

Biometrics Authentication Using Raspberry Pi

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Abstract— Biometric authentication is one of the most popular and accurate technology. Nowadays, it is used in many real time applications. However, recognizing fingerprints in Linux based embedded computers (raspberry pi) is still a very complex problem. This entire work is done on the Linux based embedded computer called raspberry pi , in which database creation and management using postgresql, web page creation using PHP language, fingerprint reader access, authentication and recognition using python were entirely done on raspberry pi This paper discusses on the standardized authentication model which is capable of extracting the fingerprints of individual and store that in database . Then I use the final fingerprint to match with others in fingerprints present in the database (postgresql) to show the capability of this model.

Index Terms— fingerprint authentication, PHP, postgresql, python, raspberry pi.

1 INTRODUCTION

The human body has the privilege of having features that are unique and exclusive to each individual. This exclusivity and unique characteristic has led to the field of biometrics and its application in ensuring security in various fields with various embedded controllers and embedded computers. Biometrics have gained popularity and has proved itself to be a reliable mode of ensuring privacy, maintaining security and identifying individuals. It has wide acceptance throughout the globe and now is being used at places like airports, hospitals, schools, colleges, corporate offices etc.

Biometrics is the study of identifying a person by their physical traits that are inherent and unique to only the person concerned. Biometric identification include fingerprint verification, palm geometry, face recognition, iris recognition, etc. The above mentioned techniques work with different levels of functionality and accuracy.

Accuracy and reliability are the two most important parameters when it comes to biometric applications and that too with advanced embedded computers. Fingerprint verification is one of the oldest known biometric techniques known but still is the most widely used because of its simplicity and good levels of accuracy. It's a well known fact that every human being is born with a different pattern on the fingers and this feature is exploited to identify and differentiate between two different persons that is what the factor which helped to initiate the model .

2 RELATED WORKS

2.1 DEVICE SUPPORT

Through prior involvement with fingerprint scanning efforts on Linux, I tested different devices to support with raspberry pi. I identified the key characteristics of each device and checked for the compatibility of each device. Finally concluded with U.are.U 4500 Module which suits the application

I tried for chapter 3 covers the technical information's of the fingerprint device used in this proposed design.

2.2 LITERATURE SURVEY

Sonam Shukla, Pradeep Mishra suggested increasing the Accuracy of an Existing Fingerprint Recognition System Using Adaptive Technique, in this approach developer mainly focusing on Integrated Automated Fingerprint Identification Service (IAFIS) of the most famous police agencies.[1] They extracted fingerprint pattern is characterized by a set of ridgelines that often flow in parallel, but intersect and terminate at some points. The uniqueness of a fingerprint is determined by the local ridge characteristics and their relationships. Main drawback of this model is this approach is not so apt for real time applications but the accuracy of system is highly adaptable. Most automatic systems for fingerprint comparison are based on minutiae matching.

Le Hoang Thai and Ha Nhat Tam in 2010 suggested Fingerprint recognition using standardized fingerprint model, now a days, fingerprint recognition is one of the most Important biometric technologies based on fingerprint distinctiveness,[2] in this approach they focused on improving the quality of fingerprint images. In fingerprint recognition process, the important step which affects on system accuracy is matching between template and query fingerprint. Many solutions are designed to increase this step's accuracy these matching algorithms may be classified into three types: minutiae-based approach, correlation-based approach and feature-based approach. However, as analyzed, the score of these algorithms is not high (especially in case fingerprints are of the same finger but they are rotated or the intersection is too small). So, it's Necessary to design a model to standardized fingerprint template in order to improve matching score.

Mukesh Kumar Thakur, Ravi Shankar Kumar, Mohit Kumar, Raju Kumar suggested Wireless Fingerprint Based

Security System Using Zigbee Technology [3]. This approach functions based on the uniqueness of each person and it integrating the biometric device along with zigbee to transmit the information obtained in this approach they are using fingerprint extraction and matching algorithm and they maintaining the database to authenticate the person who approaching for the access through the online web page created in the local server.

3 SYSTEM OUTLINE

3.1 HARDWARE ARCHITECTURE

This proposed system consists of raspberry pi and fingerprint module. This system provides the features of real time authentication facilities

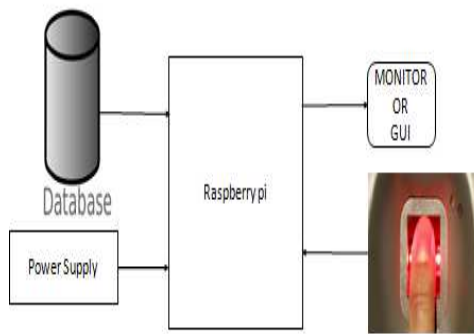


Fig 1: proposed system Block diagram

3.1.1 RASPBERRY PI

Hardware is a physical device that can be touched or held, like a hard drive or a mobile phone. Software can be thought of as a program or a collection of programs that instruct a computer on what to do and how to do it. Below is an image of the Raspberry Pi which describes some of the components that make up the hardware.

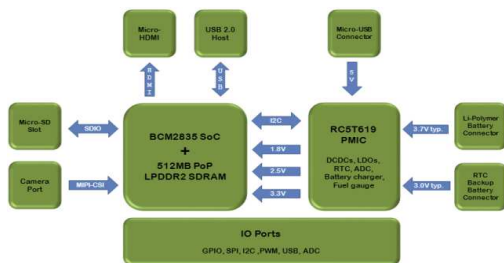


Fig.2. Hardware Components of Raspberry Pi

Fig.2 shows the hardware description of raspberry pi. The real time vehicle tracking system uses the GPIO pin, Micro SD slot, USB port and Micro USB connector. The GPIO pins are used for serial communication for interfacing GSM and GPS. It uses 8GB SD for installing the Raspbian OS and for storage. The USB port is used for connecting keyboard, mouse, dongle and pen drive. The power supply is given through USB connector.

3.1.2 U.are.U 4500 USB FINGERPRINT READER

The U.are.U 4500 is the module which I used in this project where this Module is a miniature USB fingerprint reader designed for integration in to OEM equipment where fingerprint verification or identification is needed. This module supports both windows and Linux based operating system. This self-contained module optically scans the fingerprint when the user touches the glowing window.



Fig 3: fingerprint module

Optical technology gives the highest quality fingerprint templates and reliability along with the raspberry pi embedded computer. The U.are.U 4500 Module is designed to simplify OEM integration. The module is sealed from dust and includes convenient mounting features.

The device can automatically control calibration, encryption, and data transfer through the USB interface. A “Heavy Duty” version of the module is available for unattended public installations and other high-use applications. While checking the compatibility of this module I have found this module to be more reliable for all kind of OS, even its easy to interface with raspberry pi (debian os) .The U.are.U 4500 Module and digital Persona Fingerprint Recognition Engine have an unmatched ability to authenticate even the most difficult fingerprints accurately and rapidly.

3.2 SOFTWARE ARCHITECTURE

For this project I have used softwares like PHP, postgresql, opencv (python script). The configuring procedures, saving and retrieval of fingerprint templates procedures are mentioned in the upcoming chapters.

3.2.1 PHP

PHP is a server-side scripting language designed for web development but also used as a general-purpose programming language which is been used in the project. As of January 2013, PHP was installed on more than 240 million websites (39% of those sampled) and 2.1 million web servers. Originally created by Rasmus Lerdorf in 1994, the reference implementation of PHP (powered by

the Zend Engine) is now produced by The PHP Group.^[6] While PHP originally stood for Personal Home Page, it now stands for PHP: Hypertext Preprocessor. This is been used to display the information's of workers in the monitor.

3.2.2 POSTGRESQL

PostgreSQL, often simply "Postgres", is a object-relational database management system which is used along with an emphasis on extensibility and standards-compliance. As a database server, its primary function is to store data securely in the raspberry pi, supporting best practices, and to allow for retrieval at the request of other software applications like PHP. It can handle workloads ranging from small machine applications to large Internet facing applications with many concurrent users even through the terminal in the raspberry pi server. Recent versions also provide replication of the database itself for availability and scalability in both windows and linux.

3.2.3 SOFTWARE- ALGORITHM

The software algorithm of authentication system is described here, the IP address in putty is initialized. Tightvncserver is used for viewing raspberry pi.

- Step 1 : Initialize IP address in PuTTY.**
- Step 2 : Run the tightvncserver.**
- Step 3 : Connect the fingerprint module.**
- Step 4 : open the fprint_demo gui**
- Step 5 : read and save the image template**
- Step 6 : covert the image template in to binary template**
- Step 7 : save the obtained template in the postgresql database**
- Step 8 : now comparison between various templates can be carried out using the python script**
- Step 9 : The accurate matching points will obtain between the images**

3.3 IMPLEMENTATION PROCEDURE

3.3.1 FPRINT DEMO: GRAPHICAL DEMONSTRATION APPLICATION

This proposed system is implemented in a Linux based GUI application, fprint demo and fingerprint model, with the intention of using this to demonstrate the functionality of the finger print device along with raspberry pi embedded computer. fprint demo offers an interface for enrolling fingers and deleting enrollment data for previously enrolled fingers with the help of fprint GUI, an interface for verifying a specific finger and an Interface for identifying a finger from a selection of previously enrolled fingerprint data. For imaging devices, it shows the scanned fingerprints on-screen and allows you to view the binarized version with minutiae plotted in the GUI.

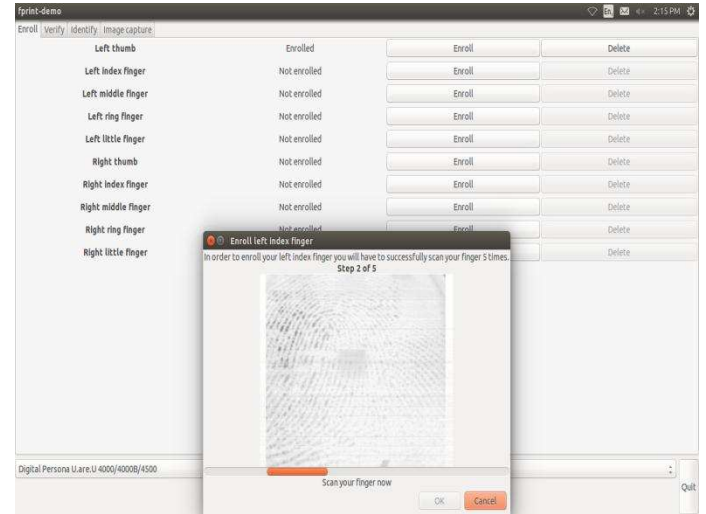


Fig 4:capturing of fingerprint template

3.3.2 CONVERTING THE TEMPLATE IN TO BINARIZED TEMPLATE

This GUI is capable of converting the fingerprint template in to binary template. The imaging performance of this device is excellent. The returned images are large and finds a large number of minutiae, leading to suitably distinct scores for matching/non-matching fingers. Fig 5 shows an image returned by this driver and its binarized form with minutiae plotted with the help of raspberry pi embedded computer.



Fig 5: normal and binarized template

4 EXPERIMENTAL RESULTS

After extracting the fingerprint template using fprint demo GUI, I was able to store the binarized image in the data base using the PHP script

Then comparison has been carried out with the help of open cv programming tool with python script

The below figure shows the image of mismatched fingers, which is identified by the python script which uses the special image processing algorithm called FLANN_INDEX_KDTREE with cv2.FlannBasedMatcher

Fig 6 given below shows mismatched fingerprints of different persons the python program is running as the background process

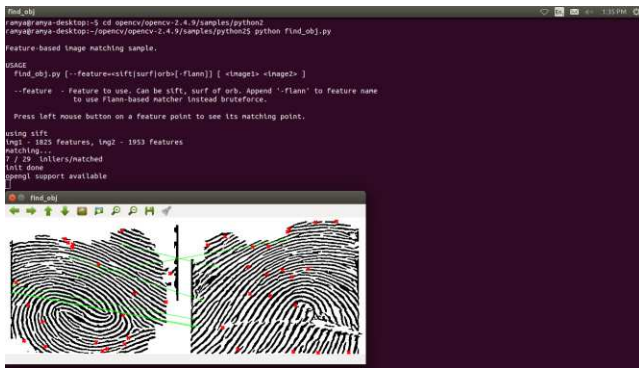


Fig 6: mismatched finger ridges in template

Thus the above figure shows the mismatched characteristics of two different fingers, while comparing the same fingers I got the matching points almost every where in finger templates

Fig 8 given below shows exactly matched fingerprints of a person the python program is running as the background process

The green coloured lines connecting two templates showing the number of matching points in the templates

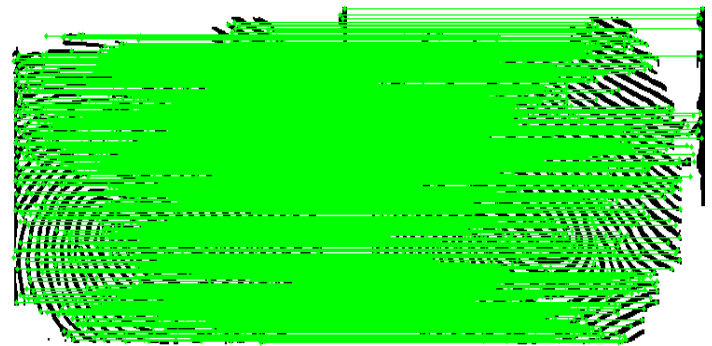
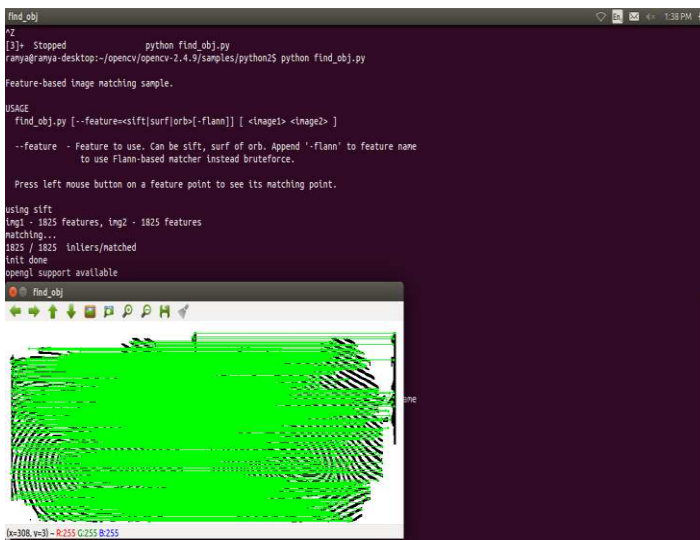


Fig 7: matched finger ridges in template

The above experimental results clearly states the ability of the proposed design to distinguish the matched and mismatched fingers.

5 CONCLUSIONS AND FUTURE WORK

Fingerprint recognition is one of the most popular and accurate Biometric technologies. Nowadays, it is used in many real time applications. However, recognizing fingerprints in Linux based embedded computers (raspberry pi) are still a very complex problem. This entire work is done on the Linux based embedded computer called raspberry pi, in which database creation and management using postgresql, web page creation using PHP language, fingerprint reader access, authentication and recognition using python were entirely done on raspberry pi. This paper discusses on the standardized fingerprint model which is used to synthesize the template of fingerprints. In this model, after pre-processing step, find the transformation between templates, adjust parameters and synthesize fingerprint. Then i use the final fingerprint to match with others in fingerprints present in the database (postgresql) to show the capability of this model.

Fine tuning has to be done to improve the accuracy of the system and developing the system for real time higher end application are need to be done as the future work for this design.

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