

Design and Implementation of RFID and Fingerprint-Based Student Verification System

Mounira Taileb

Abstract: *Thousands of students and university employees come every day to King Abdul-Aziz University, and their identities must be verified at the entrance gates by security employees, which causes crowding and delays. Moreover, security employees have to verify all the university identity cards at the end of the day when students and university employees exit the university in a normal way or in case of emergency, and they have to check all places to make sure there is no one inside the university. In addition, it is possible to lose or forget the university identity card, in that case, the student has to fill out a form manually. In this project, a system has been implemented to solve the problems mentioned previously. The system consists of an RFID and fingerprint-based verification system. The system facilitates the work of the security employees at the entrance gates, helps the educational affairs employees to manage the records of students when they forget their cards and saves the time of students when they enter/exit the university and especially when they forget their university identity cards.*

Keywords: *Fingerprint processing, control system, RFID, verification system.*

I. INTRODUCTION

In the recent years, a large number of systems based on Radio Frequency Identification (RFID) technology have been developed or proposed. The RFID technology has been utilized in a variety of applications such as transportation [1, 2], health-care [3, 4], security and control such as the attendance systems [5-7] and library management systems [8], etc. RFID technology consists of collecting signals though wireless from tags and reads information from these tags. The fingerprint processing is used as well in different biometric systems such as the attendance systems [9-12]. In general, the security and control systems use one of the two technologies to automate and facilitate the access to institutions [13], companies and parking places [14-16]. Due to the process followed by King Abdulaziz University in the entrance and exit, a system that combines both RFID and fingerprint is proposed.

Thousands of students and university employees come every day to King Abdulaziz University, and their identities must be verified at the entrance gates (by verifying their university identity cards) by security employees, which causes crowding and delays. In addition, security employees have to verify all the university identity cards at the end of the day when students and university employees exit the university in a normal way or in case of emergency, and they have to check

all places to make sure there is no one inside the university. Losing or forgetting the university identity card by students is possible, in that case, the student has to fill out a form manually and submit it to the educational affairs. To solve the problems mentioned previously, a system using RFID and fingerprint technologies is proposed. The RFID technology is used to control and verify the physical access of students and university employees when entering and exiting the university, and fingerprint is used to verify their identities when they forget their university identity cards. Therefore, the verification process is accelerated with or without an identity card and with less involvement of the security employees. The rest of the paper is organized as follows: the methodology of the proposed verification system is described in Section 2. Then the details of system design and implementation are provided in Section 3. The GUIs of the implemented system are presented in Section 4 as results to show the system after implementation along with the benefits of the system for students, security employees and educational affairs employees. A conclusion is provided in Section 5 with the future work.

II. METHODOLOGY OF THE PROPOSED SYSTEM

Determining the requirements, design and architecture of the proposed student verification system was based on a questionnaire conducted at the girls' campus of King Abdulaziz University, it was filled out by 500 students. The analysis of the data collected from the questionnaire show that:

- 77.9% of students confirmed that showing their university identity card delay them to attend their lectures.
- 75 % of students went through the experience of losing their university identity card and faced problems to proof their identities.
- 98.6% of students agree that the process of filling out the form when they forget their university identity card and then going to the educational affairs takes a lot of time and effort.
- 97.2% of students agree that the proposed system will save their time when they enter or exit the university.
- 97.2% of students prefer using the fingerprint-based system to verify their identities when they forget their university identity card.

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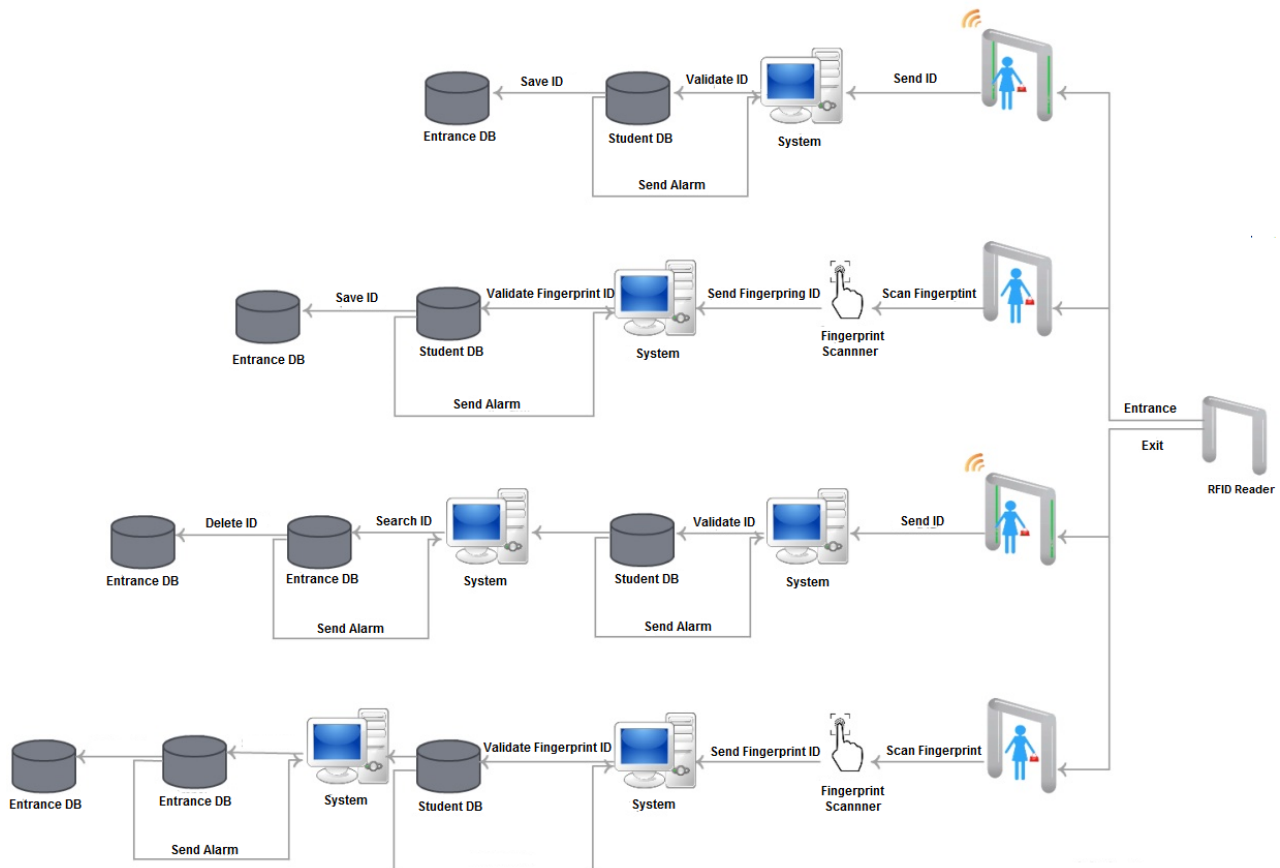


Fig.1. High-level system architectural diagram

The system proposed in this paper is to verify the students and university employees' identities when they enter or exit the university; it consists of four main components:

1. The application software: to verify identities and manage the entrance and exit.
2. The RFID reader: fixed at the entrance to read data from tags and update the application's database.
3. The tags: carried by students and university employees, each tag contains information about the holder. Tags are attached to the student or employee university identity card.
4. The fingerprint scanner: in case the student or university employee forgets the card he/she has to scan his/her fingerprint using the fingerprint scanner. Along with the entered university identity number, the identity of student or university employee is verified and a form is filled out automatically and sent to the educational affairs.

The two possible scenarios when using the proposed system are illustrated in Figure 1. The first scenario is when having the university identity card with the tag on it and the second scenario is when forgetting the university identity card.

1. The student or university employee passes by the gate with the university identity card, and then the RFID reader reads the university identifier from the tag on the university identity card and sends the information to the application software. The university identity number is used as a key to access the student's or employee's record, if it exists, the student's or employee's picture from that record is displayed on the screen for the security employee to verify his/her identity and the student's record is added to the Entrance database. When the

student exits the university, the verification process is performed as in the entrance, using the RFID technology, and his record is removed from the Entrance database.

2. The student or university employee passes by the gate without the university identity card, and then a warning alarm is displayed. In that case, the student or employee has to scan his/her fingerprint using the fingerprint scanner and enter his/her university identifier. The student's or employee record is accessed using the identifier as a key and the entered fingerprint is compared with the fingerprint saved in the record, if they match, a form is filled out automatically and sent to the educational affairs and the student's record is added to the Entrance database. When the student exits the university, the verification process is performed as in the entrance, using the fingerprint technology, and his record is removed from the Entrance database.

As described previously, the proposed student verification systems is based on the two technologies RFID and fingerprint processing. The steps performed when the student scans his/her fingerprint are illustrated in Figure 2. The features of the scanned fingerprint are extracted after performing the following pre-processing phases:

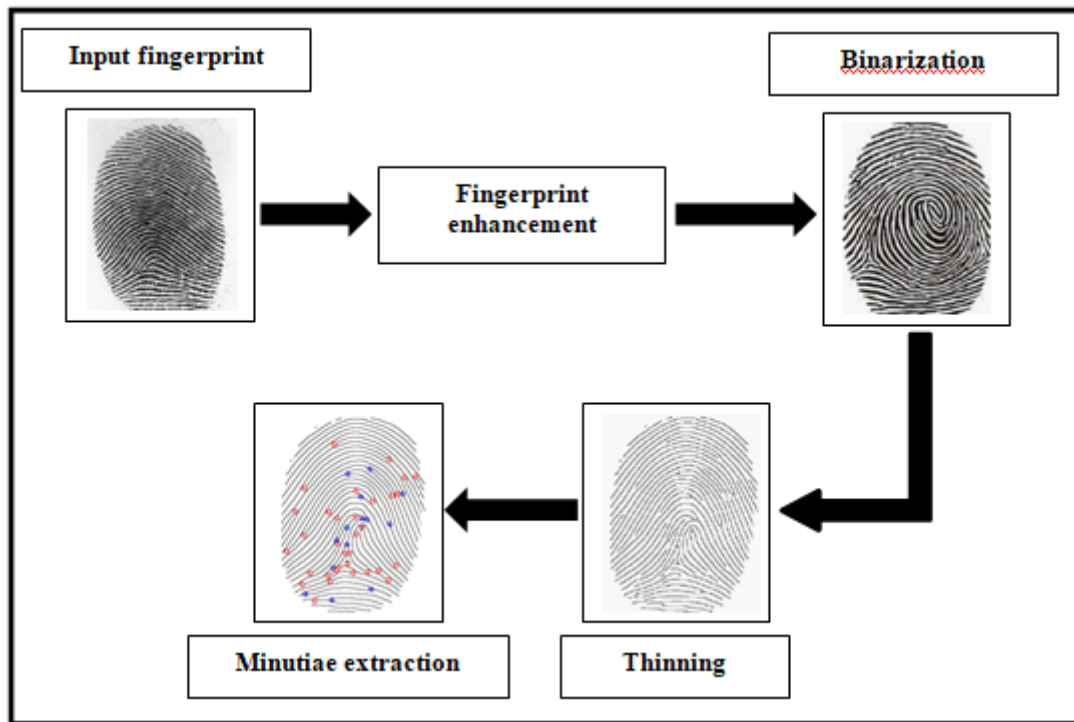


Fig.2. Minutiae extraction phases

A. Image enhancement

The low contrast in the image (scanned fingerprint) is adjusted, this is called normalization. Followed by the background detection, where the image size is changed to 252x256 pixels then it is divided into blocks of 16x16 pixels. The variance is computer for each block and compared to a threshold, if it is less than the threshold, then the region in the block is considered as a background. However, if the variance is greater than or equal to the threshold, it is considered as a foreground. After that the dominant directions are calculated using the Minimum Mean Square of the gradient (the local orientation of each block is estimated after division of the image into blocks of 32x32 pixels). The last step in the image enhancement is the filtering in order to reduce noise. The two-dimensional Gabor filter is used in filtering.

B. Binarization

The image is converted from the 256 gray levels to black and white. A threshold value is used and all pixels with values above this threshold as turned to white, and all other pixels are turned to black.

C. Thinning

The thinning, also called skeletonization, is a morphological operation. It preserves the connectivity of the original region and remove most of the original foreground pixels. The features of the fingerprint are extracted after the pre-processing phases. They are called minutiae and have several types: ridge ending, bifurcation, core, pore, island or dot, delta and crossover.

III. SYSTEM DESIGN AND IMPLEMENTATION

The following tools are used to implement the proposed system:

- GoDaddy and cPanel Hosting are used to create a domain with a remote database respectively. The tools used from cPanel to create the database are MySQL Database Wizard, Remote MySQL and PHP Admin.
- Visual Studio (Visual Basic) for implementation of RFID application and graphical user interfaces (GUIs).
- MATLAB, used for fingerprint feature extraction.
- JAVA, used for matching the features of two fingerprints.

An integration is done between Visual Basic and both MATLAB and JAVA codes. For the JAVA code an executable is created then integrated with Visual Basic.

The sequence diagram in the Figure 3 illustrates the entrance process when carrying the university identity card. The student passes by the gate with the university identity card, and then the RFID reader reads the university identifier from the tag on the identity card. The identifier is used to retrieve the record from students' database, if the record exists, the student's picture is displayed to the security employee and the student's record is added to the Entrance database. And if the student's record doesn't exist, an alarm is activated.

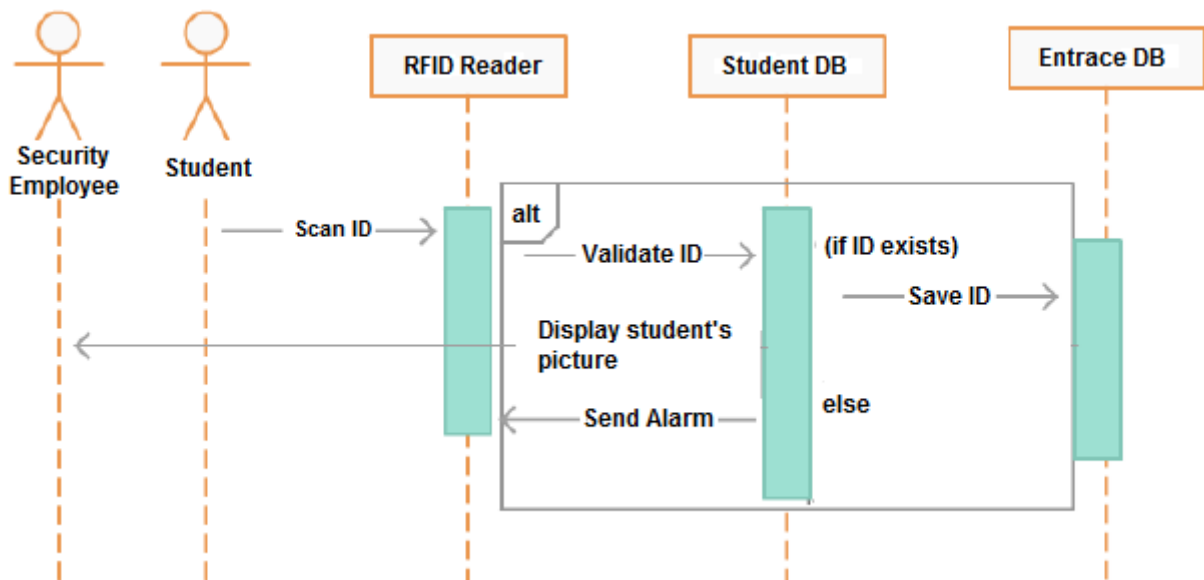


Fig.3. Sequence diagram for the entrance using RFID technology

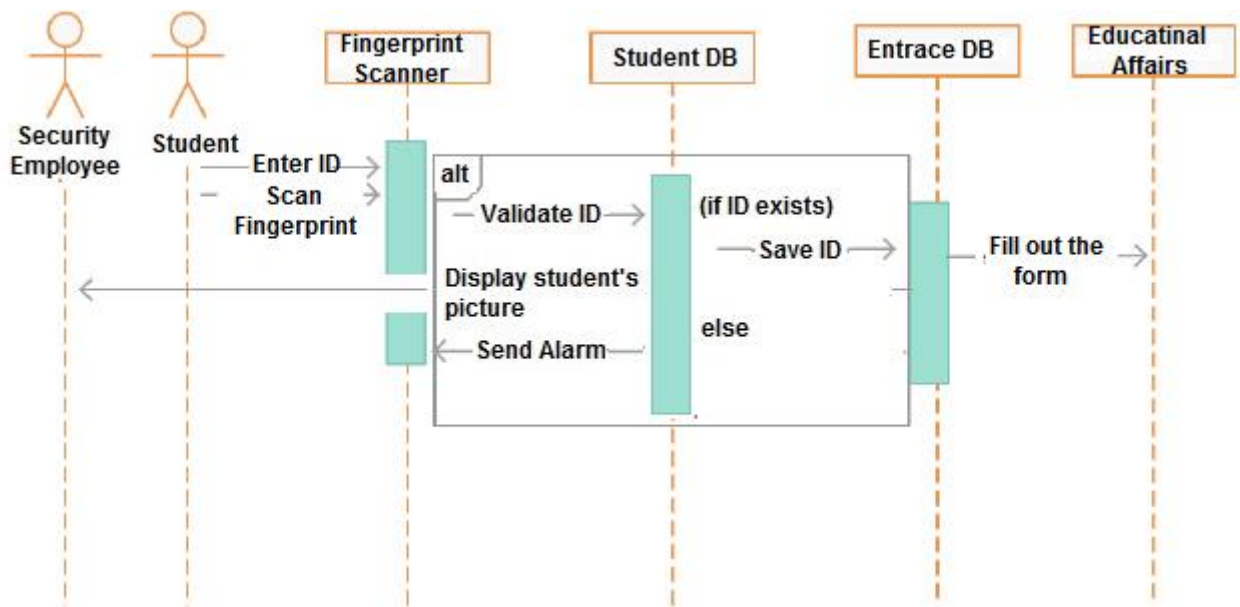


Fig.4. Sequence diagram for the entrance using fingerprint processing

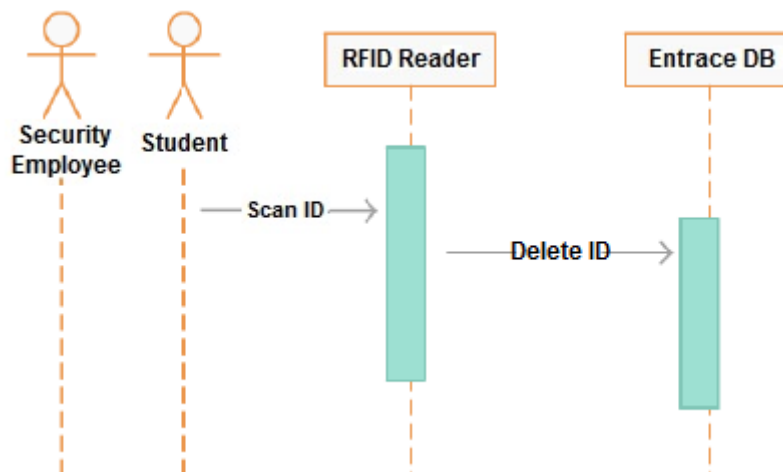


Fig. 5. Sequence diagram for the exit using RFID technology

The entrance process without the university identity card is presented in Figure 4. The student has to scan his/her fingerprint using the fingerprint scanner and enter his/her university identifier. The student's record is accessed using the identifier as a key and the entered fingerprint is compared with the fingerprint saved in the record, if they match, the student's record is added to the Entrance database and the form is filled out automatically and sent to the educational affairs.

When the student exits the university, the verification process is performed as in the entrance, using the RFID technology, and his record is removed from the Entrance database. This process is illustrated in the Figure 5.

The student who forgot his/her university identity cards when he/she exits the university, the verification process is performed as in the entrance, using the fingerprint technology, and his record is removed from the Entrance database as shown in Figure 6.

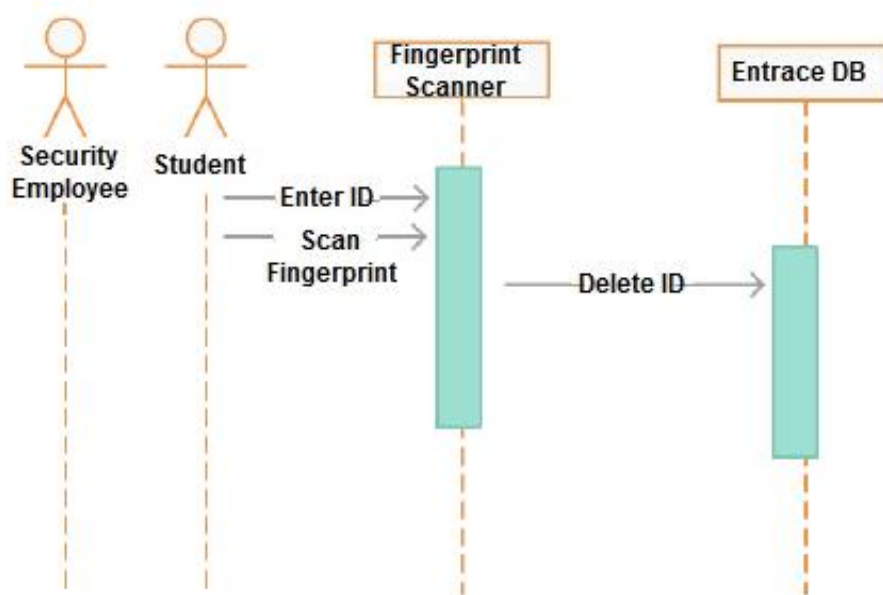


Fig. 6. Sequence diagram for the exit using fingerprint processing

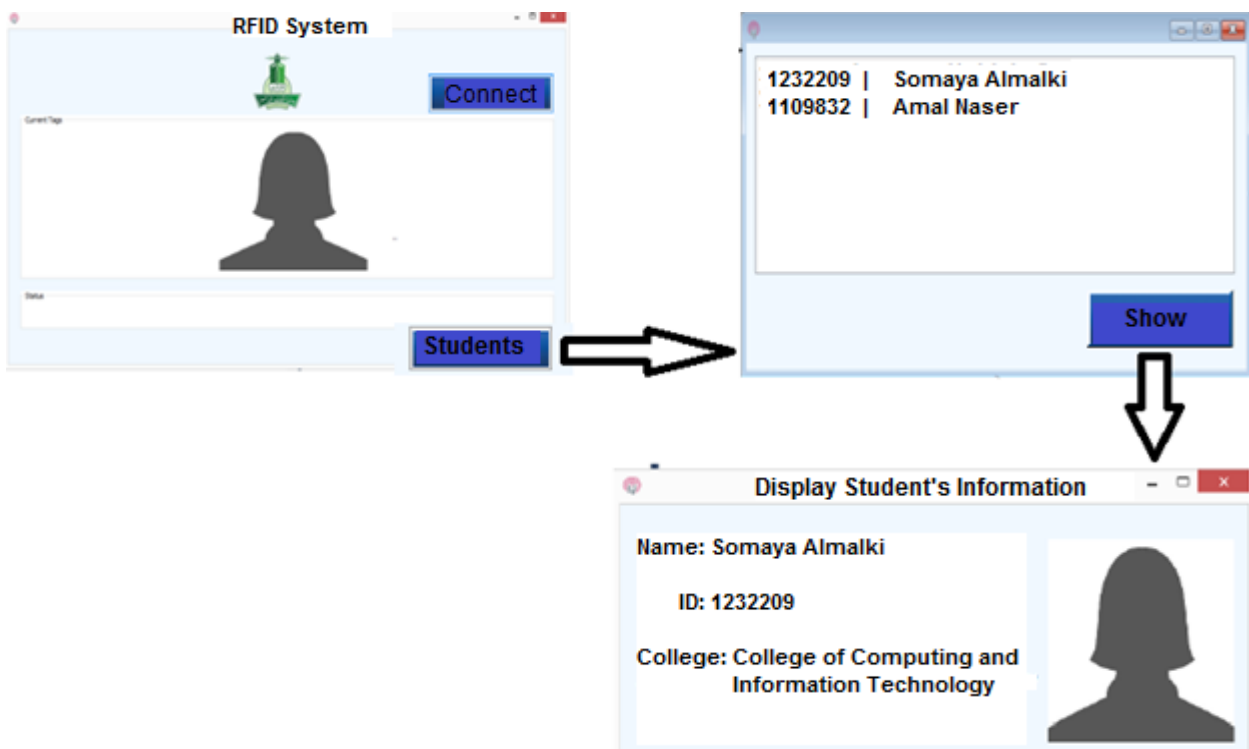


Fig. 7. Security employee interfaces when using RFID-based system

IV. RESULTS AND DISCUSSION

In this section, the proposed system is presented after implementation with its GUIs for both security employees and educational affairs employees. The security employee application has two sub-systems, the RFID-based and the fingerprint-based verification sub-systems. The interfaces of the RFID-based verification system are illustrated in Figure 7. When the security employee presses on the button “connect”, the RFID reader establishes the connection and the status of the connection is displayed. The RFID reader starts to read the tags when students pass through the gate with their university identity card and sends the information to the application software. The identity card number is used to access to the student’s record, if it exists, the student’s picture is displayed in the “student’s picture” box for the security employee to verify the student’s identity. This process is illustrated in the left corner interface in Figure 7. When the

security employee presses on the button “students” in the previous interface, the list of students inside the university is displayed, as shown in the top right corner interface in Figure 7. When the security employee presses on the button “students” in the previous interface, the list of students inside the university is displayed, as shown in the top right corner interface in Figure 7. And when the security employee selects a student from the list displayed in the previous interface and presses on the button “show”, the student’s information are displayed.

For the fingerprint-based verification system, the student scans his fingerprint and enters his university identity number in the verification interface, then the system verifies the fingerprint scanned by the student by comparing it with the fingerprint stored in the student’s record in the database. After clicking on the “verification” button, the result of the fingerprint matching is displayed, as shown in the Figure 8.

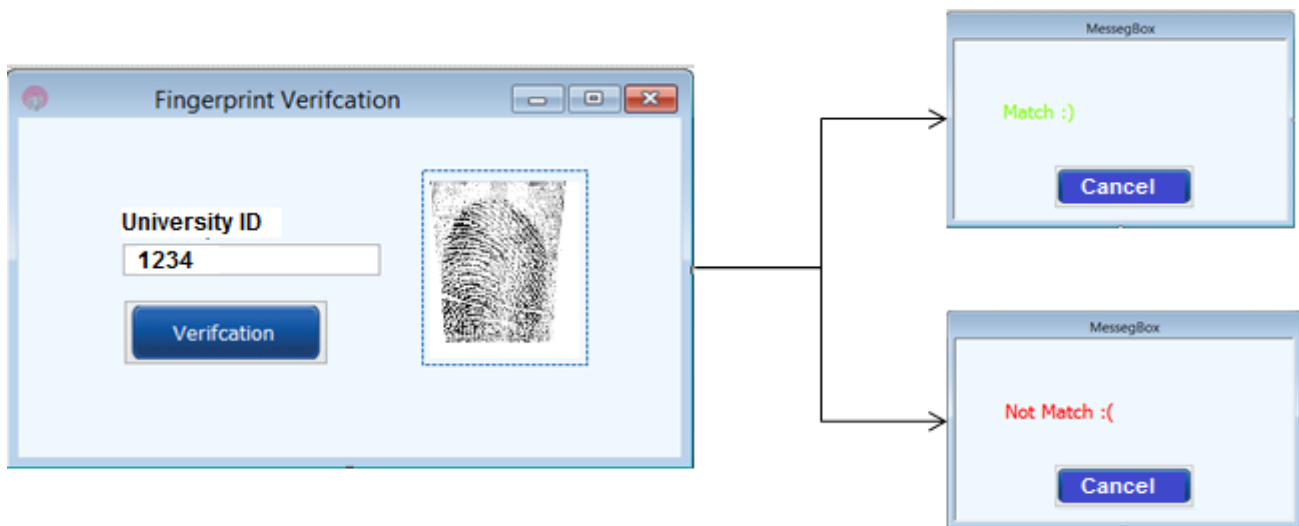


Fig. 8. Security employee interfaces when using fingerprint-based system

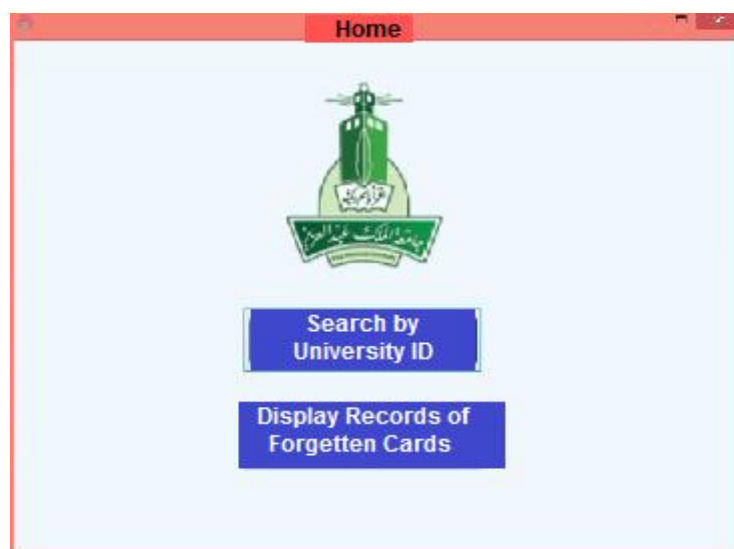


Fig. 9. Home page for educational affairs employees

The educational affairs employees from their side can use the system to manage the records of students who forgot their university identity cards. The home interface, illustrated in Figure 9, provides two main services to the educational affairs employees, the first one is the search for a specific student by his/her university identity number, and the second service is the access to the list of students who forgot their university identity cards.

The interface in Figure 10 is displayed after clicking on “*search by university ID*” button (in Figure 9), the employee has to enter a student identity number and click on the “*search*” button, the student’s information are then displayed in a new interface, as shown in Figure 11.



Fig.10. Search interface for educational affairs employees

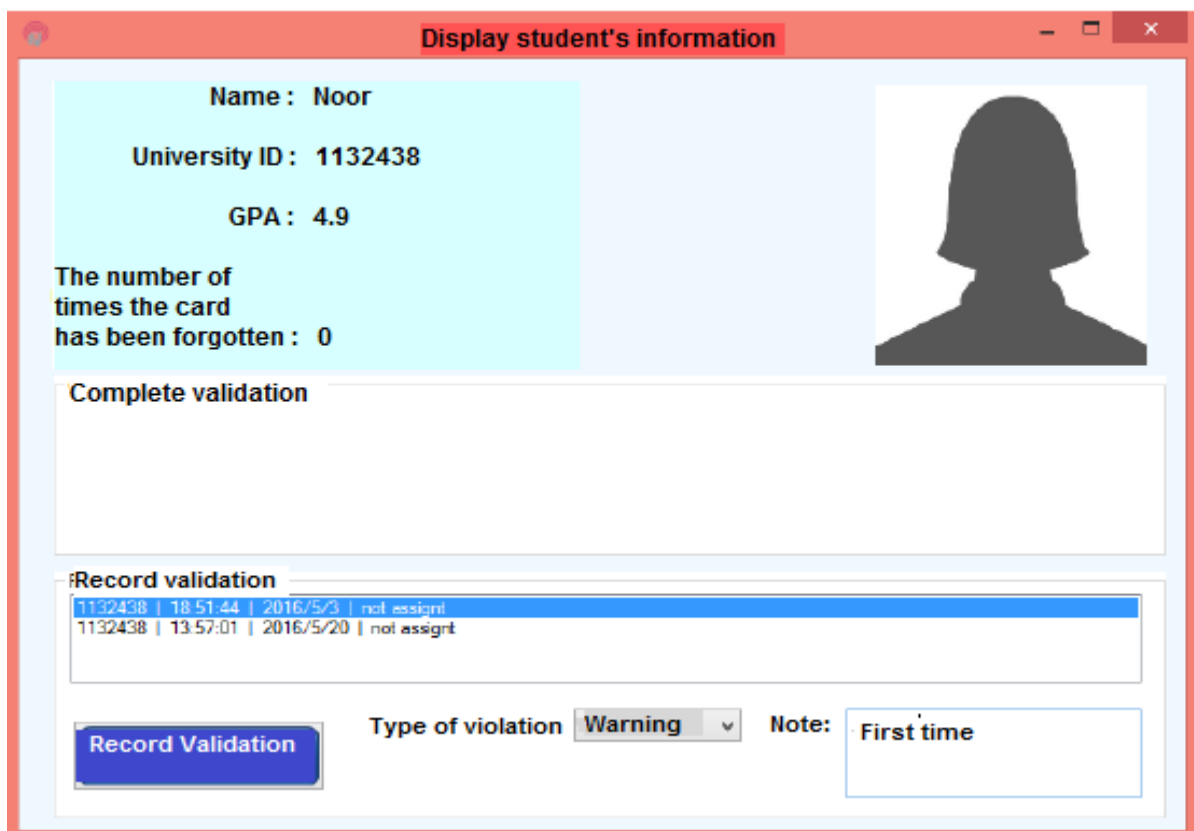


Fig.11. Display of student’s information interface

Design and Implementation of RFID and Fingerprint-Based Student Verification System

From the interface illustrated in Figure 12, the educational affairs employee has access to the records of students who forgot their university cards. The employee can manage the records by adding violations or completing the uncompleted violations. This interface is displayed after clicking on the second button in Figure 9.

The developed system has many benefits for students by saving their time and effort when entering or exiting the university, and for the security and educational affairs employees.

A. Benefits of the system for the security employees

1. The system displays the pictures of students who pass through RFID reader without need to check their identity cards manually.
2. The system is capable to recognize the university identity card when it is used for the second time by another student, or

if a student tries to pass through gate without a university identity card.

3. The system allows students who forgot their university identity card to use a fingerprint scanner to verify their identity.

B. Benefits of the system for the educational affairs employees

The system fills out automatically the forms of forgotten cards and send them automatically to the educational affairs employees. After that, it allows the educational affairs employees to manage the violations in the records of students who forgot their university identity cards.

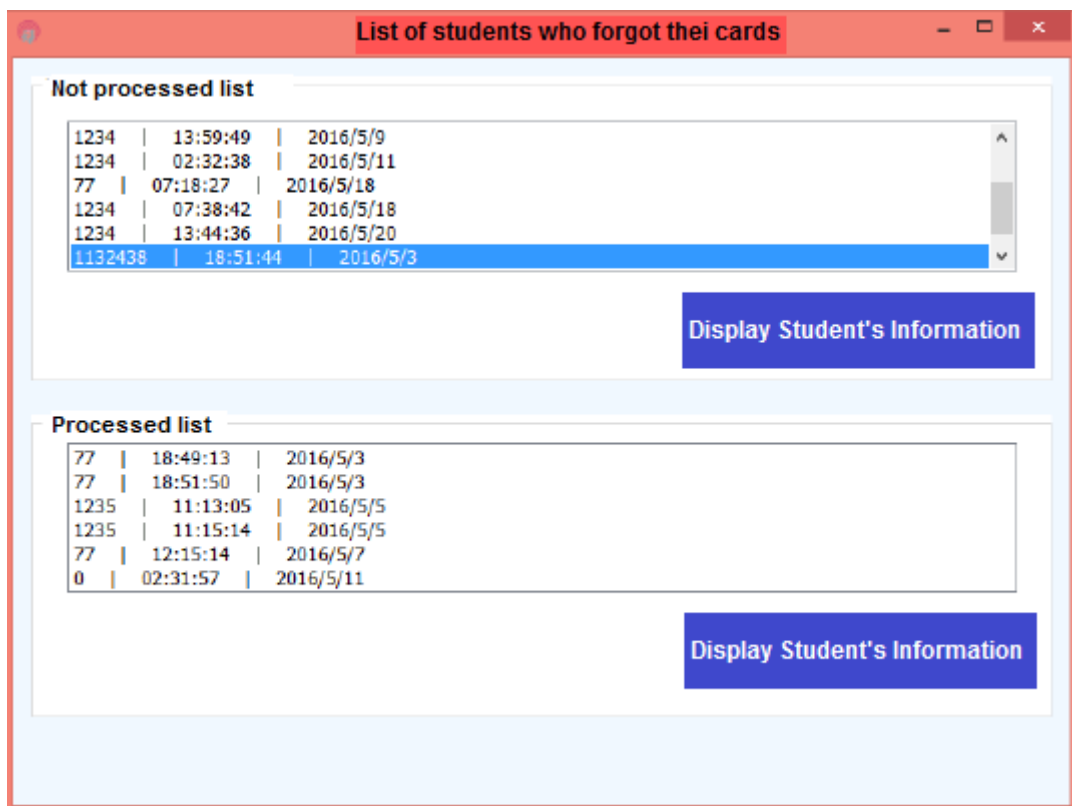


Fig. 12. Interface of students who forgot their cards

V. CONCLUSION

The goal of the system presented in this document is to facilitate the access of students and employees to the university in the morning and their exit at the end of the day using the RFID technology and fingerprint processing. The system deals as well with the case when a student forgets his/her university identity card, his/her fingerprint is used to verify his/her identity. In order to automate the detection of students who forgot their university cards, a thermal sensor has been integrated to the system to sound an alarm when a student passes by the RFID reader and no tag is read. However the thermal sensor interferes with the RFID reader. As future work, the system can be improved by using an RFID reader with an embedded thermal sensor.

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