

RESEARCH ARTICLE

## Bio-Metric Attendance System using Mobile Wi-Fi Hotspot

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Received- 12 April 2016, Revised- 17 June 2016, Accepted- 20 August 2016, Published- 30 August 2016

### ABSTRACT

Biometric technology that involves the identification and verification of individuals by analysing the human fingerprint characteristics has been widely used in various aspects of life for different purposes. Fingerprint recognition or fingerprint authentication refers to the automated method of verifying a match between the human fingerprints in the database. The analysis of fingerprints for matching purposes generally requires the comparison of several features of the print pattern. Characteristics of biometric patterns, such as ridges and minutia points are unique features found within the patterns. In this research work we have designed and developed an automated biometric attendance system (BAS). BAS records attendance electronically with the help of a fingerprint sensor and all the records are stored in a computer server. Fingerprint processing has three primary functions of enrolment, searching and verification. Among these functions, enrolment, which captures fingerprint image from the sensor, plays an important role. Authentication ensured using fingerprints results in searching and verifying process. On identification, employee's attendance record is updated in the database and he/she is notified through LCD screen. The manual time consuming system is replaced by an automated system. We have developed a BAS proto type model and validated for its functionality and redundancy for thirty employees for a period of one month.

**Keywords:** Biometric technology, Fingerprint recognition, Fingerprint sensor, Attendance record, Automated system, IoT, RFID.

### 1. INTRODUCTION

Industries, educational and research organizations used earlier during 1980s, were deployed with manual and register based systems to record the attendance of the employees. In due course of time, electronic systems are implemented in some places as, it was not easy to monitor and share information across various levels. Then card-based systems were introduced, which is liable for misuse or wrong entries by handing over cards to colleagues. In some places the barcode attendance system is being used, which requires that every employee is issued a badge/card in which there is a barcode. In order to check in/out of the company, the badge/card is swapped on the time clock, and the data is captured by the clock. In many places, RFID system is being used, which is a Radio-Frequency Identification Technology that uses, radio waves to transfer data from an

electronic tag, called RFID tag or label, attached to an object, through a reader for the purpose of identifying and tracking the object. The ID cards of the employees is embedded with RFID tag, which is read by a reader. RFID system is interfaced to a database through a computer. Each employee uses an RFID card and the reader records the data when the employee enters or exits. In biometric attendance system, there is an attendance software that is paired with a time clock for employees, which uses biometric technology for authentication purposes. When these systems are in use, the employees can use their biometric data such as finger prints for clocking in and clocking out. This method has a great benefit that the entire process is easy as well as quick. Other advantages include elimination of the cost previously incurred in getting the employees cards.

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Double blind peer review under responsibility of DJ Publications

<http://dx.doi.org/10.18831/djee.org/2016021003>

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Fingerprints are a form of biometric identification, which is unique and does not change in one's entire lifetime. It consists of two processes namely; enrolment and authentication. During enrolment, the fingerprint of the user is captured and its unique features are extracted and stored in a database along with the users identity as a template for the subject. The unique features called minutiae points were extracted using the Crossing Number (CN) method, which extracts the ridge endings and bifurcations from the skeleton image by examining the local neighborhoods of each ridge pixel using a 3 x 3 window. During authentication, the fingerprint of the user is captured again and the extracted features are compared with the template in the database to determine a match before attendance is made. Biometric technology is the foundation of highly secure identification and personal verification solutions. Currently, biometrics is being spotlighted as the authentication method because of the need for reliable security. Fingerprint authentication is one of the most well-known and publicized biometrics technologies. Because of its uniqueness and consistency over time, fingerprints have been in use for identification for over a century and more recently, it is becoming automated due to advancements in computed capabilities. Fingerprints are considered to be the best and fastest method for biometric identification. They are secure to use, possess unique user identity and do not change in one's lifetime.

Besides these, implementation of fingerprint recognition system is cost effective, easy and accurate. Fingerprint recognition has been widely used in both forensic and civilian applications. Compared with other biometric features, fingerprint-based biometrics is the most proven technique and has the largest market shares. Accessing control is faster than other techniques but also the energy consumption by such systems is too less. In this research work, the fingerprint identification technique is used for maintaining the attendance record. Managing attendance records is a tedious task. It consumes both time and paper. To make all the attendance related work automatic and on-line, we have designed an attendance management system. The record of the fingerprints of various employees is maintained in a database. The communication between the PC and module is done wirelessly

using Wi-Fi module. Several techniques and methods have been carried out effectively to monitor employee attendance. [1] proposed a cost effective computer based embedded attendance management system by which the authority electronically monitors the attendance for verification using an improvised electronic card. These cards contain necessary information of an individual. These are inserted in an electronic machine, which will record the time and other information to a server system. Password based authentication and verification of attendance monitoring system of any individuals has also been carried out in the literature. A system that applies user id and password of a person for authentication was designed and implemented by [2]. However, an issue with these electronic cards or password based system allows impersonation since cards or passwords can be shared or someone can ask other person to insert the card or password. A system was proposed and implemented by [3, 4, 5] in OTP and facial recognition based attendance registering system. The system proposed here provides full software based and distributed approach for attendance registering system [6, 7]. Attendance system uses android applications, which are part and parcel of our everyday life and can be easily installed independently on mobile devices. But the drawback with this method is all the students should have android mobile phones in their hand, which is not permitted in all the places. [8, 9] proposes attendance monitoring by fingerprint recognition using minutiae technique, which involves extraction of minutiae from two fingerprints. Three phases are employed in the process namely scanning and registration, verification and updating and based on the information, a report will be generated. Though it is efficient in attendance processing, this method does not indicate the types of leave such as on duty, leave on pay and so on.

[10, 11, 12] explains the development of fingerprint based identification system based on algorithms such as gender estimation, one to many matching and removing boundary minutiae within a wired LAN network. Even supposing this method is efficient, the matching error rate is quite high and it cannot be used in a wireless system due to high cost. [13] explains the fingerprint reconstruction technique, which reconstructs the phase image

from minutiae by orientation of field reconstruction and phase reconstruction and then converts it into a gray scale image. Besides accuracy, it also consumes more time and the algorithm has to be modified to address the problems of latent fingerprint restoration. [14] gives a brief description about ESP8266 Wi-Fi module and its terminal connections. [15] introduces an automatic attendance system using fingerprint verification by the extraction of minutiae, which includes preprocessing of fingerprint image, recognition of minutiae, post-processing of minutiae and matching of minutiae. Though this method is simple and accurate, it cannot differentiate the enhanced quality of the image. [16, 17, 18] presents the design and development of fingerprint based attendance using two microcontroller, of which the former is used to extract the data from fingerprint module and latter is used for matching the fingerprints and LABVIEW software is used for generating report. However during the enrollment the fingerprints are assumed to be very clean, which is difficult in real time implementation. These problems can be addressed by using biometric recognition system, which includes finger print or iris recognition. The proposed system is using fingerprints to identify and update the attendance and generate the reports after a fixed time duration. Individuals simply put their fingerprints on the fingerprint reader, which scans the finger print and verifies the corresponding person.

## 2. METHODOLOGY

### 2.1. Block diagram

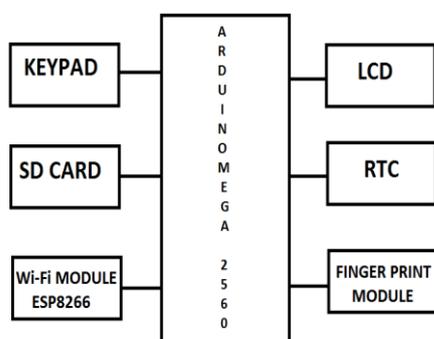


Figure 1. Block diagram

#### 2.1.1. ATmega 2560

The block diagram of the proposed bio-metric attendance system is shown in figure 1. The Arduino microcontroller is an

easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market. The Arduino is open-source, which means hardware is reasonably priced and development software is free. When we have to learn about a new computer we have to familiarize about the machine capability we are using, and we can do it by studying the internal hardware design (devices architecture), and also it helps in knowing about the size, number and the size of the registers.

#### 2.1.1.1. Salient Features of atmega2560

- AVR 8bit RISC
- 8 kB SRAM
- 16 MHz clock speed
- 54 digital I/O pins
- 256 kB flash memory
- 16 analog input pins

#### 2.1.1.2. Pin configuration

The AT mega 2560 can be powered either by USB connections, AC-DC adapter or a battery. Pins 8, 3, 31, 30, 34, 36 of AT mega 2560 are connected to the LCD segment. Pins 21 and 20 are connected to serial real time clock. Pins 8, 10 and 12, 13 are connected to ESP8266 and fingerprint module respectively via voltage regulator. Terminals 22, 24, 26, 21, 46, 47, 48, 40 are given to numeric keypad and terminals 53, 56, 51, 50 are connected to micro SD.

#### 2.1.2. LCD

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2, LCD display is a very basic module and is very commonly used in various devices and circuits. It can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in a 5x7 pixel matrix. This LCD has two registers, namely, command and data. The command register stores the command instructions given to the LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD.

#### 2.1.2.1 Pin description and diagram

Pin 1 is grounded and supply voltage (5V) is given to  $V_{cc}$ . Contrast adjustment are

made through pin  $V_{EE}$ . Register select is used to select the command register when the signal is low and selects the data register when the signal is high. DB0 to DB7 are 8 bit data pins.  $L_{ed+}$  and  $L_{ed-}$  are backlight VCC and ground respectively. The pin diagram of 16X2 LCD display is given in figure 2.

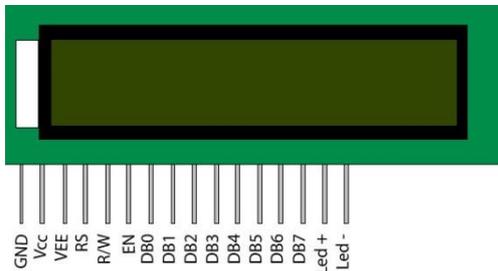


Figure 2.LCD

### 2.1.3. Micro SD (MSD)

Micro SD card is a flash-based memory card that is designed to meet the security, capacity, performance and environment requirements inherent to use in emerging audio and video electronic devices. MSD card communication is based on an advanced 8-pin interface (clock, command, 4x Data and 2x power lines) and the MSD card host interface supports regular multi-media card operation as well. MSD cards are used in mobile phones and also in handheld GPS devices, portable media players, digital audio players, expandable USB flash drives, Nintendo DS flashcards and digital cameras. Here we are storing the attendance data for each day in a text file, which has the same name as the current date.

### 2.1.4. RTC

The DS1307 serial Real-Time Clock (RTC) is a low-power, full binary-coded decimal (BCD) clock/calendar plus 56 bytes of NV SRAM. Address and data are transferred serially through an I<sup>2</sup>C, bidirectional bus. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information. The end of the month date is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The clock operates in either the 24-hour or 12-hour format with AM/PM indicator. The DS1307 has a built-in power-sense circuit that detects power failures and automatically switches to the backup supply. Timekeeping operation continues while the part operates from the

backup supply. We need this device to act as a standalone device and so even in the absence of power supply, it processes in the background.

### 2.1.5. ESP8266

ESP8266 is a highly integrated chip designed for the needs of a new connected world. It offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor. ESP8266 has powerful on-board processing and storage capabilities that allow it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area. The pin configuration of ESP8266 module is given in figure 3.

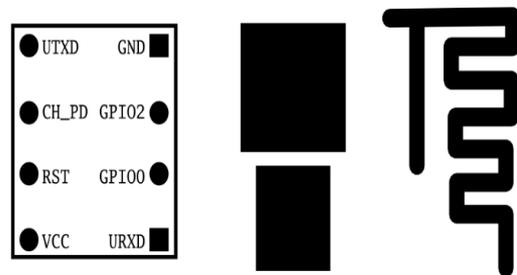


Figure 3.ESP8266

### 2.1.6. Fingerprint scanner module

Biometric identification from a print made by an impression of the ridges in the skin of a finger is often used for identification purposes. The user can store the finger print data in the module and can configure it in 1:1 or 1:N mode for identifying the person, which is shown in figure 4. The module itself has memory for which it has the capability to store the different fingerprints. Fingerprint processing includes two parts, fingerprint enrollment and fingerprint matching. When enrolling, user needs to register his finger two times. BAS will process the two time finger images, generate a template of the finger based on processing results and stores the personnel bio-metric database for processing. During personnel entry the controller checks the bio-metric registration from the database and

compares finger prints of optical sensor entered. This inturn stores the required time and date stamp of thee personnel.

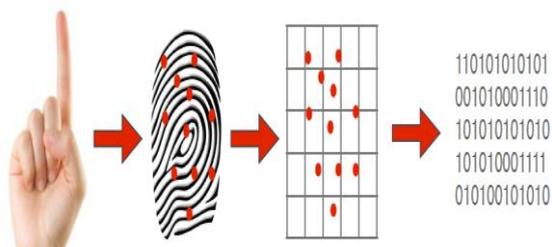


Figure 4.Fingerprint scanner concept

### 2.1.7. Keypad

A keypad is a set of buttons arranged in a block or pad, which usually bear digits, symbols and a complete set of alphabetical letters. Keypads are found on many alphanumeric keyboards and on other devices such as calculators, push-button telephones, combined locks, digital door locks, which requires numeric input. This keypad interface will process the personal data update like adding, editing and deleting processes.

### 2.1.8. Voltage regulator

A voltage regulator is used to maintain a constant voltage level. It may use electromechanical mechanisms or electronic components. Based on the design, it may regulate one or more AC or DC voltages. Electronic voltage regulators are used to stabilize the DC voltages used by the processor and other elements.

### 2.1.9. Arduino software IDE

Arduinio software IDE is an open source software, which is easy to write and upload to the board. It runs on Windows, Mac OS X and Linux. This software can be used with any arduino board.

### 2.2. BAS hardware

The program was written using an open source arduino software IDE and is uploaded to ATmega 2560 controller using an USB cable, which is shown in figure 5.

Post uploading, BAS takes the attendance electronically using the fingerprint sensor and validates the fingerprint from the stored database. Finally, a report will be generated with the complete details of the employees as shown in figure 6.



Figure 5.Arduino Program instant of uploading



Figure 6.Output obtained from the ESP8266 module

Figure 7 shows the hardware connections of the keypad, ATmega 2560, fingerprint scanner module, micro SD and RTC and the overall prototype demo of biometric attendance system is shown in figure 8.

The circuit diagram of BAS using wi-fi hot spot is given below in figure 9.

### 2.3. Validation and verification

This prototype BAS model was validated for the authenticity and redundancy. There was no false identification of the users. The users who were identified were automatically enrolled for attendance. Access entry on the SD card consumes an approximate space of 12 bytes. Each day for one person 48 bytes of data is consumed. If we take, 1 kilobyte per entry with 8 Gigabyte as total available space, then memory of SD card will be fully consumed after 2 decades approximately. Since we have used Wi-Fi hotspot for transferring files, it is required that the end device such as mobile or laptop be connected to the assigned Wi-Fi, which is password protected for security purposes. BAS has secured data transferred and ensures the

security measures. BAS secured data transfer and ensures the security measures. It cannot be cracked by any mobile data or internet connection which is a major advantage and also creates a micro cloud computing mobile networks.

sensor and all the records are saved to the server. During entry, Arduino Mega 2560 validated the enrollment from the database and compared the fingerprints of the fingerprint sensor, which is shown in figure 10.



Figure 7. BAS Hardware module

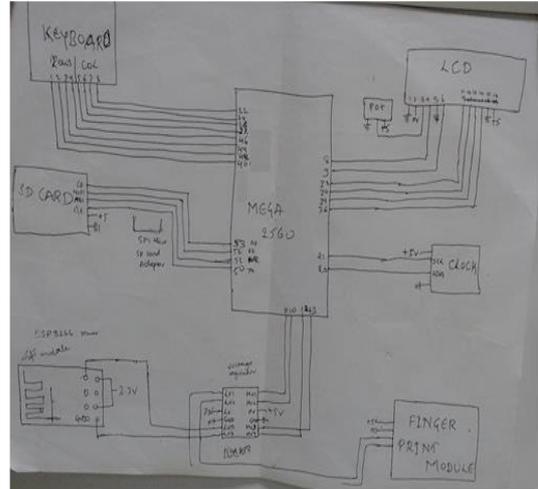


Figure 9. Circuit Diagram



Figure 8. BAS prototype demo

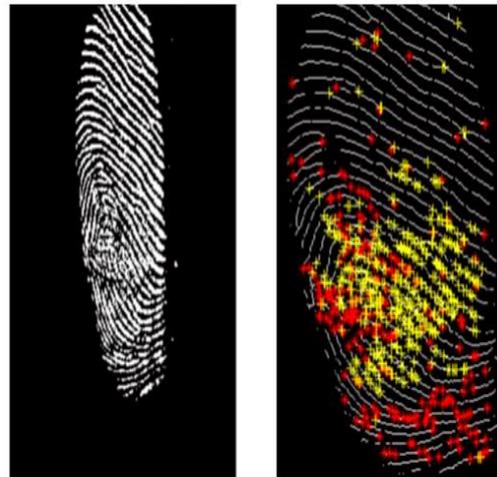


Figure 10. Fingerprint comparison

### 3. RESULTS AND DISCUSSIONS

Bio-Metric attendance system using Mobile Wi-Fi hotspot was designed and tested for the employee's enrollment and obtained a secured communication within the working area. Attendance management system is very helpful in saving time and generating report at the required situation. BAS takes attendance electronically with the help of a fingerprint

The time, date and month stamp was displayed in the LCD and the entire details was stored in the MSD, which could be used for further reference. Fingerprint processing of three primary functions viz enrollment, searching and verification are validated for 30 employees. The response time for enrolling adding, editing and deleting the personnel data is programed and its execution time was found to be 30 Seconds. BAS attendance recording time was 500 milliseconds. The manual time consuming system is replaced by an automated system. It has the capability of storing MSD data of 100 peoples for six months. It is

possible to deploy an automated attendance system using mobile data networks.

#### 4. CONCLUSION

BAS has a variety of applications apart from attendance systems. It is possible to evolve this concept to Internet of Technology and also for the development of aadhaar based attendance system secured model at cheaper cost. BAS has a variety of applications from attendance systems to security systems. It is possible to evolve this concept to Internet of Technology enabled devices for home automation or industry automation and these devices can also be controlled remotely using biometric authentication over internet.

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