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Development of Smart Door Access System Using Arduino Nano

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ABSTRACT: From earlier times and till now, security is an issue of concern in our households and also in office, shops, etc. Everyone has a fear of unauthorized person entering to their home or office without their knowledge. The normal door can be fitted with locks which are capable of breaking with the use of an alternate key. Alternatives to this system can be found like the password or pattern system in the locks which again has the possibility of getting exposed and opening the lock. So, a solution to such problems can be by combining door lock with biometrics. Biometric verification is any means by which a person can be uniquely identified by evaluating one or more distinguishing biological traits. Unique identifiers include fingerprints, hand geometry, voice waves, DNA, and signatures. This project will use fingerprint for biometric verification as it is one such thing which is unique to every individual and the use of fingerprint as the key to door locks can overcome the security problem of unauthorized people trespassing to our homes, shops, offices, etc to a great extent as duplicity in such key is not possible. Also, this system will not lead to problems like losing keys because don't require carrying keys if this system is used instead of traditional locks. So, using Arduino we will try to implement the system with features which will increase the security level.

I. INTRODUCTION

Conventional security systems used either knowledge based methods (passwords or PIN), and token-based methods (ID card) and were prone to fraud because PIN numbers could be forgotten or hacked and the tokens could be lost, duplicated or stolen. To address the need for robust, reliable, and foolproof personal identification, authentication systems will necessarily require a biometric component. The development of a door access system includes many different features from as simple as using android application to scan the biometrics to as complex as using smart cards and keypad. The Door Access System – Arduino Based is developed to overcome the issue of upgrading and maintenance the system that occur in the existing system. This report discusses on the door access system using Arduino. Arduino is a type of microcontroller that uses its own programming language. It has its own electronic prototyping platform to be used during experiment. This project has only one features as input, which is scan the fingerprint in Android Application. While the outputs is solenoid lock. Interfacing the input and output with Arduino produced accurate results in accessing the door based on the accuracy results obtained by performing a test on three individuals with three different fingerprints each person. The scanning fingerprint are clarified as input, while the output is the on solenoid lock. This project is reliable as it could increase the security level of door access system by implementing simple approach as Arduino.

II. LITERATURE SURVEY

Wheeler et.al. on face-verification system, this system is time-consuming to build because the users need to have more than one images to separate ID and non-ID images for identification data storage purposes. The advantages are Identify intra and inter dependencies. Disadvantages are an individual needs to have more than 1 image to separate id and non-id images. Very sensitive. Less speed because it takes 6 seconds to make decision while the aim is within 2 seconds [1]. **Ibrahim et. al.** on face-recognition system. Face-recognition is difficult to build as there are a lot of factor needs to be considered during image capturing which are illumination, distance and an individuals head orientation. This system is

also sensitive to aging and facial expression. It is also troublesome during experimental work as many faces need to be taken at nine different angles. The advantages are able to improve the human identification by distinguish a person's particular face from other person's face images. Disadvantages are Difficult because had to consider many other elements such as illumination, distance and an individual's head orientation for capturing image. Subject needs to be very cooperative during image capturing to have accurate results. Troublesome during experimental work because a lot of face positions needs to be stored. Results are influenced by illumination and pose [2]. **Rashid et. al.** is also a sensitive system by using voice-recognition system as it will reject the voice input if there are background noise. The advantages are Provides adjustable security level setting account for variations. Disadvantages are very sensitive. It will reject the match if there are background noise. Less speed because it uses parallel port for communication interface [3]. **Cui et. al. (2009)** agrees the fact of voice-recognition system being difficult. The reason being is because it needs to build up a speech model whereby the users have to pronounce the text according to the stated ones. Despite of its lacking in efficiency, this project done by Bo Cui and Tongze Xue has its advantages compared to other projects with similar feature by using a technology to filter low frequency disturbing. The advantages are Implements fore aggravation technology to filter low frequency disturbing. Disadvantages are Difficult because it needs to build up a speech model whereby the users have to pronounce the text according to the stated ones [4]. **Z Zhu et. al. (2011)** in their journal that fingerprint-verification overcome the issue of losing ID card where in their project is car keys. Another advantage is that the ownership can never be passed to other people. An optical fingerprint scanner is implemented in this project compared to other biometric features is because it has more advantages as stated in Table 1. The advantages are overcome the issue of car robbery if the owners lose his car keys or his car keys been stolen. Disadvantages are Designed specifically for automobile [5].

Table 1: Different biometric recognition technologies:

Technologies	Catholicity	Uniqueness	Stability	Collectible	Feasibility	Deceivability	Cost
Face shape	High	Low	Mid	High	Low	High	High
Ear shape	Mid	Mid	High	Mid	Mid	Mid	High
Hand shape	Mid	Mid	Mid	High	Mid	Mid	High
Fingerprint	High	High	High	Mid	High	Mid	Low
DNA	High	High	High	Mid	High	Low	High
Ins	High	High	High	Mid	High	Low	High
Retina	High	High	Mid	Low	High	Low	High
Palm	Mid	High	High	Mid	High	Mid	Low
Voice	Mid	Low	Low	Mid	Low	High	Low
Signature	Low	Low	Low	High	Low	High	Low

Table 1 illustrates the different biometric recognition technologies, out of which the scanning fingerprint is most stability, feasibility and less cost.

Sadeque Reza Khan(2012) in their journal a keypad is used to restrict the access of persons and a corresponding password is provided for each individual. So correct password ensures transaction through an electromagnetically locked door whether wrong password collapses the system and generates alarm. A LCD is interfaced with the main controller to show different status when a user gives his corresponding password. The advantages are a real-life equivalent of the prototype can be developed with minimal development costs. Disadvantages are, The password is forgotten, there is no way to unlock the door [6]. **Gyanendra K Verma et. al.(2010)** in their journal to design and implement a digital security system which can deploy in secured zone where only authentic person can be entered. They implemented a security system containing door locking system using passive type of RFID which can activate, authenticate, and validate the user and unlock the door in real time for secure access. The advantage of using passive RFID is that it functions without a battery and passive tags are lighter and are less expensive than the active tags. A centralized system manages the controlling, transaction and operation task. The door locking system functions in their real time as the door open quickly when user put their tag in contact of reader. The system also creates a log containing check-in and check-out of each user along with basic information of user [7].

III. PROBLEM STATEMENT

Problem statements are the problems identified by observing the existing door access system. Through observation, there are three problems that have been identified in order to develop this project which are: **1. Obsolete components:** The existence of new technologies comes from the creation of new components. This fact shows that once the old devices are obsolete, there are no spare components could replace it. Therefore new system with new components has to be created. **2. Upgrading issues:** Most of control access system nowadays uses PIC. It would be difficult with PIC because every time upgrading needs to be done, the stand-alone PIC needs to be pulled out from the circuit and burned again. **3. Complicated programming:** Since most of control access system nowadays uses PIC, many engineers will face difficulties if problem occur on the device. The reason being is because PIC is not an open-source IDE compared to Arduino. Therefore if problem occur, more time is needed for the engineers to create new coding for the device.

IV. DESIGN FOR DOOR ACCESS SYSTEM

BLOCK DIAGRAM

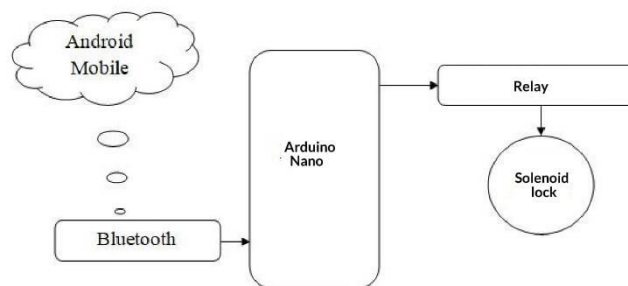


Fig 1.1 Block Diagram for Door Access System

Fig 1.1 illustrates controlling the door lock in the Bluetooth Android Application. From the Android application sending the information to open the door lock. When the data was received for the android app the Arduino Nano has transferred the information to the 1293d driver that the driver controls the relay and solenoid lock to unlock the door.

CIRCUIT DIAGRAM

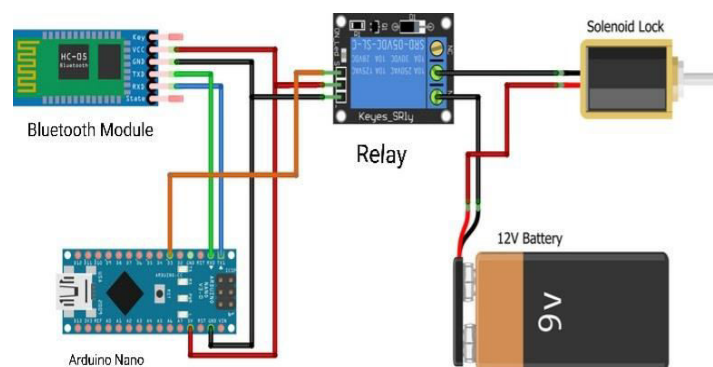


Fig 1.2 Circuit Diagram

Connections for our project is very simple. Fig 1.2 shows connecting a solenoid lock, relay module, and a Bluetooth module with Arduino Nano. The input pin of the relay is connected to the pin 9 of Arduino Nano while VCC and Ground pins are connected to 5V and GND pin of Nano. 5V and GND pins of the Bluetooth module are connected to 5V and GND of Nano while Tx and Rx pins are connected to Rx and Tx of Nano respectively. The positive pin of the battery is connected to positive pin of solenoid lock and the negative pin is connected to relay.

FLOWCHART

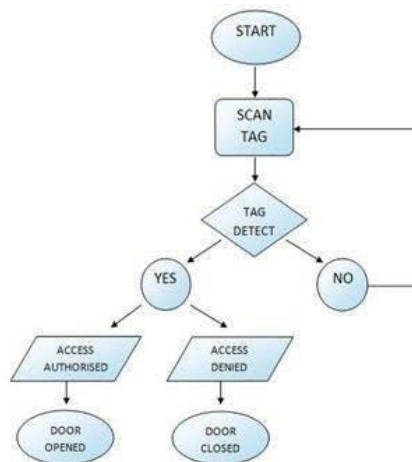


Fig 1.3 Flow chart

Fig 1.3 explains the scan tag is to scan the fingerprint, if the fingerprint is detected it goes to verify whether it is correct or not. Fingerprint is correct means it passes the signal and the door will open, otherwise the door will not open.

V. FABRICATION DETAILS

ARDUINO NANO: The Arduino Nano is a small Arduino board based on ATmega328P or ATmega628 Microcontroller. The connectivity is the same as the Arduino UNO board. The Nano board is defined as a sustainable, small, consistent, and flexible microcontroller board. It is small in size compared to the UNO board. The Arduino Nano is organized using the Arduino (IDE), which can run on various platforms. Here, IDE stands for Integrated Development Environment. The devices required to start our projects using the Arduino Nano board are Arduino IDE R3 and mini USB. The Arduino IDE software must be installed on our respected laptop or desktop. The mini USB transfers the code from the computer to the Arduino Nano board.

HC-05 BLUETOOTH MODULE: The HC05 is a serial port Bluetooth module which having fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio trans receiver and baseband. HC-05 Bluetooth Module is now more popular due to its low price and extremely high features. This module can be used in Master or Slave Mode and easy switchable between these two modes, by default Slave mode is configured. Modes can be changed using AT Commands. The slave mode in HC-05 cannot initiate a connection to another Bluetooth device, but can accept connections. Master mode can initiate a connection to other devices. Here is a very nice tutorial of interfacing the Bluetooth module with Android app and Laptop.

RELAY: To control a 5V single-channel relay module with any microcontroller, need to use a GPIO pin as a digital output pin. Digital output pin provides an active low and active high signal to control pin of relay module. When the relay switches, it can hear an audible clicking sound coming from the relay module

SOLENOID LOCK: DC 12V Cabinet Door Lock Electric Lock Assembly Solenoid can be used for locking sell-machine, storage shelf, file cabinet and etc. The hidden way of unlocking can be used for an emergency. The lock works as the circuits disconnects, and it will unlock as the instant power-on. It is steady, durable and energy-saving and had a long lifespan. In the anti-theft 21 and shockproof design, the lock is better than other kinds of locks. After connecting the wires and when the current is available, the electric lock can control the door's opening and closing. When the power is applied, DC creates a magnetic field that moves the slug inside and keeps the door in the unlocked position. The slug will retain its position until the power is removed. When the power is disconnected the slug moves outside and locks the door.

ADAPTOR: The AC/DC adapter, or AC/DC converter is a type of external power supply, often enclosed in a case similar to an AC plug. Other common names include wall wart, power brick, wall charger, and power adapter. Adapters for battery-powered equipment may be described as chargers or rechargers (see also battery charger). AC adapters are used with electrical devices that require power but do not contain internal components to derive the required voltage and power from mains power. The internal circuitry of an external power supply is very similar to the design that would be used for a built-in or internal supply.

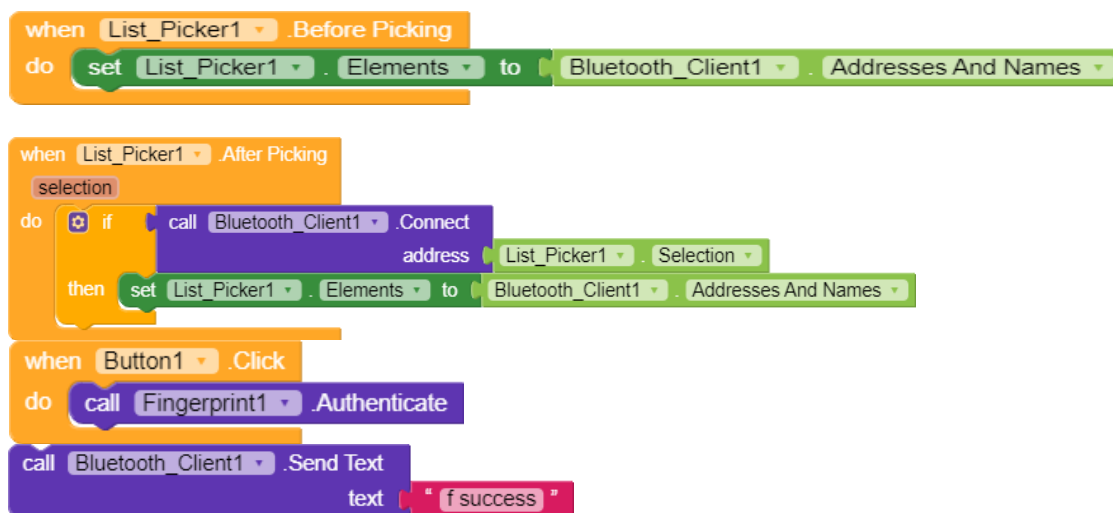
JUMPER WIRE: A jump wire is an electrical wire, or group of them in a cable as shown in Fig 4.8, with a connector or pin at each end, which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

VI. CODE DEVELOPMENT

KODULAR CREATOR:

The app for our project is designed using the Kodular app inventor. Creating an app using Kodular is very simple and can make an app by combining the blocks according to the flow chart of our project. To create an app with Kodular, navigate to Kodular.io and create an account if don't have one, Login to our account, and then click on the 'create apps' option. After that, it will be taken to the Projects screen. Click on the 'Create Project' button to create a Project. Name the app and click 'Finish'. The project will be created and it will be taken to the Designer page of the project.

CODE FOR ANDROID APPLICATION:



The above code blocks to call the fingerprint sensor of the Android phone and authenticate the fingerprint. The complete code block is shown in the above picture. Use this blocks to join the rest of the code blocks. When all the blocks are connected, export the apk file on your laptop or you can directly export the apk to your phone using the QR Code.

ARDUINO IDE (R3)

The open-source Arduino software (IDE) makes it easy to write code and upload it to the board. It runs on windows, MAX OS X, and Linux. The environment is written in java and based on processing and other open-source software. The Arduino Integrated Development Environment or Arduino software (IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common function and a series of menus. It connects to the Arduino and Genuine hardware to upload the program and communication with them.

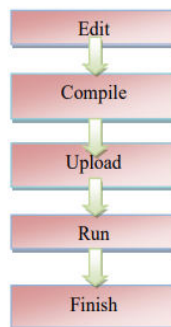


Fig 2.2 Arduino IDE Development Cycle

ARDUINO CODE:

```
String readString;
#define relay1 3 //Connect relay1 to pin D3
void setup()
{
  Serial.begin(9600); //Set rate for communicating with phone
  pinMode(relay1, OUTPUT); //Set relay1 as an output
  digitalWrite(relay1, LOW);
}
void loop()
{
  while(Serial.available()) //Check if there are available bytes to read
```

```
{
    delay(10);          //Delay to make it stable
    char c = Serial.read(); //Conduct a serial read
    if (c == '#')
    {
        break;          //Stop the loop once # is detected after a word
    }
    readString += c;      //Means readString = readString + c
}
if (readString.length() > 0)
{
    Serial.println(readString);
    if(readString == "f success")
    {
        digitalWrite(relay1, HIGH);
        delay(3000);
        digitalWrite(relay1, LOW);
    }
    readString="";
}
```

FINAL OUTPUT



Fig 3.1: Final output

The program for the Arduino Nano microcontroller is written in C language and then compiled into an executable file using the Arduino IDE. The executable file next imported into the Proteus Design Suite IDE, where the hardware circuit is designed and simulated. The system's hardware is constructed on a breadboard and programming of the Arduino microcontroller is carried out using Arduino IDE. Figure 3.1 shows the final output that the hardware construction with connections and various operations of the installed app on the phone and the hardware of the security door when communicating with the app.



VII. CONCLUSION

Android fingerprint door access system using Arduino Nano is efficient way to improvise safety and security in office and house. The implementation of a door access system using Arduino can prevent theft and ensures the safety of properties. Android fingerprint door access system using Arduino Nano can be used in houses, banks, office. The proposed system overcomes the issues of in the existing systems. Arduino based security systems will bring a whole new level of high security system with a simple new approach. The proposed systems are easy to maintain and has a long life.

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