

# Development of a Door Automation System Using Bluetooth Technology

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## ABSTRACT

With the advancement in technology, door automation system has become more advanced. This project presents an automated door that uses the Bluetooth in a mobile phone to control the operation of an automated security door. The system describes improvement of a security system that is integrated with an Android mobile phone using Bluetooth as a wireless connection protocol. An android application which was downloaded from the play store and installed on a mobile phone through which the password generated by the Arduino is recognized by the Bluetooth to control the opening and closing of the door located at some distance from the user. The Bluetooth module that was used receives commands from the android phone, and it passes the command to the microcontroller to control the opening and closing of the door. The Bluetooth module can only send and receive commands within the range of 10meters. The design of the circuit was simulated in Proteus integrated development environment after which the hardware was constructed on a Vero board and housed inside a distribution box. The design for door lock system is the combination of android smart phone as input, Bluetooth module as command agent, Arduino microcontroller as controller center / data processing center, relay as a switch and motor as door lock output. The performance of the system agrees excellently with its conception. The system can be used in various situations where access to an enclosure need to be secured.

**Keyword:** Bluetooth Module, Android smart phone, Arduino microcontroller, switch and Motor as door lock

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## I. INTRODUCTION

### 1.1 Background of Study

Security is the degree of protection against danger, loss and criminals. Home security system is an essential mean of protecting our home from illegal invasion. Security of human life and property is one of the paramount challenges facing individual and corporate organization. Security systems is necessary everywhere especially in Banks, Houses, Offices, School, Church etc. Over time, issue of security, robbery, buglers are rising daily. Most people in the urban areas goes to work and come back to discover that their house have been bugled. The conventional gates which use key is no longer helpful because the key may get lost and even intruders can easily find a way to get rid of it which necessitates the use of the smart door.

The Bluetooth based door was implemented using Atmega328 with the use of Bluetooth technology. Atmega328 is an IC with 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller. The door automation was controlled using Android application interface with door microcontroller through Bluetooth. The Bluetooth technology operate over unlicensed 2.4GHz frequency, it can link digital devices within a range of 10m to 100m at the speed of up to 3Mbps but it depending on the Bluetooth device class.

The need for an effective and reliable a smart door has become vital due to the frequent and emergence cases of robbery and burglary. Most people in the urban areas goes to work and come back to discover that their house have been bugled. The mechanical door can easily be gotten rid of, and also the user can misplace the keys at any time. Also, in the RFID systems, the card can easily get lost and also intruders can find a way to manipulate the card. In the urban areas of Nigeria, robbery and home intrusion is recorded every day. The automated door which will be implemented using Atmega328 microcontroller with the use of Bluetooth technology will bring an end to the cases. The system is user friendly, easy to implement and cost efficient.

This system will help even more in case of arrest of the police, in robbery action the police might not quickly get the exact place of intrusion and will get information after the incident. The aim of this project is to develop a smart door system using Bluetooth technology.

This project is developed in compliance with Bluetooth technology only. It is centered on the issue of insecurity in Nigeria. The Bluetooth module HC-05 was used and it uses the 2.45GHz frequency band. The transfer rate of the data can vary up to 1Mbps and is in range of 10 meters.

## II. LITERATURE REVIEW

### 2.1 Review of Related works

Hasan et al (2015) designed a microcontroller-based home security system with GSM technology. A mobile phone is interfaced with the microcontroller through a Bluetooth device in order to control the system. A manual keypad is another way to lock or unlock the system. It is a reliable security system because its bi-modal (parallel) nature, but the system lacks code registration mechanism and the microcontroller program lacks autogenerated code routine. Modifications can be made in the design by adding auto-generated code device and making the security features work serially, thus making it multiprotocol device.

Sravani, & Kannappan, (2017) implemented a system that serves the needs of people with physical disabilities at home. It uses the Bluetooth technology to establish communication between user's Smartphone and controller board. The prototype support manual controlling and microcontroller controlling to lock and unlock home door. By connecting the circuit with a relay board and connection to the Arduino controller board it can be controlled by a Bluetooth available to provide remote access from tablet or smart phone. This thesis addresses the development and the functionality of the Android-based application (Android app) to assist disabled people gain control of their living area.

Umbarkar et.al (2017) developed an electronic door lock/unlock compact system using the Arduino platform. The security systems enable to lock/unlock the door using three different modes i.e., Keypad, Bluetooth and Global System for Mobile (GSM) modules. These three modules operate on a 4-digit password. The door can be open or closed using keypad, Bluetooth application from smart phone and also by using 4-digit message from GSM phone. If any unknown person does the three consecutive unsuccessful attempts to enter the password in any one of the systems, then Arduino controller will send a warning message to preset owner GSM mobile number and also initiate the buzzer alarm as a warning of unauthorized intrusion.

Ishrat et. al (2017) designed a Smart Door Locking System with Automation and Security - an implementation of IoT (Internet of Things). The system allows the users to monitor and control their homes using the Android device. This system is designed mainly for home door locks; this design can be customized for different kinds of locks as per the need. It uses Raspberry pi as the main device with Raspbian as the operating system to be installed near the lock.

Lia et al. (2014) designed a system to simulate an electronic key, which is controlled through a Bluetooth enabled smart phone. Controlling is conducted by sending a command via Bluetooth to the Arduino circuit that acts as an interface between the Android smart phone and solenoid. The security system is simple with low failure rate but lack notification system. Modification can be made by adding another security feature to increase the reliability of the security system.

## III. METHODOLOGY

### DESIGN ANALYSIS

The block diagram in Figure 3.1 describes the system overall. The android smart phone serves as the task master, Bluetooth module as command agent, Arduino microcontroller as controller center / data processing center, and solenoid as door lock output.

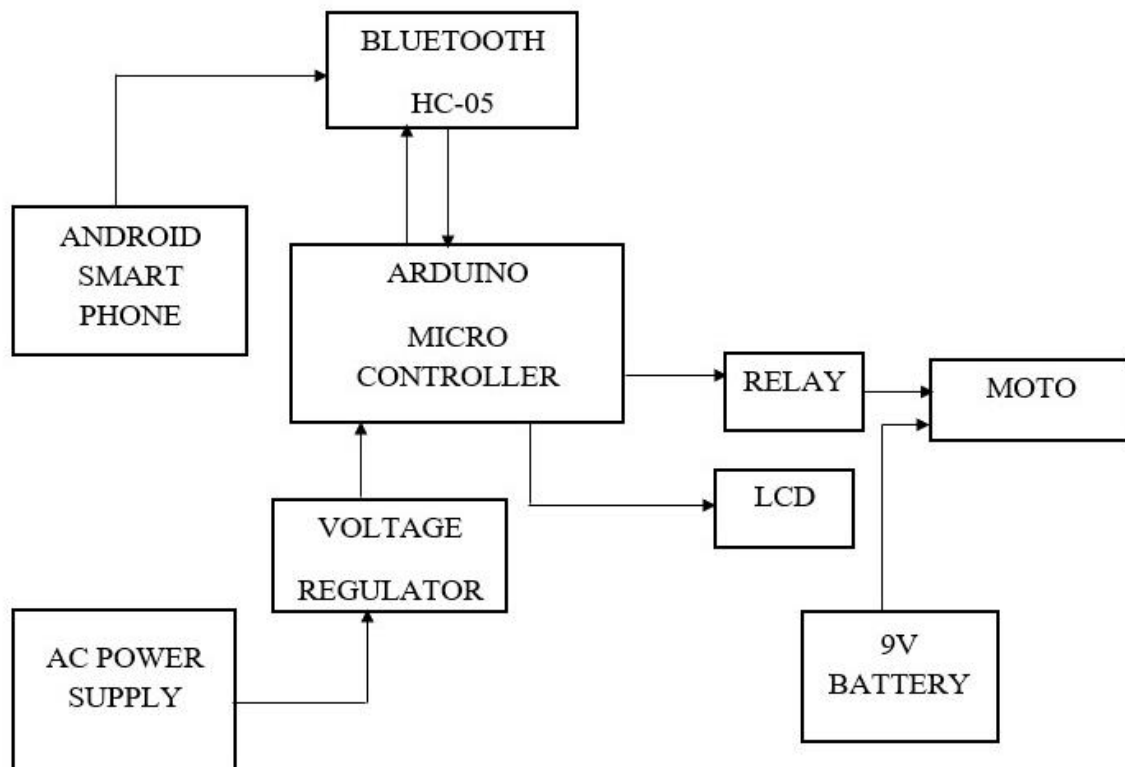


Figure 3.1: The Door Automation System Block Diagram.

### 3.2 Selection of Components

Each of the following components and the work they perform is as shown in table 3.1

Table 3.1 The function of each of the components

S/N	SYSTEM BLOCK	FUNCTION
1	AC Power Supply	Power Supply
2	Voltage Regulator	To regulate power
3	9volt Battery	To power the motor
4	Atmega328 microcontroller	As data processing center
5		As data input
6	Smartphone	As data receiver
7		As display unit
8	Bluetooth Module	As switch
9		As indicator
10	LCD Display	
11		As connector
12	Relay	As system output
	LED	
	Veroboard	



**a. AC Power Supply**

AC power supply was fed into the system and it was regulated by the 7805-voltage regulator to give 5v to the Atmega328. Capacitors was used as filters to smoothen the output power. Figure 3.3 give a pictorial view of the power supply regulated to 5v DC.

Components used to Design Power Supply Circuit on Proteus

- LM7805 – 1 unit
- LED (Any Color) – 1 unit
- 220Ω Resistor – 1 unit
- 470uf Capacitor – 1 unit
- 0.1uF Capacitor – 1 unit
- Diode – 4 units
- 2P2S Transformer – 1 unit

**b. Voltage Regulator**

The voltage regulator was used to regulate the power from the AC power supply before it gets to the Atmega328 microcontroller which need 5v so as to avoid damage to the microcontroller. The LM7805 voltage regulator which is shown in figure 3.2 produces 5v DC, it is a three-pin IC; input pin for accepting incoming DC voltage, ground pin for establishing ground for the regulator, and output pin that supplies the positive 5 volts. Figure 3.3 give a pictorial view of the power supply regulated to 5v DC.

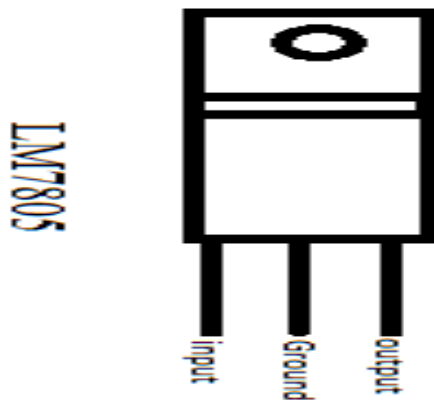


Figure 3.2: LM7805 Voltage Regulator

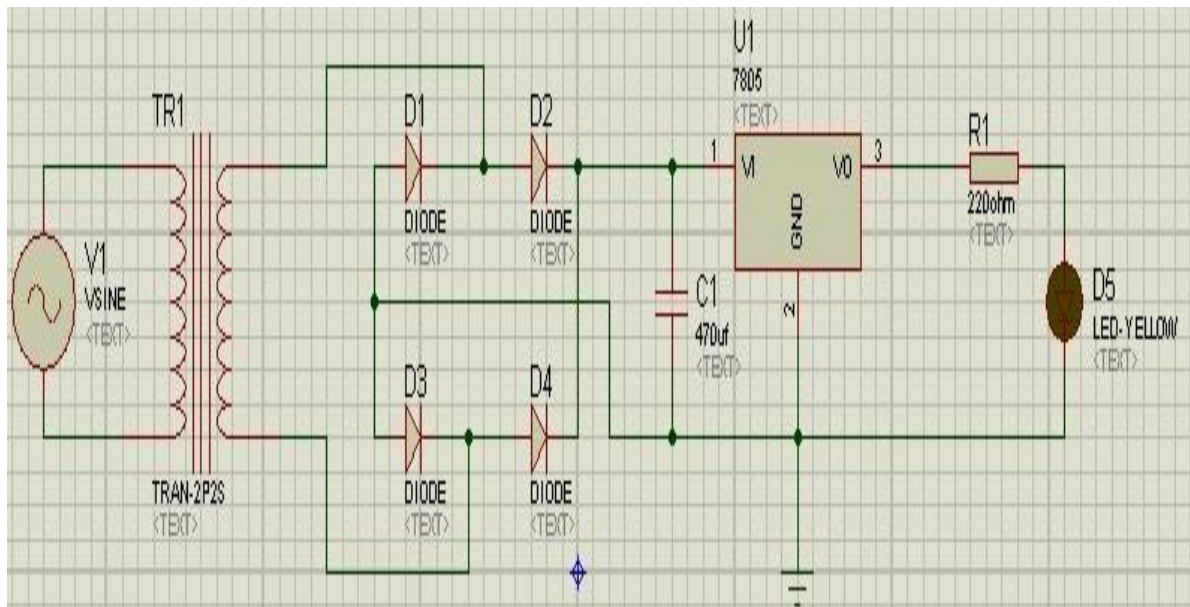


Figure 3.3: The power supply regulated to 5v DC

#### c. Battery

The battery is used to power the motor which serves as the output of the system. The motor is programmed to rotate in clockwise direction when the positive terminal of the battery is connected to the positive terminal of the relay and the negative terminal of the battery to the negative terminal of the relay. And it will rotate in anti-clockwise direction when the positive terminal of the battery is connected to the negative terminal of the relay, and the negative terminal of the battery to the positive terminal of the battery.

#### d. Atmega328 Microcontroller

The model used in this work is ATMEGA 328, the Microcontroller was programmed and compiled using the Arduino IDE.

The microcontroller serves as a data processor that controls the motor that is previously connected to a relay that functions as an on / off switch. The microcontroller is the central data in the processing system. The Arduino microcontroller has been equipped with internal EEPROM, Flash memory, etc. This section will examine the input password, and give orders to the Relay, if it matches, it will send control signal information to unlock the door. If it does not match, the door will remain locked.

#### e. Android Smart Phone

The Android smartphone is where the user will input a command. The Android platform includes support for the Bluetooth network stack, which allows a device to wirelessly exchange data with other Bluetooth devices. The application framework provides access to the Bluetooth functionality through the Android Bluetooth Application Program Interface (API). These APIs let applications connect wirelessly to other Bluetooth devices, enabling point-to-point and multipoint wireless features. All of the Bluetooth APIs is available in the Android Bluetooth package, which can be installed on any Android phone. The app displays the first menu where the correct password has to be entered before the door will open.

#### f. Bluetooth Module HC-05

Bluetooth Communication is a 2.4GHz frequency-based RF Communication with a range of approximately 10 meters. It is one of the most popular and most frequently used low range communication for data transfer, audio systems, handsfree, computer peripherals etc.

The Bluetooth module used in this circuit is the type of HC-05, which requires a 3.3 V DC power drawn from the Arduino microcontroller. The Bluetooth Modules contain six pins which are; VCC, GND, TX, RX, EN and STATE.

#### Pin Description

- **EN:** It is the enable pin. When this pin is floating or connected to 3.3V, the module is enabled. If this pin is connected to GND, the module is disabled.

- **+5V:** This is the supply pin for connecting +5V. As the Module has on-board 3.3V regulator, you can provide +5V supply.
  - **GND:** It is the ground pin.
  - **TX:** It is the Transmitter pin
  - **RX:** It is the Receive Pin
  - **STATE:** This is a status indicator pin. This pin goes LOW when the module is not connected to any device. When the module is paired with any device, this pin goes HIGH.
- The on-board LED is used to indicate the status of the connection. When the module is not paired, the LED blinks or flashes repeatedly. Once the module is paired, the LED blinks at a constant delay of 2 seconds.

#### g. **Liquid Crystal Display**

The Liquid Crystal Display is used to display the information entered into the system a to also display the operation performed in the system. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. A 16x2 LCD was used and it means it can display 16 characters per line and there are two such lines. In this LCD each character is displayed in 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. Figure 3.9 gives the pictorial view of the Liquid Crystal Display.

#### h. **Electromechanical Relay**

Relay was used as switch in this system. Two relays were used, one is to activate the motor to rotate in clockwise and other to rotate in anti-clockwise direction. The condition of rotating of the motor in clockwise direction is the opening of the door while the anti-clockwise is the closing of the door.

#### i. **Light Emitting Diode**

The light emitting diode in this system is use as an indicator to indicate when the system is connected to the power supply. Immediately the system is connected to the power source, the blue LED that was used with on. The initial state of the LED when it is not connected to the power supply is 0, but when it connected, it changes to 1.

#### j. **Vero board**

The components used were suitably positioned and soldered to the conductors to form the required circuit on the Veroboard. Breaks can be made in the tracks, usually around holes, to divide the strips into multiple electrical nodes enabling increased circuit complexity.

#### k. **Jumper wire**

Jumper wire is used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. The jumper wire is used to interconnect the Bluetooth module and LCD with the Atmega328. Figure 3.14 give a pictorial view of the Jumper Wire.

#### l. **Electric Motor**

The motor was used to control the opening and closing of the CD rom that was used for the lock. Once the relay is energized and the positive terminal of the motor and relay is connected to each other and negative terminal connected, the motor will rotate in clockwise direction. So also, when the positive terminal of the relay is connected to the negative terminal of the motor and negative terminal connected to the positive, the motor will rotate in anti-clockwise direction which serve as closing the door.

### 3.3 **Design Procedure**

#### 3.3.1 **Hardware Design Procedure**

The circuit diagram was designed using Proteus professional, version 3.9 software installed on PC which is running on a windows 10 Operating system. The Proteus circuit diagram design is shown in Figure 3.4 and 3.5. **ATmega328** is an 8-bit and 28 Pins AVR Microcontroller, the maximum voltage the microcontroller can make use is 5v. AC power supply was fed into the system and it was regulated by the voltage regulator.

The Bluetooth module (HC-05) has six pins namely: EN, STATE, VCC, GND, TX and RX. The RX pin of the HC-05 was connected to the TX of the Atmega328 while pin TX was connected to the RX of the microcontroller. Pins VCC and GND are connected to the 5V and GND pins of the Arduino respectively. The HC-05 operates on a 3.3V logic level and the ATmega328 at a 5V logic level so the digital pin 0 of the Arduino is passed through a voltage divider to reduce the logic level of the microcontroller from 5V to 3.3V.

Pin 13 and 7 of the Atmega328 was connected to the leg of the transistor one and two of which one leg was grounded and the other terminal was connected to the relay.

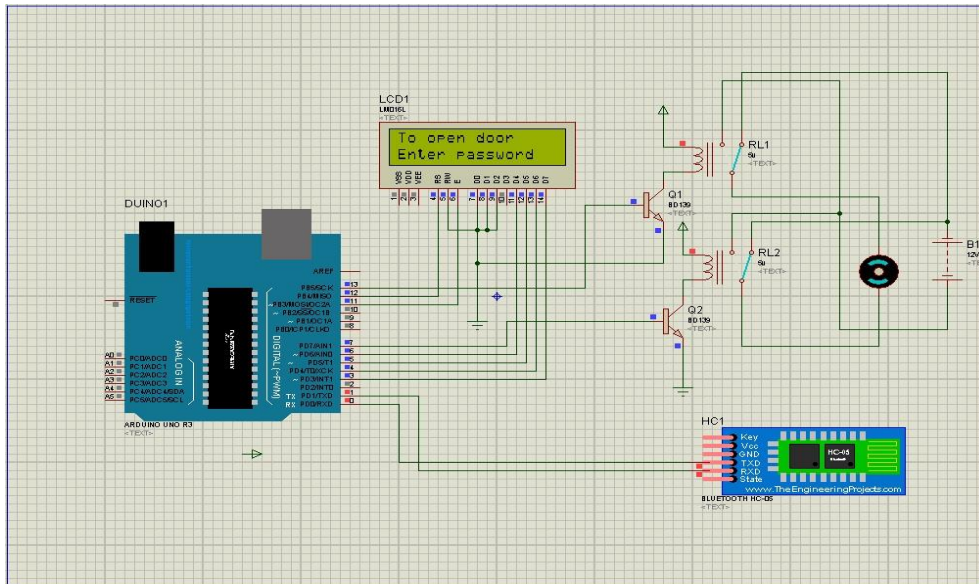


Figure 3.4: Circuit Diagram Showing the Connection Between the Components

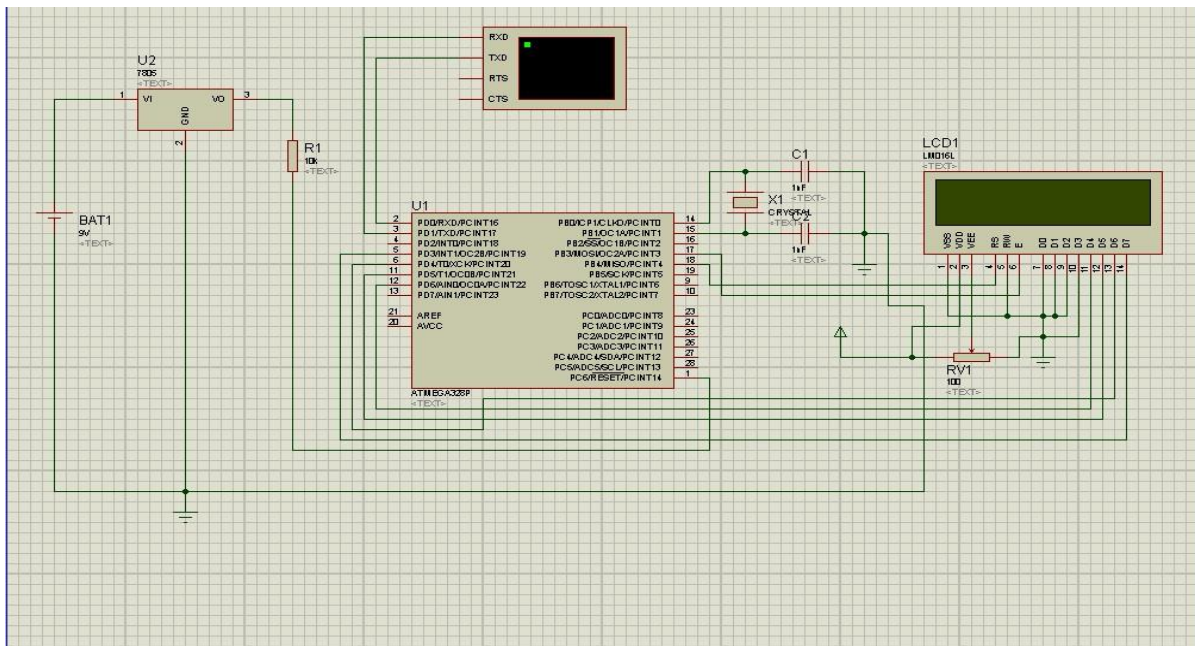


Figure 3.5: Circuit Diagram Showing the Connection Between the Components

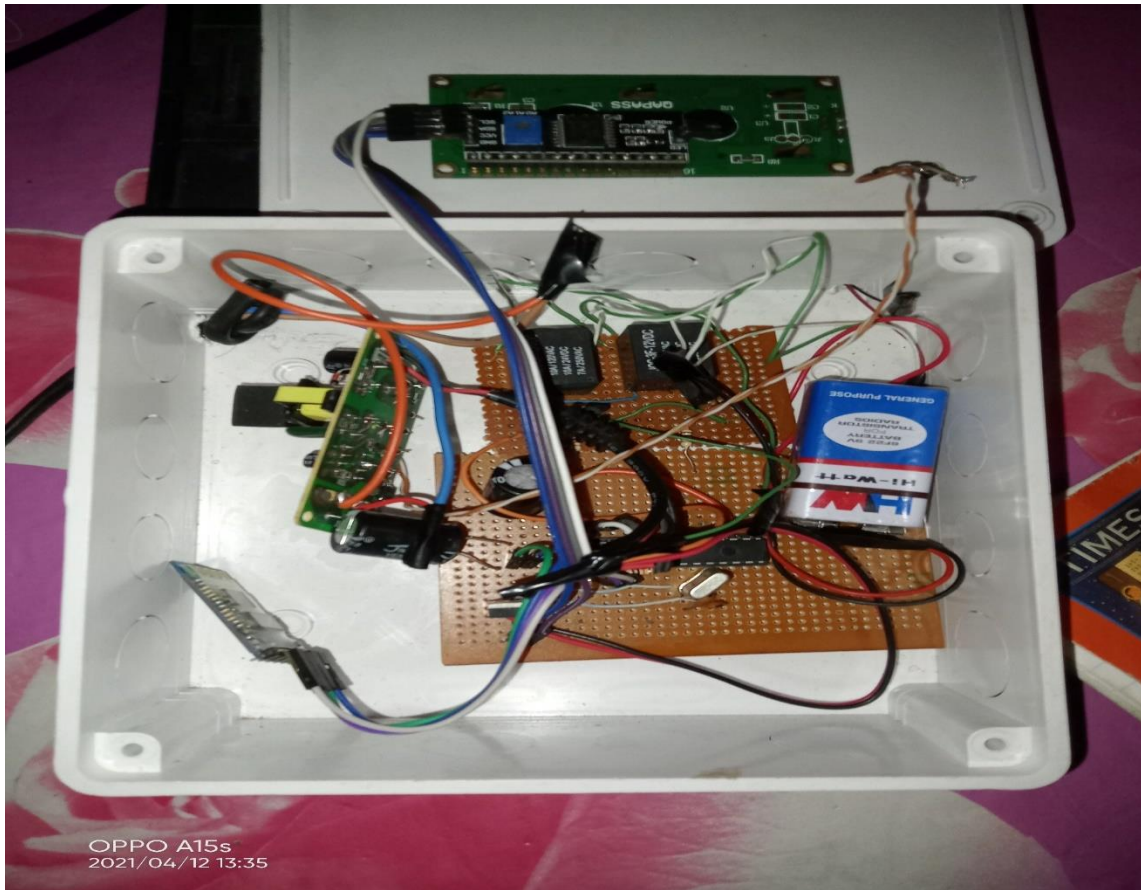


Figure 3.6: The interior of the system

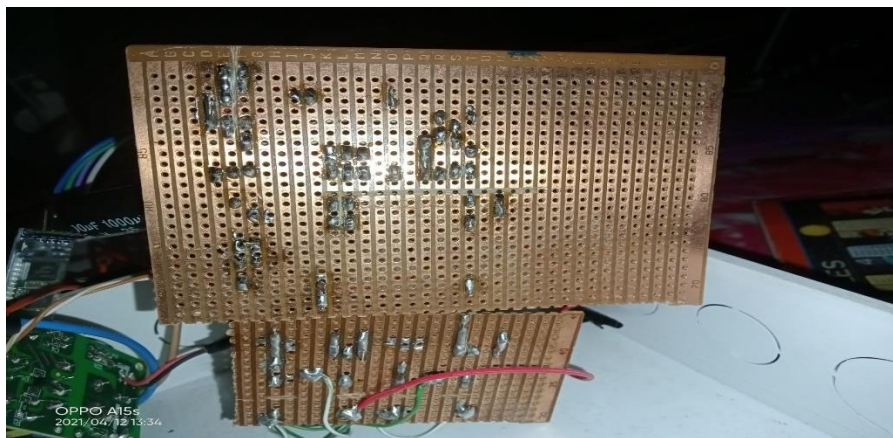


Figure 3.7: The soldered part on the Veroboard





Figure 3.8: The exterior of the system when connected to power supply



Figure 3.9: When password is entered in the terminal and the door is opening



Figure 3.10: When the door is closing after waiting for 4second

### 3.3.2 SOFTWARE DEVELOPMENT PROCESS

A software computer program called “Source code” which was written and compiled in Arduino IDE platform was used to control the Door Automation system. The source code cannot be executed directly by the microcontroller or any other computer machines unless it is compiled into a low-level machine language called the "Object code" or "Hex file". The source code for the design included in the appendix 1 of the project report. As mentioned earlier, the Atmega328 microcontroller was used, which need to be programmed in order to operate in a correct way. Certain elements are needed to accomplish this task, these elements are:

1. ATmega328 Microcontroller;
2. Arduino IDE;
4. Source Code

ATmega328 microcontroller has been described in details earlier, it's considered the heart of the whole project, where it's the main component that process the user mi – and it's the main part that send the signal response to the relay, that's why it is considered the most important component in this device.

The Arduino IDE is the environment where the source code is been written and compiled before it was been uploaded to the Microcontroller.

Source code is the code that was written and compiled by the computer programmer to give command in the system.

### 3.3.3 SOFTWARE DESIGN ALGORITHM

Step 1: Start

Step 2: User will initialize Bluetooth connection.

Step 3: Entering of password//user will enter password from mobile phone to open the door

Step 4: Check if correct password is entered // password will be checked.

Step 5: Door will be unlocked // Command will be sent from the Microcontroller to unlock the door.

Step 6: Door will be locked // The door will be locked after 4 seconds of opening.

The system design flowchart is shown in Figure 3.11

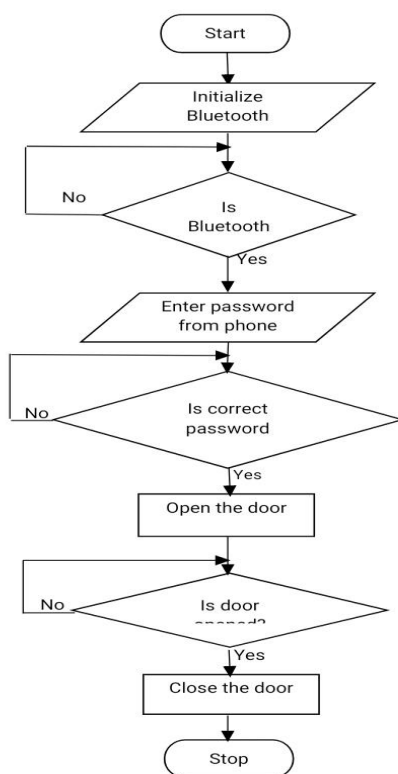


Figure 3.11: Flowchart of the design

#### IV. RESULT AND DISCUSSION

##### 4.1 Results

After the implementation phase, the testing process was performed. The results of the test series show the minimum system of the Arduino microcontroller circuit system has a minimum value 9600 Bits per second, with eight data bits and one Stop Bits. The whole series in this study operate the power of 12 volts. The power drawn from an adapter with a 7812 regulator IC. A function of this IC is to make the input voltage 220 volts of electricity into the main 12-volt DC, so it is safe and does not damage the circuit.

The Software Application (Arduino Bluetooth Controller) which was downloaded from google play store. The application was connected to the System Hardware through Bluetooth.

Firstly, the Bluetooth is needed to be paired with the Bluetooth module. Once the Bluetooth is paired, and the software application is launched, the app will automatically connect the Bluetooth.

The aim and objectives of this project was achieved and discussed below:

1. Build a circuit controlled by microcontroller where Bluetooth technology is used.

In the Design System, a circuit controlled by microcontroller where Bluetooth technology is used was constructed. The Atmega328 microcontroller was used to control the whole process of this system and the Bluetooth module HTC-05 was used to control the door wirelessly. When password is entered in the terminal of the Arduino Bluetooth Controller Mobile application, the Android phone sends a command to the Bluetooth module, after receiving this command, Bluetooth module sends the received command to the microcontroller and then microcontroller reads it and compare it with the password that was issued, if it is correct, the door will open and if not correct, it will remain closed.

2. Simulate the door automation circuit on the proteus.

The door automation was simulated on proteus 8 professional using the efficient components so as to get the best results. The code for the Atmega328 microcontroller was written in C language and was then compiled into an executable file using the ArduinoIDE. The executable file was imported into the Proteus Design Suite IDE Upon successful completion of the software simulation, the system's hardware was constructed on a Veroboard. The simulation of the door automation is shown in figure 3.15 and 3.16 respectively.

3. Construct a device where an Atmega328 microcontroller is integrated with the Bluetooth. A prototype device where an Atmega328 microcontroller was integrated with the Bluetooth was constructed. The door automation consists of the integration of the microcontroller and the Bluetooth module which were connected to two relays that serve as switch.

4. Evaluate a wireless communication between the Android smart phone and the Bluetooth Module. The use of wireless communication between the Bluetooth module and the android smartphone has been part of the design system and it was successfully achieved at the end. The status of the connection between the Bluetooth module and the Android smartphone (Line of sight 10m), is as shown in table 4.1, and it is represented in digital form  $1^s$  and  $0^s$ . Once the system is connected to the power supply, it authorized user will have to connect the phone Bluetooth to the Bluetooth module, and by doing that, a wireless communication has been established.

Table 4.1 The Table showing the status of the Door and Bluetooth base on distance and it is represented in digital form. i.e.,  $1^s$  and  $0^s$

Distance	Status of the Bluetooth Module	Status of the Door
1m	1	1
2m	1	1
3m	1	1
4m	1	1
5m	1	1
6m	1	1
7m	1	1
8m	1	1
9m	1	1
10m	1	1
11m	0	0
12m	0	0
13m	0	0

#### 4.2 Discussion

Table 4.1, shows the results of test carried out in order to be ascertain of the workability of the design system, from the test carried out, it was established that the perfect line of sight at which the design system will be able to react to command issued by the user is 10m.

The efficacy of the test carried out is know the perfect range at which the design system will be able to connect with mobile phones inbuilt Bluetooth, Bluetooth serial module for controlling the state of a door from a short distance from the door. The design system was evaluated on 13 attempts using different distance ranges (1m-13m). The different hardware and software section of the system has been described. The Software Application (Arduino Bluetooth Controller) which was downloaded from google play store was used to control the door automation. The application contains a terminal where password will be entered to open the door and the door will automatically close itself after four seconds of opening. The application program is tested on various Android mobile phones which are quite satisfactory and responses received from the community in general are encouraging.

#### V. Conclusion

Door security has made a lot of impact both on human's life and properties as a result of the fact that people find it difficult to secure their home, offices, schools etc. because of the issue of theft and buglers. It has also improved the economy tremendously as more people adopt it as a necessity of securing their life and properties. The project is based on Android and Arduino platform both of which are free open-source software. So, the implementation rate is inexpensive and can be affordable by a common person for the purpose of security.

#### 5.2 Contribution to Knowledge

This project has helped Students and Technicians to understand the basic Bluetooth circuit, which has been modified into a single and simpler module through a lot of research. This project has broadly enhanced knowledge in establishing a wireless connection between the microcontroller and the Bluetooth module. In further implementation of this project, the issue of insecurity will reduce.

### 5.3 Recommendation

This design will help in reducing overall issues of theft and it will protect life and properties. It will definitely be helpful over the days, as the world is now advancing with new ideas. Advancement can be done to improve the functionality of the project by using a DC battery and a switch to automatically control the system so that it can be standalone.

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