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Biometric Course Attendance Monitor for KNUST

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Abstract. During lectures, unless a lecturer clearly spots out that a particular student is absent, it becomes difficult to do so in an institution where manual system or sheet of papers are used for recording attendance. Students can sign the signatures of their colleagues and hence fill in the particulars of their absentee friend during attendance recording. This attitude employed by students nullifies the very purpose of taking attendance during lectures. Fingerprints are unique to each individual. They are considered as the best and fastest method for biometric identification. The hand or fingers of a student cannot be passed on to a colleague and hence his/her fingerprints. In an academic environment, the ability of a student to make a copy of his/her fingerprint for the purpose of proxy attendance recording is minimal or non-existent. A student has to be present at a lecture before he/she can be verified biometrically. In this paper, we present a fingerprint-based Biometric Course Attendance Monitor (BCAM) for recording attendance in educational institutions. The system comprises of an embedded device and a web application. The embedded device records attendance electronically after a student is identified using fingerprint recognition system. Attendance is recorded and stored locally on the embedded device. The device is then interfaced with a web application for managing the attendance records of students.

Keywords: Biometric, fingerprint, attendance, student, lecture.

1. Introduction

Punctuality and regularity are important for the growth and development of any institution as well as individual personality [1]. It is therefore required to people's attitudes towards these two ethics in check. Several methods have been adopted including head-count, writing list of names, among others. However, students use means to get their attendance marked without being present. Students especially those in tertiary are used to getting their names into the attendance list without them being present. One common way is getting their friends to write down their particulars and sign for them in their absence. In an institution such as Kwame Nkrumah University of Science and Technology, where students are prepared for employment and job creation, there is the need to ensure punctuality and regularity and hence a robust attendance system is required. Attendance monitoring is hence very crucial in the assessment of students in this institution. It is thus important to check and verify whether a student is present or absent.

In KNUST, student's attendance to lectures is recorded using sheets of paper. A sheet of paper is passed around for each student to write down his/her name and sign against it. Some students record the attendance for their mates who are absent. Due to the class size, it's very difficult for lecturers to determine who is present or absent by using this system. Some lecturers also decide to call out student names to verify their presence or not in the class. However, with a large class size, valuable time is spent out of the lecture period. This therefore defeats the purpose of taking attendance in class.

In this paper, we present a Biometric Course Attendance Monitor (BCAM) based on fingerprint data verification for taking attendance during lectures [2]. The fingerprint attendance monitoring system seeks to overcome the pitfalls associated with the manual system used in this institution. By accurately identifying a student through his or her fingerprint [3], the names of absentees in the attendance list can be easily determined. We propose the system to monitor attendance effectively and also ensure integrity of attendance recorded.

The rest of the paper is organized as follows: Related works are presented in Section 2, the proposed model is presented in Section 3, Testing in Section 4 and the Conclusion in Section 5.

2. Related Works

Suryawanshi et al. [4] proposed an attendance system using fingerprint identification with a graphical user interface (GUI). The system uses a fingerprint sensor and LCD screen connected to a microcontroller placed at the entrance of every room. To record attendance, the student places the finger on the fingerprint scanner. When the student is identified, notification is given on the LCD screen and attendance is updated locally and later updated in the database. A software was built to enroll students onto the system, and the same software is used to input test marks of students into the system. A website was also built to enable parents view test marks and attendance information of students.

Myint and Nyein [5] proposed a fingerprint-based attendance system using an Arduino Uno controller.

The system uses a fingerprint sensor connected to a microcontroller, which is also connected to a computer to record student attendance. When the fingerprint sensor is pressed, the student's fingerprint data is read and related information of the student is displayed on the computer. The information is displayed on the computer with the aid of a software called parallax microcontroller data acquisition add-on tool. The tool displays the information in an MS Excel sheet.

Krishnamurthi et al. [6] proposed a fingerprint-based attendance system. The system connects a fingerprint sensor to an Arduino microcontroller. Fingerprint data and user ID are stored in flash memory during the enrolment process. During attendance taking, the system compares captured fingerprint data with fingerprint data in its flash memory for a match and then attendance is marked against the ID.

The system proposed by Suryawanshi et al. is not mobile and could easily be damaged by student vandals. Also, in the case of a large class size, there will be long waiting times for students to have their attendance updated, which could lead to a delayed start of the class. The system proposed by Myint and Nyein needs a connection to a computer, making it immobile. The system proposed by Krishnamurthi et al. has no central secure database and attendance data will be lost in the event of failure of the flash memory. It also does not provide a way to easily view attendance records.

3. Proposed Model

The proposed model consists of three major components: the processing module, the fingerprint module and the web application.

The processing module is the major component of the BCAM. It is responsible for initializing the system and also coordinates the entire operations of the system. It is made up of a microcontroller, an LCD screen, LEDs and pushbuttons for operation. It also has a storage unit connected which stores data locally.

The fingerprint module captures the fingerprint data of the student to record attendance.

The web app is a graphical user interface platform which provides access to the database. The database contains information about registered courses of students, student details, lecturer details and information on attendance retrieved from the processing module. The web app is hosted on a local server and is not accessible to the general public.

The storage unit connected to the microcontroller is capable of storing an offline database of the students, lecturer and course details to enable attendance taking. Minutiae fingerprint templates are used to store fingerprint data to reduce the size they occupy on the storage device and also to improve on the security of the system [7].

Figure 1 below is a representation of the proposed model.

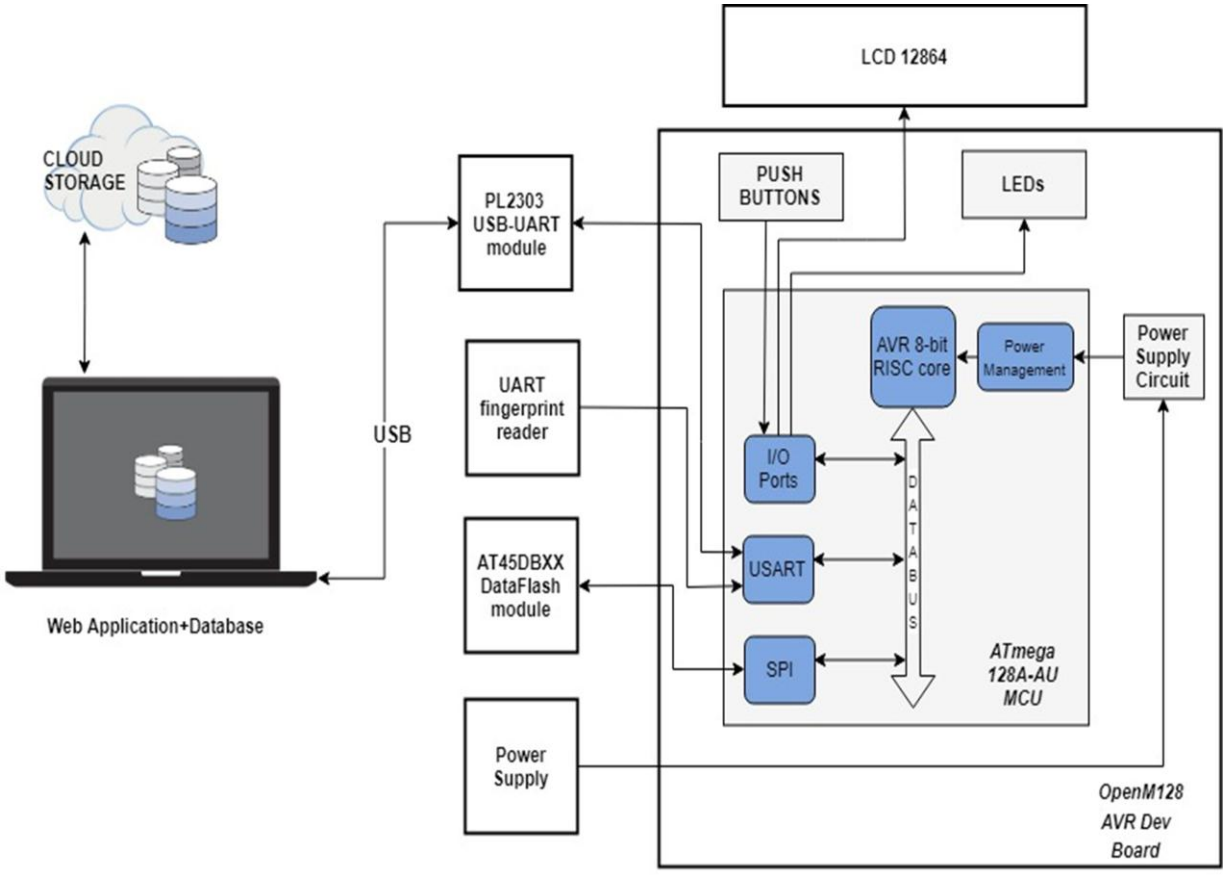

Figure 1. Proposed model

3.1 System Operation

For the BCAM system to function as intended, it goes through four major stages: Registration, Fingerprint scanning and authentication, Attendance recording and Attendance updating. The stages are described below.

- **Registration**: Fingerprint data and students' courses of study are required for the operation of the system. This data is acquired through registration of the students. Student's names, index number, fingerprint data, courses registered and course lecturer are acquired at the beginning of the semester during the registration period. This information is stored in the BCAM database. The information is then downloaded onto the processing module's storage unit for attendance recording during lectures
- **Fingerprint Scanning and Authentication**: Fingerprint scanning and authentication is done during attendance taking at lectures. The student's finger is scanned and compared to existing fingerprint data on the storage unit for a match. If a match is found, the corresponding name and index number, represented with a unique ID is sent to the student list for attendance recording
- **Attendance Recording**: Attendance recording follows immediately after fingerprint authentication. The received ID from the fingerprint authentication is used to mark against the student's name and index number to indicate their presence in the lecture
- **Attendance Updating**: After the lecture, the lecturer connects the processing module via USB to a computer and downloads the attendance recorded via the web app to the database.

3.2 Operation Modes of BCAM

The mobile BCAM operates in three modes: Attendance recording mode, Records viewing mode and Data Loading mode. The operations are described below.

- **Attendance Recording Mode**: In this mode attendance, is marked for each student that is present in class and whose fingerprint been verified for the course. The course is first selected by entering

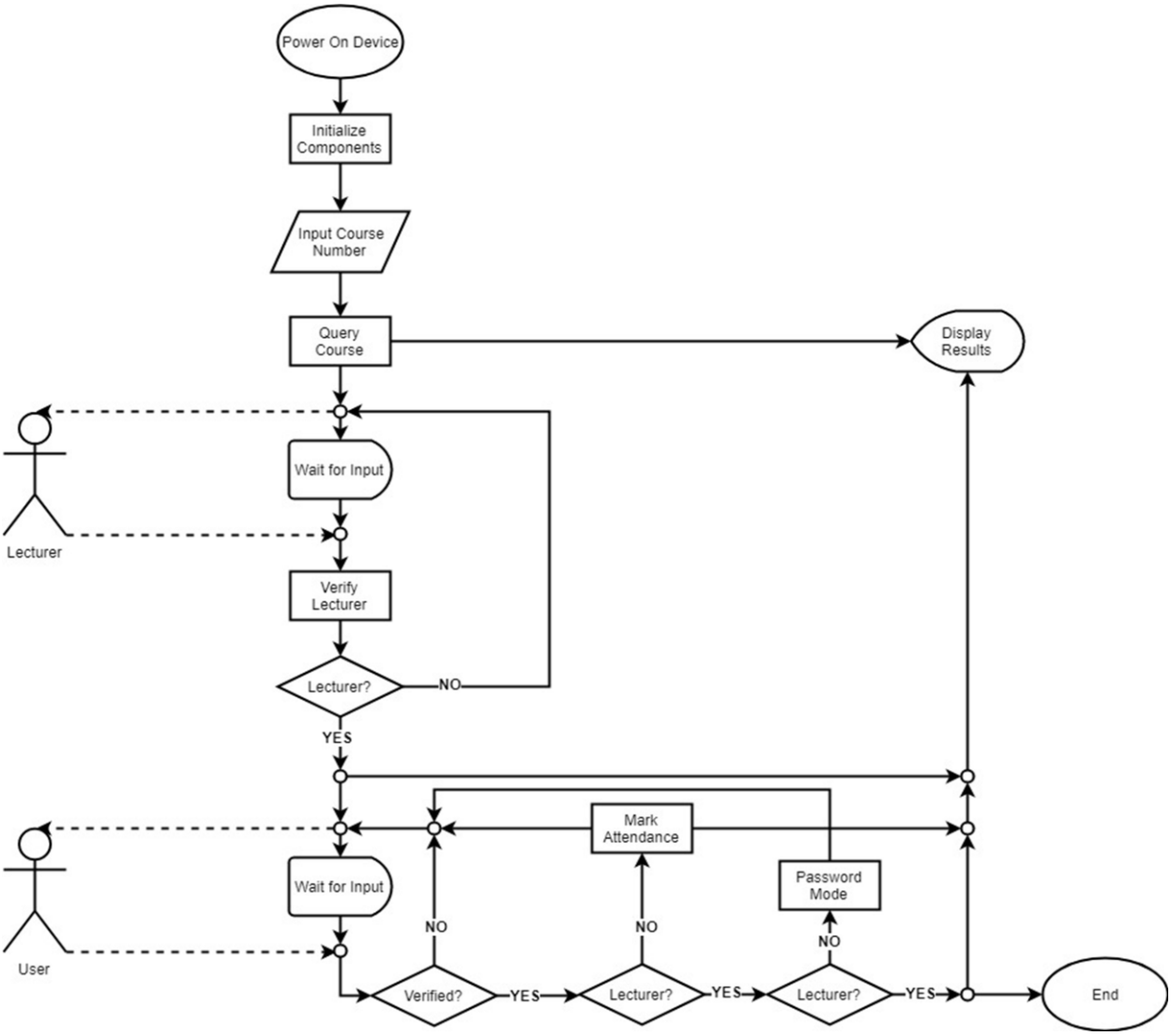

Figure 2. Attendance marking process flow

course ID, then the lecturer of the course is authenticated using the fingerprint module. The Lecturer ID from the fingerprint module is verified against data in memory and the attendance recording begins. Figure 2 shows a flow chart of the attendance recording process. For students whose fingerprint data cannot be captured for one reason or the other, a password mode is provided for the lecturer to manually mark attendance for that student

- **Records Viewing Mode**: In the records viewing mode, a lecturer is able to view attendance recorded for each student taking that course. The course number must first be supplied followed by lecturer authentication and verification through the fingerprint module. After this, the record of each student is displayed one at a time on the LCD screen, navigation is possible via the pushbuttons. These records can also be viewed easily on the web application. Figure 3 shows a flow chart of the records viewing process
- **Data Loading Mode**: In data loading mode, data is downloaded from the database through the web app to the mobile BCAM or from the mobile BCAM to the database for updated records

4. Testing

A prototype of the BCAM system was built using an AVR Open-M-128 Development board as the processing module, an AT45DBXX data flash board for storage, a PL2303 USB UART Board for USB interfacing, an LCD screen and a fingerprint reader. The setup is shown in figure 4. A web app was written and a database was created. Connection to the PC is shown in figure 5.

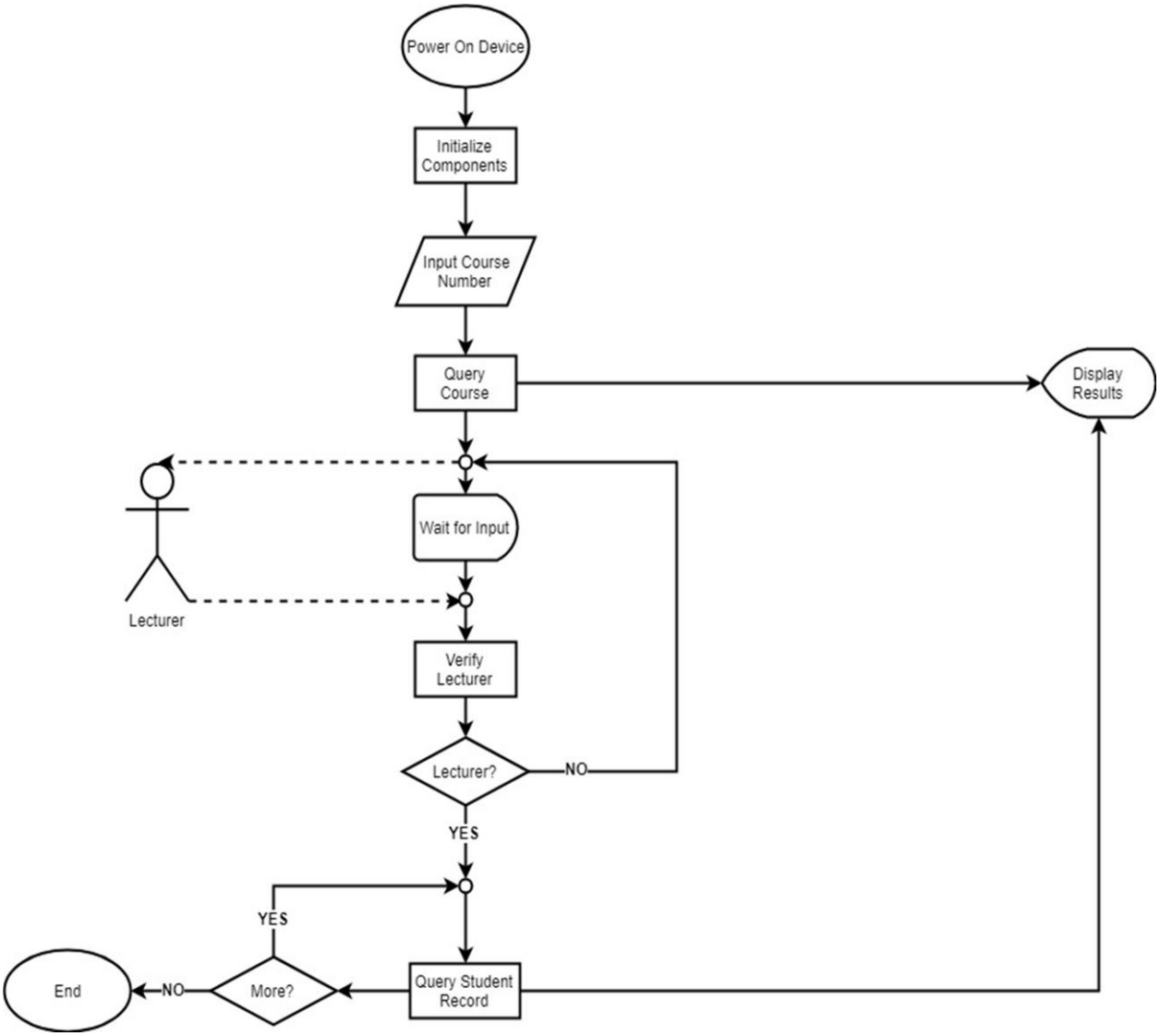

Figure 3. View Records process flow

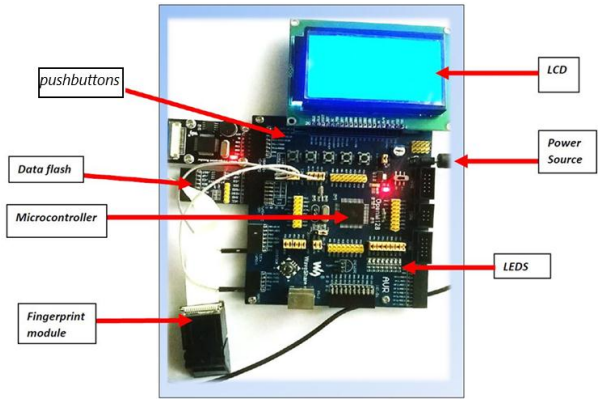

Figure 4. Handheld BCAM system

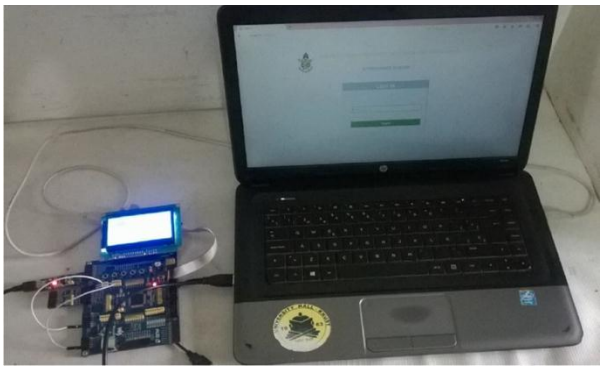

Figure 5. Handheld BCAM connected to PC

The system was setup and tested with dummy data input into the database. The different modes of operation were then tested. Figure 6 shows the LCD display of the mode selection menu.

Figure 6. Mode selection

The first mode selected was the Load Data mode. The Load data mode puts the device in receive mode to download data from the computer-based database via the web app through the USB connection. The data was successfully loaded onto the device and Figure 7 shows the success message

Figure 7. Data loaded

The various other modes were also tested to ensure they work as expected. Figures 8-12 show the various modes and functions tested and the feedback on the LCD screen.

Figure 8. Mark Attendance mode selection

Figure 9. Course selection

Figure 10. Course selection confirmation

Fgure 11. View Records mode selection

Figure 12. Attendance record of student

5. Conclusion

By successfully building a fingerprint attendance monitor, we have been able to create and maintain a simple and effective attendance management system. Using fingerprint for identification and verification will ensure that no student can record attendance for his/her friend since fingerprints cannot be passed on to another. The Biometric Course Attendance Monitor was designed to be portable and mobile to ensure attendance can be taken during lectures in KNUST by passing the device round. The web application also enables connection and updating of the centralized database with students' attendance records from the mobile device. The system was tested and worked as expected. More tests and analyses will be conducted to determine the efficiency, power consumption, latency, costs of mass production as well as miniaturization of the system hardware.

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