Fingerprint Based Access Control System

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Abstract—the goal of our project is to design and assemble a fingerprint based access control system that uses fingerprint scanning and recognition to authenticate the user. Upon successful authentication, the user will be allowed to access the safe. On the other hand, if the access is denied, it will be reported to the center administrative console for audit purposes. The fingerprint scanning device utilizes serial communication. This device will be connected to our microprocessor. The system will consist of an Atmel 89C51 microprocessor, LCD display, fingerprint sensor, electronic door strike. Software will be written for the PC that allows the owner to register and delete fingerprints and monitor door entry. LCD's and LED's will be used to display whether or not access was granted or denied. The biggest challenge that will be faced is figuring out how to interface the Atmel 89c51 with interface which allows the owner to manage fingerprint access. If time permits a cell module will be used to alert the owner of a possible break-in attempt.

Keywords:-Fingerprint identification, BIOMETRIC ACCESS, research in biometric

I. INTRODUCTION

A fingerprint in its narrow sense is an impression left by the friction ridges of a human finger in a wider use of the term, fingerprints are the traces of an impression from the friction ridges of any part of a human or other primate hand. A print from the foot can also leave an impression of friction ridges. A friction ridge is a raised portion of the epidermis on the digits (fingers and toes), the palm of the hand or the sole of the foot, consisting of one or more connected ridge units of friction ridge skin. These are sometimes known as "epidermal ridges" which are caused by the underlying interface between the dermal papillae of the dermis and the interpapillary pegs of the epidermis. These epidermal ridges serve to amplify vibrations triggered, for example, when fingertips brush across an uneven surface, better transmitting the signals to sensory nerves involved in fine texture perception. These ridges may also assist in gripping rough surfaces and may improve surface contact in wet conditions.

Impressions of fingerprints may be left behind on a surface by the natural secretions of sweat from the echini glands that are present in friction ridge skin, or they may be made by ink or other substances transferred from the peaks of friction ridges on the skin to a relatively smooth surface such as a fingerprint card.[1] Fingerprint records normally contain impressions from the pad on the last joint of fingers and thumbs, although fingerprint cards also typically record portions of lower joint areas of the fingers.

Since the early 20th century, fingerprint detection and analysis has been one of the most common and important forms of crime scene forensic investigation. More crimes have been solved with fingerprint evidence than for any other reason.

II. IDENTIFICATION

Fingerprint identification, known as dactyloscopy, or hand print identification, is the process of comparing two instances of friction ridge skin impressions (see Minutiae), from human fingers or toes, or even the palm of the hand or sole of the foot, to determine whether these impressions could have come from the same individual. The flexibility of friction ridge skin means that no two finger or palm prints are ever exactly alike in every detail; even two impressions recorded immediately after each other from the same hand may be slightly different. Fingerprint identification, also referred to as individualization, involves an expert, or an expert computer system operating under threshold scoring rules, determining whether two friction ridge impressions are likely to have originated from the same finger or palm (or toe or sole).

Fig. 1: An image of a fingerprint created by the friction ridge structure

An intentional recording of friction ridges is usually made with black printer's ink rolled across a contrasting white background, typically a white card. Friction ridges can also be recorded digitally, usually on a glass plate, using a technique called Live Scan. A "latent print" is the chance recording of friction ridges deposited on the surface of an object or a wall. Latent prints are invisible to the naked eye, whereas "patent prints" or "plastic prints" are viewable with the un-aided eye. Latent prints are often fragmentary and require the use of chemical methods, powder, or alternative light sources in order to be made clear. Sometimes an ordinary bright flashlight will make a latent print visible.

When friction ridges come into contact with a surface that will take a print, material that is on the friction ridges such as perspiration, oil, grease, ink or blood, will be transferred to the surface. Factors which affect the quality of friction ridge impressions are numerous. Pliability of the skin, deposition pressure, slippage, the material from which the surface is made, the roughness of the surface and the substance deposited are just some of the various factors which can cause a latent print to appear differently from any known recording of the same friction ridges. Indeed, the conditions surrounding every instance of friction ridge deposition are unique and never duplicated. For these reasons, fingerprint examiners are required to undergo extensive training. The scientific study of fingerprints is called dermatoglyphics.

III. TYPES OF FINGERPRINT IDENTIFICATION

A. Exemplar

Exemplar prints, or known prints, is the name given to fingerprints deliberately collected from a subject, whether for purposes of enrollment in a system or when under arrest for a suspected criminal offense. During criminal arrests, a set of exemplar prints will normally include one print taken from each finger that has been rolled from one edge of the nail to the other, plain (or slap) impressions of each of the four fingers of each hand, and plain impressions of each thumb. Exemplar prints can be collected using Live Scan or by using ink on paper cards.

B. Latent

Although the word latent means hidden or invisible, in modern usage for forensic science the term latent prints means any chance or accidental impression left by friction ridge skin on a surface, regardless of whether it is visible or invisible at the time of deposition. Electronic, chemical and physical processing techniques permit visualization of invisible latent print residues whether they are from natural sweat on the skin or from a contaminant such as motor oil, blood, ink, paint or some other form of dirt. The different types of fingerprint patterns, such as arch, loop and whorl, will be described below.

Latent prints may exhibit only a small portion of the surface of a finger and this may be smudged, distorted, overlapped by other prints from the same or from different individuals, or any or all of these in combination. For this reason, latent prints usually present an "inevitable source of error in making comparisons," as they generally "contain less clarity, less content, and less undistorted information than a fingerprint taken under controlled conditions, and much, much less detail compared to the actual patterns of ridges and grooves of a finger."

C. Patent

Patent prints are chance friction ridge impressions which are obvious to the human eye and which have been caused by the transfer of foreign material from a finger onto a surface. Some obvious examples would be impressions from flour and wet clay. Because they are already visible and have no need of enhancement they are generally photographed rather than being lifted in the way that latent prints are. An attempt to preserve the actual print is always made for later presentation in court, and there are many techniques used to do this. Patent prints can be left on a surface by materials such as ink, dirt, or blood.

D. Plastic

A plastic print is a friction ridge impression left in a material that retains the shape of the ridge detail. Although very few criminals would be careless enough to leave their prints in a lump of wet clay, this would make a perfect plastic print.[8] Commonly encountered examples are melted candle wax; putty removed from the perimeter of window panes and thick grease deposits on car parts. Such prints are already visible and need no enhancement, but investigators must not overlook the potential that invisible latent prints deposited by accomplices may also be on such surfaces. After photographically recording such prints, attempts should be made to develop other non-plastic impressions deposited from sweat or other contaminants.

E. Electronic recording

There has been a newspaper report[9] of a man selling stolen watches sending images of them on a mobile phone, and those images included parts of his hands in enough detail for police to be able to identify fingerprint patterns.

F. Classifying

Before computerization replaced manual filing systems in large fingerprint operations, manual fingerprint classification systems were used to categorize fingerprints based on general ridge formations (such as the presence or absence of circular patterns on various fingers), thus permitting filing and retrieval of paper records in large collections based on friction ridge patterns alone. The most popular ten-print classification systems include the Roscher system, the Juan Vucetich system, and the Henry Classification System. Of these systems, the Roscher system was developed in Germany and implemented in Germany and Japan, the Vucetich system (developed by a Croatian-born Buenos Aires Police Officer) was developed in Argentina and implemented throughout South America, and the Henry system was developed in India and implemented in most English-speaking countries.

In the Henry system of classification, there are three basic fingerprint patterns: loop, whorl and arch, which constitute 60–65%, 30–35% and 5% of all fingerprints respectively. There are also more complex classification systems that break down patterns even further, into plain arches or tented arches, and into loops that may be radial or ulnar, depending on the side of the hand toward which the tail points. Ulnar. Loops start on the pinky-side of the finger, the side closer to the ulna, the lower arm bone. Radial loops start on the thumb-side of the finger, the side closer to the radius. Whorls may also have sub-group classifications including plain whorls, accidental whorls, double loop whorls, peacock's eye, composite, and central pocket loop whorls.

Other common fingerprint patterns include the tented arch, the plain arch, and the central pocket loop.

The system used by most experts, although complex, is similar to the Henry System of Classification. It consists of five fractions, in which *R* stands for right, *L* for left, *i* for index finger, *m* for middle finger, *t* for thumb, *r* for ring finger and *p* (pinky) for little finger. The fractions are as follows: *Ri/Rt + Rr/Rm + Lt/Rp + Lm/Li + Lp/Lr*. The numbers assigned to each print are based on whether or not they are whorls. A whorl in the first fraction is given a 16, the second an 8, the third a 4, the fourth a 2, and 0 to the last fraction. Arches and loops are assigned values of 0. Lastly, the numbers in the numerator and denominator are added up, using the scheme:

$$(Ri + Rr + Lt + Lm + Lp)/ (Rt + Rm + Rp + Li + Lr)$$

and a 1 is added to both top and bottom, to exclude any possibility of division by zero. For example, if the right rings finger and the left index finger have whorls, the fractions would look like this:

0/0 + 8/0 + 0/0 + 0/2 + 0/0 + 1/1, and the calculation: (0 + 8 + 0 + 0 + 0 + 1)/ (0 + 0 + 0 + 2 + 0 + 1) = 9/3 = 3.

Using this system reduces the number of prints that the print in question needs to be compared to. For example, the above set of prints would only need to be compared to other sets of fingerprints with a value of 3.

G. Footprints

Friction ridge skin present on the soles of the feet and toes (plantar surfaces) is as unique in its ridge detail as are the fingers and palms (palmar surfaces). When recovered at crime scenes or on items of evidence, sole and toe impressions can be used in the same manner as finger and palm prints to effect identifications. Footprint (toe and sole friction ridge skin) evidence has been admitted in courts in the United States since 1934.

The footprints of infants, along with the thumb or index finger prints of mothers, are still commonly recorded in hospitals to assist in verifying the identity of infants. Often, the only identifiable ridge detail that can be seen on a baby's foot is from the large toe or adjacent to the large toe.

It is not uncommon for military records of flight personnel to include bare foot inked impressions. Friction ridge skin protected inside flight boots tends to survive the trauma of a plane crash (and accompanying fire) better than fingers. Even though the US Armed Forces DNA Identification Laboratory (AFDIL), as of 2010, stored refrigerated DNA samples from all active duty and reserve personnel, almost all casualty identifications are effected using fingerprints from military ID card records (live scan fingerprints are recorded at the time such cards are issued). When friction ridge skin is not available from military personnel's remains, DNA and dental records are used to confirm identity.

H. Live scan devices

Fingerprint image acquisition is considered to be the most critical step in an automated fingerprint authentication system, as it determines the final fingerprint image quality, which has a drastic effect on the overall system performance. There are different types of fingerprint readers on the market, but the basic idea behind each is to measure the physical difference between ridges and valleys.

All the proposed methods can be grouped into two major families: solid-state fingerprint readers and optical fingerprint readers. The procedure for capturing a fingerprint using a sensor consists of rolling or touching with the finger onto a sensing area, which according to the physical principle in use (optical, ultrasonic, capacitive or thermal) captures the difference between valleys and ridges. When a finger touches or rolls onto a surface, the elastic skin deforms. The quantity and direction of the pressure applied by the user, the skin conditions and the projection of an irregular 3D object (the finger) onto a 2D flat plane introduce distortions, noise and inconsistencies in the captured fingerprint image. These problems result in inconsistent, irreproducible and non-uniform irregularities in the image.[15] During each acquisition, therefore, the results of the imaging are different and uncontrollable. The representation of the same fingerprint changes every time the finger is placed on the sensor plate, increasing the complexity of any attempt to match fingerprints, impairing the system performance and consequently, limiting the widespread use of this biometric technology.

In order to overcome these problems, as of 2010, non-contact or touch less 3D fingerprint scanners have been developed. Acquiring detailed 3D information, 3D fingerprint scanners take a digital approach to the analog process of pressing or rolling the finger. By modelling the distance between neighboring points, the fingerprint can be imaged at a resolution high enough to record all the necessary detail.

I. Laboratory techniques

Although there are hundreds of reported techniques for fingerprint detection, many of these are only of academic interest and there are only around 20 really effective methods which are currently in use in the more advanced fingerprint laboratories around the world. Some of these techniques, such as ninhydrin, diazafluorenone and vacuum metal deposition, show great sensitivity and are used operationally. Some fingerprint reagents are specific, for example ninhydrin or diazafluorenone reacting with amino acids. Others such as ethyl cyanoacrylate polymerization work apparently by water-based catalysis and polymer growth. Vacuum metal deposition using gold and zinc has been shown to be non-specific, but can detect fat layers as thin as one molecule. More mundane methods, such as the application of fine powders, work by adhesion to sebaceous deposits and possibly aqueous deposits in the case of fresh fingerprints. The aqueous component of a fingerprint, whilst initially sometimes making up over 90% of the weight of the fingerprint, can evaporate quite quickly and may have mostly gone after 24 hours. Following work on the use of argon ion lasers for fingerprint detection a wide range of fluorescence techniques have been introduced, primarily for the enhancement of chemically-developed fingerprints; the inherent fluorescence of some latent fingerprints may also be detected. The most comprehensive manual of the operational methods of fingerprint enhancement is published by the UK Home Office Scientific Development Branch and is used widely around the world.

IV. INTRODUCTION

The fingerprint based access control system we are designing is beneficial for a number of reasons. It provides high identification performance, low power consumption, and can easily be integrated into a wide number of applications such as a door lock system, safe box, simple access controller, vehicle control, and ATM. Our device will differ from other devices out on the market due to our systems ability to be interfaced with a PC via the USB cable. This feature will make setting up and securing the system easy.

V. RESEARCH ON FINGERPRINT IDENTIFICATION

The International Fingerprint Research Group (IFRG) which meets biennially consists of members of the leading fingerprint research groups from Europe, the US, Canada, Australia and Israel and leads the way in the development, assessment and implementation of new techniques for operational fingerprint detection.

One problem for the early twenty-first century is the fact that the organic component of any deposited material is readily destroyed by heat, such as occurs when a gun is fired or a bomb is detonated, when the temperature may reach as high as 500°C. Encouragingly, however, the non-volatile inorganic component of eccrine secretion has been shown to remain intact even when exposed to temperatures as high as 600°C.

A technique has been developed that enables fingerprints to be visualized on metallic and electrically conductive surfaces without the need to develop the prints first. This technique involves the use of an instrument called a scanning Kelvin probe (SKP), which measures the voltage, or electrical potential, at pre-set intervals over the surface of an object on which a fingerprint may have been deposited. These measurements can then be mapped to produce an image of the fingerprint. A higher resolution image can be obtained by increasing the number of points sampled, but at the expense of the time taken for the process. A sampling frequency of 20 points per mm is high enough to visualize a fingerprint in sufficient detail for identification purposes and produces a voltage map in 2–3 hours. As of 2010, this technique had been shown to work effectively on a wide range of forensically important metal surfaces including iron, steel and aluminium. While initial experiments were performed on flat surfaces, the technique has been further developed to cope with irregular or curved surfaces, such as the warped cylindrical surface of fired cartridge cases. Research during 2010 at Swansea University has found that physically removing a fingerprint from a metal surface, for example by rubbing with a tissue, does not necessarily result in the loss of all fingerprint information from that surface. The reason for this is that the differences in potential that are the basis of the visualization are caused by the interaction of inorganic salts in the fingerprint deposit and the metal surface and begin to occur as soon as the finger comes into contact with the metal, resulting in the formation of metal-ion complexes that cannot easily be removed.

Another problem for the early twenty-first century is that during crime scene investigations, a decision has to be made at an early stage whether to attempt to retrieve fingerprints through the use of developers or whether to swab surfaces in an attempt to salvage material for DNA profiling. The two processes are mutually incompatible, as fingerprint developers destroy material that could potentially be used for DNA analysis, and swabbing is likely to make fingerprint identification impossible.

The application of the new scanning Kelvin probe (SKP) fingerprinting technique, which makes no physical contact with the fingerprint and does not require the use of developers, has the potential to allow fingerprints to be recorded whilst still leaving intact material that could subsequently be subjected to DNA analysis. A forensically usable prototype was under development at Swansea University during 2010, in research that was generating significant interest from the British Home Office and a number of different police forces across the UK, as well as internationally. The hope is that this instrument could eventually be manufactured in sufficiently large numbers to be widely used by forensic teams worldwide.

VI. BLOCK DIAGRAM

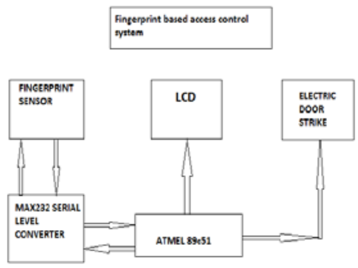

Fig. 2: Block Diagram

VII. FLOW OF WORK

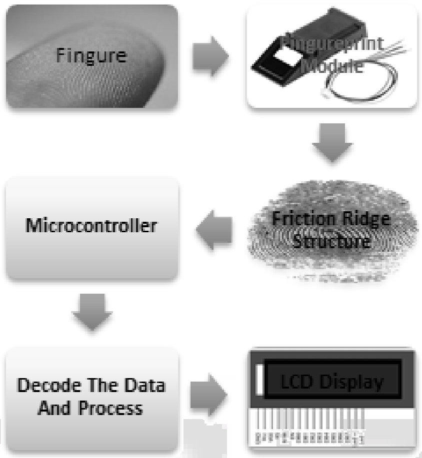

Fig. 3: Flow of work in project

VIII. DESCRIPTION OF BLOCKDIAGRAM

A. *Microcontroller*

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4Kbytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel’s high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

B. *Fingerprint Sensor*

The analysis of fingerprints for matching purposes generally requires the comparison of several features of the print pattern. These include patterns, which are aggregate characteristics of ridges, and minutia points, which are unique features found within the patterns. It is also necessary to know the structure and properties of human skin in order to successfully employ some of the imaging technologies.

Fig. 4:Fingerprint Serial Data Module

C. Patterns

The three basic patterns of fingerprint ridges are the arch, loop, and whorl:

1) Arch: The ridges enter from one side of the finger, rise in the center forming an arc, and then exit the other side of the finger.
2) Loop: The ridges enter from one side of a finger, form a curve, and then exit on that same side.
3) Whorl: Ridges form circularly around a central point on the finger.

Scientists have found that family members often share the same general fingerprint patterns, leading to the belief that these patterns are inherited.

Fig. 5: Friction Ridge Structure

*D. 16*2 LCD*

A liquid-crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly.

The LCD screen is more energy efficient and can be disposed of more safely than a CRT. Its low electrical power consumption enables it to be used in battery-powered electronic equipment. It is an electronically modulated optical device made up of any number of segments filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in color or monochrome. Liquid crystals were first discovered in 1888. By 2008, annual sales of televisions with LCD screens exceeded sales of CRT units worldwide; the CRT became obsolescent for most purposes.

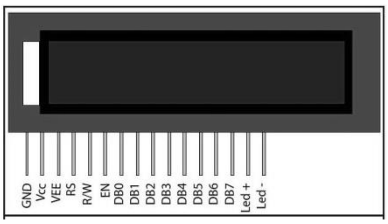

Fig. 6: LCD for Display 16*2

IX. INTRODUCTION

Implementation of this project required vast knowledge in many areas of technology. Good knowledge about the sensors and instrumentation. Programming the software part as well as hardware implementation also required. Coding of controller is the main part of the work. Coding will do basic control and identification of fingerprint. Also the interfacing with different peripherals is important. If the coding is proper but the input or the signal will not match with commands than this project cannot work.

X. CIRCUIT DIAGRAM

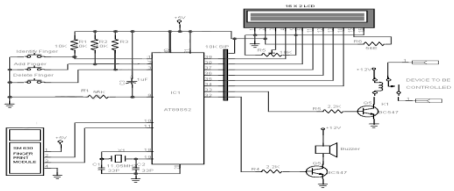

Fig. 7: Circuit Diagram

XI. SOFTWAR REQUIREMENTS

There are two basic software's which are required for programming, debugging and loading into microcontrollers are given below:

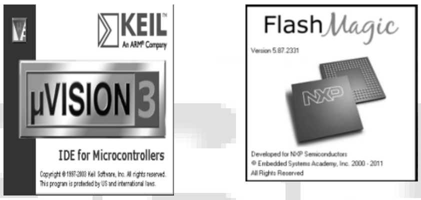

Fig. 8: Software

It is compiler to use for simulating and compiling the programming or coding which is made for microcontroller. We can detect and solve error from this software. Hex file can be generated from C language or Assembly language programming. This Hex file is used in loading program into controller.

A. FLASH MAGIC

It is loader software which loads the program into microcontroller. We have to make hex fie and flash magic loads the program in just seconds.

XII. FEATURES OF BIOMETRIC ACCESS

1) Automatic access of door
2) Biometric identification protection
3) Used in antitheft-protection system
4) Safety system of locks and other documents.

XIII. DIAGRAM

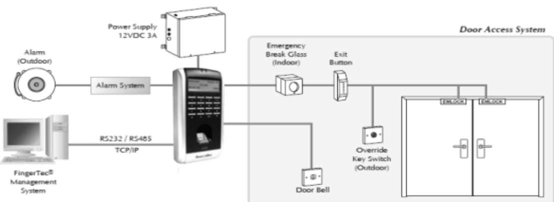

Fig. 9: Diagram of System

XIV. REFERENCES

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