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ATM THEFT PROTECTION USING FINGERPRINT SENSOR

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Abstract—Identification and verification of a person today are common practices, encompassing door-lock systems, safe boxes, vehicle controls, and access to bank accounts via ATMs. Conventional methods like ID card verification or signatures lack perfection and reliability. Systems deployed in these scenarios must be fast and robust. The use of Automatic Teller Machines (ATMs) for convenient banknote transactions faces challenges in maintaining valid customer identities due to increasing criminal cases resulting in financial losses. In this paper, the authors propose a simple fingerprint recognition system using LPC2148 as a core controller. The system utilizes the FIM 3030 fingerprint scanner equipped with a DSP processor and optical sensor. This system ensures enhanced security due to the uniqueness of fingerprints, along with convenience, low power consumption, and portability.

Index Terms—Liquid Crystal Display, Global System For Mobile Communication, Integrated Development Environment

I. INTRODUCTION

In the modern era, the ATM system is an essential part of our lives. Over the past three decades, consumers have largely depended on and trusted Automatic Teller Machines (ATMs) to conveniently fulfill their banking needs, making transactions that were once tedious much easier. Traditional ATM systems authenticate users primarily using debit cards and passwords, which have inherent flaws. Debit cards and passwords alone cannot precisely verify a user's identity. Many criminals tamper with ATM terminals to steal users' debit cards and passwords by illegal means. Once a user's bank card is lost and the password stolen, criminals can swiftly withdraw all cash, resulting in significant financial losses to the customer. Validating the customer's identity has become a focal point in the current financial landscape.

In our project, we propose to enhance the security of current ATM systems by integrating Biometric Authentication and GSM technology. This approach mitigates many flaws introduced by traditional ATM systems, such as shoulder surfing and skimming devices. The utilization of fingerprint and One-Time Password (OTP) authentication in ATMs instead of traditional PIN numbers ensures heightened security, assuring users that their accounts cannot be accessed by unauthorized individuals, thus maintaining secrecy. Additionally, the incorporation of OTP alongside fingerprint authentication further fortifies the system against unauthorized access.

The objective of our project is to provide biometric security through fingerprint authentication in ATM applications. The experiments conducted illustrate key issues in fingerprint recognition

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consistent with existing literature. The underlying principle is biometric authentication, and we propose a method for fingerprint matching based on minutiae matching.

Everyone faces numerous challenges in the process of earning money, necessitating the improvement of security systems. Fingerprint sensor-based ATM systems offer increased security and safety as each individual's fingerprint features are unique. Fingerprint authentication ensures unique identification for every user, utilizing fingerprints as a form of authentication. Fingerprints are arguably a person's most unique physical characteristic, and while humans have possessed the innate ability to recognize and distinguish between different fingerprints for millions of years, computers are only now catching up. The uniqueness of fingerprints enables software to identify and extract fingerprints from scenes, comparing them with a database of stored images to enhance security in various applications.

A. PROBLEM SPECIFICATION

In the current scenario, traditional ATM systems rely solely on PIN code security, making it easy for unauthorized individuals to access an account. This indicates that traditional ATM systems are not fully secure. A fingerprint is a unique feature pattern of an individual's finger. It is widely believed, with strong evidence, that each fingerprint is unique to its owner. Fingerprints have long been used for identification and forensic investigations. A fingerprint consists of numerous ridges and furrows. While these ridges and furrows exhibit similarities in local areas, such as parallelism and average width, extensive research on fingerprint recognition shows that fingerprints are primarily distinguished by minutiae, which are abnormal points on the ridges.

B. CONTRIBUTIONS

The authors have acknowledged the numerous security challenges faced by Automated Teller Machines (ATMs). Recognizing that existing security measures within ATM systems have failed to address these challenges adequately, they propose enhancing ATM security to overcome these issues. Financial crime cases have been on the rise in recent years, with many criminals tampering with ATM terminals to illegally obtain users' credit card information and passwords. Once a user's bank card and password are stolen, criminals can swiftly withdraw all funds, resulting in significant financial losses for the user.

C. METHODOLOGIES

In this proposed system, users authenticate themselves using their fingerprint for banking transactions. Upon login using the fingerprint, users are required to enter a PIN code to proceed with transactions. Users can withdraw money from their accounts or transfer funds to other accounts by providing the recipient's account number. To withdraw money, users must specify the amount and select the account from which they wish to withdraw (e.g., savings or current account). Sufficient balance in the ATM account is necessary to complete transactions. Users can also view the available balance in their respective accounts and access information on their last five transactions.

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II. LITERATURE REVIEW

A. PROBLEM IDENTIFICATION

Various techniques are currently employed for ATM security, including the use of CCTV cameras to record transaction activity. However, such methods alone may not provide sufficient security. GSM technology has emerged as a solution, allowing for the detection and encoding of information related to ATM attacks or threats, which is then transmitted via radio frequency signals. These signals have a wide transmission range and can alert authorities while simultaneously preventing the thief from escaping. Activation of a toxic gas generation unit renders the thief unconscious, further deterring unauthorized access. Power-saving modes conserve energy, while alarm systems alert surrounding individuals to irregular activity within the ATM. GSM also facilitates message delivery to multiple recipients, enhancing security and reliability. This multi-level security approach aims to prevent unauthorized access and protect against criminal activities such as theft of ATM passwords. The proposed design includes a fingerprint module that compares stored fingerprint templates with user input, providing an additional layer of security. In cases of failed authentication, a warning SMS with the location is sent to the user's enrolled mobile phone after three attempts.

III. SYSTEM DESIGN

A. BLOCK DIAGRAM

This project is designed for ATM theft protection. We have utilized the Arduino Mega 2560 due to its large number of pins, which suits our project requirements. For complete security of the ATM, we have incorporated a fingerprint sensor R307 and a GSM module for sending OTPs to the user, thereby verifying the mobile number of the user. The project operates as follows: initially, the user is prompted to scan their fingerprint. Upon a successful match, an OTP is sent to the registered mobile number of the user. Subsequently, the user is prompted to enter the OTP using the available keypad. If the entered OTP matches the system OTP, the transaction is initiated. However, if the OTP is incorrect, the system halts the transaction and prompts the user to rescan their fingerprint.

B. SOFTWARE REQUIREMENTS

The software used in this project for uploading code onto Arduino is the Arduino IDE.

1. **INTRODUCTION TO ARDUINO IDE:**

IDE stands for Integrated Development Environment. The Arduino IDE is a text editor-like program that facilitates writing Arduino code. It is intentionally streamlined to keep things simple and straightforward. When you save a file in Arduino, it is called a sketch – where you save the computer code you have written. The coding language used in Arduino is very much like C++, which is a common language in computing. The code written is human-readable and organized for easy understanding. The IDE translates this human-readable code into machine-readable code to be

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executed by the Arduino. This process is called compiling. Error messages help identify mistakes in the code, ensuring perfect syntax, crucial for successful compilation.

2. **THE SEMICOLON:**

A semicolon needs to follow every statement written in the Arduino programming language. It signifies the end of a statement, similar to a period in a sentence.

3. **THE DOUBLE BACKSLASH FOR SINGLE LINE COMMENTS:**

Comments are used to annotate code and provide explanations. They are ignored by the compiler and are meant to inform readers about the code's functionality. Curly braces are used to enclose instructions within functions, and forgetting to close them results in compilation errors.

The loop() function, which contains the main body of the program, is continuously executed in a loop.

1) *FUNCTION ( ):* Functions are pieces of code that are used so often that they are encapsulated in certain keywords so that you can use them more easily. For example, a function could be the following set of instructions. . . This set of simple instructions could be encapsulated in a function that we call WashDog. Every time we want to carry out all those instruc- tions we just type WashDog and voila – all the instructions are carried out. In Arduino, there are certain functions that are used so often they have been built into the IDE. When you type them, the name of the function will appear orange. The function pinMode(), for example, is a common function used to designate the mode of an Arduino pin. What's the deal with the parentheses following the function pinMode? Many functions require arguments to work. An argument is information the function uses when it runs. For our WashDog function, the arguments might be dog name and soap type, or temperature and size of a bucket. pinMode(13,OUTPUT);

The argument 13 refers to pin 13, and OUTPUT is the mode in which you want the pin to operate. When you enter these arguments the terminology is called passing. You pass the necessary information to the functions. Not all functions require arguments, but opening and closing parentheses will stay regardless though empty. Notice that the word OUTPUT is blue. There are certain keywords in Arduino that are used frequently and the color blue helps identify them. The IDE turns them blue automatically.Now we won't get into it here, but you can easily make your own functions in Arduino, and you can even get the IDE to color them for you. We will, however, talk about the two functions used in nearly EVERY Arduino program.

2) *VOID SETUP ( ):* The function, setup(), as the name implies, is used to set up the Arduino board. The Arduino executes all the code that is contained between the curly braces of setup() only once. Typical things that happen in setup() are setting the modes of pins, starting You might be wondering what void means before the function setup(). Void means that the function does not return information. Some functions do return values – our DogWash function might return the number of buckets it required to clean the dog. The function analogRead() returns an integer value between 0-

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1023. If this seems a bit odd now, don't worry as we will cover everycommon Arduino function in depth as we continue the course. Let us review a couple things you should know about setup(). . .

1 setup() only runs once.

2 setup() needs to be the first function in your Arduino sketch.

3 setup() must have opening and closing curly braces.

VOID LOOP ( ): You have to love the Arduino devel- opers because the function names are so telling. As the name implies, all the code between the curly braces in loop() is repeated over and over again – in a loop. The loop() function is where the body of your program will reside. As with setup(), the function loop() does not return any values, therefore the word void precedes it. Does it seem odd to you that the code runs in one big loop? This apparent lack of variation is an illusion. Most of your code will have specific conditions laying in wait which will trigger new actions.

C. INTRODUCTION TO ARDUINO LIBRARIES

Libraries are collections of code that simplify connecting to sensors, displays, modules, etc. For instance, the built-in LiquidCrystal library facilitates communication with character LCD displays. Numerous additional libraries are available for download on the Internet, expanding the functionality of Arduino. Both built-in and additional libraries are listed in the reference. To utilize additional libraries, they need to be installed.

Arduino libraries are managed in three different locations: inside the IDE installation folder, inside the core folder, and in the libraries folder within your sketchbook. The compilation process selects libraries to allow for updates to those present in the distribution. Placing a library in the "libraries" folder in your sketchbook overrides other library versions.

Similarly, libraries present in additional cores installations follow the same overriding principle. The version of the library in your sketchbook may be lower than the one in the distribution or core folders, but it will be used during compilation. Selecting a specific core for your board utilizes libraries from the core's folder instead of the IDE distribution folder.

It's crucial to note how the Arduino Software (IDE) upgrades itself: all files in Programs/Arduino (or the IDE installation folder) are deleted, and a new folder is created with fresh content. Therefore, it's recommended to install libraries to the sketchbook folder to avoid deletion during the Arduino IDE update process.

As hobbyists, artists, programmers, and professionals converge around this open-source platform, their contributions accumulate into a vast repository of accessible knowledge beneficial to novices

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and experts alike. Arduino originated as a tool for rapid prototyping at the Ivrea Interaction Design Institute, intended for students without electronics and programming backgrounds. With its expansion into a broader community, Arduino evolved to meet new demands, diversifying its offerings from simple 8-bit boards to products for IoT applications, wearables, 3D printing, and embedded environments. All Arduino boards are open-source, enabling users to independently build and customize them to suit their specific requirements. The software is also open-source, growing through global user contributions.

IV. HARDWARE REQUIREMENTS Hardware Components

1. Arduino Uno with ATmega328P Microcontroller
2. R307 fingerprint sensor
3. 16X2 LCD
4. SIM800L GSM MODEM
5. 12V ADAPTOR
6. 4X4 KEYPAD
7. Buzzer
8. DC MOTOR

A. INTRODUCTION TO ARDUINO MEGA 2560

Arduino is an open-source electronics platform based on user-friendly hardware and software. Arduino boards can read inputs - such as light on a sensor, a finger on a button, or a Twitter message - and convert them into outputs, like activating a motor or turning on an LED. Instructions are sent to the microcontroller on the board using the Arduino programming language (based on Wiring) and the Arduino Software (IDE), based on Processing.

Over the years, Arduino has been the foundation of numerous projects, from everyday objects to complex scientific instruments. A global community of makers - including students, hobbyists, artists, programmers, and professionals - has utilized Arduino for a diverse range of applications. Thanks to its simplicity and accessibility, Arduino has been integral in various projects and applications. It is used in educational settings for building low-cost scientific instruments, teaching programming and robotics, and more. Designers, architects, musicians, and artists use Arduino for prototyping, interactive installations, and experimentation. Makers utilize Arduino for projects showcased at events like the Maker Faire. Arduino serves as a versatile tool for learning and experimentation, suitable for users of all ages and skill levels.

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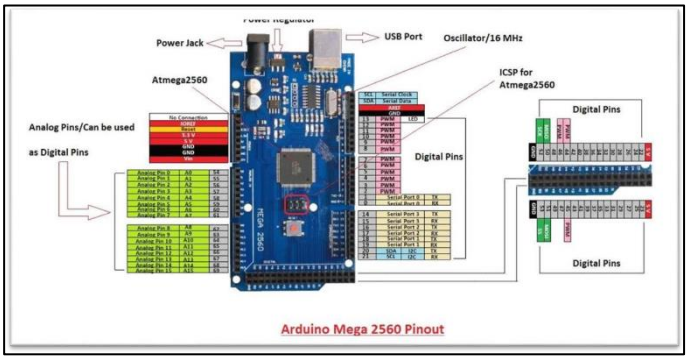

Fig. 2. Arduino Mega 2560

1) WHY ARDUINO:

Arduino's simple and accessible user experience has made it a popular choice for thousands of projects and applications. Its software is beginner-friendly yet flexible enough for advanced users. It is cross-platform, running on Windows, Mac, and Linux, unlike most microcontroller systems which are limited to Windows.

2) ADVANTAGES OF ARDUINO:

- Inexpensive: Arduino boards are relatively affordable compared to other microcontroller platforms. Even the least expensive version of the Arduino module can be assembled by hand, and pre-assembled modules cost less than $50.
- Cross-platform: The Arduino Software (IDE) runs on Windows, Mac, and Linux operating systems, offering flexibility in software development environments.

MEGA 2560: The Arduino Uno is a microcontroller board based on the ATmega328. Arduino, an open-source prototyping platform, is ideal for both hobbyists and professionals due to its simplicity. The Arduino Uno features 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains all the necessary components to support the microcontroller. Simply connect it to a computer using a USB cable or power it with an AC-to-DC adapter or battery to get started.

Features of the Arduino UNO:

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limits): 6-20V
- Digital I/O Pins: 14 (6 of which provide PWM output)

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- Analog Input Pins: 6
- DC Current per I/O Pin: 40 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB (0.5 KB used by bootloader)
- SRAM: 2 KB (ATmega328)
- EEPROM: 1 KB (ATmega328)
- Clock Speed: 16 MHz

B. INTRODUCTION TO FINGERPRINT SCANNER: Fingerprints are patterns of friction ridges on fingers, unique to each individual and difficult to alter. Due to their uniqueness and durability, fingerprints have become an ideal means of identification. GSM (Global System for Mobile Communications), originally developed by the European Telecommunications Standards Institute (ETSI), is a standard used in mobile communication systems.

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	VEE
4	Selects command register when low; and data registerwhen high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight Vcc(5v)	Led+
16	Backlight ground(0v)	Led-

Fig. 3. LCD PIN DESCRIPTION

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V. IMPLEMENTATION

A. CIRCUIT CONNECTIONS

The components of the project "ATM THEFT PROTECTION USING FINGERPRINT SENSOR" are connected as shown in the above circuit connections. The components include Arduino Mega 2560, 16x2 LCD, DC motor, 4x4 keypad, buzzer, L298 driver, GSM module, and R307 fingerprint sensor. These components are connected to the Arduino Mega 2560. The DC motor serves as a transaction message indicator in ATMs. Its control is managed by the L298N driver based on two conditions: 1. The user's finger must match with the internal memory of the sensor. 2. The correct OTP must be entered by the user. If either of these conditions fails, the system generates SMS alerts to the department regarding the wrong finger or wrong password.

Fig. Circuit Connections

VI. RESULT

The working model of the project demonstrates the functionality of the system. The GSM module and driver, when connected to the Arduino, illuminate upon uploading the code to Arduino, and the output is displayed on the LCD screen. The output of this project includes both the buzzer and the LCD display. Fingerprints are unique to each individual, and users need to update their fingerprint and register it with their mobile number. The system prompts the user to scan their updated fingerprint using the fingerprint sensor. If the entered fingerprint matches the system fingerprint, the GSM module sends an SMS to the registered mobile number through the SIM card, as displayed on the LCD. Otherwise, the GSM module sends an SMS to the registered mobile number indicating that the fingerprint was not found.

The user is then asked to enter the OTP sent to their registered mobile number using the 4x4 keypad. If the entered OTP matches the system OTP, the transaction is successful. If there are any mistakes in the OTP entry process, the buzzer will sound. With this security measure using fingerprint recognition, users can feel confident about the safety of their bank accounts, reducing the risk of fraudulent activities.

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Fig. Connection of DC Motor

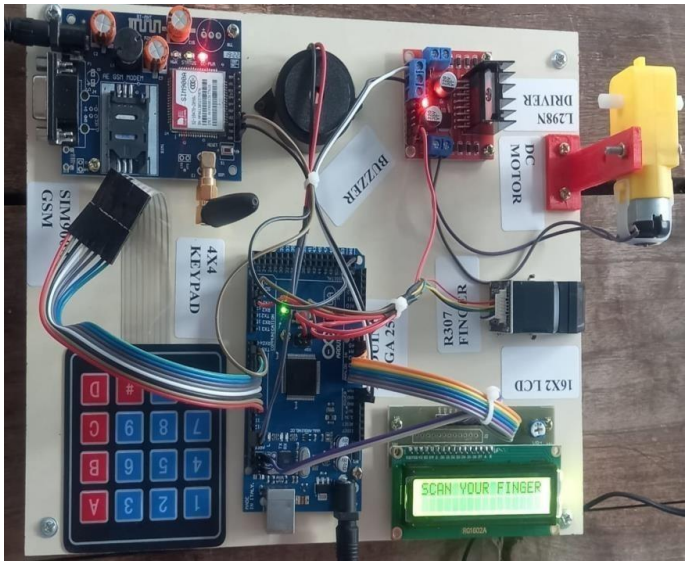

Fig. Working Model

VII. CONCLUSION AND FUTURE SCOPE

A. CONCLUSION

Automatic Teller Machines (ATMs) have evolved into a mature technology providing financial services worldwide. Enhancing the security and reliability of this process is crucial. The implementation of ATM security using fingerprint recognition and GSM Modem takes advantage of the stability and reliability of fingerprint characteristics. When fully deployed, this system will

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significantly reduce fraudulent activities on ATM machines, ensuring only registered owners or nominees have access to bank accounts, enhancing safety, reliability, and ease of use.

B. FUTURE SCOPE

Future enhancements of the proposed system include integrating iris and face recognition technologies for ATM transactions to further enhance security. Additionally, the system can be improved by adding retina scans, palm scanners, and other biometric devices for credential verification. More sensors, such as temperature sensors and anti-break glass door sensors, can be incorporated to ensure ATM safety. Implementing minutiae-based approaches can further prevent database-type attacks, enhancing overall security measures.

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