ARDUINO-DRIVEN SMART DOOR LOCK WITH FINGERPRINT AUTHENTICATION AND BLUETOOTH CONTROL

[1]*Shivprasad,*[2]*Vineetha,*[3]*Himaja*
[123]*Students*
Department Of ECE

ABSTRACT
Security is a growing concern in today's digital era, especially for residential and office spaces. This project introduces an Arduino-driven smart door lock system that integrates fingerprint authentication and Bluetooth-based smartphone control to enhance security and convenience. The system utilizes a fingerprint module for biometric access and an HC-05 Bluetooth module to enable mobile control via Android devices. The core controller is the Arduino Uno, which manages signal processing and locking mechanisms through a solenoid actuator. The system ensures that access is granted only to authorized users, either by fingerprint match or mobile command. It also provides a cost-effective, scalable, and reliable alternative to traditional locking systems. This dual-authentication approach significantly strengthens access control and offers real-time control and logging possibilities, making it ideal for smart home and office automation.

I. INTRODUCTION

1.1 Introduction

Traditional mechanical lock systems have remained relatively unchanged for decades, often lacking in flexibility, traceability, and resistance to unauthorized access. With advancements in embedded systems and the rise of smart technologies, there is an increasing push toward automated, secure, and user-friendly door locking mechanisms. Fingerprint-based authentication provides a unique, non-transferable method of identity verification, while Bluetooth connectivity enables remote access control using smartphones.

This project proposes a hybrid smart locking system that leverages the capabilities of Arduino, a fingerprint sensor, and the HC-05 Bluetooth module. The system is designed to offer users two secure methods to unlock doors: (1) biometric fingerprint scanning and (2) smartphone-based Bluetooth commands. The Arduino microcontroller acts as the central unit, processing user inputs, verifying identity, and controlling a solenoid lock to allow or deny access.

The aim is to provide a low-cost, easily implementable, and efficient security system for homes, offices, and other secure areas. The combination of biometrics and mobile technology ensures that the system is both convenient and highly secure, while still being accessible to a broad range of users

1.2 Block Diagram:

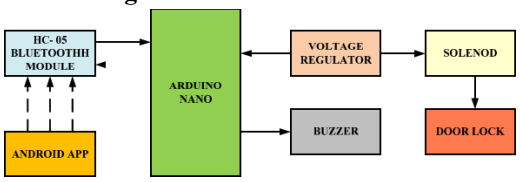

Figure 1. Block Diagram

Block diagram consists of HC-05 Bluetooth module to the nano by powering the device with a 5V power supply and connect the TX pin to RX pin of your microcontroller and RX pin to the TX pin of the microcontroller. You need to add a red LED to display the power status of the Arduino nano and a green LED to show if the door is unlocked. You also need to connect a buzzer. The connection diagram is also shown below for easy understanding. To control the solenoid lock, you need to use a control circuit that comprises an NPN Transistor and N channel MOSFET.

We will control the NPN transistor by connecting the D9 pin of the Nano to the base pin of the transistor via a 550 Ohm resistor to control the current flowing into the Transistor. When the D9 pin is pulled high, the transistor is turned on and the gate pin of the MOSFET is pulled to the ground, turning the MOSFET OFF that turn off the solenoid lock and when the D9 pin is LOW, the NPN transistor is off which means that the GATE of the MOSFET is pulled to 12V via a 2kOhm pull up resistor to turn on the MOSFET and power the solenoid lock. In this way, you can control the Solenoid lock using your 5V Arduino Nano. You cannot directly control the IRF540N MOSFET with 5V pins from the Nano as it is not a logic-level MOSFET so it won't fully turn on or off with 5V from the nano, hence we will use the BC547 NPN transistor to control the MOSFET.

II. HARDWARE DESCRIPTION

2.1Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328. It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

The Arduino Nano as the name suggests is a compact, complete and bread-board friendly microcontroller board. The Nano board weighs around 7 grams with dimensions of 4.5cms to 1.8cms (L to B). This article discusses about the technical specs most importantly the pinout and functions of each and every pin in the Arduino Nano board.

Arduino Nano has similar functionalities as Arduino Duemilanove but with a different package. The Nano is inbuilt with the ATmega328P microcontroller, same as the Arduino UNO. The main difference between them is that the UNO board is presented in PDIP (Plastic Dual-In-line Package) form with 30 pins and Nano is available in TQFP (plastic quad flat pack) with 32 pins. The extra 2 pins of Arduino Nano serve for the ADC functionalities, while UNO has 6 ADC ports but Nano has 8 ADC ports. The Nano board doesn't have a DC power jack as other Arduino boards, but instead has a mini-USB port. This port is used for both programming and serial monitoring. The fascinating feature in Nano is that it will choose the strongest power source with its potential difference, and the power source.

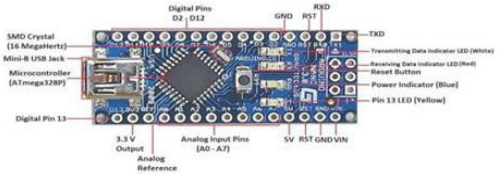

Figure 2.Arduino Pin Reference

III. HC-05 BLUETOOTH MODULE

The HC-05 is a popular module which can add two-way (full-duplex) wireless functionality to your projects. You can use this module to communicate between two micro- controllers like Arduino or communicate with any device with Bluetooth functionality like a Phone or Laptop. There are many android applications that are already available which makes this process a lot easier. The module communicates with the help of USART at 9600 baud rate hence it is easy to interface with any micro-controller that supports USART. We can also configure the default values of the module by using the command mode. So if you looking for a Wireless module that could transfer data from your computer or mobile phone to micro- controller or vice versa then this module might be the right choice for you. However do not expect this module to transfer multimedia like photos or songs; you might have to look into the CSR8645 module for that.

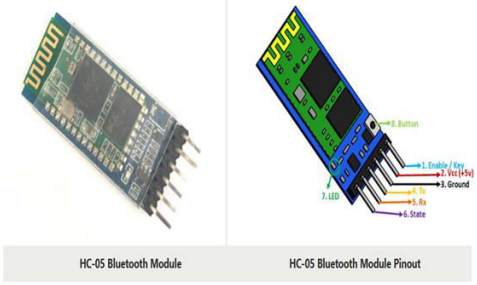

Figure 3. HC 05 Bluetooth Module

SOLENOID LOCK

The solenoid lock is also known as the Electric strike lock. It can be used to lock or unlock doors, cabinets, and drawer.

Inside the solenoid valve:

1. There is a coil of insulated copper wire which is wound in the shape of a hollow cylinder.
2. There is an armature inside the coil which moves freely.
3. When we pass the electric current to the coil it generates a magnetic field near it.
4. The movement of the armature depends on the magnetic field generated by the insulated copper coil.

Figure 4: Solenoid Lock

3.1 Buzzer

A buzzer is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications.

Figure .5: Buzzer

There are two types of buzzers that are commonly available. The one shown here is a simple buzzer which when powered will make a Continuous Beeeeeeppp sound, the other

type is called a readymade buzzer which will look bulkier than this and will produce a Beep. Beep. Beep. Sound due to the internal oscillating circuit present inside it. But, the one shown here is most widely used because it can be customized with help of other circuits to fit easily in our application.

This buzzer can be used by simply powering it using a DC power supply ranging from 4V to 9V. A simple 9V battery can also be used, but it is recommended to use a regulated

+5V or +6V DC supply. The buzzer is normally associated with a switching circuit to turn ON or turn OFF the buzzer at required time and require interval.

3.2 LED

A light-emitting diode (LED) is a semiconductor device that emits light when an electric current flows through it. When current passes through an LED, the electrons recombine with holes emitting light in the process. LEDs allow the current to flow in the forward direction and blocks the current in the reverse direction. When the diode is forward biased, the minority electrons are sent from p → n while the minority holes are sent from n

→ p. At the junction boundary, the concentration of minority carriers increases.

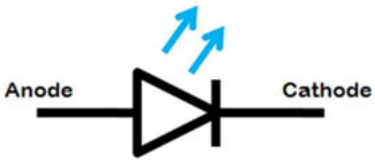

Figure 6.Symbol of LED

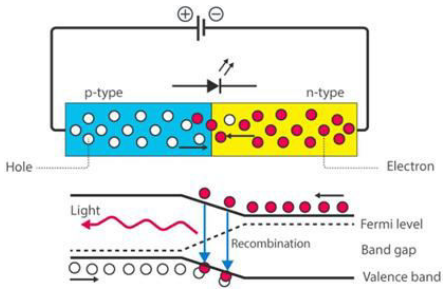

Figure.7: Working of LED

RELAY

A Relay is a device that opens or closes an auxiliary circuit under some pre-determined condition in the Main circuit. The object of a Relay is generally to act as a sort of electric magnifier, that is to say, it enables a comparatively week current to bring in to operation on a much stronger current. It also provides complete electrical isolation between the controlling circuit and the controlled circuit.

IV. CIRCUIT CONNECTIONS AND RESULT

4.1 Circuit Diagram:

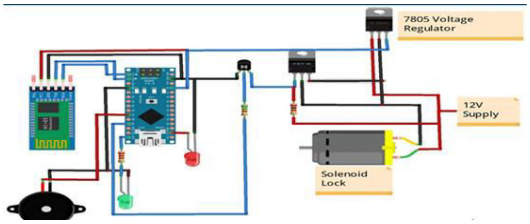

Figure .8: Hardware Circuit Diagram

The above circuit diagram shows how to interface and control a solenoid lock with an Arduino through a MOSFET.

As shown in the above circuit diagram we need to connect the HC-05 Bluetooth module to the nano by powering the device with a 5V power supply and connect the TX pin to RX pin of your microcontroller and RX pin to the TX pin of the microcontroller.

We need to add a red LED to display the power status of the Arduino nano and a green LED to show if the door is unlocked. We should also need to connect a

buzzer. If we give wrong fingerprint then the buzzer will On and make sound.

The prototype of the Cell-phone controlled solenoid door lock using Arduino and HC-05 is shown below:

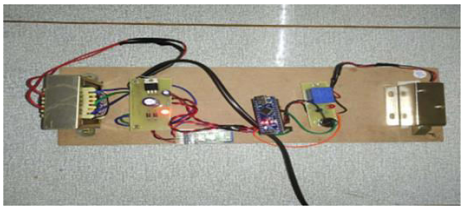

Figure 9.Working Module

4.2 Advantages

1. High security and assurance
2. Flexible system is customized and Flexible
3. Easy to use
4. Non transferable
5. Accountability

4.3 Disadvantages

1. Different biometric technologies need the use of different devices that have a range of cost.
2. Entry and delete fingerprints need to operate multiple steps, the program is too much trouble, convenience is not enough.
3. Performance can be fluctuated to dry, wet, dirty fingers.

4.4 Applications

1. Used in Biometric door locks
2. Theft protection
3. Safe lockers
4. Fingerprint security system in car
5. Office security

V. CONCLUSION

The Arduino-driven smart door lock system with fingerprint authentication and Bluetooth control successfully demonstrates a dual-access security solution that is both practical and reliable. By combining biometric verification with wireless mobile access, the system enhances traditional security models while improving user convenience and control.

The implementation shows that the integration of HC-05 Bluetooth modules and fingerprint sensors into a centralized Arduino-based control unit enables secure and flexible access management. The design is cost-effective, easy to build, and adaptable for further expansion, such as IoT-based logging or GSM alerts.

In conclusion, this project provides a scalable prototype for modern smart locking solutions and paves the way for further innovations in smart home automation, secure workplace entry, and embedded security systems.

BOOKS

REFERENCES

1. Digital Electronics – By: JOSEPH J.CARR
With the help of this book digital counter for measuring the consumed energy is designed.
2.Digital and Analog Communication System - By: K. sam Shanmugam
3. Electronic Circuit guide book – Sensors – By JOSEPH J.CARR
4. The 8051 Micro-controller Architecture, programming & Applications - By: Kenneth J. Ayala
5. Programming and Customizing the 8051 Micro-controller - By: Myke Predko
6. The concepts and Features of Micro-controllers - By: Raj Kamal
7. Irrigation Engineering - By: B.R. Gupta

WEBSITES

https://ieeexplore.ieee.org/document/8741459
https://www.researchgate.net/publication/336279067_Smart_Door_Lock_System_with_Fingerprint_Interface
https://maker.pro/arduino/projects/how-to-create-a-fingerprint-reading-door-lock-system- with-an-arduino-uno
https://electronicsworkshops.com/2020/09/12/fingerprint-door-based-lock-system-arduino/