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Smart Wireless Attendance System

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***Abstract* —** This paper describes a method for attendance monitoring through a wireless network of smart devices (IoT). Today, IoT is enabled by the latest developments in RFID, smart sensors, communication technologies, and Internet protocols. IoT is expected to bridge diverse technologies to enable new applications by connecting physical objects together in support of intelligent decision making. The basic premise here is to have smart sensors collaborate directly without human involvement to deliver a new class of application. Compared with the existing technology where local sensors are deployed to monitor attendance OR where often the technology is barely used requiring human intervention, our intention here is to provide a hassle free system which is mobile and requires no human intervention (except for the unavoidable initial set-up). Not only our solution eradicates the burden on human resource but also, provides a convenient way to interact by hosting a web-page for viewing the attendance report of every student.

***Keywords*—**Biometric attendance, Mobile attendance monitoring, Internet of Things,

I. INTRODUCTION

Traditionally, in schools and colleges, the attendance of each student is taken manually by teachers. The teacher notes down the roll number of students and updates it on to the website later. On an average 5-10 minutes are spent in taking attendance of each class. The above steps are to be carried out by each teacher for every class they engage. The attendance data of students is not updated onto the website everyday but, once in a week or in a fortnight.

In various organizations, automated attendance systems are used which are based on electronic tags, barcode badges, magnetic stripe cards, biometrics etc. These systems are static and are mount at specific places. Every individual has to approach the module to cast his attendance. Thus, these systems cannot be employed in schools and colleges as they involve taking attendance of a large number of students on an hourly basis. We aim to address the issues in existing attendance monitoring system by designing Smart Attendance System. It is a portable biometrics based attendance system which updates the attendance directly onto the website without teacher's intervention. This paper starts by briefing about the incorporated methodology in order to achieve attendance monitoring and proceeds further by explaining about the different modules in the system. Next, paper details on implementation and algorithm specifics and briefs about each step involved in attendance monitoring. Finally, the paper ends with the results obtained.

II. METHODOLOGY

A typical use case of Smart Attendance System in a school/college environment is shown in figure 1. Handheld devices are used in different classrooms to record the attendance and a server updates the same into a database.

A. *Block description*

Smart Attendance System comprises of:

1. Multiple Handheld devices
2. Gateway device
3. Server

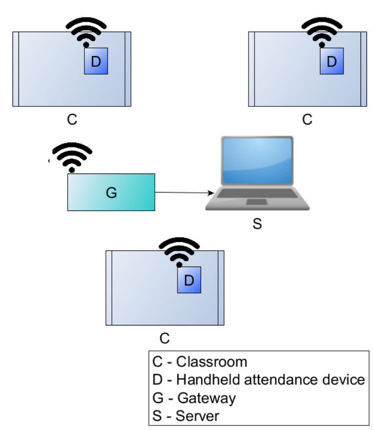

Figure 1: Block diagram for Smart Attendance System

1) Handheld device

Each handheld device is made up of a fingerprint module, a microcontroller, and a Zigbee transceiver. This device is circulated throughout the class to register attendance.

a) Fingerprint module:

The fingerprint module is a biometric device used for student identification. It comes with a storage to save user's fingerprint and an on-board processor to identify them later on. Different algorithms are used to uniquely identify an individual [2][3]. Depending on the size of the class, modules of different capacity can be used. The module attaches a unique ID for each fingerprint stored and on identification, returns the same ID. It sends the ID of the user on a serial interface, which is interpreted by the microcontroller.

b) Zigbee:

For the wireless communication between the handheld device and the server, Zigbee-enabled devices are used. Xbee is one such device which implements the Zigbee standard.

In a Zigbee network, the nodes can be classified as coordinator, router, and end device. In brief, a coordinator is responsible for forming the Zigbee sensor network, the router is responsible to route data between different end nodes in the network, end devices cannot route data they are either connected to a router or the coordinator and are designed in a way to consume low power[4].

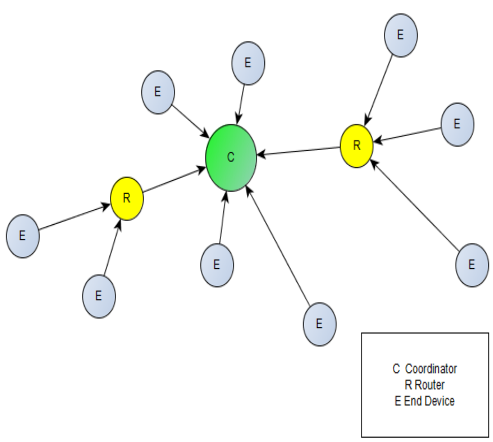

Figure 2: Zigbee network

Communication using Xbee is possible in two modes, AT (Transparent) mode or API (Application programming Interface) mode. AT mode is limited to fixed point-to-point communication between two Xbee devices. In API mode it is possible to send and receive data from any Xbee device in the network. Additionally, other information can also be exchanged such as knowing the status of remote IO and ADC and also control them, feedback of the packet reception etc.

In this project, the Xbee present at the server end is configured as the coordinator. It acts as a gateway device between the sensor network and the remote server PC. The Xbee in the handheld device is configured as an end device. Both coordinator and end device are configured with API mode.

c) Microcontroller

Both fingerprint module and Zigbee device are interfaced to a microcontroller. The microcontroller receives information from the fingerprint module, interprets it and then intelligently transmits the required data to gateway device via Xbee. ATMega328P was used as the controller whereas any microcontroller which supports 2 UARTs can be used for this application.

d) Server:

The server is serially connected to the gateway device (Xbee coordinator) which provides the data received from various handheld devices. The server decodes it and updates the central attendance database.

III. IMPLEMENTATION

This section covers the topics –

1. Fingerprint enrollment
2. Updating attendance
3. Frame format
4. Xbee frame transmission
5. Data transmission

A. *Fingerprint Enrollment*

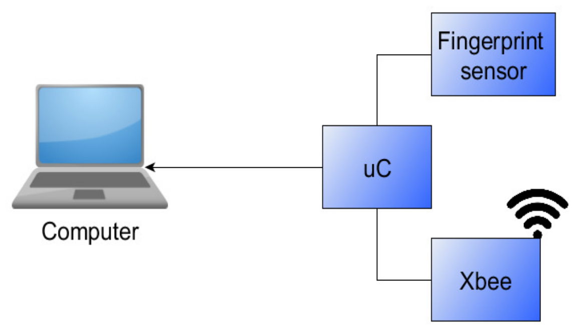

Figure 3: Enrollment setup

The first step in Smart Attendance System is to enroll the fingerprints of students and professors in a distinct handheld device which is a one-time event.

Figure 3 shows the setup required during fingerprint enrollment phase. The fingerprint module is connected to the microcontroller and they communicate with each other using serial communication. The controller is also initialized for serial communication with a computer. The flowchart in figure 4 explains the series of actions performed by the controller during the enrollment of a new fingerprint. A unique identification number (Roll number) is sent via computer to the controller serially. This identifier is used by the controller to command the fingerprint module to store the thumb impression template at the ID specified. Thus each fingerprint stored is associated with a corresponding ID. For the enrollment of each fingerprint, two images are taken and the information from both the images is used to generate a template which is then stored in the module. This template is used for search operations and whenever a match is found, the corresponding ID is sent serially to the microcontroller.

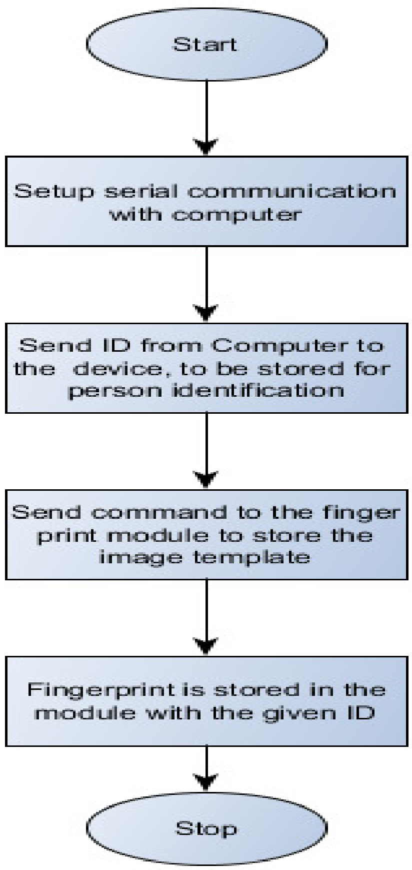

Figure 4: Fingerprint enrollment

B. Updating attendance

The first step in taking the attendance is Subject Selection. The professor selects the relevant subject using a button interface. As he presses the button, subjects pertinent to the class are iterated and are displayed on the LCD. He then confirms it by asserting his fingerprint on the sensor. The device is then passed onto the students so that they can register their attendance. After all the students have recorded their attendance, the professor closes the session by asserting his fingerprint again. Now, the device frames the attendance data and stores it locally, further sends it to the gateway device according to a smart algorithm explained later. The figure 5 depicts the flow explained above.

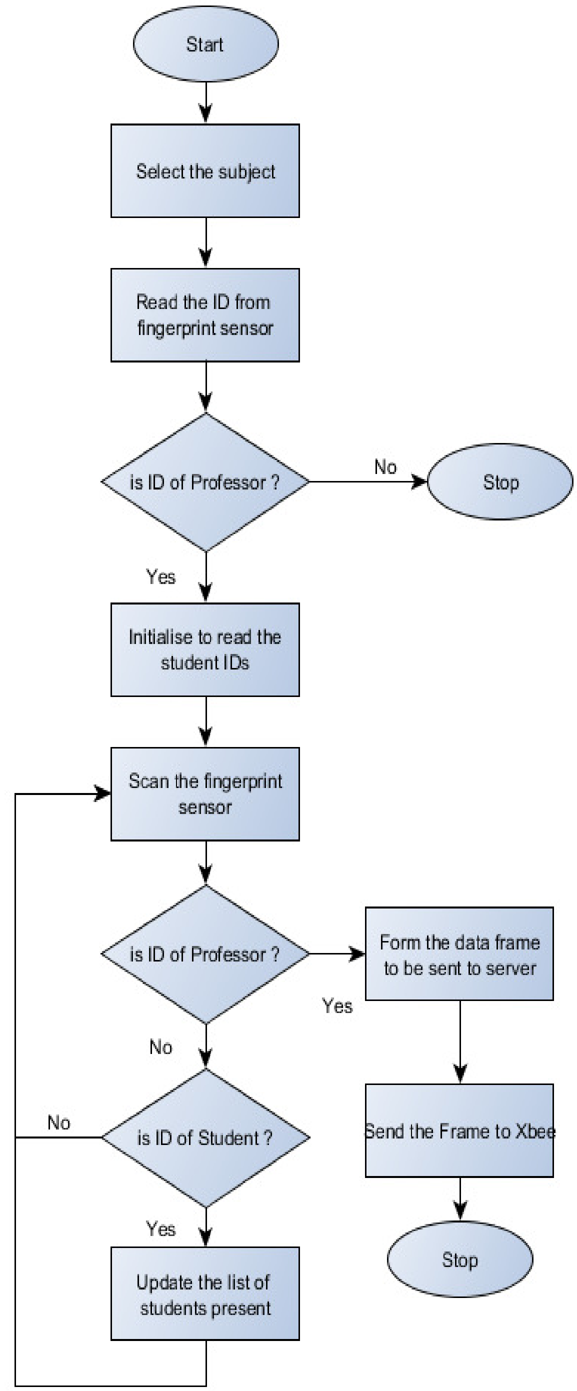

Figure 5: Flowchart for updating attendance

C. Frame format

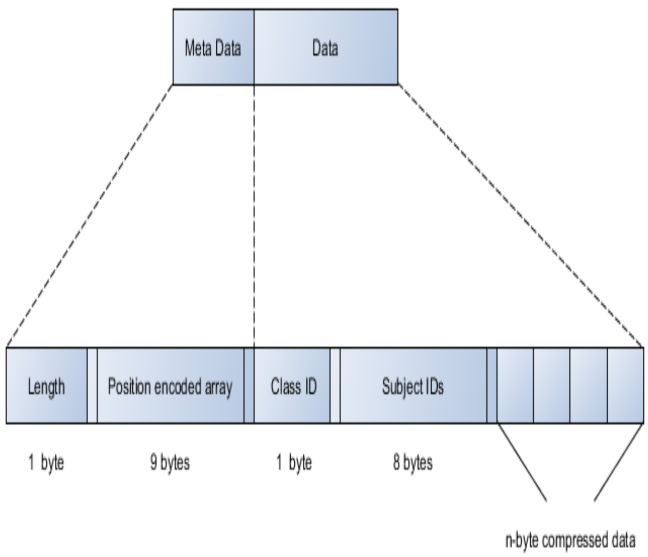

Figure 6: Frame format

Figure 6 shows the frame template that is transmitted from handheld device to gateway device.

The frame consists of Metadata and Data (payload).

Metadata is made up of:

1) Length: Size of frame in bytes.
2) Position encoded data: This is generated during - Maximum occurrence byte encoding

Payload is made up of:

1) Class ID: a unique ID assigned to each class.
2) Subject IDs: Unique subject IDs for classes conducted in order.
3) n-byte compressed data: This is the data obtained after Run-length encoding.

D. Xbee frame transmission

All Xbees are configured in API mode. Data needs to be sent in API frame format from controller to the end device serially in order to transmit it to the coordinator (gateway). Figure 7 shows the generic API frame format.

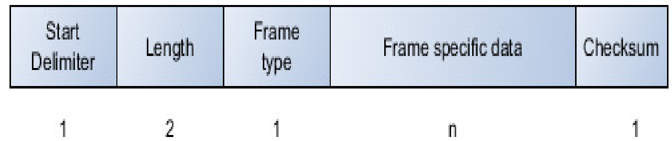

Figure 7: API frame format

For transmission, Frame type is configured to – Transmit Request Frame (0x10). Frame specific data has 3 important fields for Transmit Request Frame:

1) 64-bit Destination address – This address should correspond to coordinator's address.
2) Options – 0x40 - Use the extended transmission timeout for this destination. On setting this option, Xbee retries transmission multiple times, in the case of failure.
3) RF Data - This will be compressed attendance data obtained after RLE. It can be up to 255 bytes.

E. Data transmission

Sending the recorded attendance data is done through Xbee. Xbee while transmitting data can consume up to 215mA (Link), which can be considered as overwhelming for a handheld battery backed device. Hence we need to use Xbee efficiently to save power. The power consumed by Xbee increases with every byte of data transmitted. It approximately takes 32 microseconds [1] for transmission of 1 byte of data. Thus, it is evident that by reducing the size of data, we can reduce the transmission time, hence power. Various compression mechanisms can be employed to reduce the payload[5]. However, the resource limitations of microcontroller have to be considered while selecting the compression technique.
Taking into account all these factors, data is compressed using the following 3 steps:

1) Packing of attendance data:

Attendance of each person for 7 classes is packed into 1 byte. In figure 8 C1, C2 ... represent the attendance, in order, for the classes conducted. A bit is set if the student is present, else cleared. MSB is reserved for facilitating Run-length encoding.

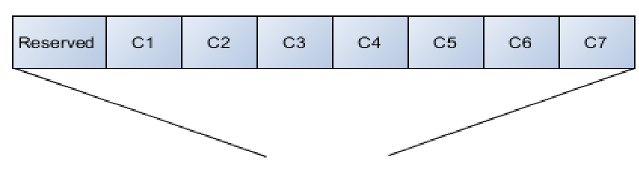

Figure 8: Packing of attendance data

2) Maximum occurrence byte encoding:

It is very likely that attendance of multiple students is same. To encode such repetitive data, the following technique is used [6].

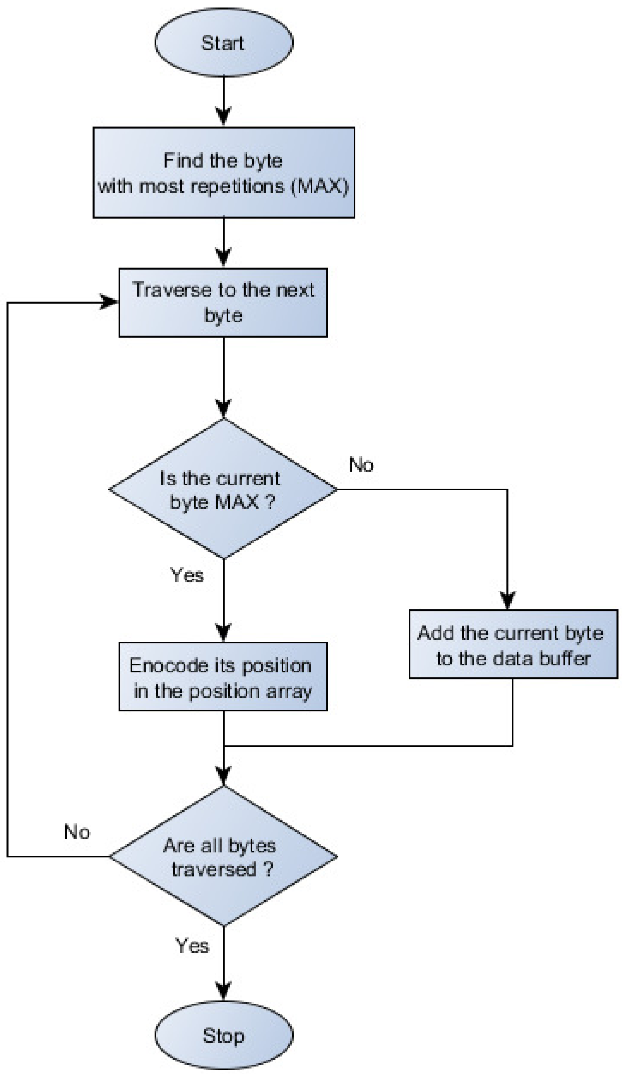

Figure 9: Maximum occurrence byte flowchart

Ex: Consider the data:

0x32, 0x5f, 0x4d, 0x1, 0x1, 0x1, 0x3c, 0x3c
Here, the element with maximum repetitions is 0x01. Following iterations show the values of position array and data buffer

Position array	Data buffer
0x00	0x32
0x00	0x32, 0x5f
0x00	0x32, 0x5f, 0x4d
0x10	0x32, 0x5f, 0x4d
0x18	0x32, 0x5f, 0x4d
0x1c	0x32, 0x5f, 0x4d
0x1c	0x32, 0x5f, 0x4d, 0x3c
0x1c	0x32, 0x5f, 0x4d, 0x3c, 0x3c

The position array will be a part of metadata. The data buffer will be passed to RLE algorithm for further encoding.

3) Run-length encoding:

Run-length encoding (RLE) is a very simple form of lossless data compression in which runs of data (that is, sequences in which the same data value occurs in many consecutive data elements) are stored as a single data value and count, rather than as the original run.

PackBits is a commonly used format in RLE. Here, PackBits format is employed with some modifications. In standard PackBits format, both signed and unsigned integers can be encoded, here, we are limiting it from 0 to 127. By introduction of this limitation, the overhead data of delimiters is reduced.

Ex: if the data is –

0x1, 0x32, 0x5f, 0x4d, 0x1, 0x1, 0x1, 0x3c, 0x3c, 0x3c, 0x3c, 0x4d, 0x5c, 0x5c, 0x5c, 0x5c, 0x5c, 0x5c, 0x3d, 0x7c, 0x7c, 0x7c
Length of data – 22 bytes

RLE Encoded data –
0x1, 0x32, 0x5f, 0x4d, 0xfd, 0x1, 0xfc, 0x3c, 0x4d, 0xfa, 0x5c, 0x3d, 0xfd, 0x7c
Length of encoded data – 14 bytes

The above method of encoding was tried with multiple samples of attendance data and we found that -
Data was compressed to an average of 70-75% of the actual data. Thus, both number of transmissions and power consumed were reduced.

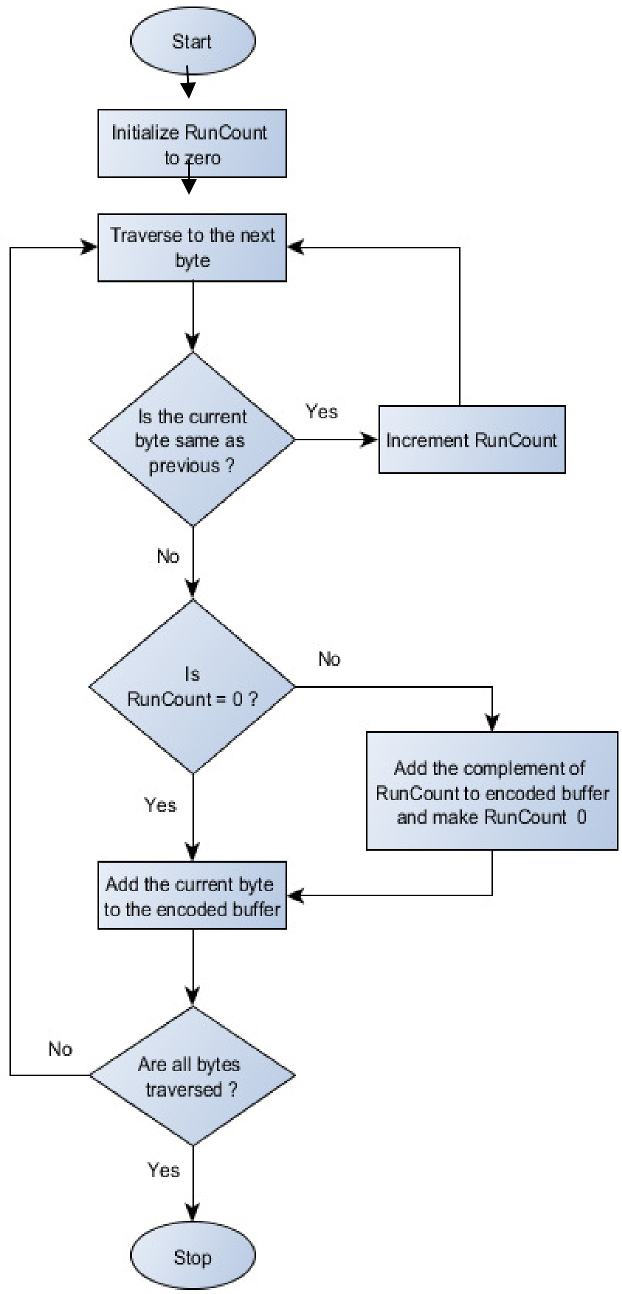

Figure 10: Run-length encoding

IV. RESULTS

The proposed Smart Attendance System was implemented using ATMega328 as a controller, XBee Tx and Rx, R305 fingerprint sensor, and a PC running localhost server. Smart handheld devices were used in multiple classrooms and the attendance data was continuously updated in the localhost server.

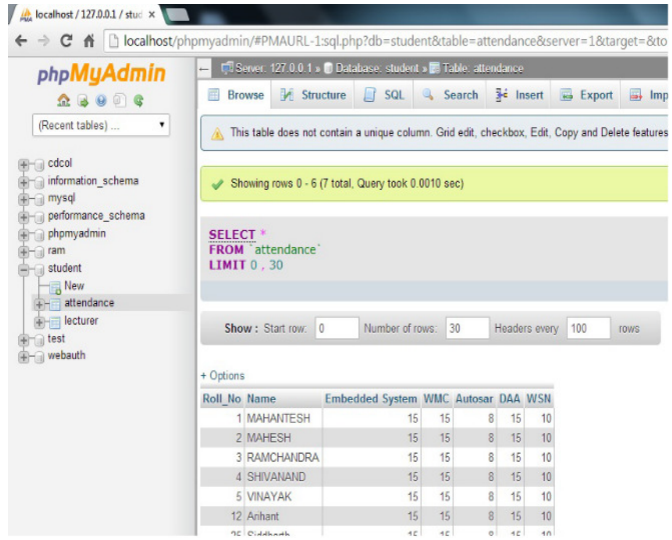

Figure 11: MySQL database

Figure 11 shows a database of student names and attendances for each course. This data is fetched using PHP, to create an HTML page for display.

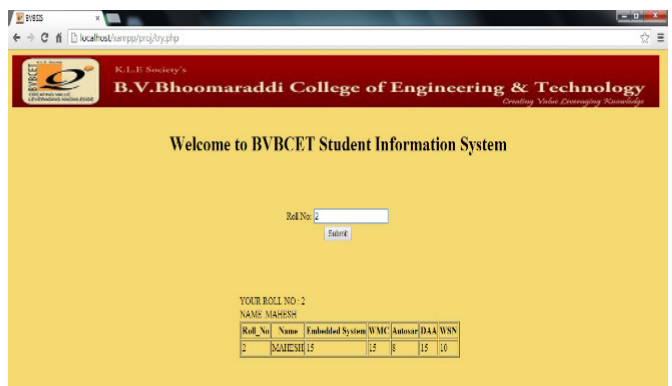

Figure 12: Webpage showing student attendance

The Figure shows a webpage containing the attendance data of a student.

Figure 13: Student registering his attendance

Figure shows the completed portable handheld module used for the Smart Attendance System

V. CONCLUSION

Through this project we were able to model a simple and fool proof attendance system which monitors students' attendance by using biometrics and automatically updates it to the school/college website without teacher's intervention and thus helping to solve the problems existing in attendance monitoring in schools and colleges.

VI. FUTURE WORK

This system can also be used for attendance monitoring not only in schools/colleges but also in various scenarios like corporate offices, government offices, clubs etc.

A standalone module could be developed using GPRS technology which will eliminate the requirement of a local web server.

A central database containing information about all the fingerprints can be maintained which can eliminate the restriction of using a unique module to every class.

Better compression algorithms can be used by using advanced controller.

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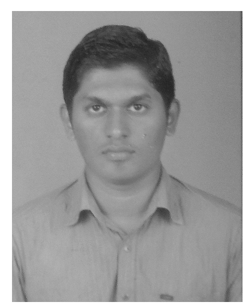

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