An Advanced Door Lock Security System using Palmtop Recognition System

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ABSTRACT
Biometric technology is used to identify a person based on his/her physical behavioral characteristics. One of the extensive uses of biometric technology is a fingerprint recognition system. The technology has broad use mainly for its easiness, reliability and accuracy in human identification process. This paper presents work done on minutiae based palmtop recognition system for automatic door open and locking system. Here, the palmtop recognition system works by taking an image of the person, partitioning it, processing it and finally verifying the person. This system provides input for an electric circuit. The circuitry system consists of two unique states; door open and door lock. The whole system basically uses extensive Image processing for minutiae based palmtop recognition. Thus reducing the probability of error in human recognition and solves maximum problems of fingerprint recognition. This paper shows a better solution for recognizing people, which helps to solve security related problems in human life.

Keywords
Biometric recognition, Fingerprint recognition, Minutiae extraction, Palmtop recognition.

1. INTRODUCTION
Biometric systems work with behavioral and physiological biometric data for identifying or verifying a person [1, 2]. Signature, gait, speech and keystroke are behavioral biometric parameters [3]. However, these parameters changes with the change of age, environment, accident, etc. On the other hand physiological characteristics such as face, fingerprint, palm print, iris remain unchanged for the full lifetime of a person [4]. The biometric system works in mainly two modes: - one is verification mode, another is identification mode [5]. Different biometric applications decide basically in which mode they will work. The verification mode works with the validation process of a person's identity by comparing captured biometric data with a ready-made template [6]. On the other hand, identification mode works by recognizing process of a person's identity by performing matches against multiple finger biometric templates [7]. Fingerprints are widely used in daily life for more than 100 years due to its feasibility, distinctiveness, permanence, accuracy, reliability and acceptability [8]. The fingerprint is a pattern of ridges, furrows and minutiae [9]. A good quality fingerprint contains 25 to 80 minutiae depending on sensor resolution, finger placement on the sensor, the quality of the input device, etc. [10]. The false minutiae are the false ridge breaks due to insufficient amount of ink and cross connections due to over linking. It is difficult to extract reliably minutiae from poor quality fingerprint impressions. This may arise from very dry fingers [11] and fingers mutilate by scars, scratches due to accidents, injuries [12]. Very often sensors are not clear because of environments dust, heat and so on. As for this quality, the image becomes very distorted and it becomes hard to find the features of fingerprint at that time. This is the main reason, due to which extract features and identify the person becomes hard. Again, there is a probability of error identification of people during the time of fingerprint recognition system's execution period because of two quite same fingerprints and fractioned or damped fingerprint [13]. Again, the old person's fingerprint is not clear all the time [14]. These are some of the many factors for which it becomes hard to identify people accurately. Again, for identification system some percentage of errors are overlooked which sometimes cause an error at time of differentiating between two people's single fingerprint. For these reasons, if the inputs are given into the electronic circuits of the room or building entrance door, it doesn't work properly and becomes complicated [15].

The accuracy of feature extraction and recognition of a palmtop, means the fingers and some other portion of a palm print, depends fully on the quality of the input fingerprint image. Direct binarization [16] using standard technique renders images for the extraction of fine and subtle features such as the minutiae points. For this reason, it is necessary to improve the quality of ridge structures of palmtop images. Also need to maintain their integrity and retain the connectivity of the ridges. As the distance between minutiae is normalized [17] by the ridge frequency at each minutiae, the distance variation by nonlinear deformation is minimized. The performance of palmtop recognition highly depends on the preprocessing steps, where various ways to extract and represent distinguishable features among classed can be applied [18]. The main purpose of palmtop recognition is to facilitate the management of large palmtop databases and to speed up the process of palmtop matching. As the database of palmtop increased, manual identification became monotonous and automated methods became more widespread.

This paper proposes a new method to recognize the palmtop of a person based on minutiae. The palmtop is divided into various portions and then the recognition process is applied on every portion of it. For this reason, the error rate decreases than the existing works. Again, this paper depicts its real life application by showing a design methodology of secured door lock system based on the results of palmtop recognition.

This paper is organized in the following parts: - section 2 describes the related work of palmtop recognition system; section 3 discusses the basic features and theory of palmtop recognition process; section 4 describes the proposed model, its architecture and processes; section 5 discusses the instruments require, and execution steps for the proposed model; section 6 describes the results or output of the proposed model from different directions and section 7 shows contribution of this paperwork and the future interests.

2. RELATED WORK

Various methods are proposed for this minutiae based fingerprint recognition [21-35]. Research also takes on non-minutiae based fingerprint features [36, 37]. But these models sometime fail to recognize persons perfectly because of the environments and quite similar fingerprints. For this reason, one fingerprint of each person is not enough for minutiae based fingerprint recognition system. More than one fingerprint of each person can give best results.

Fuzzy logic based fingerprint recognition are also mentionable [38-44]. Here fuzzy logic is used for taking decision up to a level to find whether a fingerprint is related with the person of interested in minutiae based recognition. But this model takes much time and very often fails to recognize the fingerprint. For this reason, this model is used to some extent but not broadly. Neural Network based fingerprint recognition system is another important research topic at present [45-50]. Here, Neural Network is used to search out the weight of the fingerprint and then recognize it with the help of those which are calculated at time of training the computer [51-53]. But the training process takes considerably huge time for computers. In this process fixed position image is necessary. If the image is not positioned properly, the result will produce a large scale of errors. It also fails to give the right results because of quite same fingerprints. Again, 2 layer training process or ensembles takes huge time and memory for collecting weights. For this, a good amount of time is required for identifying a person. Such cases required to take more than one fingerprints to get good results. With the goal of removing this time complexity and make efficient fingerprint recognition system, people are now researching of finding out singular point based fingerprint recognition system. Every person has two singular points in his/her fingerprint: - Core and Delta [54-61]. Every person hasone or highest two cores and delta each in his/her fingerprint.With the help of extracting features of core and delta of one's fingerprint the person can be recognized. In this process, the first orientation of minutiae and ridges are first calculated and then an algorithm for finding out the core and delta is applied. But this model is not effective all the time because of calculation error. Though it is rare but giving the same result for two fingerprints is seen. At that time, the authenticating process can be hampered and thus right person cannot be recognized. This process also required more than one fingerprints for recognizing the authenticated person. Research has also taken on genetic algorithm based fingerprint recognition system [62-65]. But again same fingerprint problems may generate here because of one quite same fingerprints. Some other methods and processes are also available now a day to extract features of fingerprints and try to recognize the people [66-69]. Some works have also taken place on a fingerprint recognition system in an efficient way. Ways and methods for recognizing the fingerprint with the help of different methodologies are also available nowadays [70-75]. However, all of these approaches deal with only one fingerprint. Most of the cases single finger is used to take the print. But due to aging effect and the troubles present in the input devices these approaches sometimes provide wrong results. For this reason, verification or identification process fails to give actual result..

The automatic door lock system is now a day very familiar to all of the people of the world. In many departmental shops, offices, multinational organizations, etc. are using an automatic door opening and locking system]. Research works are taking place on newer automatic door lock systems which are cost effective. This paper has worked with a circuit for automatic door opening and locking system. Here, different low cost and effective electronic materials are used for developing the circuit for the automatic door opening and locking system. This gives the whole work more practical touch.

3. BACKGROUND

In order to describe the proposed methodology more clearly, descriptions of few technical and important terms and points of palmtop recognitions are required. The basic features of one fingerprint are: - minutiae, ridge, core, delta and so on. The image and features of a fingerprint are shown below –

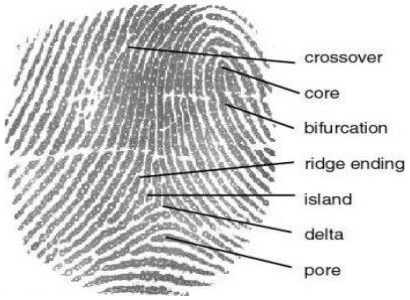

Fig 1. Features of a fingerprint

Discontinues of ridge is known as minutiae. These minutiae are used for fingerprint recognition. There are more than 150 types minutiae in this world. Two features of these minutiae are used for fingerprint recognition process. They are: - bifurcation and termination, means ridge ends. The patterns of these two features of minutiae are given in figure 2: -

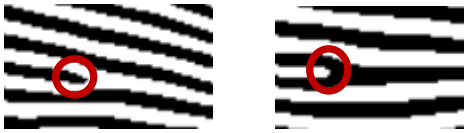

Fig 2. Ridge end and Bifurcation

After taking the image of fingerprint from the people it is first converted to grayscale and then searching algorithm is applied for finding out the matched minutiae. Here, mainly the minutiae are tried to find out and then make those detached from the actual one. Then algorithm is applied on the detached points for finding out the features of the minutiae taken and then keeps them in memory for future identification, recognition or verifies the persons. The verification process needs the following process: -

In our work we have applied the verification process with the help of fingerprint recognition system stated in figure 3. During this process some steps need to follow. At first the image of the fingerprint needs to be converted into grayscale format. Then the converted image needs to be processed for getting good fingerprint. Then the ridge direction of the fingerprint is needed to calculate for finding out the features

of the fingerprint. It is mainly done to take out the minutiae from the fingerprints. The most common minutiae patterns, which are tried to search out, are given in figure 3: -

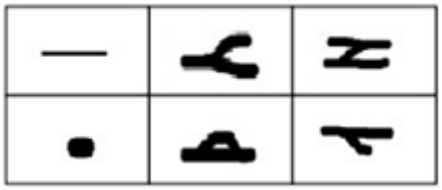

Fig 3. Very common minutiae patterns

4. PROPOSED METHODOLOGY FOR FEATURE EXTRACTION

The main steps for minutiae extraction are given in figure 4.

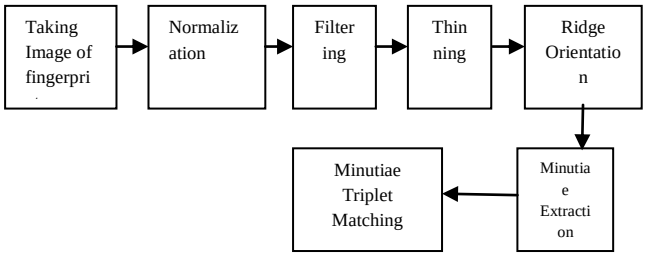

Fig 4. Basic steps of minutiae extraction and verification

At first, palmtop images are taken with the help of input device. After taking the images, the proposed methodology tries to find the ridge pattern (as shown in Figure 3) in different portions of palmtop. For this, the methodology follows the steps shown in Figure 4.

Normalization to ridge orientation processes are completed under the image processing process. These processes are done after taking the fingerprint image. Filtering and thinning are done for getting actual result and get the purified patterns for minutiae so that the image pattern matching result become good. Pre-steps for minutiae extraction are stated in following discussion: -

Step 1 is taking image with the help of input devices like camera, sensors, etc. Step 2 is normalization. This process includes grayscale conversion of the image of the fingerprint. Step 3 is filtering. The sensor with which the image is taken may be old or pore with dust. Again, the age old persons fingerprint is not clear at all, because the ridges of his/her fingerprints become into broken parts. So, for better calculation this fingerprints need to be redrawn and filter for getting approximate full ridge print. Step 4 is Thinning. After normalizing and filtering the images they are thinned for removing noises and make the ridges thinned. This is done for getting the proper ridge orientation and minutiae features. Next step is Ridge Orientation. The image is first converted into binary format. Here, RBG color is checked. If RBG is (0, 0, 0) then it is black. For this reason one pixel is put For this reason color match. If RBG is (255, 255, 255) then it is white point. Nothing is needed to do for it. The direction-field of ridges is taken for getting the angle of minutiae in the fingerprint. Joining of points on ridges, which are created at time of filtering and thinning give the directional field for ridges. This also helps to find out the minutiae points. Step 6 is Minutiae Extraction. Patterns of probable minutiae are extracted from the fingerprint for getting information of that fingerprint which will be used for future verification or identification. Then, last step, step 7 is Minutiae Triplet Matching. It is done only at the final stage when the two fingerprints are matched. Here with the previous extracted features are compared with the new fingerprint image and after that the matched results are used for taking decision about the two fingerprints.

After getting the results of minutiae based palmtop recognition system, the door lock system can take decision whether it opens the lock or not. For this reason circuit is needed to design. Microcontroller is used for taking decision, means sending pulse to the gate circuit. If it is one, the gate is opened. If it is zero, the door remain closed and the warning bell will be ranged. Here, the main theme is to protect the electrical circuits from being damaged. For this reason, some resistance and extra circuitry is used For this reason protection.

5. EXPERIMENTAL SETUP

This paper works with more than one fingerprint of every person for get much accuracy in the fingerprint verifying security system. Features are extracted for every portion of the palmtop and these results are kept in memory. Finally, the combination of all the results give the final output, means the decision whether the fingerprint is verified or not. The steps which we have followed for our work is given below: -

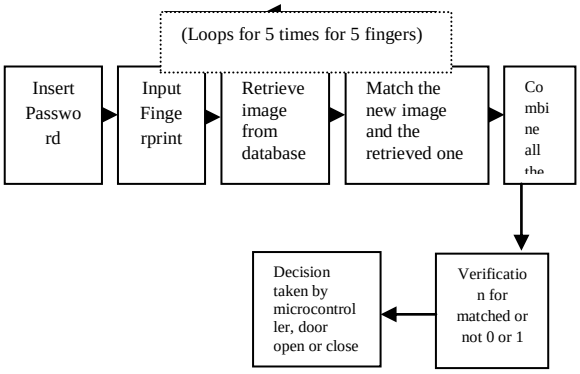

Fig 5. Steps for proposed work

As we have worked with minutiae based fingerprint matching process the basic steps described in figure 5 are all followed in our work. At first the fingerprints are taken with the help of scanner. Then five fingers' prints are detached from it. Then step by step process for minutiae extraction are executed for getting minutiae. Every time one fingerprint is taken into execution process and finally all the calculation are combined. The systematic execution processes are stated in following figures.

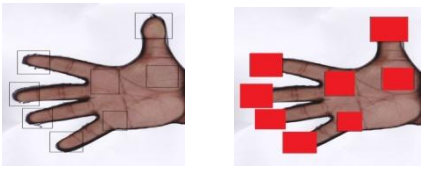

Fig 6. Fingerprint Detestation

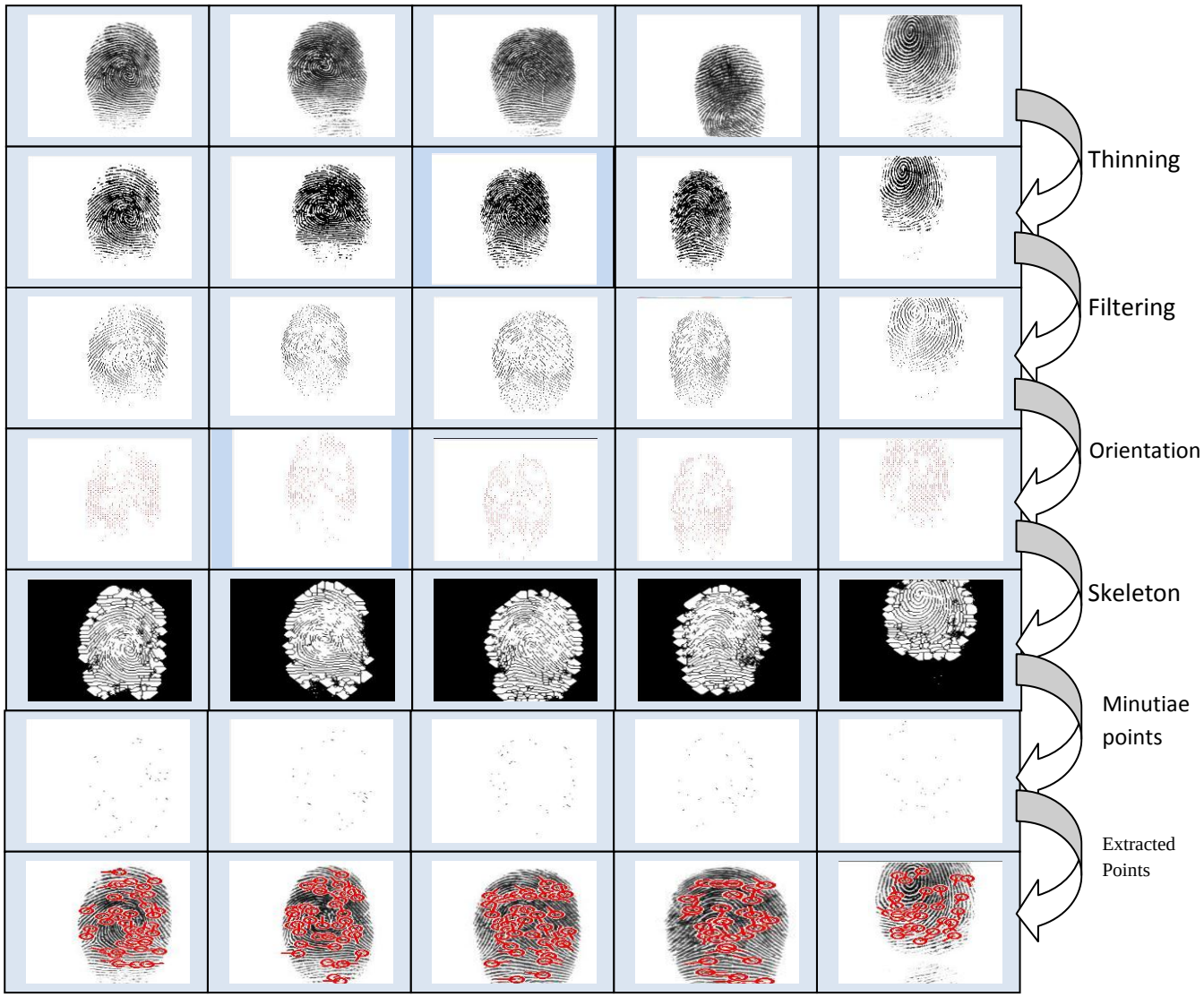

Figure 7: - Systematic Minutiae Extraction Process Output on each steps

After taken the palmtop and detached the fingerprints the processes described in figure 5 are executed and the following results are achieved. We use Hit and Miss class to extract the minutiae points and the scale it in the main feature:

At last stages on every step we get the minutiae of each fingerprint. We calculate the position and the angle of the minutiae points with each other and then save them in files. These results are used for second time verification processes.

After getting the fingerprint images the person is asked to give a password. Password works as the identification no of the fingerprint images extracted features. When a person wants to insert in a room which is secured with fingerprint recognition process, he needs to insert his password and then his palmtop print. The processor will extract the features from that image like figure 7. After verification this will work as input for the circuit which has developed for automatic door lock and open process for secured gate opening and closing process. The circuit is developed with the help of microcontroller, hex buffer IC, extra circuitry for microcontroller execution, electric magnet and so on.

Here, after verification process, the signal is sent by the serial port [74] to the microcontroller. We use Atmel 89c51 [75] in our work. But, as there is direct communication between serial port and microcontroller, max 233 [76] is used For this reason communication. After taking the output from max 233 it goes to microcontroller and then Hex Buffer IC. Here, input value 1 turns to 0. Relay [77, 78] is used in this circuit for switching from one stage to other. There are two relays in our circuit. Relay's input's one point has 6V input for switching and other point is attached with Hex buffer IC. In relay, one slot is connected with 220V AC for sending signal to the automated door for unlock and after sometimes locked again. It is mainly an electromagnet [79, 80]. Another relay is connected with warning bell. Here, 10W 10-Ohm resistance is used with the circuit so that the circuit does not destroy in high voltage. This circuit needs both DC and AC power supply. So we need to convert the AC voltage to DC voltage for our work.

From the block diagram of figure 8 we can see that the output from the serial port goes to the input of MAX 233. MAX 233 converts the input and makes it readable for the

Microcontroller. The microcontroller has two pin for serial port communication.

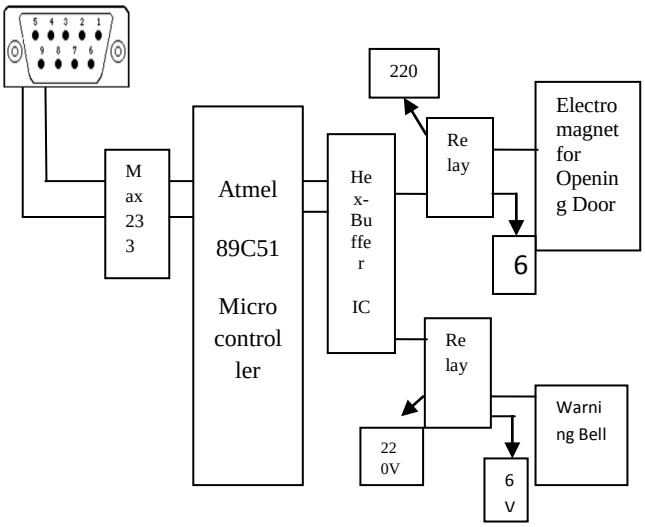

Fig. 8: - Block Diagram for Automatic Secured Door Operation

So, connecting the output of MAX 233 to the input pin of microcontroller passes the signal from serial port to serial port to microcontroller. According to the input of microcontroller, it will take decision and generates it signal. The output pins of microcontroller are connected with the input pins of inverter buffer IC. Two pins of the IC work as output result for the whole circuit. If any input of the IC is 1, the output of the buffer IC becomes 0. Here, the ground portion of the relays' connection is connected and the input portion is connected with a 6V DC power supply. So, when O comes in output then the circuit for relay switching becomes active. In relay, one point is connected with ground and another is connected with 220V power supply. Normally the relay stays in ground connected state. When the relay becomes active it switches to 220V supply and the door opens or the bell rings up. These two states are vice versa. This switching mainly works with an algorithm which is loaded in microcontroller and on the basis of serial port data which is sent by PC after verifying the fingerprint. The pseudo code of the algorithm is given in figure 9.

The block diagram of the circuit has applied in our work. It works very well in lab environment. We also perform high voltage test for finding better results. The automatic door system which we have used in lab is shown in figure 10.

The full proposed model will ensure a high security for an organization, a house and so on. It is also cost effective and easy to use. The work is mainly developed with the help of following platforms: -

1. Visual Studio (C#)
2. Core 2 duo (2.9 GHz Processor), 2 GB RAM
3. Atmel 89c51 microcontroller
4. Relays (6V, 220V)
5. Electromagnet (Automatic Door System)

All the combination of this works within a very short time to execute the whole program. Among them some results are shown in table I.

6. EXPERIMENTAL ANALYSIS

At first we have taken palmtop input from 20 persons. We examine the execution time for the whole process of their palmtop and also for the second time insertion process.

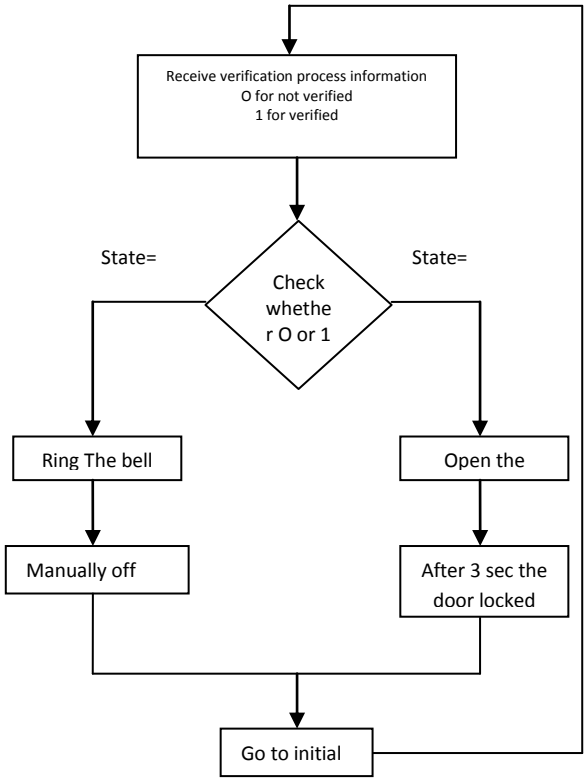

Fig. 9:- Flow Chart of Microcontroller Based Circuitry System

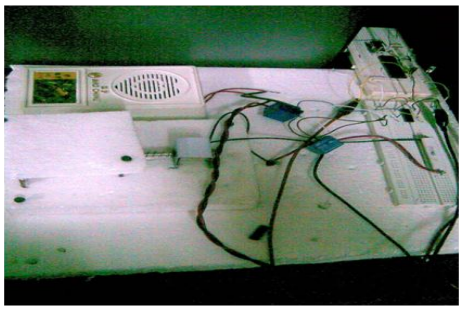

Fig. 10: - Automatic door open and lock system

Table 1. Table captions should be placed above the table

Person No	Number of fingerprints Input	Feature Extraction time	Second phase recognition time
1	5	5 sec	9 sec
2	5	7 sec	12 sec
3	5	6 sec	10 sec
4	5	7sec	11 sec
5	5	6 sec	11 sec

It is seen that execution process of our process is high than other models, but it's accuracy for recognize a person is higher than any other model. Here security is also high than other models, because here has less probability of error in our work. In our work in lab we have extracted about 20 people's fingerprint features. Some of them are shown in table III.

Table 2. Number of Extracted features for each person

Person No	Number of Minutiae in a palmtop	Average in one fingerprint
1	74	19
2	79	21
3	72	19
4	59	14
5	76	20

From the observation of table III we can see that only one fingerprint minutiae extraction process is not enough for taking decision about verification. There remains a probability of same fingerprints and minutiae numbers in time of examining with one fingerprint. But working with a palmtop shows good result and less probability of error.

From 20 people observation, in which every edge of people are included, we see that probability of error in results is increasing in every insertion of new persons with quite similar fingerprints in different models which work with only one fingerprint. In our model probability of error is less than others because here five fingerprints are taken for verifying one person. So accuracy becomes high. Figure 12 shows this:

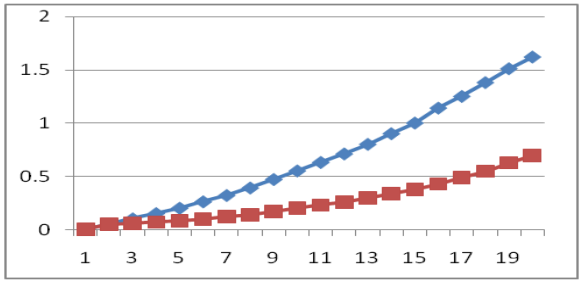

Fig. 12 Probability of Error Proposed Model(RED) and Present Model(BLUE)

From figure 12 we can see that there is much less probability of occurring error in our proposed model. Though this model needs little bit higher time for execution than other models, but its accuracy gives much time better results than the previous ones'. Again, the circuitry for automatic door system is much cost effective than other processes. A simple comparison is shown in figure 13.

From the above observation and results, we have seen that the model on which we have told in this whole paper is much better than the previous models, which are now running in the whole world. The model proposed for automated door open lock system is also cost effective and can be applied in different organizations.

7. Conclusion

In this paper we have shown a model for palmtop recognition system which mainly works with five fingerprints of each person. It is useful for verification of people at any environment and in any situation. It has much good response than others. The automatic controlled door circuit is also useable in any position and condition because of its parts availability and lower cost. But sometimes it fails to obtain its full performance because of sensor.

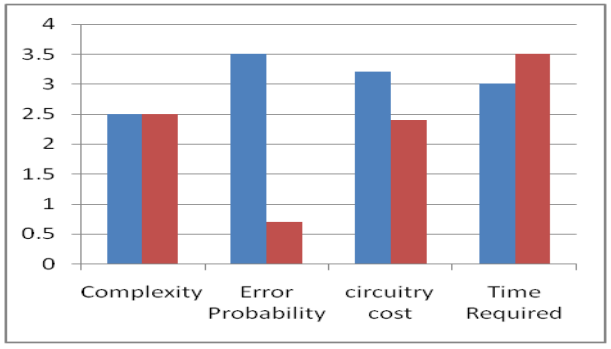

Fig 12: Comparison in Proposed Model(RED) and Present Model(BLUE)

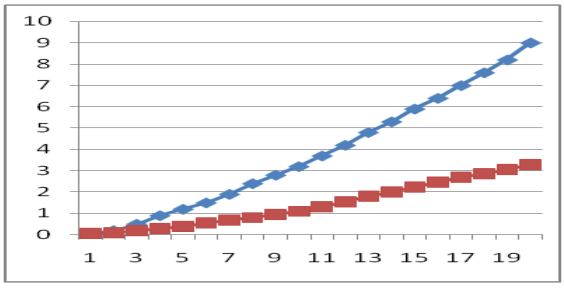

Fig. 13: - Probability of error in Proposed Model(RED) and Present Model(BLUE)

As we use low resolution scanner in our work so we get some error. But if high resolute scanner is used with the proposed model then probability of error will become quite zero which is highly required for any security ensuring system. Though the proposed model works with minutiae based palmtop recognition system, any types of fingerprint recognition system can be used with this model. Output result will not vary much for this reason.

In future we want to work with the circuit system of the proposed work to find out more cost effective circuit and want to reduce time and complexity of our palmtop print verification system. We also want to work with different processes of palmtop recognition system for finding out more efficient and less execution time required algorithm for increasing efficiency of the proposed biometric user authentication architecture, means palmtop recognition system of the proposed model. If we can work with high resolute scanner in future then we hope we can easily increase the efficiency of the program which will help to execute the proposed model with less time than the present one.

8. ACKNOWLEDGMENTS

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