Iot-based Integrated Home Security and Monitoring System

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Abstract. Home safety remains a critical issue not only in metropolitan city but also in suburban area, particularly for people who spend many activities outside home. A proven strategy to improve and make sure security system and monitoring house environment remotely is needed. This study designed and developed an integrated home security and monitoring system using Internet of Things (IoT) by combining the Arduino-nano and NodeMCU ESP8266 as a controller. The home security system involved RFID reader, numerical code to open the door and email notifications to users. The monitoring system used PIR sensor to detect the intruder, DHT-22 sensor to detect the room temperature and humidity, rain sensor to detect the rain, fire sensor to detect the stove’s fire, and LDR sensors to monitor the light condition. Also, we set up light bulbs and solenoid valves used as the actuators. The results of this study showed that the system can monitor the condition of the house and control the output of lights and solenoid valves remotely by using an application on the smartphone through internet connection.

1. Introduction

Internet of Things (IoT) become a major interest as results of technology development and industry revolution 4.0. Application of IoT has been widely implemented in every sector such as security systems, industry, farming, and medicine. Several studies have been developed IoT-based smart home such as home security system using internet of things. Previous study suggested to use Arduino Uno, module ESP wifi, dan reed sensor, however, in that study only applied sensor reed that placed in front of the door as a security system and users received notification in smartphone after the door opened. This system still has a higher risk for criminalization [1].

Another study, used IoT-based smart security and home automation system with sensor PIR installed at the entrance of the building, so that if there is a human movement, the sensor will trigger to input the microcontroller, the owner will get a notification through voice calls. This systems can provide real action directly for owner to provide warning system by turning on the light and alarm so an owner using the keypad button that has been programmed previous [2]. IoT based smart home using Blynk Framework, this system consists of three different isolated sub-systems including relay module systems, GPS module systems and temperature sensors, as well as PIR sensors and ultrasonic sensors to measure the water level in the connected tank using Nodemcu via wifi, and the interface using Blynk App [3]. Whereas smart home design based on ethernet systems can protect homes and monitor home conditions such as humidity, temperature, gas leak and fire using sensors that are integrated with the Arduino Mega microcontroller and Ethernet shield. Notification via message was set up as a
warning system for owner if there is uncommon or unusual activity. However, Ethernet systems can only be used local network [4].

![System architecture](image)

Figure 1. System architecture

While, an integrated approach towards designing an embedded wireless monitoring and access control system using RFID and MMS technologies, and microcontroller AT89C52. People who have access must provide a valid RFID tag. If the number is found, the microcontroller sends an interrupt signal to the microcontroller in the MMS section that issues AT commands to the Quectel M33 cellular machine to capture photos of people and send images to cellphone owners (MMS) from the GSM network. And the owner replies with a message to grant or deny access. Owners can also request more images from the site to make decisions. Microcontroller uses AT-command to read messages from cellular and move the stepper motor to open the gate or turn on the alarm [5].

Design and implementation of security systems for smart home based on GSM technology, using a web camera system that detects motion and sends emails to users. GSM-based systems can send SMS when detecting flames or rising temperatures, but the time spent sending SMS depends on the specified cellular network coverage. If the phone is coverage networking, then the SMS will be sent within 25-30 seconds [6].

Base on previous study, the purpose of current study was to develop an integrated systems of home safety and monitoring using several sensor and a layered security systems. Thus, can early detected if there is incoming intruders, rain, monitoring temperature and humidity, and warnings on the smartphone every few minutes when the stove is on. Furthermore, users also can controlled the output remotely.
2. Materials and Method

2.1 System Architecture

This integrated home security and monitoring system based on Internet of Things (IoT) was a prototype that designed and developed which is combined in two layer security function using RFID card and numerical PIN code installed in the door of house and home monitoring via the internet network remotely. Users can monitor the condition of the house such as the temperature and humidity of the room, the flame of the stove, rain and detect the intruder entering the house. In addition, this system has function to control electronic equipment inside the house such as lights and solenoid valves from a distance.

Every family member or house holder has RFID as an access card to enter the house. If the RFID owner enters the house, the system will send a notification via email to other family members. However, if there is an intruder detected by the PIR sensor, the system will send an email to the user indicated an intruder, then the buzzer will be sounded. This prototype also can monitor the flames on the kitchen stove and the system will send a notification through cellphone that connected in the Blynk application every 10 minutes. Users can turn off the stove by closing the gas line through the solenoid valve manually or automatically remotely.
In addition, this system was equipped with a rain sensor to detect raindrops as a reminder if couldn’t hear the rain. The overall system was comprised of two main part included hardware and software system, while the system architecture was shown in Fig. 1

2.2 Hardware System Design
The hardware comprise RFID reader MFRC-522 as ID Card detector, keypad 3x4 with series resistor to produce analog signal output for numerical PIN code interface, KY-026 flame sensor circuit to detect stove fire, PIR HC-SR501 sensor to detect intruders entering the house, temperature sensor and DHT-22 humidity to detect room temperature and humidity, rain Sensor to detect raindrops. Also, applied Arduino Nano and Nodemcu ESP 8266 as a controller as well as an interface for data communication with smartphones via the internet network, Catalex YX5300 MP3 Player is used as sound output for notification to the user, solenoid door to open and close the locked door, solenoid valve to close and open LPG gas channels on the stove, and AC 220V LED lights that are equipped with LDR sensor to determine the condition of the lamp whether is turned on or off. The sub-systems in detail and how to assembly are shown in Fig. 2

![Figure 2](image-url)

**Figure 2. Sub-systems in detail and how to assembly**

2.3 Software System Design
Design and development of software was performed on Arduino nano and NudeMCU ESP8266 as controller by compiling program algorithms for each controller as described in the following section. However, designing user interface application on the smartphone was done by downloading the Blynk application then selecting and compiling the widget for monitoring and controlling system controllers as shown in Fig. 3. Then synchronize with the software developed on NodeMcu.

System Algorithm

1. Read RFID card and sensors
2. Send the sensor data to the Blynk server and display on the smartphone screen.
3. If the RFID tag is accepted, then read the numerical code from keypad, otherwise back to step #1
4. If password is correct, then door lock opened, otherwise the buzzer alarm and also send an email notification.
5. If the moving object detected, then send alert notification to the smartphone.
6. If the fire detected, then send the notification to the smartphone. The solenoid valve can be controlled from the smartphone.
7. If the rain detected, send the notification to the smartphone.
8. If the light detected from the bulb, then send the notification to the smartphone.

Figure 4. Complete hardware system

3. Results and Discussion

The results of hardware system was implemented in prototype with a home miniature equipped with all the system functions as shown in Fig. 4. While the developed software system on smartphones through the Blynk application is shown in Fig. 5. By testing the system that has been integrated both hardware and software showed that the system was working properly according to the planned algorithm.

Figure 5. User interface system
Based on the results of the performance test, showed that the PIR sensor has a maximum coverage distance of 500 cm for the detection, temperature sensor has an accuracy of 0.5 °C and a humidity sensor has an accuracy of 2%. While the e-mail notification when the user can unlock the door shown in Fig. 6.

![Email notification]

**Figure 6.** Email notification

4. Conclusion

Based on implementation and validation process of designed system, all sub-systems can successfully worked. In the home security part, the system can detected RFID card that integrated with notification system by sending an email to family members and used a password to open the door. While, in the monitoring system, room temperature and humidity, the flame on the stove, rain conditions, the presence of intruders and also controlling the AC bulbs and solenoid valve as actuators can be monitored on the smartphone screen remotely via the internet network.

5. References

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