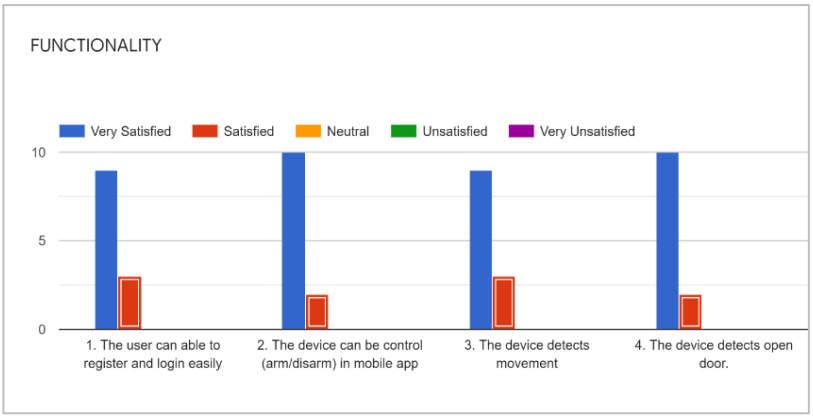

Figure 2. System Functionality Chart

Figure 2 shows the graph result for the evaluation of system functionality. As for the first criteria, it received a score of 9 Very Satisfied after registering and login into the app because more users can simply register and log in, and then 3 more people have given the app a Satisfied rating. For the second criteria, it has 10 Very Satisfied, and 2 more people gave it a Satisfied rating. After reviewing the device's functionality, the third criteria obtained a score of 9 Very Satisfied, and 3 additional individuals gave it a Satisfied rating. During and after the device's testing, the last criteria received a score of 10 Very Satisfied, and 2 more people gave it a Satisfied rating.

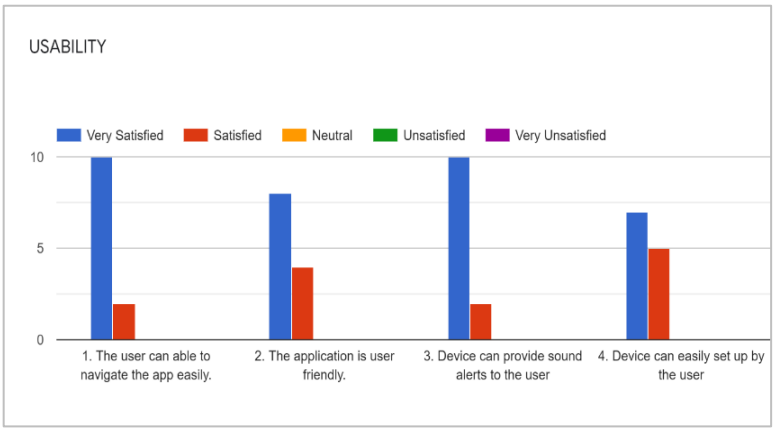

Figure 3. System Usability Chart

Figure 3 shows the result for the usability of the system. The first criteria obtained a score of 10 Very Satisfied rating since the user can easily navigate the application. Due to the device's insufficient specifications, 2 individuals rated it a Satisfied rate. Since this application is easy to use, the second criteria got an 8 Very Satisfied rating then due to the slight confusion of using the app, respondents rated the Satisfied rate. Because the device alarm tone works well, the third criteria received a score of 10 Very Satisfied, and 2 additional respondents gave it a Satisfied rating. The last criteria received a score of 7 Very Satisfied after rapidly setting up the device. Because the device is easy to set up, 5 respondents gave it a Satisfied rating.

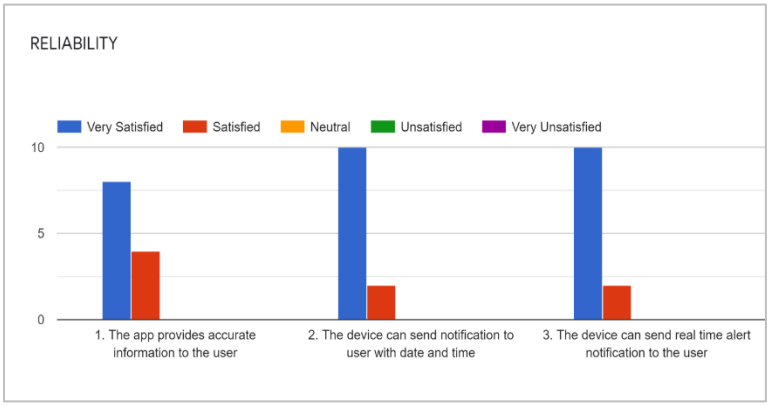

Figure 4. System Reliability Chart

Figure 4 shows the result for the reliability of the system. Since this application gives relevant information to the user, the first criteria received an 8 Very Satisfied rating and 4 people rated the app as Satisfied. The second requirement received a score of 10 Very Satisfied since the device sent detailed information including date and time. The second requirement received a score of 10 Very Satisfied since the device could send a notification to the user including the date and time then, 2 users rated it as Satisfied rate. Lastly, because the device can transmit real-time alarm notifications to the user, the last criteria obtained a score of 10 Very Satisfied because the device does not have too much delay in transmitting notifications then, 2 individuals rated it a Satisfied rating.

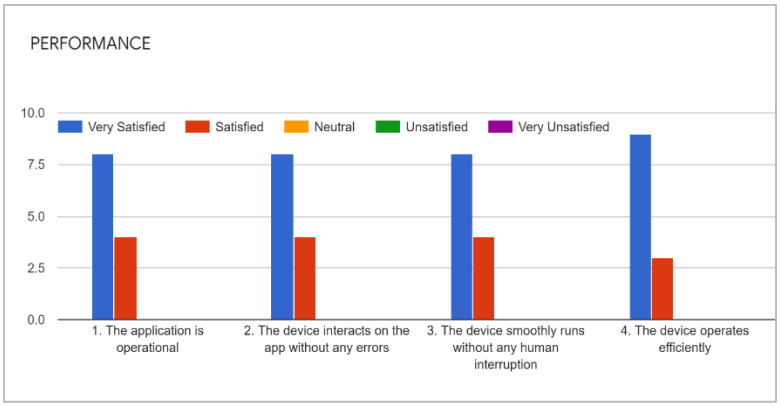

Figure 5. System Performance Chart

For the system's performance as shown in Figure 5, the first criteria earned an 8 Very Satisfied rating. Due to the user's mobile phone that has limited specs, 4 individuals rated it a Satisfied rating. The second requirement received an 8 Vey Satisfied, and then a Satisfied rating is given by other respondents. The third criteria gained 8 with Very Satisfied users owing to the device's seamless operation and 4 Satisfied users due to the device's low specs. The last criteria received a score of 9 Very Satisfied and 3 Satisfied.

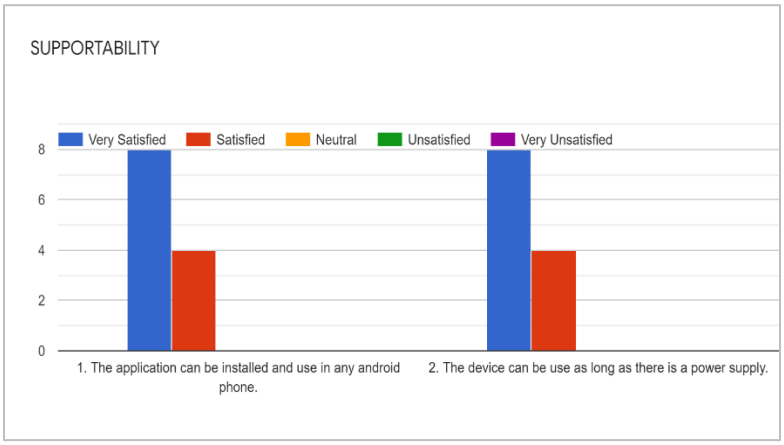

Figure 6. System Supportability Chart

Figure 6 is the last chart which is the system's supportability. Since the application can be installed and used on any Android phone, the first requirement received an 8 Very Satisfied rating. 4 users are satisfied, while 1 user gives a rating of neutral. Since the device can be used as long as there is a power source, the second requirement for this received an 8 Very Satisfied rating and 4 satisfied ratings are given by the other respondents.

6. Conclusion

One of our responsibilities is to keep our homes safe. Everyone wants a safe environment in their homes so that they can enjoy a pleasant and quiet life. Since the advent of technology, security systems have become a necessity, and the possibility of intruders and trespassers is still increasing, which is a concern for everyone's safety. The researchers have been successfully developed and implemented the system. The overall result of the study makes it clear that the intrusion alarm system is an effective way to provide additional security in addition to the usual physical security that you have inside your home. The study is upgradable. Some recommendations for future researchers include the system feature that would send an alert to security officials for them to respond quickly to burglar situations and the implementation of an automatic door lock system that can be operated via a mobile application.

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