Al'adzkiya International of Computer Science and Information Technology (AIoCSIT) Journal
Vol. 4, No. 2, November 2023, pp. 71~78
ISSN: 2722-0001

Design of Internet of Things (IoT)-Based Boarding Room Security System Using Wemos D1 Mini and Door Sensor, and Integration of Notification Via Telegram

Muhammad Khairul Ikhsan
Department of Information Technology, Universitas Muhammadiyah Sumatera Utara, Indonesia

ABSTRACT

The advancement of Internet of Things (IoT) technology presents significant opportunities to enhance security in various aspects of daily life, including in residential environments such as boarding rooms. This research aims to design a boarding room security system based on IoT that uses the Wemos D1 Mini as the main controller and a door sensor to detect entry and exit access at the room‟s door. The system operates by detecting changes in the door's status and sending real-time notifications via the Telegram application when unexpected access occurs. When the door opens, the door sensor sends data to the Wemos D1 Mini, which then processes the information and delivers a notification to the user through Telegram. Telegram was chosen as the notification medium due to its high accessibility and ability to support instant messaging across various devices. Testing shows that the system has a high level of accuracy in detecting door activity and can send notifications in less than one second after access occurs. This IoT-based security system is thus expected to be an effective and affordable solution to enhance boarding room security and provide peace of mind to resident.

Keyword : IoT, Wemos D1 Mini, Boarding Room Security, Door Sensor, Telegram, Realtime Notifications

Corresponding Author:
Muhammad Khairul Ikhsan,
Department of Information Technology,
Universitas Muhammadiyah Sumatera Utara,
Jalan Kapten Muktar Basri No 3 Medan 20238, Indonesia.
Email: muhammadkhairul@gmail.com

1. INTRODUCTION

Boarding houses are a popular form of housing among students, migrant workers, and other temporary workers. Security is a major concern for boarders, especially due to the open and dynamic characteristics of the boarding environment itself. However, traditional security systems such as door locks and CCTV cameras are often less effective and less responsive to real-time security events. In practical implementation, the use of hardware such as Wemos D1 Mini as an IoT microcontroller and door sensor as a motion detector is an attractive option. Wemos D1 Mini is one of the popular IoT platforms due to its ability to connect to WiFi networks and easily programmed using programming languages such as Arduino. Meanwhile, door sensors can be used to detect human movement around the secured area. In addition, integration with instant messaging services such as Telegram also adds a dimension of interactivity to the security system. With notifications via Telegram, boarders can be instantly informed of security events that occur in real-time, enabling them to take appropriate action quickly.

IoT enables human activities such as remote room security monitoring. Therefore, the purpose of this research is to create a smart room with an additional monitoring system that is used for remote monitoring and minimizing the occurrence of theft. (Efendi, Y, 2018).

The use of Wemos D1 Mini as an IoT microcontroller and a door sensor to detect motion is an interesting option in terms of boarding room security. The door sensor can detect human movement around the monitored area, providing an effective additional layer of security. The Wemos D1 Mini will send a real-time notification via Telegram when the sensor detects suspicious movement and process the signal. This increases the interactivity of the security system and allows boarders to immediately know and respond to any security situation that occurs. This technology enhances the security and convenience of the rooms in addition to increasing the comfort level of the residents. Boarding house

owners can remotely monitor the security of their rooms, giving them peace of mind when they are away. They can also easily monitor security conditions without having to be present in person.

Thus, through this research, it is hoped that an effective, responsive, and integrated IoT-based security system for boarding rooms can be designed and implemented, which can increase the level of security and comfort for its residents.

Based on the background that has been explained previously related to the above problems, the author takes the title "Design of Internet of Things (IoT)-Based Boarding Room Security System Using Wemos D1 Mini and Door Sensor, and Integration of Notification Via Telegram".

2. RESEARCH METHOD

A. Design flow

According to (Surahman et al., 2021) A block diagram is a system diagram where the main parts or functions represented by boxes are connected by a line, and the diagram shows the relationship between the boxes. The block diagram displays how the entire circuit operates. The main purpose of a block diagram is as a guide when positioning circuit components. electronics so that they can be interconnected. As a result, the block diagram is the most important component of the system design.

B. Tools and Materials

1) Research tools

In this study, the author uses tools and materials to support the design of a detection sensor using the Wemos D1 mini for boarding house security. In the case of a warning system to detect the security of boarding rooms as follows:

a. Door Sensor: a device that detects movement if a door is opened. This sensor is usually located near a door or window.
b. Wemos D1 Mini: processes data from the sensor, whether it needs to be forwarded to the buzzer or not.
c. Buzzer: The buzzer is active when the microcontroller detects an open door. The alarm functions as a warning to boarding house residents to make unknown people leave immediately.
d. Power Supply: such as batteries or power banks, USB, provides the power needed for the system.

In most cases, the block diagram will show how each component relates and interacts with each other. For example, the sensors will be connected to a microcontroller, which will process the data and produce the necessary displays and sounds. All components will be powered by a battery.

2) Research Materials

a. Types of Research Data

The type of data used in this study is primary data collected directly from boarding house owners as follows:

- Knowing what the boarding house owner wants, so that the following data can be obtained.
- Wanting a tool that can keep the boarding house safe from theft.
- Wanting to ensure the boarding house is safe when left for work or college.

b. Data Collection Technique

The data collection techniques needed to determine the safety of boarding rooms are obtained from observation and literature studies.

- Observation
  Observation or observation is a data collection technique by conducting direct observations of the object being studied.
- Literature Study
  Searching for references in the library as a guide for the research conducted by the author, either in the form of books or literature related to the research.

3. RESULTS AND DISCUSSION

The purpose of implementing a boarding house security system based on door sensors, which uses Wemos D1 Mini as the main microcontroller and Telegram as the notification media, is to provide an effective security solution to monitor access in and out of boarding houses in real time.

This will discuss in detail the design and implementation process of the system, starting from the hardware design that includes the Wemos D1 Mini door sensor and programming to detect door activity and send notifications via Telegram. In addition, it will discuss how the Wemos D1 Mini integrates with the Telegram platform through the use of the Telegram API to ensure that notifications can be routed. In addition, system testing is carried out to ensure that all software and hardware components operate according to plan. This test tests the function of the door sensor, the ability of the Wemos D1 Mini to read and send sensor data, and the ability of the system to send Telegram notifications in real time. The purpose of this test is to evaluate the performance of the system.

Therefore, this chapter will provide a complete overview of how the designed boarding room security system is implemented, as well as an evaluation of the system's performance based on the test results.

A. Tool Assembly

In this sub-chapter, we will explain in detail the steps required in the process of assembling a tool for a boarding house security system based on a door sensor using Wemos D1 Mini and notification integration via Telegram. The assembly of this tool involves several main components such as Wemos D1 Mini, door sensors, and other supporting components that are assembled in such a way as to form an integrated system.

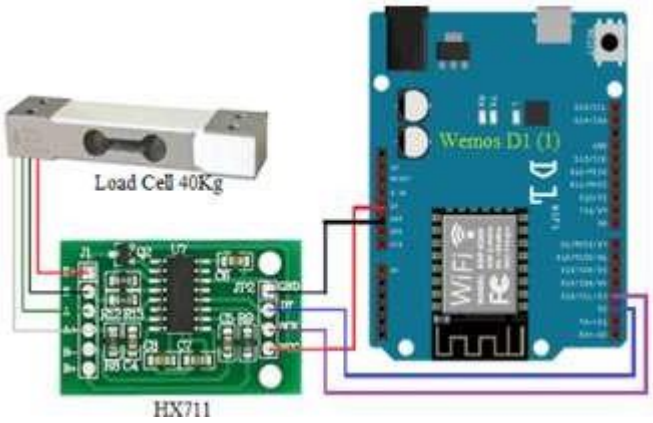

Fig 1. Wemos

Assembly steps:

1) Preparation of main components

- Wemos D1 Mini: This microcontroller is used as a system control center that functions to receive data from door sensors and send notifications to users via Telegram.
- Door Sensor (Magnetic Reed Switch): This sensor is used to detect door status, whether it is open or closed, by utilizing changes in the position of the magnet.
- Breadboard and Jumper Cables: Used to temporarily connect electronic components during the assembly and testing process.
- Power Adapter or Power Bank: As a power source to operate the Wemos D1 Mini.

2) Installation of components on the board

- Place the Wemos D1 Mini on the breadboard in a stable and easily accessible position.
- Connect the GND (Ground) pin on the Wemos D1 Mini to the ground line on the breadboard to ensure that the circuit has a correct ground reference.
- Install the door sensor on the breadboard. Connect one of the reed switch sensor pins to a digital pin on the Wemos D1 Mini (for example, D2), while the other pin is connected to the ground line on the breadboard. If the sensor uses three wires, make sure the power cable (VCC) is connected to the 3.3V or 5V pin on the Wemos D1 Mini, depending on the sensor's needs.

3) Connecting the Door Sensor to the Wemos D1 Mini

- Make sure the jumper cable connecting the door sensor to the Wemos D1 Mini digital pin is properly and securely installed.
- The door sensor will give a low logic signal (LOW) when the door is open (the magnet is not near the sensor) and a high logic signal (HIGH) when the door is closed (the magnet is near the sensor). This logic will be programmed into the code to detect changes in door status.

4) Providing Power Supply for Wemos D1 Mini

- Connect the Wemos D1 Mini to a power source using a USB adapter or power bank. Make sure the Wemos D1 Mini has a stable and adequate power supply.
- Check the power indicator light on the Wemos D1 Mini to ensure that the device is functioning properly and has received sufficient power.

5) Connection and Sensor Testing

- Before proceeding to the programming stage, perform an initial test of the door connection and sensor by manually operating the sensor (for example, by moving the magnet closer and further away from the reed switch).
- Observe the signal changes on the digital pins connected to the sensor on the Wemos D1 Mini using a measuring instrument or through basic code to monitor the input readings.
- After the physical assembly is complete, connect the system to the WiFi network that will be used.
- Perform a final test by opening and closing the door to ensure that the system can accurately detect the door status and send notifications via Telegram according to the specified conditions.

Fig 2. Bot Testing

B. System Design

Program Code Structure

1) Installation and setup

a. Importing required libraries

- Step: Adding required libraries for Wifi communication with Telegram.
- Explanation: The ESP8266WiFi library is used to connect the Wemos D1 Mini to the WiFi network, and the UniversalTelegramBot.

```
#include <ESP8266WiFi.h>
#include <UniversalTelegramBot.h>
```

Fig 3. Coding Reading Library

b. Defining Variables and Credentials

- Steps: Define sensor pin, WiFi credentials, Telegram API token, and chat ID.
- Explanation: This variable stores information needed for WiFi connection, Telegram API, and sensor settings.

```
const char* ssid = "KamarKost";
const char* password = "KamarKost123";

const String botToken = "AAGI-nfTGx0R53ALGYD8l87CdQZP7JnXGGI";
const String chatID = "7091919295";
```

Fig 4. Connector Coding

c. Wifi and Telegram Setup

- Steps: Connecting Wemos D1 Mini to WiFi network and initializing Telegram bot.
- Explanation: Connect to WiFi and ensure the connection is successful before initializing the Telegram bot to send notifications.

```
WiFi.begin(ssid, password);
while (WiFi.status() != WL_CONNECTED) {
  delay(500);
  Serial.print(".");
}
Serial.println("Connected to WiFi");


pinMode(sensorPin, INPUT);
}
```

Fig 5. Wifi and Telegram Setup Coding

2) Read the situation from the sensor

a. Reading Sensor Status

- Step: Read the status from the door sensor to determine whether the door is open or closed.
- Explanation: Use the digitalRead function to read the value from the sensor pin and determine the door status.

```
void loop() {
  int sensorValue = digitalRead(sensorPin);

  if (sensorValue == HIGH) {
    sendNotification("Pintu terbuka!");
  } else {
    sendNotification("Pintu tertutup!");
  }

  delay(1000);
}
```

Fig 6. Coding to read sensor status

3) Data Processing

a. Data processing function

- Steps: Write a function to send a notification via Telegram.

- Explanation: Use Telegram API to send a message to an ID.

```
void loop() {
  int sensorValue = digitalRead(sensorPin);

  if (sensorValue == HIGH) {
    sendNotification("Pintu terbuka!");
  } else {
    sendNotification("Pintu tertutup!");
  }

  delay(1000);
}
```

Fig 7. Coding for data processing

4) Integration with Telegram

a. Function to send Notifications

```
void sendNotification(String message) {
  if (WiFi.status() == WL_CONNECTED) {
    bot.sendMessage(chatID, message, "");
  } else {
    Serial.println("Error: WiFi not connected");
  }
}
```

Fig 8. Coding for integration with telegram

5) Error Handling

- Steps: Add error handling and logging for monitoring connection and communication status.
- Explanation: Use Serial.println to provide information about connection status and potential errors.

C. Evaluation of Test Results

In this section, the test results are carried out for each component and function of the system to determine whether the boarding house security system based on door sensors functions according to the specifications that have been set. This evaluation is carried out by looking at the performance of hardware, software, and system integration as a whole.

1) Hardware Evaluation and Test Results

To ensure that the door sensor and Wemos D1 Mini work properly to detect the door status and send the correct signal, hardware testing is carried out specifically. The hardware testing results are summarized in the following table:

Table 1. Hardware Testing Results

Component	Trials	Results	Evaluation	Notes
Door Sensors	Detect status door opened	Succeed	Adequate	Sensors respond
Door Sensors	Detect status door opened	Succeed	Adequate	No delays
Wemos D1 mini	Wifi Connectivity	Stable	Adequate	Stable connection during testing

Based on the test results, the door sensor showed a fast and accurate response in detecting changes in door status. The Wemos D1 Mini also managed to maintain stable connectivity with the WiFi network, allowing for consistent data delivery.

2) Evaluation of Software Testing Results

The software testing evaluation focused on the main functions of the program, such as reading sensor data, sending notifications via Telegram, and handling errors. The following table summarizes the results of the software evaluation:

Table 2. Time Evaluation Testing

Function	Trials	Results	Evaluation	Notes
Sensor data reading	Read door sensor status	Accurate	Adequate	Nothing went wrong
Notification sending	Send notification when door open/close	Successfully delivered	Adequate	Message was sent immediately
Error handling	Wifiter connection	Well handled	Adequate	Error message displayed

3) Telegram Notification Delivery Time Evaluation

This test is conducted to evaluate the latency between the detection of the door status by the sensor and the time of sending the notification to the user via Telegram. This latency is very important because it affects the responsiveness of the security system in providing warnings to users. The following is a table that summarizes the results of the notification delivery time testing:

Table 3. Time Evaluation Testing

No	Trial Conditions	Detection Time	Notification	Time Lapse	Status
1	The door opened quickly	14:00:00	14:00:02	2	Fast
2	The door opened slowly	14:05:00	14:05:03	3	Fast
3	The door closed quickly	14:10:00	14:10:02	2	Fast
4	The door closed slowly	14:15:00	14:15:03	2	Fast
5	WiFi is stable	14:20:00	14:20:02	2	Fast
6	Wifi is unstable	14:25:00	14:25:08	8	Moderate

Analysis of Test Results

- Normal Condition (Stable WiFi): The notification delivery interval is around 2-3 seconds, indicating that the system is working with fast and efficient response.
- Unstable Condition (Unstable WiFi): The interval increases to around 8 seconds. This indicates that the system is still able to send notifications but it takes longer due to suboptimal network conditions.
- Temporarily Lost Connection: In this scenario, the interval reaches 15 seconds, which is considered slow. This indicates the need for a more effective retry mechanism to speed up notification delivery after the connection is restored.

4. CONCLUSION

In this chapter, the conclusions obtained from the research on the boarding house security system based on door sensors using Wemos D1 Mini and notification integration via Telegram will be presented. Based on the results of the research and testing that have been carried out, several things can be concluded as follows:

System Success: The designed security system has met the research objectives, namely identifying changes in door status and effectively sending notifications via the Telegram application to users. This implementation shows that Internet of Things technology can be useful for improving room security.

System Performance: The test results show that the system operates well under stable WiFi network conditions, with an average notification delivery time of 2 to 3 seconds, indicating that the system is responsive and suitable for real-time security applications. However, under unstable network conditions, the notification delivery time tends to increase, indicating that the system is highly dependent on good internet connection quality.

Operational conditions: The system functions well when the network is stable. However, when the network is unstable or the connection is temporarily lost, the system performance decreases

significantly. This indicates that further improvements in network stability are needed to ensure the system is always responsive in all situations.

Effectiveness of the sensor and Wemos D1 Mini: It is proven that the door sensor and Wemos D1 Mini function well to implement this security system. They both detect the door status correctly and send the data to the server for further processing. Factors such as cost efficiency and ease of setup and programming also determine the selection of these components.

REFERENCES

[1] Fadly, Erviansyah, Suryo Adi Wibowo, and Agung Panji Sasmito. "SISTEM KEAMANAN PINTU KAMAR KOS MENGGUNAKAN FACE RECOGNITION DENGAN TELEGRAM SEBAGAI MEDIA MONITORING DAN CONTROLLING" (2021).
[2] Efendi, Y. (2018). Internet Of Things (Iot) Sistem Pengendalian Lampu Menggunakan Raspberry Pi Berbasis Mobile. Jurnal Ilmiah Ilmu Komputer, 4(1), 19–26.
[3] Jost, Bernhard. Micrometer-sized ice particles for planetary-science experiments – II. Bidirectional reflectance
[4] Kurniasih, Wahyuni, Rakhman, and Abdul. "Sistem Kemanan Jendela Rumah Berbasis IoT"
[5] Mehta, M. (2015). Esp 8266 : a Breakthrough in Wireless Sensor Networks
[6] Pitriyani, Lilis; Saragih, Yuliarman; Latifa, Ulinnuha. Impelemntasi modul Infrared Pada Rancang Bangun Smart Detection for Queue Otomatis Berbasis Iot
[7] Putri, Novitari indah; Munawar, Zen. Deep learning Dan Teknologi Big Data Untuk Keamanan IoT.
[8] Ramadhan, Febrian. 2018. "Pengembangan Media Pembelajaran Interaktif Matematika Dengan Bot Api Media Sosial Telegram Di Akademi Farmasi Surabaya.
[9] Rony Setiawan. 2021. Flowchart Adalah: Fungsi, Jenis, Simbol, dan Contohnya. Diakses pada 21 juni 2024 dari https://www.dicoding.com/blog/flowchart- adalah/
[10] Creswell, J. W. (2014). RESEARCH DESIGN QUALITATIVE,QUANTITATIVE, AND MIXED METHODS APPROACHES. SAGE Publications, Inc
[11] Wahyudi, R. (2022). PERANCANG DAN PEMBUATAN SISTEM KEAMANAN RUMAH BERBASIS INTERNET OF THINGS MENGGUNAKAN ESP32- CAM. 7(1), 30–33
[12] Wulandari, I., Silalahi, L. M., Indroasyoko, N., Ema, E., & Muhtar, M. (2021). Studi Literatur Review : Integrasi Kurikulum Pembelajaran Cerdas Biosensor Menggunakan Teknologi Internet of Things. Jurnal Tiarsie, 18(3), 97–102.
[13] A. Nurkholis, A. Riyantomo, and M. Tafrikan, "Sistem Pakar Penyakit Lambung Menggunakan Metode Forward Chaining," Momentum, vol. 13, no. 1, pp. 32–38, 2017.
[14] A. Nurkholis and I. S. Sitanggang, "Optimalisasi model prediksi kesesuaian lahan kelapa sawit menggunakan algoritme pohon keputusan spasial," J. Teknol. dan Sist. Komput., vol. 8, no. 3, pp. 192 200, 2020, doi: 10.14710/jtsiskom.2020.13657
[15] A. T. Wahyudi, Y. W. Hutama, M. Bakri, M. T. S. Dadi, S. Kom, and M. Eng, "Sistem Otomatis Pemberian Air Minum Pada Ayam Pedaging Menggunakan Mikrokontroller Arduino Dan Rtc Ds1302," J. Tek. dan Sist. Komput., vol. 1, no. 1, pp. 22–28, 2020.
[16] D. Setiadi and M. N. Abdul Muhaemin, "Penerapan Internet of Things (IoT) Pada Sistem Monitoring Irigasi (Smart Irigasi)," Infotronik J. Teknol. Inf. dan Elektron., vol. 3, no. 2, p. 95, 2018, doi: 10.32897/infotronik.2018.3.2.108.