IoT Based Biometric Attendance System using Fingerprint Sensor

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Abstract

The research aimed to develop an IoT-based biometric attendance system using an ESP8266 NodeMCU, Arduino Uno, and R307 fingerprint sensor. The system tracks attendance and collects data for daily use. The collected data was stored in the open-source IoT platform called ThingsBoard. Additionally, the data was also stored in Google Sheets via the Pushing Box API, which is saved in Google Drive. To implement the system, the fingerprint module and stored fingerprints were connected to the ESP8266 NodeMCU. Whenever a finger is placed on the fingerprint sensor, the fingerprint is compared with the ones stored in the database. The ESP8266 NodeMCU is connected to the Google Sheet and ThingsBoard platform via Wi-Fi, where the attendance data is recorded and stored. The data was also displayed on the serial monitor and a 16x2 LCD display module.

Keywords: *IoT, Biometric, Attendance, ThingsBoard, NodeMCU, Arduino Uno*

1.0 Introduction

Biometrics, particularly fingerprint recognition, is a valuable tool in the realm of technology. This project focuses on creating a specialized system that utilizes fingerprints for attendance purposes [1]. The system is built using Arduino and ESP8266 NodeMCU, enabling the development of a fingerprint sensor-based biometric attendance system. The project involves interfacing an LCD display and a fingerprint sensor with the ESP8266 board. Attendance data is recorded using the fingerprint module in conjunction with an Arduino board [2-3]. Biometric attendance systems are commonly employed in businesses and educational institutions to accurately record attendance. This project has widespread applications in schools, colleges, businesses, and workplaces where precise and timely attendance management is crucial. By incorporating a fingerprint sensor, the system enhances security for users [4].

To establish a connection between the microcontroller and the Fingerprint Scanner R307, an ESP8266 board is employed. The Fingerprint Scanner

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R307 is used to store the fingerprints of each student. When attendance is marked, the scanner compares the current fingerprint with the stored ones. If a match is found, the microcontroller retrieves and displays the relevant information associated with that fingerprint on the LCD display. A Google Spreadsheet is utilized to maintain an attendance record for future reference. Additionally, the biometric data from the NodeMCU is transmitted to Google Sheets using the PushingBox API. Furthermore, the ThingsBoard app is employed to store the data in the cloud [5-6].

Previous research has explored various effective methods for recording and storing attendance. For instance, M A Muchtar et al. [7] centralized fingerprint identification data processing using Arduino and Raspberry Pi, achieving a 98.5% success rate for centralized server recording. Nur Izzati Zainal et al. [8] developed a portable and efficient miniature attendance system with improved security. Khin San Myint et al. [9] designed an attendance system using a fingerprint module, Arduino UNO controller, and PLX DAQ tool, with attendance records displayed in Excel. Karthik Vignesh E et al. [10] proposed an automatic attendance system utilizing a fingerprint sensor to manage student attendance records. A.K. Jain et al. [11] investigated various types of attendance systems, comparing and studying their advantages and disadvantages. Piyush Devikar et al. [12] presented an IoT-based system to automate the process of manually taking and storing student attendance records, effectively preventing proxy attendance, improving data reliability, and securely storing data in the cloud. Niharika Yadu et al. [13] proposed the use of IoT and fingerprint sensors to automate the attendance system in universities and schools, offering improved proficiency and flexibility in attendance recording.

From the literature review, it was observed that some researchers focused on using R305 and similar fingerprint modules. The utilization of IoT for attendance storage was found to reduce time and space requirements. Implementing Google Sheets enables real-time data observation by faculty during attendance taking. This project attempts to concurrently utilize both platforms. Moreover, the use of the R307 fingerprint module with higher storage capacity allows for the storage of more fingerprints. The collected data can be referenced and analyzed to determine the regularity of students' attendance.

2.0 Methodology

2.1 Hardware

Real time processing and recording of attendance system is possible if the hardware used is capable of effectively supporting the processing. To carry

out the work proposed in the paper we use R307 fingerprint sensor (Fig.1) which has two interface TTL UART and USB2.0, the USB2.0 interface can be connected to the computer and the UART can be directly connected to the microcontroller, ESP8266 NodeMCU, Arduino Uno, 16 x 2 LCD and breadboard. The major components mentioned are shown in Fig. 2.

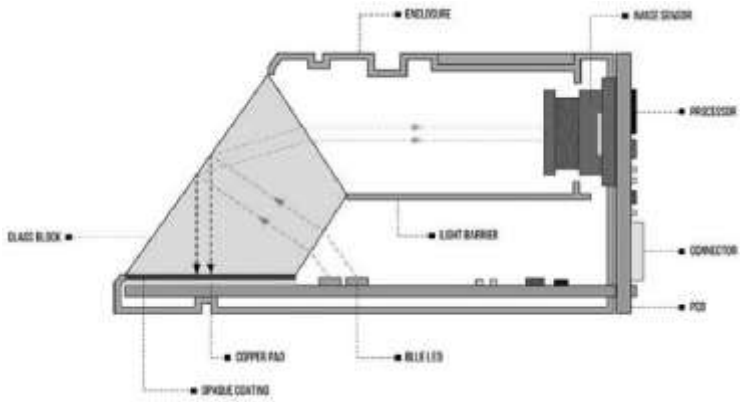

Fig. 1. Schematic of R307 Fingerprint Sensor

The major components mentioned are shown in Fig. 2.

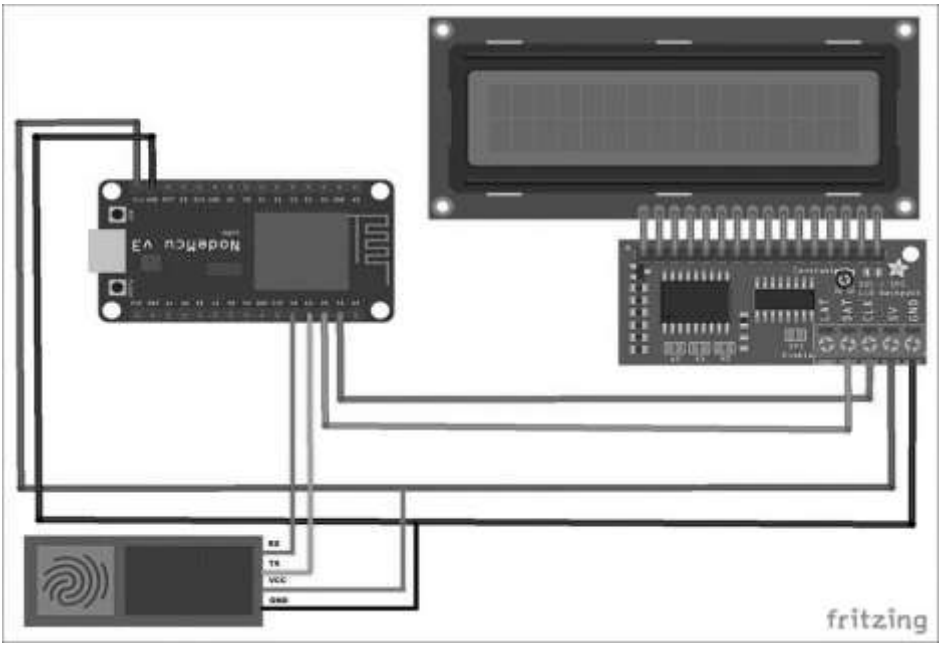

Fig. 2. Fritzing Diagram of Biometric module

2.2 Creation and storing data in Google Sheet

To set up the integration between Google Sheets and the Pushing Box

API, the following methodology is adopted:

1. Log in to Google Docs using your Google account credentials. From there, select the option to create a new spreadsheet and name it, for example, "ME PG Attendance." Create columns for Date, Time, and Name to structure the attendance data.
2. In the Google Sheets interface, go to the "Tools" menu and select "Script editor." In the script editor, write the necessary functions to insert data into the Google Sheet. Save the Google script as "ME PG Attendance."
3. Create an account on pushingbox.com using the same email address associated with your Google account. On the PushingBox dashboard, select the "My Services" tab and click on "Add a service." Choose the "Custom URL" option and fill in the required form. Select the GET method for data retrieval. Copy the Root URL provided by PushingBox.
4. Paste the copied Root URL into the web app URL of your Google Sheet. This URL should have been saved earlier when creating the Google Sheet.
5. Create a scenario in the "My Scenarios" section of PushingBox and give it a suitable name. Within the scenario, create and name a service by selecting "Add an action with this service." To obtain the device ID, use "=$Name$" as the name for the form.
6. Finally, link the PushingBox API to the code you have written. Upload the code to the Arduino and ESP8266 NodeMCU devices to establish the connection between the attendance system and the Google Sheet.

2.3 Creating and sending data to ThingsBoard IoT platform

To integrate ThingsBoard into the project, the following steps were followed:

1. First, a ThingsBoard account was created. The user proceeded to click on "Asset" and added a new device. An access token was obtained for the device and copied. This access token was then pasted into the code, allowing communication between the device and ThingsBoard. The device relation of the asset was defined in order to establish the connection.
2. After creating the dashboard in ThingsBoard, the required widgets were added. The system was then tested to ensure that data was being received and displayed correctly on the dashboard.
3. Secondly, the project involved recording and storing each individual's

fingerprint in the R307 fingerprint sensor. The necessary connections were made, and the device was connected to Wi-Fi. During attendance marking, the module scanned each fingerprint and compared it with the stored database. If a match was found, the attendance was recorded, and the data was sent to ThingsBoard via the NodeMCU. This process was repeated for each individual to record their attendance.

4. These steps allowed for the successful integration of ThingsBoard into the biometric attendance system, enabling the recording and visualization of attendance data on the ThingsBoard dashboard.

3.0 Results and Discussion

The biometric attendance system was proposed, designed and successfully implemented in the project where the attendance is recorded in real time (Fig 3). The data recorded in real time is sent through the NodeMCU to Google Sheets via PushingBox API. Additionally, the data is also sent to the IoT based cloud platform called as ThingsBoard (Fig 4). The data can be accessed at any time and referenced whenever required by the concerned authorities thereby allows for an ease in recording attendance as well as storing the data without any hassle. The recorded data can also be easily analyzed to find out about the students who are regularly attending the classes and those who are not doing the same. The commercials required towards purchase of various components required to assemble this device is very reasonable and anyone can afford to spend this amount.

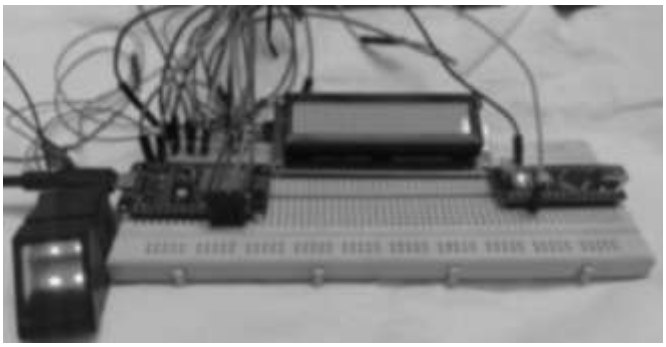

Fig. 3. Biometric Attendance System Using Fingerprint Sensor

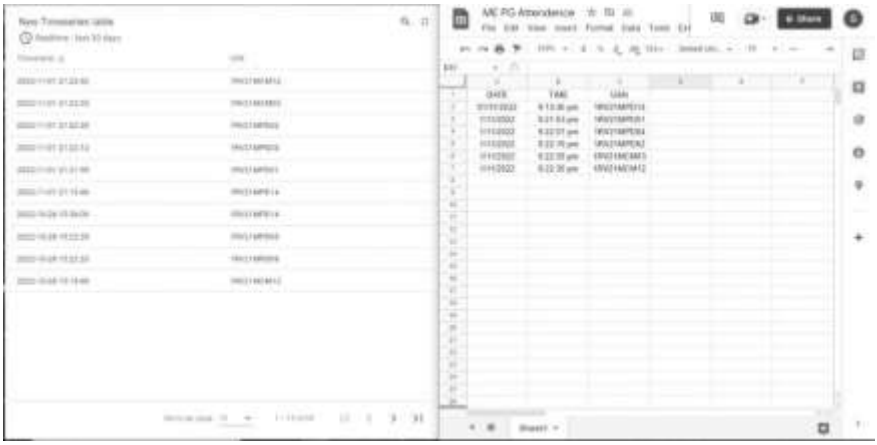

Fig. 4. Data recorded at ThingsBoard and Google Sheets

Conclusion

Development of an IoT-based biometric attendance system using ESP8266 NodeMCU, Arduino Uno, and R307 fingerprint sensor was successfully achieved. The system effectively tracks attendance and collects data for daily use, storing it in both ThingsBoard and Google Sheets via the Pushing Box API. By connecting the fingerprint module to the ESP8266 NodeMCU, the system compares the scanned fingerprints with the stored database in real-time. The attendance data is recorded and stored on the Google Sheet and ThingsBoard platforms, providing easy access and reference for concerned authorities. The system's implementation includes data display on the serial monitor and an LCD display module. Moving forward, future improvements should focus on enhancing the device's compactness and integration, optimizing hardware design, software performance, and usability. Exploring additional features and functionalities would further enhance the system's overall capabilities and usability.

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