

# Development of Online Voting System using Minutiae based Algorithm

Talib A. Divan, Veena A. Gulhane

**Abstract**— Voting is one of important task which has to conduct in a country for electing a government. But being such an important part hence it has to be manage securely and accurately. But the voting percentage decreases year by year because of inflexibility. Most of existing system studied suffers from high FRR rate. In this paper a minutiae based algorithm is used for designing a voting system which is implemented using combination of hardware and software. Minutiae based algorithm uses two fingerprint authentication which make system more secure. Proposed system aims to design a flexible low FRR rate system with high accuracy. The simulation result of proposed system is discussed in the result section. Also, the proposed is analysed comparing with the existing system considering the FAR and FRR rate

**Index Terms**— EVM, Fingerprint, FAR, FRR, Minutiae based algorithm, Template, Voting system.

## 1 INTRODUCTION

Electronic voting machine is generally used now days in some countries including India for conducting election of government in a country. But the Electronic voting machine has certain disadvantages like illegal voting and insecurity. Hence the concept of online voting system is started in some countries for conducting election. Most of the developed countries have started using online voting system but they are facing some problems in conducting it. Estonia is the only country started conducting the online voting system in national election. But the percentage of voting is only 20% to 30%.

Different researchers have designed a online voting system But the system are not so much efficient in terms of accuracy and security. Also the voting system has high error rate. Hence the voting system is not flexible and can be used for specific region only. Biometric authentication is found to be more secure and accurate in certain application. Different biometric authentications like fingerprint, retina etc. can be used in designing an application to enhance the security. As fingerprint of every individual is unique it can be used for designing a voting system. Different fingerprint matching techniques has been discussed considering the FRR ratio.

Various techniques based on fingerprint matching such as Threshold cryptography , Fuzzy Vault, Latent fingerprint matching , Minutiae based algorithm has been reviewed depending upon their error rate. In proposed method, a voting system has been designed using minutiae based algorithm. Minutiae based algorithm is the best techniques in fingerprint matching using the minutiae position from fingerprint template. The voting website has been designed which uses a fingerprint authentication to allow the user to cast his valuable vote. MATLAB software is used for processing the fingerprint image using various steps like binarization, thinning, Minutiae detection and removal of false minutiae.

GSM based EVM [1] was based on fingerprint authentication, but there are certain problem in these system i.e. high error rate. Hence, the system lags with high FRR ratio. Minutiae based algorithm is not yet been used in designing any vot-

ing system hence proposed system implements a Fingerprint based online voting system. By using the proposed system the FRR rate is found to be less and the voting system is found to be more effective in sense of accuracy and security. By using the proposed system the voting percentage in country may increase and also people who are unable cast their votes can do it easily.

To achieve the objective i.e. to calculate the FRR rate in proposed system, fingerprint images of certain users are taken and system is test by fingerprint authentication. As False Rejection rate is defined as the ratio of number of user rejected which are authorised to total number of verification. The FRR is calculated which is described in result section. The web page is designed which is found to be more effective in casting votes for authorised user living anywhere in country.

The related work about the previous research is explained in section II. Section III described details of proposed methodology and steps in minutiae based algorithm. Section IV describes methodology for online voting system. Section V describes the system architecture showing the proposed model. Section VI describes the results obtained by showing the snapshot of hardware and MATLAB simulation. VII describes the result analysis of proposed system by comparing it with other existing ones. Section VIII describes the conclusion.

## 2 RELATED WORK

Various researches have been carried out on designing the online voting system using different techniques. Most of them were designed the online web application which just allow the user to cast their valuable votes by using the authentication using login id and password system. It is found to some extent that is better, but the problem is system prone to various database attacks. Hence it is not employed in some countries because of validation of the system.

In GSM based voting [1] system a single fingerprint scanner is used for enrolment and authentication of particular user. But the problem exist with this system is that it is lim-

ited to specific region and hence the system is not flexible. Also, the error rate i.e. FRR is very low. The FRR rate of this system is found to be 1.4%.

Minutiae based algorithm [2] is studied in which two fingerprints image are used for creating a new template which can be stored in database. It is found with the experimental result i.e. FRR rate is very low i.e. 0.4%. Minutiae positions are extracted from the fingerprint image by considering the orientation and reference points. Reference points are selected from first and orientation field is selected from the second fingerprint and the template is stored in the database. During authentication phase, the fingerprint images are matched with the template stored in the database and if shares match with it, the user gets authenticated.

Latent Fingerprint Matching [7] technique is used generally in some smudgy and damaged fingerprint images which are not authenticated by using different techniques. Hough transform is used which improves robustness & distortion in fingerprint image. In this process two types of methods are used manual marking and automatic marking to extract the minutiae positions. The latent fingerprint matching technique is found to be more efficient in smudgy fingerprint image than normal ones. Hence, it produces very low accuracy while using normal fingerprint images.

Moodle [3] is a software package used for creating different course and internet based websites. For registration of student to access the website a new concept i.e. fingerprint matching is used. Fingerprint image is used as the authentication in login window for studying certain courses. It is found that it is more secure by using fingerprint biometric authentication than password based system.

Threshold Cryptographic [5] technique is one of most important fingerprint matching technique. In this technique, fingerprint image is divided into two are more shares using cryptography and then compression is applied for compressing image in database. One part of shares is stored in database for particular user and other is given with the user. If both shares match, the user gets authenticated. The error rate i.e. FRR by using threshold cryptography is low.

Some of papers based on online voting system is also studied which describes how the online system helps in reducing time, increasing number of user and security.

Biometric-Secure e-Voting [11] is designed to replace the existing system. The design of the Biometric system guarantees the community that there will be no false voting in the election. Hence the percentage of voting user increases automatically. Also main focus of Biometric e-Voting is achieving the election integrity. But the system is not employed in real world using fingerprint scanner.

Online Voting System [12] based on Aadhar Id verification is proposed. In this paper a voting system is conducted based on unique number for enrolment of particular user. A framework is designed which is expected to be more secure and free from accessing by any unauthorised user. But in this system user id and password based authentication is used which is not much secure.

To achieve high accuracy in proposed system, a minutiae algorithm based on two fingerprint sensor is designed. By employing two fingerprints image authentication the system will be more secure and produce accurate results.

### 3 METHODOLOGY FOR ONLINE VOTING SYSTEM

The following online voting system model to be constructed aims to provide a low FRR rate. The model is divided into two parts i.e. hardware part and software part which shows simulation results in MATLAB software. Firstly, a circuit diagram is designed which consist of Microcontroller (ATMEGA 16), Fingerprint sensor (R305) and Serial Communication (RS232). Two Fingerprint sensors are interfaced using Relay to microcontroller ATMEGA16. Port D is used in which pin no. 2 & 3 is used for connecting serial communication i.e. RS232 for transmission and reception of data. The second stage is of software part which is again divided into two parts namely extracting minutiae position of fingerprint in MATLAB and online voting part which allow the user to cast vote by login in website. The minutiae based algorithm implementation is shown in MATLAB simulation. The flow chart of how the voting is carried is shown below. The user first has to enrol for only one time with fingerprint verification which is stored in the database. After enrolment the user fingerprint are applied with minutiae based algorithm in MATLAB software. After which user is authenticated with name if fingerprint matches with database. Then, user has to visit the website. User has to create new account and then the vote is recorded. In this way the process of online voting system is carried out, the result and snapshot of proposed system is shown in further section. The flow is designed below which shows how the whole system works for casting a vote. If the user visit website without fingerprint verification then the website shows a error message showing fingerprint does not matches.

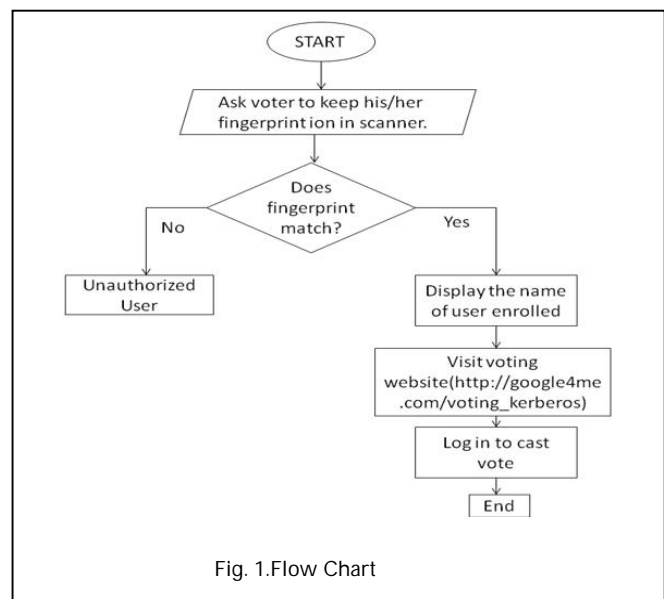


Fig. 1.Flow Chart

### 4 SYSTEM ARCHITECTURE

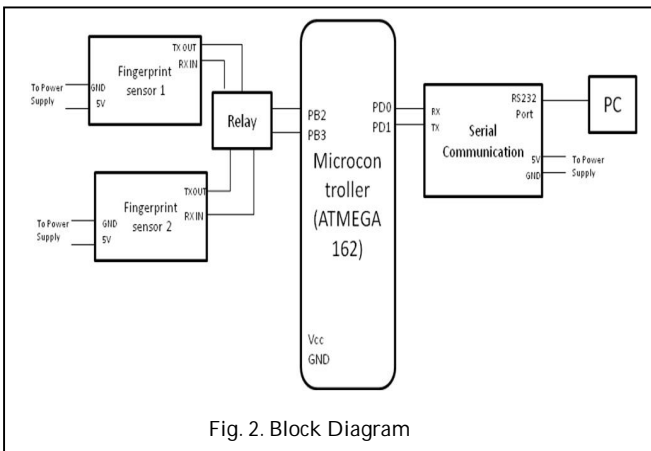


Fig. 2. Block Diagram

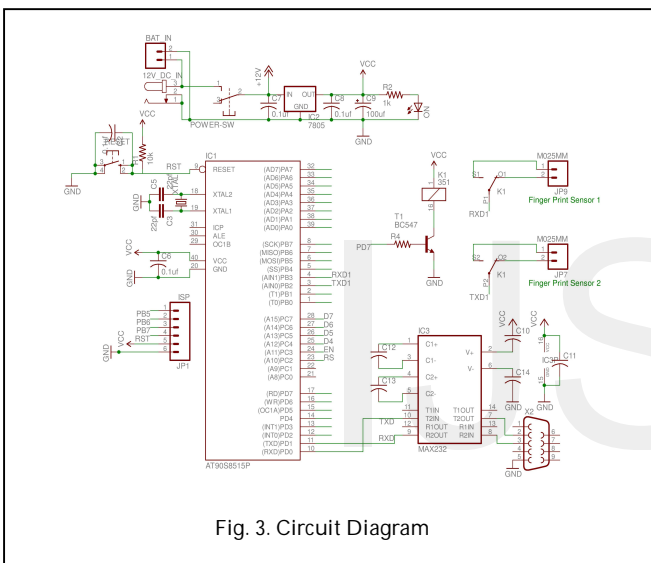


Fig. 3. Circuit Diagram

The system consists of fingerprint sensors, microcontroller (ATMEGA16), RS232 (Serial Communication), PC (MATLAB Simulation). The circuit diagram is constructed as per the block diagram. Fig 2. shows the following circuit diagram of the system.

Sensors are the devices which are used for converting the physical quantity into electrical signals. These signals will be sensed and with the property of the data captured from sensor further processing is done. In proposed system two sensors are used which is connected to microcontroller. If two fingerprint image captured by sensor matches with data stored in database then the user gets authenticated. As two sensors are used the system will be more secure than comparison to other ones. R305 Fingerprint sensor is used in proposed system which is an optical sensor with low power consumption, low cost, small size and performance is fine. Verification Speed and Scanning Speed of Fingerprint sensor is very low, hence it performs the operation quickly.

In proposed system, ATMEGA16 is used which is an 8-

bit microcontroller with High-performance and Low-power AVR. It has 16k Bytes of ISP Flash and 512K Bytes of EEPROM. ATMEGA16 achieves throughputs of 1 MIPS per MHz by executing instruction in single clock cycle. It consists of Two 8-bit Timer/Counters and one 16-bit Timer/Counter with separate pre scalar. In proposed system two fingerprint sensors are interfaced with microcontroller with two UART and the Serial Communication is done via a Relay as third UART port. It has 16K bytes of In-System Programmable Flash Program memory with Read-Write capabilities and 1KB SRAM. For serial communication between the DTE(Data Terminal Equipment) and DCE(Data Communication Equipment) RS232 is used which acts as an asynchronous serial communication between MAX232 IC and computer. Serial Communication does not directly communicate with computer rather first it sends signals via MAX232. For sending the signals for reading fingerprint image from computer to microcontroller, RS232 is used. It is for reading and writing data. As ATMEGA 16 consists of only two UART, in proposed system three UART are required i.e. for interfacing fingerprint sensor1 & 2 and RS232 for serial communication. A relay is used which works as an additional UART in system.

The software part of proposed system composed of MATLAB and PHP server side language is used for website purpose. The Minutiae based algorithm is shown in the MATLAB using various steps involve in it like binarization, thinning, minutiae detection and false minutiae removal. The user has to keep his fingerprint in sensor and then after capturing image from both fingerprint image the algorithm is applied. The second part of software is PHP language which is used for designing the website for online voting. WAMP server is used for designing the check vote, manage votes and other features in the website. The flow how the proposed will work is shown below and the results obtained from the proposed is shown in the result section.

1. Start
2. Initialize port D and fingerprint sensor pins
3. Ask user to keep 1<sup>st</sup> fingerprint impression in sensor 1
4. Ask user to keep 2<sup>nd</sup> fingerprint impression in sensor 2
5. If match found display the name enrolled
6. Otherwise, repeat step 3 & 4 for new enrolment
7. Apply Minutiae based algorithm in both fingerprint image
8. Visit the website for casting vote.
9. Signup with same name as enrolled in database.
10. Login to cast vote.



- 11. If user logged in without fingerprint authentication in MATLAB.
- 12. Error message as Fingerprint match not found.
- 13. End

### 5 RESULTS

Proposed system consist of both hardware and software implementation. Hardware part consist of fingerprint sensor, microcontroller and RS232 for serial communication. Software part consist of simulation of fingerprint image by applying minutiae based algorithm in MATLAB software and online voting part in website. The detail of how the online voting is conducted is shown below considering various snapshots.

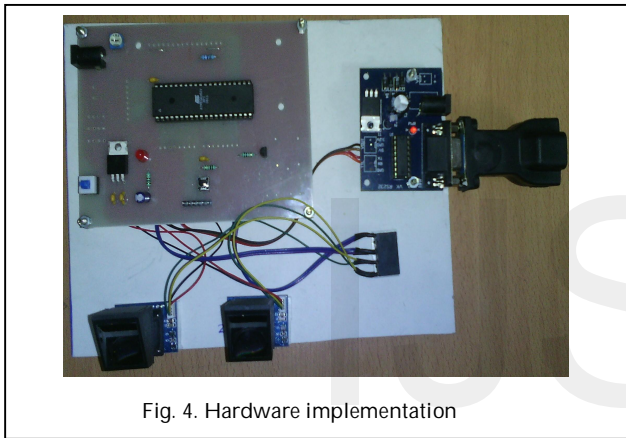


Fig. 4. Hardware implementation

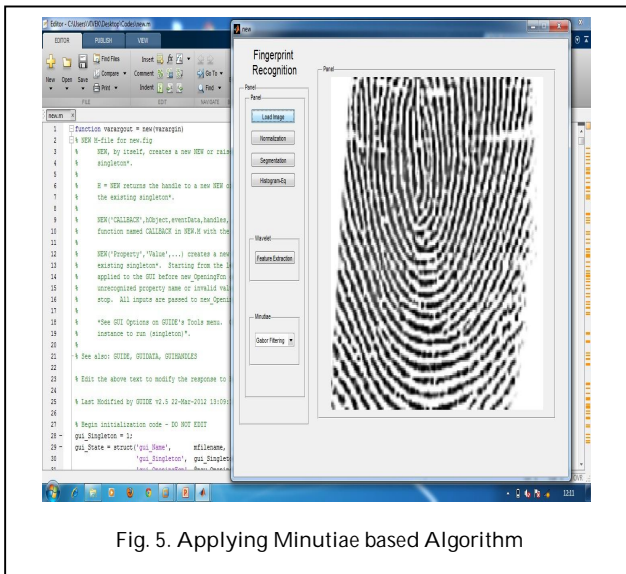


Fig. 5. Applying Minutiae based Algorithm



Fig. 6. Authenticating user through minutiae points

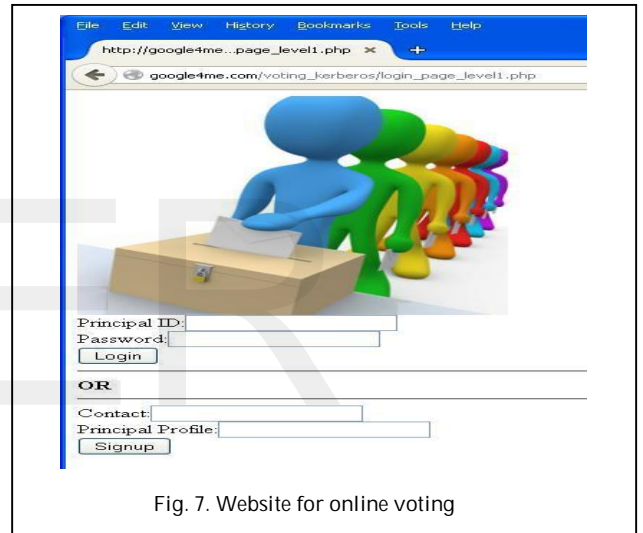


Fig. 7. Website for online voting

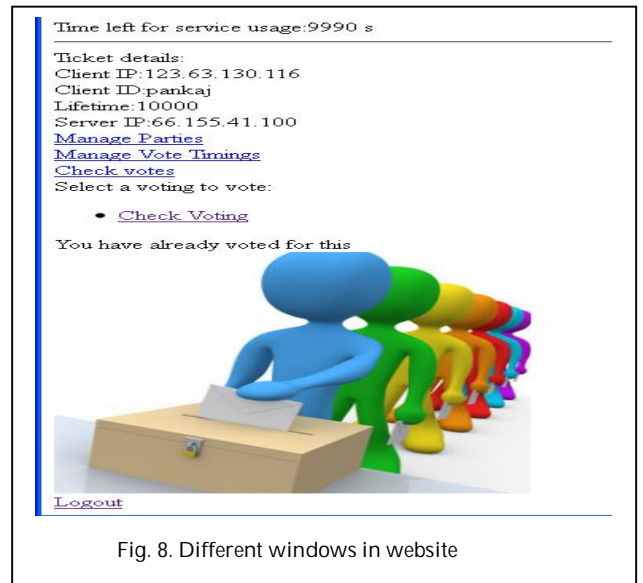


Fig. 8. Different windows in website

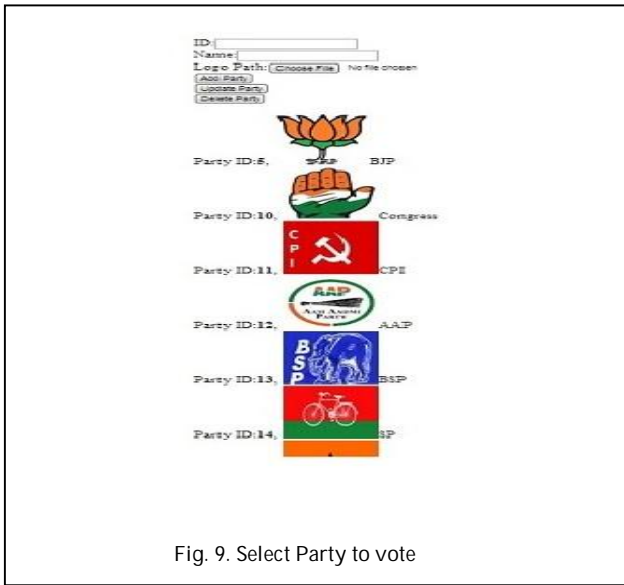


Fig. 9. Select Party to vote

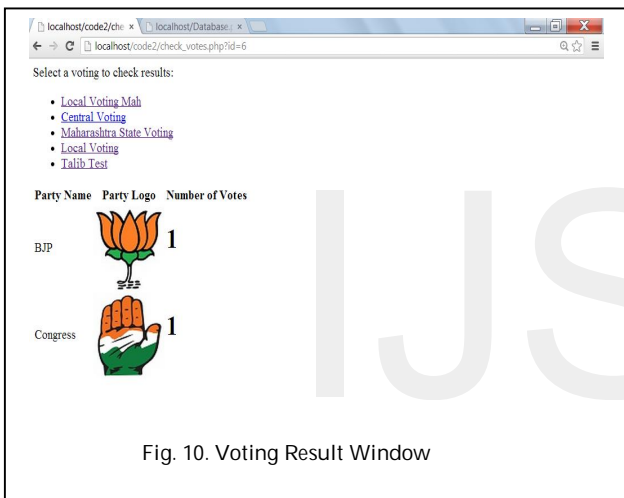


Fig. 10. Voting Result Window

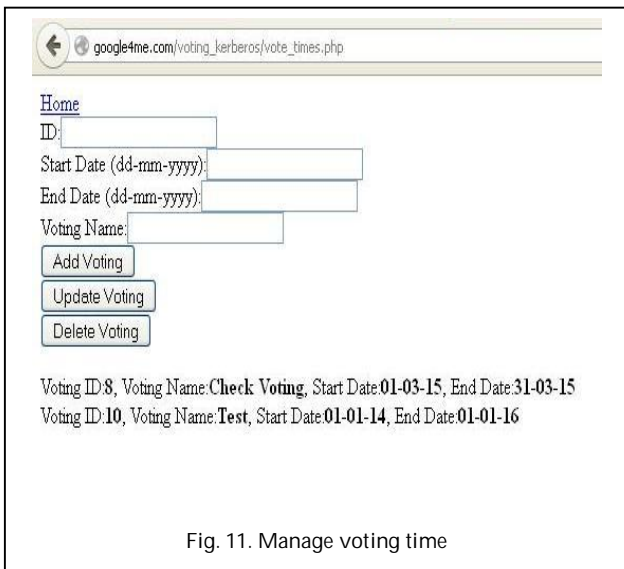


Fig. 11. Manage voting time

The above snapshot shows how the online voting is performed using the proposed system. For analyzing proposed system from differentiating with other existing one, following analysis has been carried out. The main objective of proposed is to design a system with low error rate i.e FRR rate which is explained below.

1) FRR (False Rejection Rate)

False Rejection rate is defined as the ratio of number of times the genuine user gets rejected to total number of verifications.

It is given by

$$FRR = \frac{\text{No. of times the genuine user rejected}}{\text{Total No. of Verification}}$$

2) FAR (False Acceptance Rate)

False Acceptance rate is defined as the ratio of number of times an unauthorized user gets accepted to total number of verifications.

It is given by

$$FAR = \frac{\text{No. of times an unauthorized user gets accepted}}{\text{Total No. of Verification}}$$

Both the above parameters are tested in the proposed system and it is found that the first parameter i.e FRR(False Rejection Rate ) is very low i.e only one time the system has rejected the authorized user. The second parameter i.e. FAR (False Acceptance Rate ) is found to be zero i.e. there is no such acceptance of any unauthorized user in the system. The system is tested by enrolling more users.

TABLE 1  
VALUES OF FAR & FRR

FAR	FRR
0	0.03%

TABLE 2  
DETAILS OF EVALUATION

No of Enrollment	Successful Verification	Unsuccessful Verification
30	29	1

**TABLE 3**  
**COMPARING WITH OTHER SYSTEM**

TYPE OF SYSTEM	FRR	FAR
ONLINE VOTING SYSTEM USING MINUTIAE ALGORITHM	0.03%	0%
GSM BASED VOTING SYSTEM	1.4%	0.02%

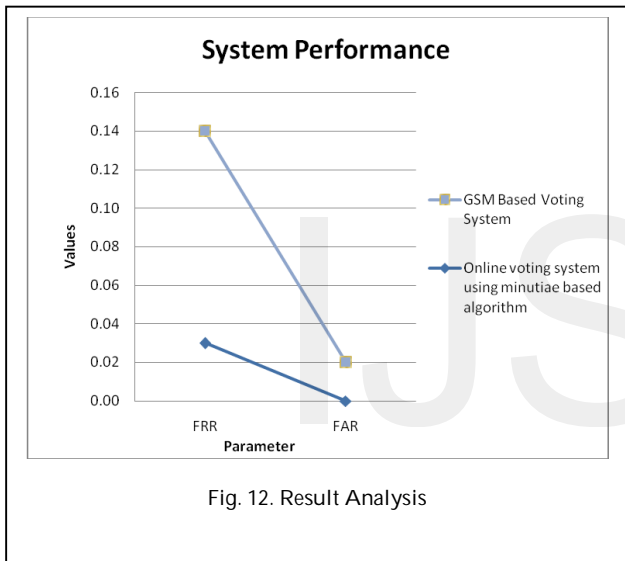


Fig. 12. Result Analysis

The online voting system using minutiae based algorithm is compared with the existing system and it is found that the proposed system is much better than existing ones in terms FRR, FAR and accuracy. As user can cast vote more easily with very less time. The graph is plotted based on the result obtained from voting system.

**CONCLUSION**

A system with online voting using minutiae based algorithm with low error rate is proposed. For analyzing the system for checking for accuracy two parameters are calculate and the detailed of test results are described. Simulation results of proposed system are shown in MATLAB software. Also the minutiae based algorithm is used for extracting the minutiae position of fingerprint images. The FRR rate of proposed is found to be 0.03% with no FAR rate.

**REFERENCES**

- [1] Sreenath Sreenath.M, Sukumar.P, Naganarasaiah Goud.K, P.Sivakalyani & V.Phani Kumar, "GSM based electronic voting machine using touch screen," IOSR Journal of Electronics and Communication Engineering, June 2014.
- [2] Sheng Li and Alex C. Kot "Fingerprint Combination for Privacy Protection," IEEE Transactions on Information Forensics and Security, February 2013.
- [3] Rosario Gil, Mohamed Tawfik, Alberto Pesquera Martín & Sergio Martín, "Fingerprint Verification System in Tests in Moodle," IEEE Journal of Latin-american Learning Technologies, February 2013.
- [4] Diponkar Paul & Sobuj Kumar Ray, "A Preview on Microcontroller Based Electronic Voting Machine," International Journal of Information and Electronics Engineering, March 2013.
- [5] Rajeswari Mukeshi & V.J.Subashini, "Fingerprint Based Authentication System Using Threshold Visual Cryptographic Technique," IEEE-International Conference On Advances In Engineering, Science And Management, March 2012 .
- [6] Muhammad Umer Munir and Dr. Muhammad Younas Javed, "Fingerprint Matching using Gabor Filters," National Conference on Emerging Technologies, 2004.
- [7] Paulino & Jianjang Feng, "Latent Fingerprint Matching Using Descriptor-Based Hough Transform," IEEE Transactions on Information Forensics and Security, March 2013.
- [8] Karthik Nandakumar, Anil K. Jain & Sharath Pankanti, "Fingerprint-Based Fuzzy Vault: Implementation and Performance," IEEE Transactions on Information Forensics and Security, December 2007.
- [9] Sheng Li and Alex C. Kot, "A Novel System for Fingerprint Privacy Protection," 7<sup>th</sup> International Conference on Information Assurance and Security, 2011.
- [10] Xi Cheng, Sergey Tulyakov and Venu Govindaraju, "Minutiae-based Matching State Model for Combinations in Fingerprint Matching System," IEEE Conference on Computer Vision and Pattern Recognition Workshops, 2013..
- [11] Mohammed Khasawneh, Mohammad Malkawi, Omar Al-Jarrah, & Laith Barakat, "A Biometric-Secure e-Voting System for Election Processes," 5th International Symposium on Mechatronics and its Applications (ISMA08), Amman, Jordan, May 27-29,2008.
- [12] Himanshu Agarwal & G.N.Pandey "Online Voting System for India Based on AADHAAR ID" 2013 Eleventh International Conference on ICT and Knowledge Engineering.