Fingerprint Authenticated Device Switcher Using Microcontroller and Arduino Uno

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Abstract
Fingerprint matching has been successfully used by law enforcement for more than a century. The technology is now finding lot of other applications such as identity management and access control. In this context, an automated fingerprint recognition system and identification of key challenges are described along with the switching opportunities. The description is like a product design in this report implementing RTOS (Real time operating system) under the domain of embedded system. Fingerprint Recognition is a widely popular but complex pattern recognition Problem. In this paper, we have come with a novel approach to solve the existing problems with a proper Embedded System Design. In this project as well the fingerprint detection makes it coherent with the application involved within. The solutions viable are never ending but the switching mechanisms are to be sought after.

Keywords
Microcontroller, Fingerprint, Biometric Recognition, Arduino Uno.

I. Introduction

Biometrics is the measurement and statistical analysis of people's physical characteristics. The technology is mainly used for the identification and access control of various switches for identifying individuals that need surveillance or automation.
Fingerprints are the prominent physiological characteristic of the human body. In order to protect users of computer systems and to secure network-based transactions, demand is increasing for improved user authentication procedures to establish the identity of an actual user and to bar access to a terminal to anyone who is unauthorized. Personal identification using biometrics, a person's physical or behavioral characteristics, has come to attract increased attention as a possible solution to this issue and one that might offer reliable systems at a reasonable cost. While traditionally this technology has been available only with such expensive, high-end systems as those used in law enforcement and other government applications, today many personal-level applications have also become possible thanks to the advancements in pattern recognition technology. Fingerprint sensors can be made small and thin enough to be implemented easily for small applications and even on pocket-sized terminals.
The major advantages presented through the usage of biometrics and finger print detection are stable, reliable and highly accurate identification software is currently available even for use on personal usage.
Thus we come across the enabling of this sensor which is efficient and not expensive to be the middle ground for the working class to optimize the surroundings. The main advantage of this project is to enable the switching or even enrolling any device for the change in the state of a system.

A. Fingerprint Sensing Technology

A fingerprint is a pattern of fine ridges and valleys (spaces between ridges) on the surface of a finger, and a fingerprint sensor makes a digitized image of it. The sensing resolution is 500ppi (pixel per inch; also known as 500dpi, i.e., dots per inch) in most cases, which is equivalent to 20 pixels in 1 millimeter.

B. Fingerprint Authenticated Device Switcher

User Based Device control using fingerprint sensing. We come across areas where we need to switch no device for a particular user as soon as he enters. The device could be his Pc, fan, lights etc. For this purpose we suggest a fingerprint based device switcher project. The system switches on device for a particular user automatically on sensing him through his fingerprint scan. For this we use a fingerprint scanner interfaced to a microcontroller based circuit. As soon as a person enters he/she is allowed to scan his/her finger on the scanner.On scanning the data is sent to the microcontroller, based on this data the scanned copy is now verified for authentication. If the user is verified the microcontroller switches on a device (light) to indicate as the users verification.
A single device can be used for multiple functions and this rectifies the problem of having different access keys.
The main principle of this device however is the way a single person being able to control all the different accessing switches with different fingerprints reducing the redundancy of having multiple devices or physical switches.

C. The Main Solid-State Sensor

Non-optical, solid-state sensors have also appeared on the market in recent years. In this case, theridge patterns of a finger placed directly on a siliconchip (sufficiently coated, of course, to protect its surface) are sensed on the basis of differences in capacitance, temperature, or pressure. Such one-chip sensors offer a low-cost implementation for smaller, thin devices. These sensors can be small, thin, and comparatively cheap.

D. Microcontroller

The third important component is the microcontroller. Microcontrollers are the combinations of different peripherals with microprocessors. It is an integration of all the input/output peripherals, memory and core. It is a vital part of the project as it is able to identify the required patterns and is able to process and give out the required instruction output accordingly. The microcontroller being dealt with are either arduino Uno or at mega 328. The outputs of finger prints are in pixels of 500 dpi. The resultant output is sent serially through the sensor to the microcontroller. This results in the operation of the microcontrollers being mandatory. Then the further processing of the data occurs.

II. Literature Review

This chapter presents the work done by other researcher related to fingerprint authenticated device switcher. In this chapter description about all reference papers are summarized.

Chandra Prakash Singh at [1] proposedto automate a classroom attendance procedure busing a fingerprint recognition module interfaced with 8051 microcontroller. A fingerprint recognition

system can be used for both verification and identification. In verification, the system compares an input fingerprint to the "enrolled" fingerprint of a specific user to determine if they are from the same finger (1:1 match). In identification, the system compares an input fingerprint with the prints of all enrolled users in the database to determine if the person is already known under aduplicate or false identity (1:N match).

Jonnavel A. Lerit at [2] presentedThe USB Door Lock using Biometrics Fingerprint Technology aims to interface a bio-metric reader, specifically a fingerprint scanner, and a door lock using a USB port that will secure a specific room. This device can be a replacement for keys and cards. The design is composed of the USB interfaced fingerprint reading device and a circuit to trigger the locking and unlocking of the door. Pic BASIC is used in the programming of the microcontroller unit to interact with the fingerprint reader in triggering relays for locking and unlocking of the door. With this system, securing access to establishments is guaranteed while providing convenience and efficiency in entering a room.

Subhajit Dey at [3] presented Arduino Uno microcontroller is the central part of the design where the server program for controlling is burned. Thus all the controlling is done by it. For the web application the Html part is provided inside the program thus it doesn't require any other application to be developed for different gadgets. The security mode is very invulnerable where nobody can access the system without deactivating the security system from the activating device. The automated mode makes life easier for users by complete automation of necessary appliances without any human effort.

Moheb R. at [4] proposed an approach to image extraction and accurate skin detection from web pages. This paper proposes a system to extract images from web pages and then detect the skin color regions of these images. As part of the proposed system, using BandObject control, they build aminutia unification by decomposing a branch into three terminations, and matching in the unified x-y coordinate system after a two-step transformation are used in the work.

Hoi Le at [5] proposed online fingerprint identification with a fast and distortion tolerant hashing method. National ID card, electronic commerce, and access to computer networks are some scenarios where reliable identification is a must. Existing authentication systems relying on knowledge-based approaches like passwords or token-based such as magnetic cards and passports contain serious security risks due to the vulnerability to engineering-social attacks and the easiness of sharing or compromising passwords and PINs. Biometrics such as fingerprint, face, eye retina, and voice offer a more reliable means for authentication. However, due to large biometric database and complicated biometric measures, it is difficult to design both an accurate and fast biometric recognition. Particularly, fast fingerprint indexing is one of the most challenging problems faced in fingerprint authentication system. In this paper, they present a specific contribution by introducing a new robust indexing scheme that is able not only to fasten the fingerprint recognition process but also improve the accuracy of the system.

Mayank Vatsa at [6] proposed an combining pores and ridges with minutiae for improved fingerprint verification. This paper presents a fast fingerprint verification algorithm using level-2 minutiae and level-3 pore and ridge features. The proposed algorithm uses a two-stage process to register fingerprint images. In the first stage, Taylor series based image transformation is used to perform coarse registration, while in the second stage, thin plate spline transformation is used for fine registration. A fast feature extraction algorithm is proposed using the Mumford–Shah functional curve evolution to efficiently segment contours and extracts the intricate level-3 pore and ridge features. Further, Delaunay triangulation based fusion algorithm is proposed to combine level-2 and level-3 information that provides structural stability and robustness to small changes caused due to extraneous noise or non-linear deformation during image capture. They defines eight quantitative measures using level-2 and level-3 topological characteristics to form a feature super vector. A 2n-support vector machine performs the final classification of genuine or impostor cases using the feature super vectors. Experimental results and statistical evaluation show that the feature super vector yields discriminatory information and higher accuracy compared to existing recognition and fusion algorithms.

Umut Uludaga at [7] proposed a Biometric template selection and update: a case study in fingerprints. Sweat pores have been recently employed for automated fingerprint recognition, in which the pores are usually extracted by using a computationally expensive skeletonization method or a unitary scale isotropic pore model. In this paper, however, real pores are not always isotropic. To accurately and robustly extract pores, they propose an adaptive anisotropic pore model, whose parameters are adjusted adaptively according to the fingerprint ridge direction and period. The fingerprint image is partitioned into blocks and a local pore model is determined for each block. With the local pore model, a matched filter is used to extract the pores within each block. Experiments on a high resolution (1200dpi) fingerprint dataset are performed and the results demonstrate that the proposed pore model and pore extraction method can locate pores more accurately and robustly in comparison with other state-of-the-art pore extractors.

III. Methodology

The primary method for the initial process is managing the software for programming and debugging the program of detection and output processing. The second software used is arduino IDEand fingerprint SFG. The other hardware specifications are as follows.

A. Tools & Technology Used

The major software tools that were used in the project:

1. Arduino IDE

Arduino is an open source, computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers.

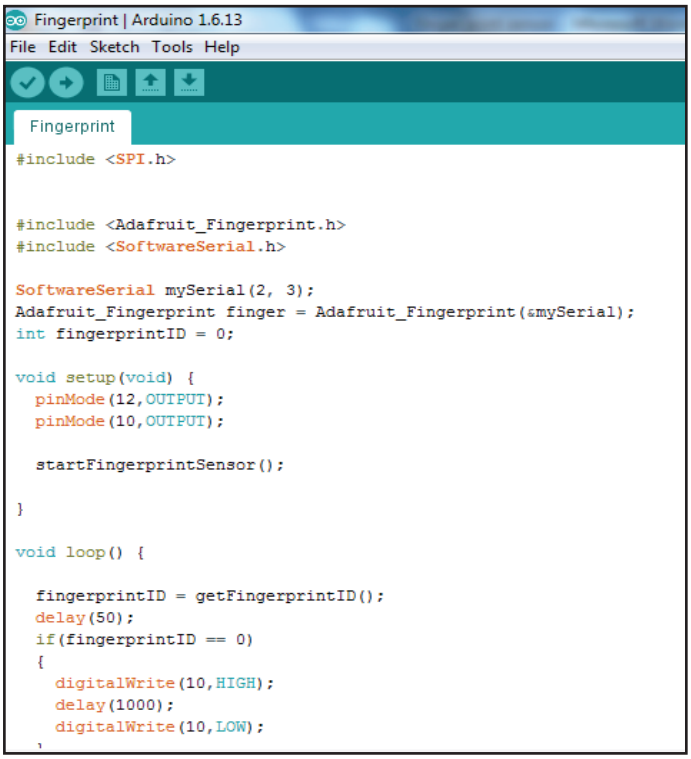

Fig. 1: Arduino 1.6.13

2. Serial Monitor

The Serial Monitor and it is part of the Arduino IDE software. Its job is to allow you to both send messages from your computer to an Arduino board (over USB) and also to receive messages from the Arduino.

3. SFG

Special enrollment program for fingerprints. This software makes it possible to visibly check the finger prints. Match the fingerprints and provide them the specific identities for further use of it in the programming process.

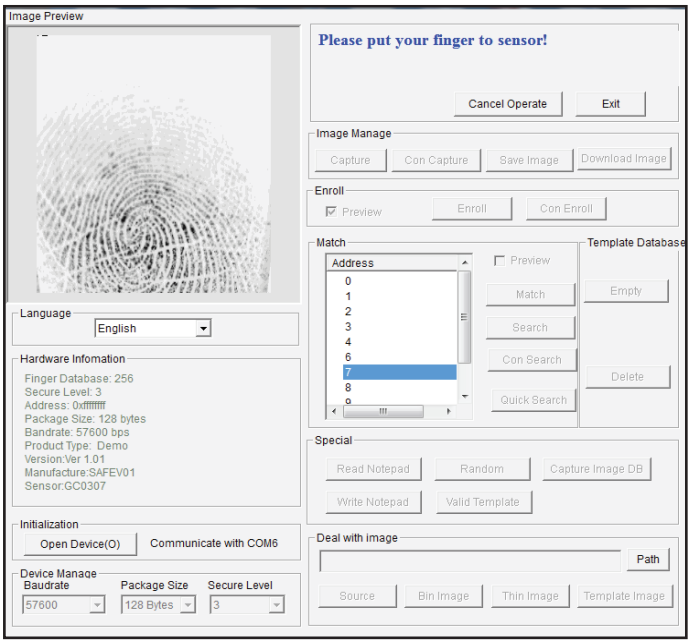

Fig. 2: SFG

B. Hardware Specification Requirements

Finger Print Module, Microcontroller (Atmega 328) or Arduino Uno, LEDs and switches) as required).

Fig. 3: Fingerprint Sensor

Fingerprint sensor module with TTL UART interface for direct connections to microcontroller UART or to PC through MAX232 / USB-Serial adapter. The user can store the finger print data in the module and can configure it. The FP module can directly interface with 3v3 or 5v Microcontroller.

C. Microcontroller Used

The Arduino Uno is an open-source project that created microcontroller-based kits for building digital devices. For this project the Uno is added with the initial fingerprinting libraries and thus the sensor is able to process the inputs. Thus being able to manipulate the inputs and access other outputs such as relays and other required LEDs.

D. Program for Switching

```
#include <SPI.h>
#include <Adafruit_Fingerprint.h>
#include <SoftwareSerial.h>
SoftwareSerial mySerial(2, 3);
Adafruit_Fingerprint finger = Adafruit_Fingerprint(&mySerial);
int fingerprintID = 0;
void setup(void) {
 pinMode(12,OUTPUT);
 pinMode(10,OUTPUT);
 startFingerprintSensor();
 }
void loop() {
 fingerprintID = getFingerprintID();
 delay(50);
 if(fingerprintID == 0)
 {
  digitalWrite(10,HIGH);
  delay(1000);
  digitalWrite(10,LOW);
 }

  if(fingerprintID == 2)
 {
  digitalWrite(12,HIGH);
  delay(2000);
  digitalWrite(12,LOW);
 }
```

```
}
void startFingerprintSensor()
{
  Serial.begin(9600);
  finger.begin(57600);

  if (finger.verifyPassword()) {
    Serial.println("Found fingerprint sensor!");
  } else {
    Serial.println("Did not find fingerprint sensor");
  }
  Serial.println("Waiting for valid finger...");
}
int getFingerprintID() {
  uint8_t p = finger.getImage();
  if (p != FINGERPRINT_OK)  return -1;
 p = finger.image2Tz();
if (p != FINGERPRINT_OK)  return -1;
 p = finger.fingerFastSearch();
  if (p != FINGERPRINT_OK)  return -1;
   // found a match!
  Serial.print("Found ID #"); Serial.print(finger.fingerID);
   Serial.print(" with confidence of "); Serial.println(finger.
confidence);
  return finger.fingerID;
}
```

IV. Conclusion

This project uses very popular finger print sensing technology for the purpose of electrical switching for security and various other switching purposes. The technology is mainly used for the identification and access control of various switches for identifying individuals that need surveillance or automation.

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