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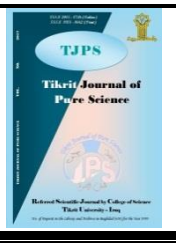

Arduino – Based Electronic Voting Machine

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Abstract

The main objective of this paper is to design and implement Electronic Voting Machine (EVM) using fingerprint sensor for authentication. The design is based on the microcontroller (Arduino Mega 2560), fingerprint sensor for scanning voter's fingerprint before voting, "2.4" TFT LCD screen for displaying the instructions and voter information, Buzzer, SD card reader. System database comprising password ID for all voters and fingerprint are stored in microcontroller for comparing and verification during polling. If already voter casted his vote and he/she trying to enter for second time into the electronic voting machine, then buzzer will alert the master user. The proposed Electronic Voting Machine will save the time and effort of voters as it is characterized by reliability and ease of use in addition to rapid response to users. At the end of the ballot, the result will be stored in flash memory through which the master user can retrieve and see them. During the construction of any electronic voting system, several aspects must consider, the most important is the privacy of voters and the accuracy of the voting process in addition to maintaining the security of data, this research provides a safe and reliable voting system.

I. Introduction

Voting schemes have evolved from hand counting methods in the early days of their appearance to more advanced systems that include the use of materials to facilitate voting process like: paper, punch card, mechanical leveraging, Due to the increasing technological development, scanning machines were used [1]. The main aim of the vote is to give voters the opportunity to exercise their right to express their choices on many issues [2]. The electronic voting system offers better features and capabilities than a traditional voting system such as ease of use, access to more accurate results, ease of navigation and verification as well as flexibility [1].

There are several types of voting machines as the following: DRE voting/counting, machine, EVM with voter verifiable paper audit trail (VVPAT), and EVM with paper ballot [3].

Almost all electronic voting systems around the world include several steps such as voter identification, voter authentication, store voting results, vote counting, and publish voting results. All these steps are used to help voters to cast their vote and to facilitate the voting process by their supervisors [2, 4].

Security is one of the most important considerations that must be applied in the development of the Electronic Voting Machine (EVM), so it is very necessary to design a secure Electronic Voting Machine (EVM).

The motivation of our proposed system is to improve the security of the Electronic Voting Machine (EVM) and to eliminate the problems facing the voting process, including process of repeating the votes and Illegal votes. This is done by using the fingerprint to verify the identity of the voter. The fingerprint images of all voters and the password ID are stored by the master user in a (EVM) database; this facilitates the process of voting and counting the votes as it helps to reduce the error.

II. Related work

Pal N.S. and et al. [5] developed and designed an EVM using the RFID and fingerprint sensor. The proposed system saves the information of voters like (fingerprint, name, address, gender, age) in a system database. Each voter must have a unique RFID tag, It must have its own RFID tag as it is confirmed by comparing it with the database in the microcontroller then fingerprint is taken to the sound and after confirmation of the vote allows the vote, all the

information is displayed on the LCD, and if the information is not recognized the message "Access denied" will appear on LCD, security alarm will ring to inform the polling officer's and t he person is not allowed to poll his vote.

Sudhakar M. and Sai B. [6], Design and develop a web based Electronic Voting Machine called (FP-EVM) by using Ethernet networking technologies for local area networks. In this system the details of the voter like: (fingerprints, name, constituency, voter ID) stored in the remote server, Also the voting result will be saved, they use also the photo of the voter to increase the security of the system, "Biometrics method" have been used to develop (FP-EVM), this method recognizing a person based on physical or behavioral features like: fingerprint, face, voice, iris, hand geometry, and handwriting. The hardware components that used to develop (FP-EVM) are: ARM9 microcontroller, KY-M6 finger print module, while the software code is developed in WINCE6 development environment. The proposed (FP-EVM) provides many interfaces for its users that enable them to interact with (FP-EVM), details of the voter are displayed on ARM9 LCD from remote server and results are viewed at central server by an authorized person.

Satheeswari1 D. and et. al., [1] develop an electronic voting system that enables the voters to use the mobile device in the voting process through a special application to assist them to cast their vote, to use this application detect fingerprint must be available in mobile devices, when this facility unavailable, In this case, special voting booths will be created. It is important to note that, all voters will be allowed to cast their votes after they enter their fingerprint and verify them. When voting is completed, voting information is sent to server. This information can be display as a list. Arduino microcontroller and finger print sensor were used in the design of this system.

A. HARDWARE COMPONENTS

In this paragraph we will display the hardware components that we need to design and implement our proposed system (EVM).These are as follows:

B. ARDUINO MEGA 2560

"The Mega 2560 is a microcontroller board based on the A mega 2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button". See Fig 1.

One of its advantages is the ease of connecting it to a computer with a USB cable or by using a battery to get started, or power it with a AC-to-DC adapter, The Mega 2560 board is compatible with many designed shields and it greatly supports microcontroller [7][8].

Figure 1: Arduino Mega 2560.

C. FINGERPRINT SENSOR

The best and simplest way to ensure the security of information and verify user identity is the use of fingerprints, and through its use we terminate the need for the user to create and protect the password.

It is possible to obtain fingerprints using an optical sensor fingerprint that can detect and verify fingerprints very easily. This sensor is used in many applications including: safes there's a high powered DSP chip that does the image rendering, feature finding search, and calculation [9].

Connect to any microcontroller with Serial Tel, and packets of data are sent to take photos, hash and search and print recognition. It is possible to store at least 162 fingerprints in the onboard FLASH memory. In order to distinguish the working of the sensor, There is a red LED in the lens, which lights up to inform the user that it works, and when the red LED light up indicates that the sensor is ready to capture the fingerprint of the user.

The easy-of-use and straight forward windows software increases the user's desire to select this sensor to develop different types of applications, and it also provides the possibility to display fingerprint images on computer screen of any LCD screen for Arduino [6]. See Fig 2.

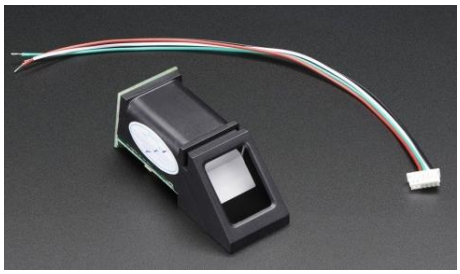

Figure 2: Fingerprint sensor

D. "2.4" TFT LCD

"2.4 inch TFT touch Screen LCD module for Arduino, This TFT display is big (2.4″ diagonal) bright (4 white-LED backlight) and colorful (18-bit 262,000 different shades)! 240×320 pixels with individual pixel control".

It is possible to use a beautiful and bright colors touch screen with Arduino projects, that display information with built in micro SD card connection

"2.4" TFT LCD is more accurate than white and black 128 x 64 display, this type of screens is characterized by high accuracy, which Helps users to make it easy to use, as it is possible to detect finger touch at anywhere on the screen [10] [11]. See Fig 3.

Figure 3: "2.4" TFT LCD screen.

E. BUZZER

Buzzers come in two varieties, active and passive. "An active buzzer just outputs a single tone when you connect it to Vcc and ground". Where "A passive buzzer is similar to a loudspeaker and needs a signal to make it work".

There are many types of active buzzer used in different applications. The YL-44 is one of those types, which is a small buzzer model that can work around the audible 2 kHz frequency range. It does not need an external frequency generator to be able to output an alarm, If you want to turn this buzzer on you can do that by taking the I / O pin LOW, and in case it turns off this pin should be HIGH, it is possible to control this buzzer through PWM [12]. See Fig 4.

Figure 4: Active buzzer

F. SD CARD READER

This type of card reader is easy to handle programmatically as it enables the user to read and write using Arduino as a compatible sensor shield module [13]. See Fig 5.

Figure 5: SD card reader

III. Proposed system

The EVM system consists of "Arduino Mega 2560" card, fingerprint sensor, buzzer, 320 x 240 color graphics LCD screen and SD driver card.

With the appropriate wiring all the components of EVM will be connected to PCB, on the other hands all components connected to each other, by this connection all the components can to carry out the their tasks, and the fingerprint sensor was connected to the card with the (18 "TX", 19 "RX "), port (Serial 1) is represent it, while the graphic display and memory card were connected to the pins that specified by its own libraries, a random selection done to choose buzzer pin but should not be busy with other component. Fig 6 represents the block diagram of the designed system.

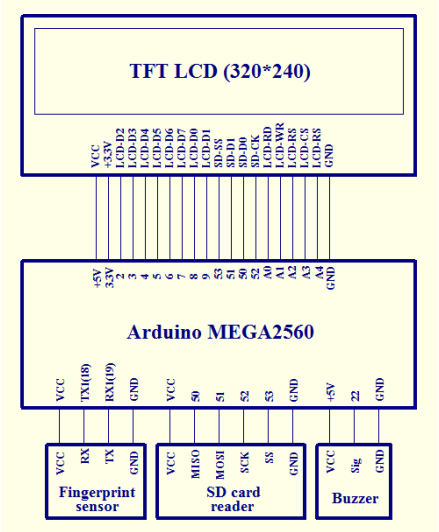

Figure 6: Circuit diagram of the voting system.

The main activites of (EVM) can be described by following flow chart see Fig 7.

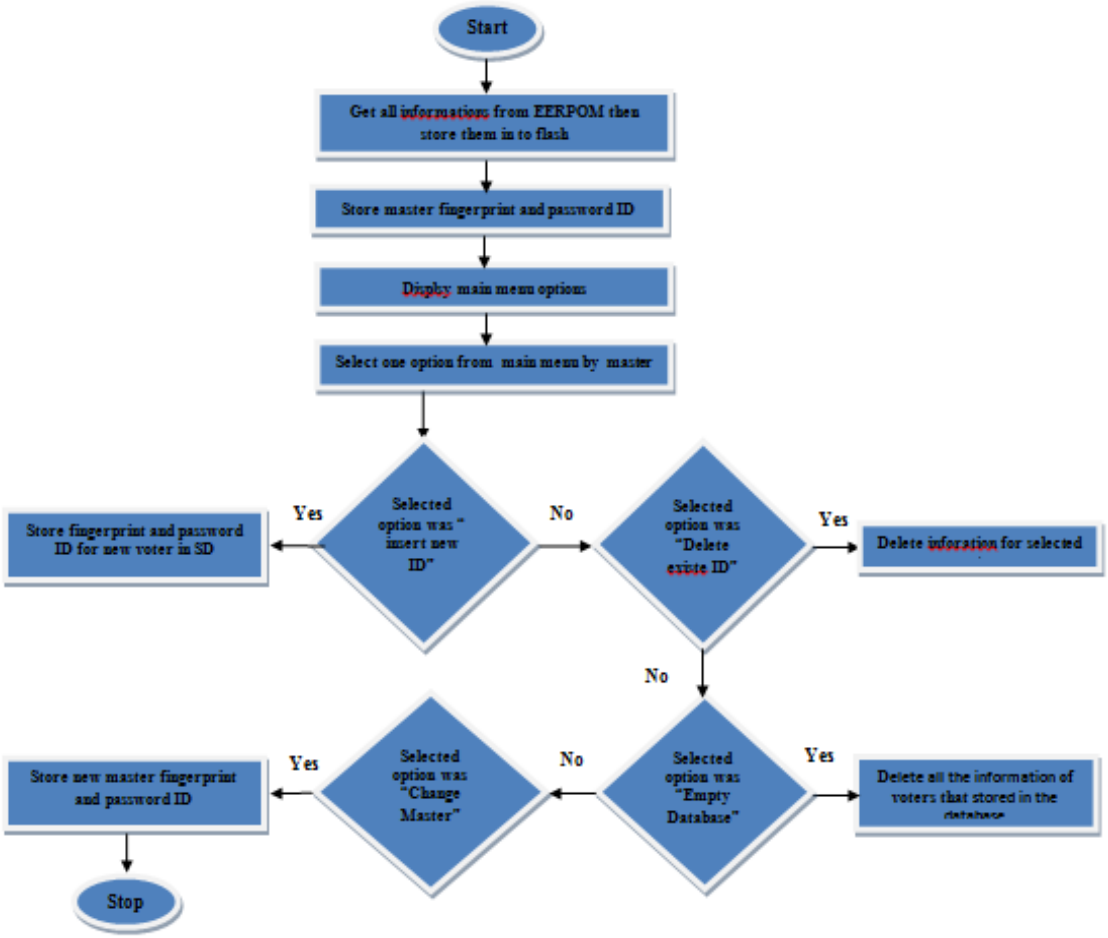

Figure 7: main activites of (EVM).

Generally, EVM development is carried out using UML "Unified Modeling Language"; we choose "use cases diagram", "activity diagram", and "sequence diagram" to analyze our proposed system. Use case diagram describe the interactions between system and the external environment and depict the roles of each actor. Use case diagram is given in Fig 8.

UML activity diagram represents the various processes of EVM, the activity diagrams for EVM depicted in Figure 9 and 10.

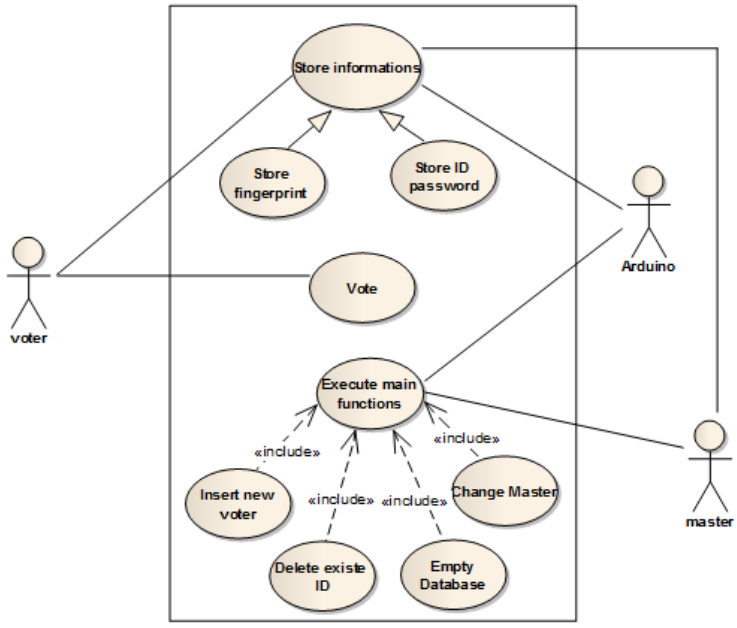

Figure 8: Use case diagram for EVM.

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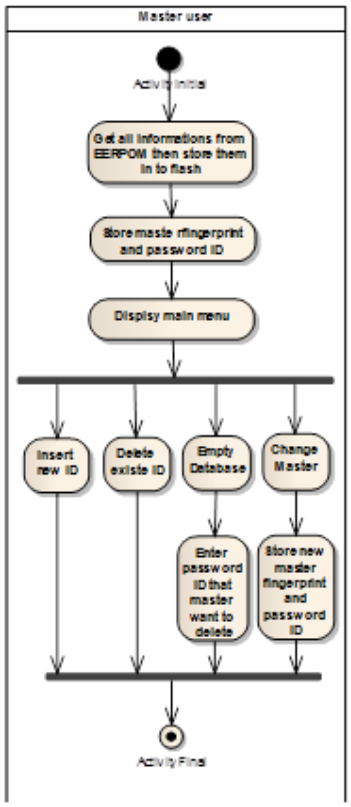

Figure 9: Activity diagram that describe the activities of the master user

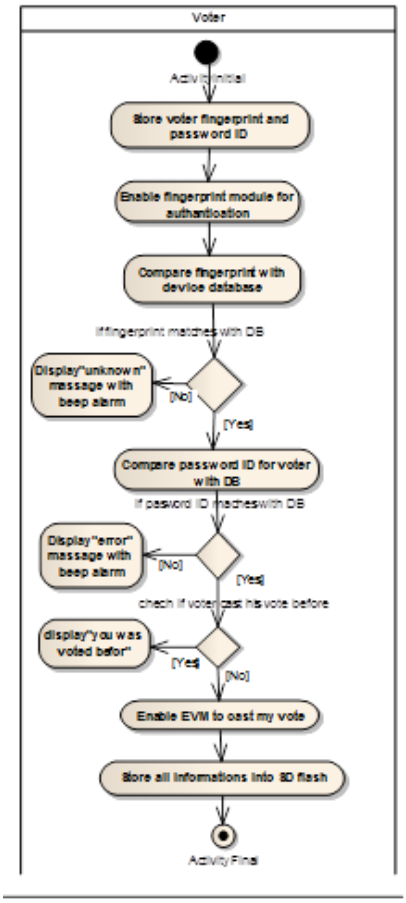

Figure 10: Activity diagram that describe the activities of the voter.

While the sequence diagram describe the operation execution sequence for EVM over time. See Fig 11 and 12.

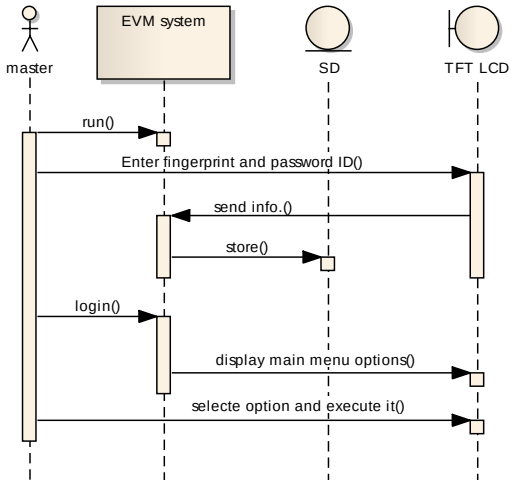

Figure 11: Sequence diagram that describe the operations of master user.

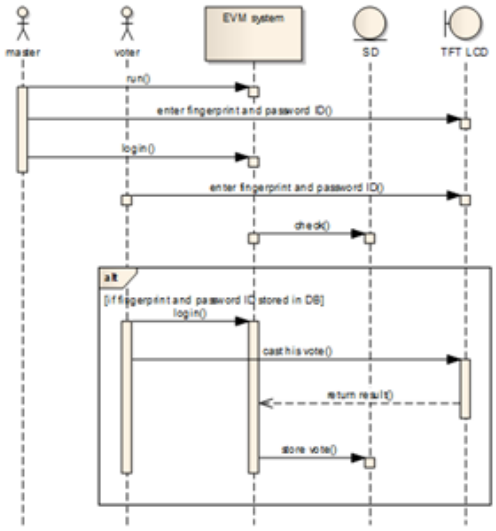

Figure 12: Sequence diagram that describe voting process.

IV. Experimental work and results

When the (EVM) is turned on, the size of the database is displayed on the TFT LCD. The database is empty when the system is run for the first time; the master user enters his fingerprint and password ID. See Fig 13 and 14.

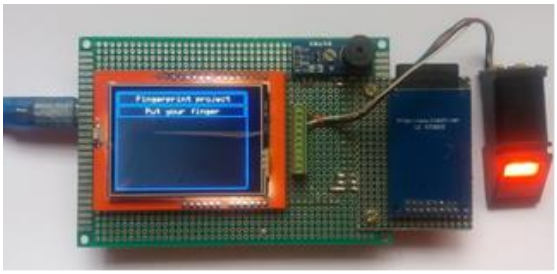

Figure 13: EVM asked for a fingerprint.

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Figure 14: Enter password ID interface.

After confirming the authenticity of the master's identity, the master user can access the system. The main menu, which consists of four options, is displayed, see Fig 15.

When the maste'r user selects the first option (Insert new ID), a new interface was displayed that asks for the voter fingerprint same as Fig 13, and his password ID same as Fig 14. This information then stored in SD. See the Fig 16.

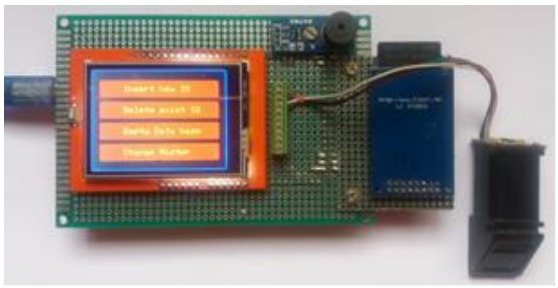

Figure 15: Main menu options.

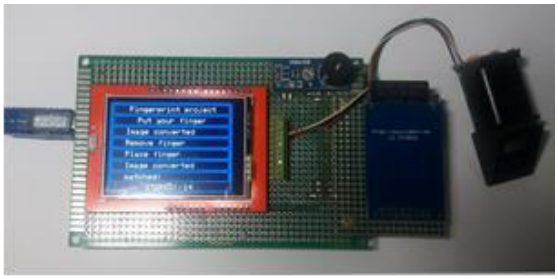

Figure 16: The process of taking fingerprint photo.

The second option (Delete exist ID) gives the master user the possibility to delete a specific voter record from the database, the master user must enter the password ID of voter to delete his information. See Fig 17.

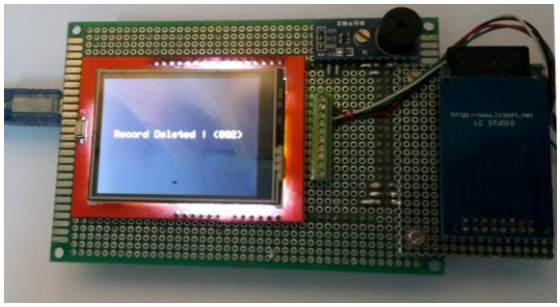

Figure 17: Delete voter record from database.

When the master user executes third option (Empty Database) from the main menu, he was being able to delete all the information stored in the database. See Fig 18 and 19.

Figure 18: Alert message for deleting database.

Figure 19: Delete database.

The fourth option (Change master) gives the possibility of changing the master user and this can be done by store a fingerprint and the password ID of the new master user, new master information was stored in the EVM database.

In order to conduct the voting operation using EVM, the voter enters his/her fingerprint and password ID, after being identified by EVM, is allowed to cast his/her vote. But if he is not recognized, he is not allowed to vote, and alert message was displayed. See Fig 20.

If a voter votes in advance and then tries to vote again, EVM will not be allowed to do so. See Fig 21.

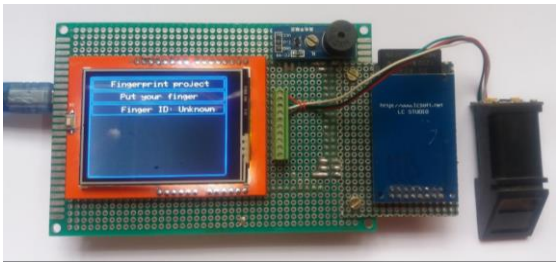

Figure 20: Alert message for unknown voter.

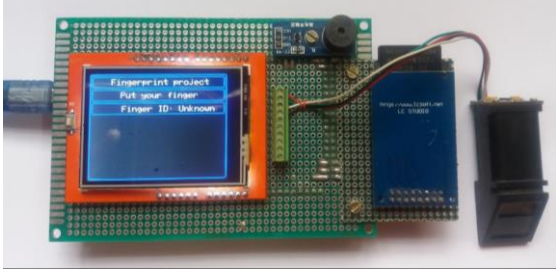

Figure 21: Alert message for repeated voting.

It is important to note that the master user is the only user who can perform all the functions and operations

provided by the main menu of the system. All the information of master user or voters should be stored in the SD including the voting results. We conducted the voting process using the EVM. The voting process was conducted by several voters to choose the best project from a total of several projects.

V. Discussion

In this section we discuss the results obtained in the experimental, these results were saved in notepad file that stored in SD, Fig 22 illustrated data base summary, the first column in histogram show the number of voter, while the second column can only be one of two values: "1" if the voter cast his/her vote, or "zero" if the voter has not yet been voting. Fig 23 illustrate information as following sequence: first column show password ID for the voters, second column show number of voter, and the third column show the choose of the voter. Fig 24 illustrate the number of possible votting options and the the number of votes for each option.

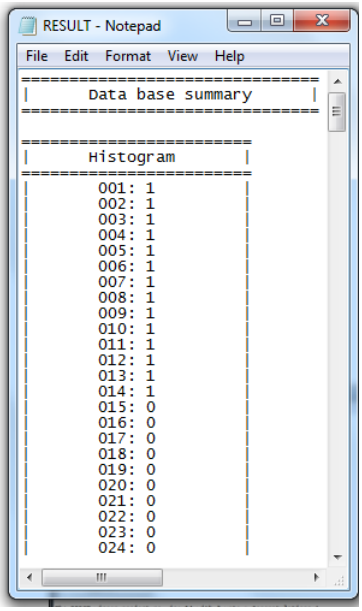

Figure 22: Illustrate database summary.

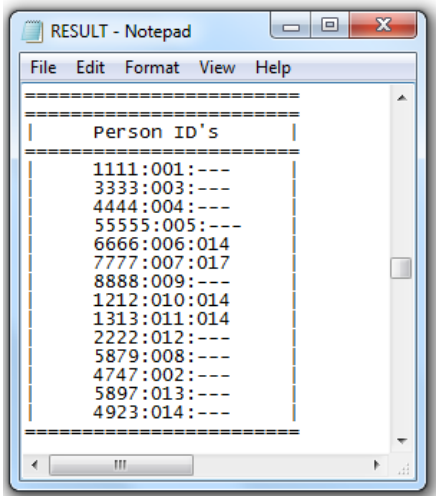

Figure 23: Database summary.

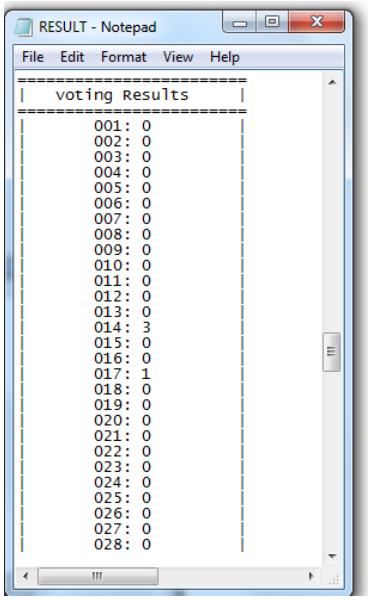

Figure 24: Voting result information.

At the end of file a the result of voting process was displayed. See Fig 25.

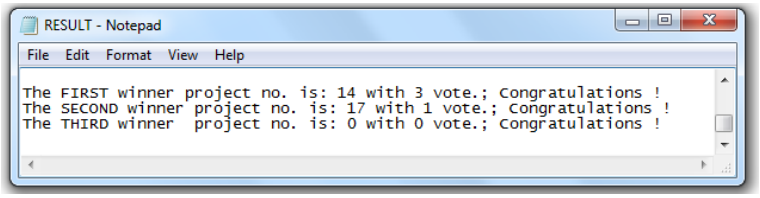

Figure 25: Summary of the voting result. process was displayed. See Fig 24.

It is worth mentioning that the largest possible number of voters in the experiment that was applied using the EVM was 150 votes.

VI. Conclusion

This paper used to increase and enhance the security of EVM such as reputation by using fingerprint sensor to make sure from users authentication. All voters' information was stored in microcontroller database, with ability to display this information on LCD, EVM characterized with many features: provides clear and ease interfaces for voters, portable, short response time, and flexible.

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آلة التصويت الالكتروني بأستخدام اردينو

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قسم هندسة البرمجيات , كلية علوم الحاسوب والرياضيات , جامعة الموصل , الموصل , العراق

الملخص

الهدف الرئيسي من هذا البحث هو تصميم وتنفيذ آلة التصويت الإلكتروني (EVM) باستخدام جهاز استشعار بصمات الأصابع للتأكد من هوية الشخص المصوت. تم تصميم آلة التصويت الالكتروني بأستخدام الاجزاء التالية: متحكم (اردوينو ميجا 2560)، متحسس بصمات الأصابع لمسح بصمة المصوت قبل التصويت، "2.4" TFT screen لعرض التعليمات ومعلومات المصوتين، الجرس، بالاضافة الى قارئ بطاقة SD. يضم النظام قاعدة بيانات تحتوي على كلمة السر وبصمات الأصابع لجميع المصوتين التي تخزن في المتحكم, وتستخدم هذه المعلومات للمقارنة والتحقق من هوية المصوت خلال عملية التصويت. إذا قام المصوت بالادلاء بصوته ثم حاول الدخول للمرة الثانية الى آلة التصويت الإلكتروني لتكرار عملية التصويت، في هذه الحالة, آلة التصويت لن تسمح له بذلك, أذ يتم تنبيه المستخدم الرئيسي من خلال رن الجرس. إن آلة التصويت الإلكتروني المقترحة توفر الوقت والجهد للمصوتين حيث أنها تتميز بالموثوقية وسهولة الاستخدام بالإضافة إلى الاستجابة السريعة للمستخدمين. في نهاية عملية التصويت، يتم خزن النتيجة في ذكرة وميضية (flash memory) التي من خلالها يمكن للمستخدم الرئيسي استرداد تلك النتائج والاطلاع عليها. عند تطوير أي نظام للتصويت الإلكتروني، يجب الاهتمام بعدة جوانب، والجانب الأكثر أهمية هو خصوصية المصوتين ودقة عملية التصويت بالإضافة إلى الحفاظ على أمن البيانات، ويوفر هذا البحث نظام تصويت آمن وموثوق به.