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Internet of Things-Based Monitoring and Mapping of Absentee Visualization on the Shop-Floor

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Abstract

In all the companies, attendance of the employee is taken after the employee enters the factory through their signature or biometrics which would consume a lot of time. The main objective is if the attendance of the operators is taken even before they enter the premises, the supervisor gets to know if a particular employee is absent. This can be done by virtually connecting the nger-print sensor output to the cloud and so that the supervisor can access the cloud and get the information of the operators who have boarded the buses. The R-307 ngerprint sensor is used as the main input. The Raspberry Pi will process the data and the global system for mobile communication (GSM) will send the text message to the respective supervisors. The nger-print sensor can determine the nger-print stored in the database with an average response time of 0.8 seconds.

Keywords: Attendance system, Cloud server, Finger-print sensor, General packet radio service (GPRS), Global system for mobile communication (GSM), Raspberry Pi.

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Introduction

In the automobile industry, the entire production is usually done manually—from wire cutting to nal assembly of the wiring inside the car. For this, the company needs both skilled and unskilled workers/operators in their shop- oor. If a skilled operator is not present in the line, the entire conveyor belt cannot start its functionality. The supervisor of the line has to nd a substitute for that skilled operator. This process takes a minimum of 30–45 minutes. Due to this delay, the production gets a ected. Thus, if the supervisor gets prior information about the operators who will not be coming for the day, he can nd a substitute and start the belt at the assigned time.

Employee attendance checking systems are usually finger-print based. Biometric can be defined as the physiological and behavioral characteristics that can be used to verify a person's identity. The use of the ngerprint sensor and the GSM/general packet radio service (GPRS) will help in producing an e cient and e ective system to record the attendance. The aim of this research was to build the system of absentee visualization that integrates biometric, GSM/GPRS, and a Raspberry Pi.

By starting the production unit at the assigned time, the production rate per day can be increased. Since 90 to 95% attendance has been marked before entering the premises itself, there is a remarkable reduction in the time consumed for punching. It will also help in tracking the details of all the employees working under di erent shifts or the speci c bus, which are allotted to employees. This would ultimately help the supervisor to decide the substitute for the absent employee and start the work on time. Hence, this will be bene cial for the companies in terms of production and time.

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Literature Survey

Jisha *et al.*,[1] an Android application for school bus tracking and student monitoring system has used technologies, like GPS and GPRS and Firebase to develop an Android application for school bus tracking. Its implementation is done cost-e ectively as it needs mobile's GPS and internet connection only.

Lia *et al.*,[2] real-time online attendance system based on ngerprint and GPS in the smartphone uses a nger-print sensor, which recognizes the finger-print stored in the database with an average response time 1.39 seconds, with GPS—latitude, and longitude with an average error 0.007352, and 0.0003%, respectively.

Tiwari *et al.*,[3] Internet of things (IoT)-based attendance log system using Raspberry Pi successfully authenticates the student's identity from his ngerprint and database from the server. The algorithm detects the nger-print and is capable of matching with the right database.

Pradeep *et al.*,[4] smart attendance system using Raspberry Pi discusses the standardized authentication model which is capable of extracting the ngerprints of individuals and store that in the database. Then, the employment of the nal ngerprint to match with other ngerprints present within the database is done to point out the capability of this model and also update the database obtained to the organization by creating an application through the cloud.

Dhanya *et al.*,[5] student attendance tracking system using a portable biometric device presents the development of a portable attendance system which is based on the ngerprint mechanism to handle the attendance status of the students, like calculating the shortage of attendance automatically to ease the burden of the lecturers.

Thus, combining literature,[1,2] we will be able to monitor the bus and take the attendance in the bus using a biometric machine that can be installed in the bus itself. Also, in this system, we will be able to achieve a better average response time of the ngerprint sensor.

System Design

The main block consists of a fingerprint sensor and a Raspberry Pi for the collection of the data on the bus. The second component is the GSM module for transmitting the text messages to the supervisors.

Fingerprint Sensor

The ngerprint sensor is the main component in this system. Fingerprint sensors are security systems of biometrics. Everyone has marks on their fingers. They cannot be removed or changed because of which it is the ideal means of identi cation. There are multiple types of ngerprint sensors, such as, optical sensors, CMOS sensors, ultrasound ngerprint sensors, and thermal sensors.

The fingerprint sensor used here is R-307. It consists of an optical ngerprint sensor and a high-speed Digital Signal Processing (DSP) processor with a high-performance ngerprint alignment algorithm. It has a perfect function—independent ngerprint collection, ngerprint registration, ngerprint comparison (1:1), and ngerprint search (1: N) function. It is small in size which is easy to install with ultra-low power consumption. The average response time for this sensor is 0.8 seconds. In comparison with the older model R305 and R307, t has the following advantages as shown in Table 1.

Table 1: Comparison between R305 and R307

Parameters	*R305*	*R307*
Storage capacity (ngerprints)	250	1,000
3.3V operation	No	Yes
USB operation	No	Yes
Finger detect output	No	Yes

Raspberry Pi

The Raspberry Pi is a credit-card-sized single-board computer developed in the UK by the Raspberry Pi foundation. It is a very cheap computer that runs Linux but also provides a group of general-purpose input/output (GPIO) pins that permit controlling of electronic components for physical computing. The Raspberry Pi is provided with generic USB ports for connecting a computer keyboard and a mouse.

The Raspberry Pi 3 Model B+ uses a Broadcom BCM2837 system-on-chip (SoC) with an integrated 64-bit quad-core ARM Cortex-A53 processor with a speed of 1.4 GHz. It is a 40-pins GPIO header with a memory of 1 GB SDRAM. It o ers 2.4/ 5 GHz dual-band IEEE 802.11.b/g/n/ac wireless LAN, Bluetooth 4.2, and Wi-Fi onboard. The Raspberry Pi has an updated control administration wellspring of 5V USB control supply up to 2.5A. The ethernet port provided is a built-in ethernet adapter using SMSC LAN9514 chip. With the expansion of gigabit ethernet over USB 2.0, the wired ethernet execution is additionally supported, with an extraordinary throughput of around 300 MB.

Global System for Mobile Communication (GSM)/ General Packet Radio Service (GPRS)

GPRS is a packet-oriented mobile data standard on the second generation (2G) and third generation (3G) cellular communication network's GSM. In 2G systems, GPRS provides data rates of 56 to 114 kbit/sec. It provides moderate-speed data transfer by using unused time division multiple access (TDMA) channels. The GPRS core network allows 2G, 3G, and wide-band code division multiple access (WCDMA) mobile networks to transmit IP packets to external networks, such as, internet.

GPRS extends the GSM packet circuit-switched data capabilities and offers a number of services like Short Message Service (SMS) messaging and broadcasting, internet applications for smart devices through wireless application protocol (WAP), point-to-point, and point-to-multipoint services, etc. An SMS transmission speed of about 30 SMS messages per minute can be achieved, if SMS over GPRS is used, which is faster than the ordinary SMS over GSM, whose SMS transmission speed is about just 6 to 10 SMS messages per minute. SIM 800A quad-band GSM/ GPRS module has been used for this system. Brand Omatom Power input voltage 9 to 12V DC quad-band 850/900/1,800/1,900 MHz DC.

Database

A database is an organized collection of data, generally stored and accessed electronically from a computer system. When the databases are more complex, they are often developed using formal design and modeling techniques. The database management system (DBMS) is the software that interacts

with the end-users, applications, and also the database itself to capture, and analyze the information. In the relational database model, the data structures including data tables, indexes, and views remain separate from the physical storage, allowing administrators to edit the physical data storage without a ecting the logical data structure. The standard user and application interface (API) of a relational database is the structured query language (SQL).

We have used MySQL which is a relational database management system supported SQL. It is free and open-source software under the terms of the GNU General Public License and is also available under a variety of proprietary licenses.

METHODOLOGY

Proposed Methodology

As shown in Figure 1, the fingerprint sensor takes the ngerprint and identi es the person with the help of the database which is stored in the cloud. The adapter for the Raspberry Pi works as a power supply for the controller. The Wi-Fi router will provide the internet required for the Wi-Fi module in the controller to send the data to the server. The data in the cloud can be accessed by the user using a mobile, tablet, laptop, etc.

Enrollment of the Fingerprint

Input will be taken from the employee by giving his/her fingerprint through the fingerprint scanner. A person's captured ngerprint image is converted to an electronic biometric data format. When a person is enrolled in any biometrics system including a biometric time and attendance, he has to present his ngerprints for the initial biometrics capture. This initial biometrics ngerprint capture is also called biometric enrollment. Figure 2 (a) depicts the image of the ngerprint once it gets enrolled. As each ngerprint is unique, the ngerprint sensor identi es some distinguishing features of the ngerprint (an example is depicted in Figure 2 (b)) which can be used for identi cation of the person.

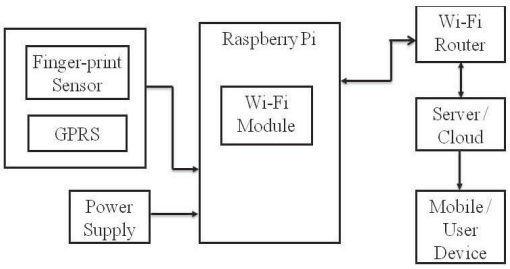

Figure 1: Proposed block diagram

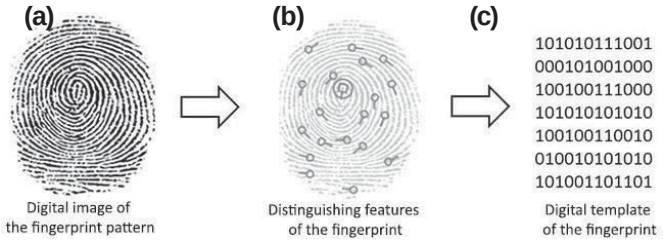

Figure 2: (a) Digital image of the ngerprint pattern; **(b)** Distinguishing features of the ngerprint; **(c)** Digital template of the ngerprint

Fingerprint Template

After the ngerprints are captured by a ngerprint sensor/ biometric fingerprint scanner (also known as biometric reader), the fingerprint image is further processed into electronic data that is called a ngerprint template as shown in Figure 2 (c). A ngerprint template has a reduced size than the initial image captured. After the biometric ngerprint image has been captured, the collectible and measurable biometric data are extracted. Fingeprint scanner data is extracted. This is the data that uniquely di erentiates a particular person from any other person's ngerprint. This data can now be saved into a database somewhere remotely or within the internal database of the biometrics time and attendance system.

Compare and Match with the Database

During fingerprint comparison, an equivalent sequence of events takes place again, only that now the extracted ngerprint data is not saved into the unit's database but compared with the already existing data in the biometrics time and attendance unit using ngerprint identi cation and fingerprint verification software logic built into its onboard rmware. Using the match and compare block, if the ngerprint matches with the ngerprint in the database, it is a "Match" and the attendance will be processed. If the fingerprint does not match with any fingerprints in the database, it will display "No Match".

Capturing of the Data

As the employees will give the input through biometric, the attendance will be updated and the data will also be stored in the cloud. Before the bus reaches its nal destination, the supervisor gets the message of which of the employees is absent so that he can nd a substitute that particular employee and start the work on the conveyor belt on time.

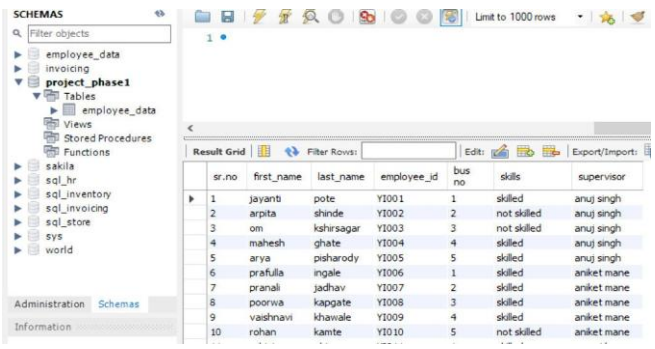

Figure 3: Sample database

Creation of Database

In our project, we have used MySQL for database creation. We have made a database of 25 employees in a company as shown in Figure 3. The database is named as Employee_Data, in which we have created a table as employee data. This table contains the required information of the employees, like full name, employee ID, bus number, name of supervisor, and also states whether the employee is skilled or unskilled.

Algorithm

There are various software that can be used according to the controller used. We used Python to program the Raspberry Pi. The following are the algorithms that are used for the required project.

Part 1: Registering the Fingerprint

Step 1—Initialization of the controller.
Step 2—Connect the ngerprint module.
Step 3—Open the fingerprint_demo graphical user interface (GUI) in the controller.
Step 4—Register the ngerprint and save the image template.
Step 5—Conversion of the image template to binary form.
Step 6—Save these ngerprints in the MySQL Database.
Step 7—Now comparison of the various templates can be carried out by Python.
Step 8—The accurate matching points will be found in between the images.
Step 9—After the initial comparing and matching of the ngerprint is done, the overall database is stored in an excel le that can be uploaded to the cloud.

Part 2: Attendance of the Employee

Step 1—Employee punches his ngerprint on the ngerprint sensor.
Step 2—This ngerprint is scanned through the database to nd its match.
Step 3—If the ngerprint does not nd a match, it shows "No Match."
Step 4—If the fingerprint matches with the one in the database, it shows "Match."
Step 5—The data of this employee will be stored and marked as present.
Step 6—Now, before the bus reaches its destination, the employees who are marked absent, and their details will be sent to their respective supervisor.

Experimental Results

As shown in Figure 4, in ngerprint_demo, there are four parts—Enroll, Verify, Identify, and Image Capture. The actual ngerprint that is enrolled is depicted in Figure 5. This image is processed to form a ngerprint template (as shown in Figure 6) which is further processed into binary form. Each employee has to enroll in his ngerprint and get it veri ed.

Once the enrollment of the ngerprint is done, the ngerprint is verified which is stored in the database. After this when

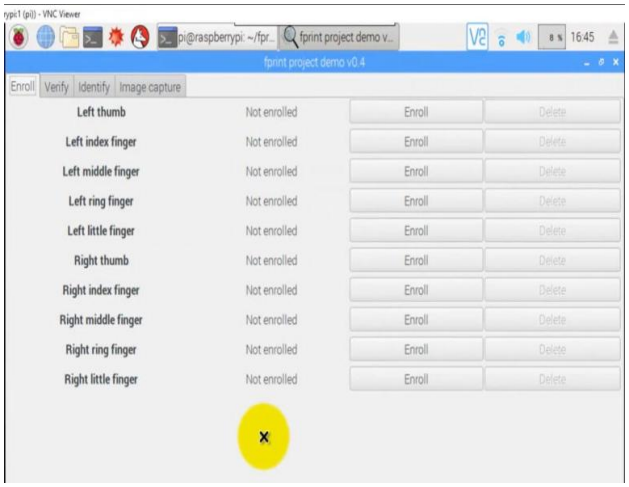

Figure 4: Enrollment

Figure 5: Enrolling the ngerprint

Figure 6: Fingerprint template prepared

the employee punches and the ngerprint is matched, the attendance gets recorded. The employees who are not present, their supervisors will receive an SMS regarding that employee.

Conclusion and Future Scope

This paper is regarding improving the current attendance systems in the industries and provides the supervisor with prior information regarding his employees or operators under him. The accuracy and average searching time of the ngerprint is improved to 0.8 seconds. SMS messages sent over GPRS can transmit 30 messages per minute, which are better than the ordinary SMS messages over GSM which can send only 6 to 7 SMS messages per minute. By implementation of the hardware, the production of the company would increase in a signi cant manner. Also, the time required by the supervisor to decide a substitute for the absent or skilled employees will decrease.

The ngerprint sensor module used in the project is with the

Transistor Transistor Logic (TTL) Universally Asynchronous Receiver/ Transmitter (UART) interface. The user can store the ngerprint data within the module and can con gure it in 1:1 or 1: N mode for identifying the person. It would also be used in preventing impersonation, like fraud detection and to verify individuals' identity. Regarding performance and e ciency, this project will provide a better approach to check absenteeism compared with the traditional method of marking the attendance manually.

In the future, this attendance system can also be implemented by iris scanning instead of ngerprint scanning. Another change that can be done in this system is that the supervisor can be suggested an employee with the same skills as a substitute to the employee in his conveyor belt.

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