# Design and implementation of a digital calling bell with door lock security system using fingerprint.

[1]M.A. Kader, [2]Md. Yousuf Haider, [3]Md.Rezaul Karim, [4]Md. Saiful Islam, [5]Mohammad Mamun Uddin
[1]Assistant Professor, [2-5]Student, Dept. of EEE
International Islamic University Chittagong (IIUC), Chittagong, Bangladesh
kader05cuet@gmail.com, yousufhaider7@gmail.com, ssuton71@gmail.com, si.iiuc@yahoo.com, eee.mamunctg@gmail.com

***Abstract*—The term 'Home Security' numerously growing as a major concerning issue in today's life. The challenge of developing a home security device is to make it user friendly which can reduce human effort as well as ensure safety and security of people and their home. In this paper, a security device is proposed which is developed from the concept of conventional calling bell. The device analyzes the fingerprint of a person and matches it with stored fingerprint database to categorize the person as home member or known guest or unknown guest. When it detects a home member the entrance door automatically opens. In case, the person categorize as known guest, the device sounds a tune but don't open the door automatically rather people inside home can open the entrance door from anywhere of the home. As guest is known people don't need to walk towards door to open it. And when device detects the person as unknown guest, it generates a tunes which is different from previous one making aware the people inside that an unknown person wish to enter your home.**

***Keywords— Fingerprint module, Arduino Uno; microcontroller; wireless control; RF Tx-Rx; UART.***

## I. INTRODUCTION

In rapidly developing technological world, people are searching devices to ensure security and convenience in their home. Considering the increasing demand researchers are trying to develop security devices for smart home with more intelligence and convenience to user. Devices are developed from different perspective based on application. Some security devices are concerned about the entrance of unauthorized person in home [1]-[3], some concern about safety from gas leakage or fire [4] and some are developed based on password or biometric lock at entrance door [5]-[7]. In this paper, a security device is proposed considering the home security and reduction of human effort. The device act as finger print based calling bell and door lock as well as users inside home can open the entrance door from any place of home by a remote controller through this device. The device takes the finger print from a person wish to enter the home by a finger print scanning module. The module match it with finger print data base stored in its memory and categorize the person among any one of three categories indicated as 'home member', 'known guest' and 'unknown guest'. Here we define 'home member' as regular family member who are staying at home, 'known guest' are those relatives or people who frequently visit at home. The finger print of home member and known guest should be stored in the database of fingerprint module. 'Unknown guest' are those people who are rarely visit at home and their finger prints are not stored in database. For a home member the device directly opens the door and generates no sound. When device gets a known guest it does not open the door but generates a sound which indicates the sound of known guest. In this case people inside home should not come towards door to open it as the visitor is known to them. So, they can open the door from any place of home by using a remote. For unknown guest the device doesn't open the door but generates a sound different from the sound produced for known guest. In this case, people inside home cannot open the door by remote. As the guest is unknown so they have to come towards door and after getting identity they can open the door by pressing a switch beside it. The device reduces human effort in the sense people inside home should not go towards door in most of the time to open the door.

## II. SYSTEM OVERVIEW

The block diagram of the system is shown in 'Fig. 1'. The fingerprint scanner captures the fingerprint of a person and verifies it. It communicates with microcontroller via universal asynchronous receiver-transmitter (UART) module of microcontroller. After getting verification result from fingerprint module microcontroller takes decision to make sound from any of the buzzers or opening door based on

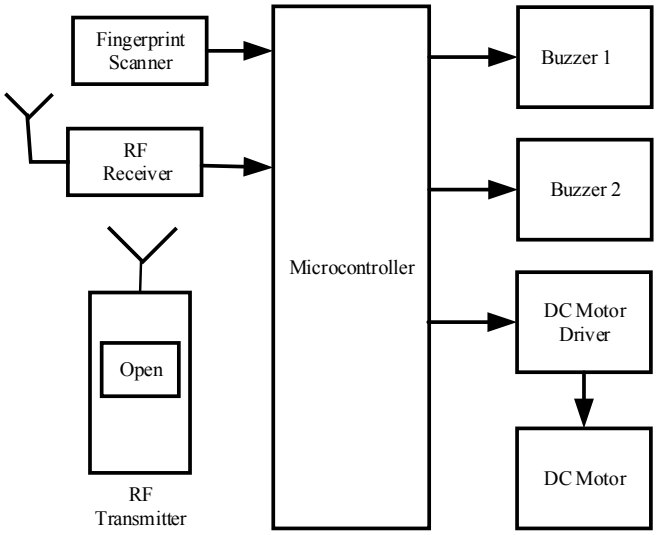


Fig. 1: System block diagram.

**978-1-5090-6122-8/16/$31.00 ©2016 IEEE**

person's identity. RF receiver-transmitter pair is used to control entrance door from any place inside home incase finger print module identify a known guest. RF transmitter uses a push buttons to open and close the door.

## III. System Design

This section describes the different component used in the system, interfacing the components with microcontroller and circuit diagram of the system.

### *A. Fingerprint Scanner*

Fingerprint scanner used here is an optical fingerprint recognition embedded module GT-511C3 developed by ADH technology as shown in "Fig. 2". The module itself does all of the heavy lifting behind reading and identifying the fingerprints with an on-board optical sensor and 32-bit CPU. The module can store up to 200 different fingerprints and is capable of 360° recognition. The device can be operated and configured by sending some simple commands. Some important commands are given in "Table-1". To get started, user can register each fingerprint by sending corresponding commands and pressing finger against the reader three times. The fingerprint scanner can store different fingerprints and the database of prints can even be downloaded from the unit and distributed to other modules. Some key technical specification of fingerprint scanner is given in "Table-2". [8]

TABLE I. Some important Commands for GT-511C3

| Number (HEX) | Alias | Description |
|---|---|---|
| 01 | Open | Initialization |
| 02 | Close | Termination |
| 22 | EnrollStart | Start an enrollment |
| 23 | Enroll-1 | Make 1st template for an enrollment |
| 24 | Enroll-2 | Make 2nd template for an enrollment. |
| 25 | Enroll-3 | Make 3rd template for an enrollment, merge three templates into one template, save merge template to database. |
| 26 | IsPressFinger | Check if a finger is placed on the screen. |
| 40 | DeleteID | Delete the fingerprint with the specified ID |
| 41 | DeleteAll | Delete all fingerprints from the database. |
| 50 | Verify | 1:1 Verification of the capture fingerprint image with the specified ID. |
| 51 | Identify | 1:N identification of the capture fingerprint image with the database |
| 52 | VerifyTemplate | 1:1 Verification of a fingerprint template with the specified ID |
| 61 | MakeTemplate | Make template for transmission |

TABLE II. Technical Specifications of GT-511C3

| Item | Value |
|---|---|
| CPU | ARM Cortex M3 Core |
| Sensor | Optical Sensor |
| Effective area of the sensor | 14X12.5 (mm) |
| Image Size | 202X258 Pixels |
| Resolution | 450 dpi |
| The maximum number of fingerprint | 200 fingerprints |
| Matching Mode | 1:1, 1:N |
| The size of template | 496 Bytes (template)+ 2 Bytes (checksum) |
| Communication Interface | UART, default baud rate 9600bps |
| Identification Time | <1 sec (200 fingerprints) |
| Enrollment time | <3 sec (3 fingerprints) |
| Operating Voltage and Current | DC 3.3-6 V and <130 mA |

Fig. 2: Fingerprint Scanner - TTL (GT-511C3).

### *B. Universal Asynchronous Receiver-Transmitter (UART)*

The finger print scanner has four pins: Vcc, Tx, Rx and Gnd. The module sends data serially through transmit (Tx) pin and receive data or commands serially by receive (Rx) pin. The serial communication used here is asynchronous serial communication. Microcontroller (ATmega328P) used in this project has inbuilt UART module. Microcontroller communicates with fingerprint scanner through this UART module. The UART transmits and receives data using a standard non-return-to-zero (NRZ) format [9].

### *C. RF Transmitter and Receiver Module*

The RF module, as the name suggests, operates at Radio Frequency. The digital data is represented as variation in the amplitude of carrier wave which is known as Amplitude Shift Keying (ASK). RF transmitter can transmit digital data through radio frequency carrier wave. RF receiver receives this data mixed with radio frequency carrier wave and separates digital data from it. In this application, RF remote is suitable than IR remote, as RF signal can travel through larger distance than IR

signal and RF signal can travel even when there is an obstruction between transmitter and receiver. Here, the receiver and transmitter pair operates at a frequency of 434 MHz.

### *D. Circuit Diagram*

The complete circuit diagram of the system is shown in "Fig. 3". The circuit consists three parts: Power supply circuit, Transmitter circuit (RF remote controller) and Receiver circuit. The function of power supply circuit is to convert 9V DC voltage into 5V DC. This 5V DC source acts as power source for microcontroller, fingerprint scanner and other components. The transmitter circuit is shown in dotted box in the figure. Transmitter circuit sends 12-bit data to the receiver circuit. These 12 bits are classified into 8 address bits (A0-A7) and 4 data bits (D0-D3). HT12E is an encoder IC used in transmitter circuit which converts 12 bit parallel data inputs into serial outputs. This serial data is provided to TX pin of RF transmitter module. A push button SW1 connected with D0 pin of HT12E. D0 pin is pulled down to ground through a 1K resistor. Normally D0 pin is LOW, but when SW1 is pressed D0 becomes HIGH and this data is send to the receiver circuit. The receiver unit is the main part of this system. It has fingerprint scanner, ATmega328P microcontroller, RF receiver module, buzzers to produce sound and a DC motor to open or close the door. Microcontroller communicates with fingerprint scanner through TX and RX pins. PB5 pin controls the relay which further controls the DC motor. Buzzer-1 and Buzzer-2 are connected with PB3 and PB4 respectively.

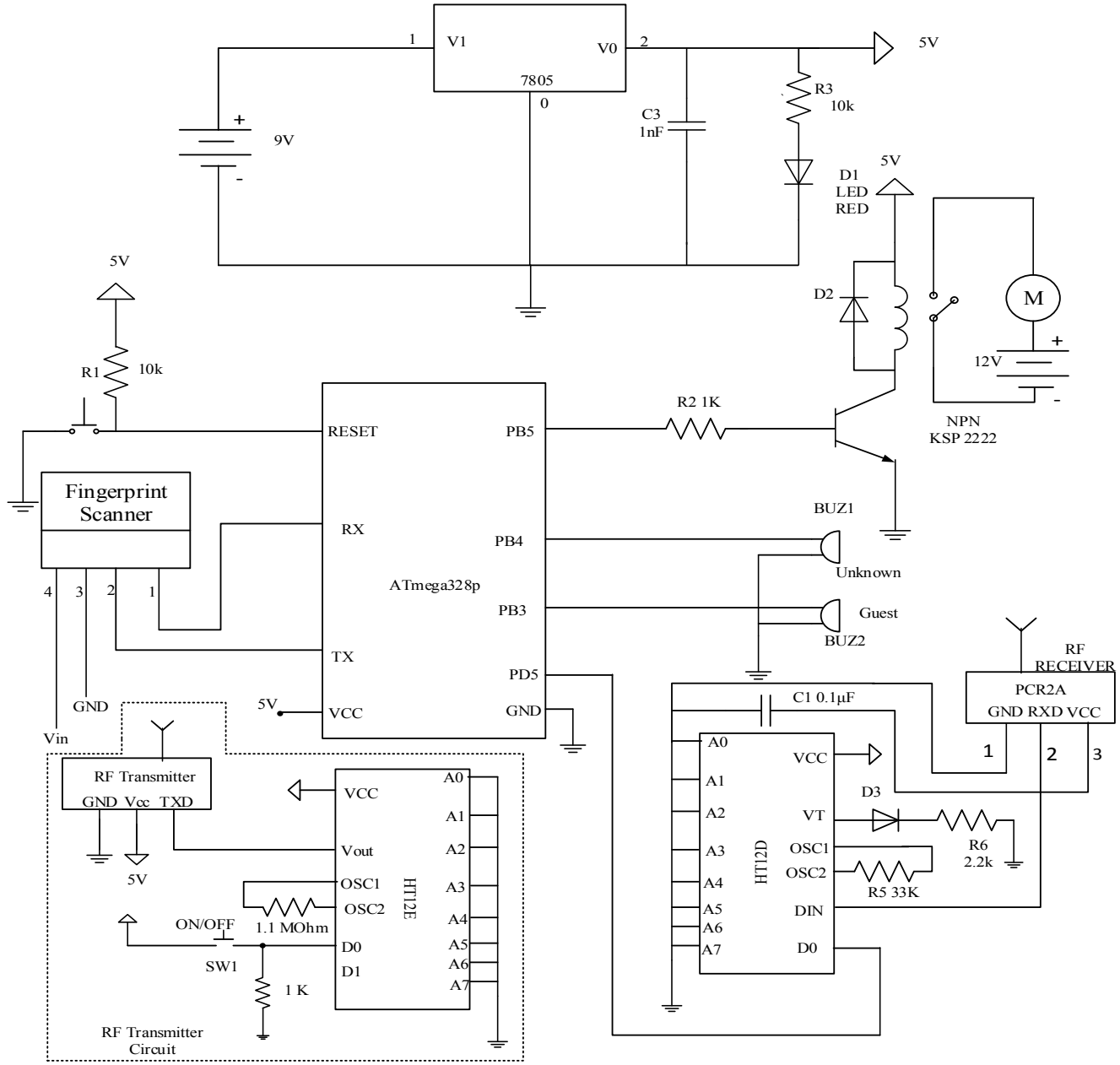


Fig. 3: Complete circuit diagram of the system.

## IV. PROGRAMMING AND IMPLEMENTATION

This section represents the programming algorithm and practical implementation of our system.

### *A. Programming Algorithm*

The flow chart of the program loaded in microcontroller is given in "Fig. 4". The system initialize by scanning finger print of visitor. Then it processes the finger print image to get the finger print template. After that this finger print template is matched with stored fingerprint. If finger print is not matched with stored finger print sound generated from buzzer 2. On the other hand, if finger print is matched, the system further checks whether the visitor is home member or not. If it gets home member the door opens automatically. In other case, system generates sound from buzzer 1 and check received data from RF receiver. The appropriate data of RF receiver opens the door. This process repeatedly runs by microcontroller.

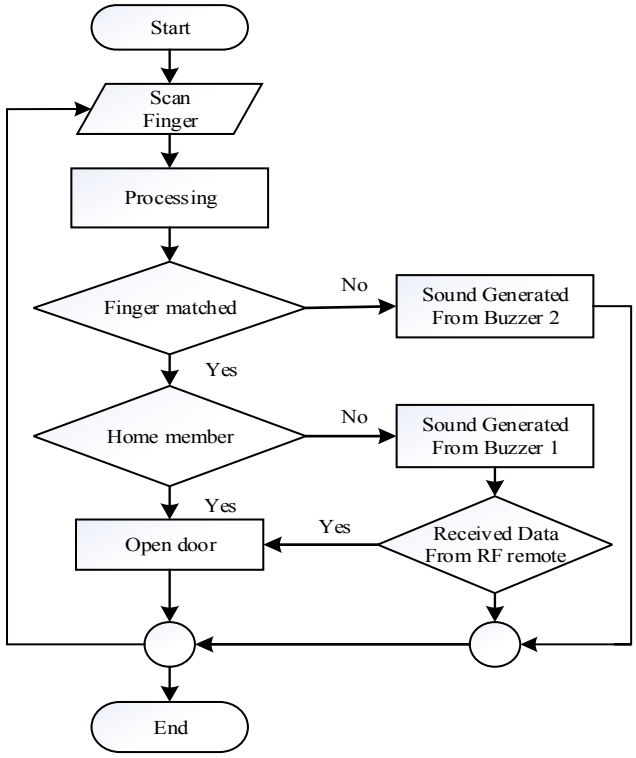


Fig. 4: Flow chart of program.

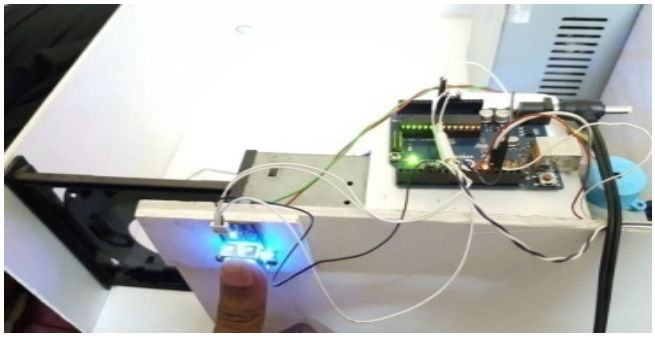

Fig. 5: Prototype of the system, finger placed on finger print scanner.

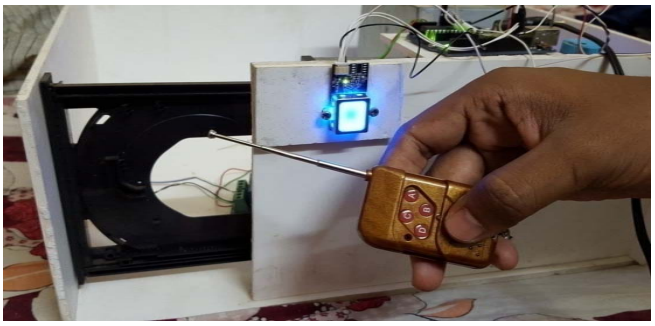

Fig. 6: Prototype of system and RF remote to open the door from inside of home .

### *B. Implementation*

A prototype of the system is developed. "Fig. 5" and "Fig. 6" shows some images of the prototype. The prototype is checked for a home living a family of 6 members and considering 12 people as frequently coming guest categorized as known guest in this system. The system worked properly as described earlier. Some specifications are listed in "Table-III", which are obtained from analysis of implemented system. Total cost of the implemented prototype is about 3800 BDT (around 47 USD) as shown in "Table-IV". To implement a real system instead of prototype cost will increased up to 80 USD approximately. Mass production of real system will decrease the cost about 15 USD i.e. the cost of the system will be 65 USD.

TABLE III. SYSTEM SPECIFICATIONS

| **Action Name** | **Required Time** | **Field** | **Specification** |
|---|---|---|---|
| Finger print identification | <1 sec | Number of fingerprint storage | 200 people |
| Fingerprint identification and opening door | < 2sec | Range of RF remote | Approx.. 100m in indoor |
| Closing door | < 1 sec | Power required | 1.2 W |

TABLE IV. COST CALCULATION OF PROTOTYPE

| **Field** | **Cost (BDT)** |
|---|---|
| Fingerprint scanner | 2500 |
| Microcontroller | 200 |
| RF receiver and transmitter pair | 1000 |
| DC motor, power supply circuit and others | 100 |
| Total | 3800 (around 47 USD) |

## V. CONCLUSION

The purpose of this system is to ensure home security and to reduce human effort. When peoples inside home are busy in cooking, reading, sleeping, bathing or any other daily activity opening or closing door in conventional way can break their concentration in activity. So, the use of this system may help them to concentrate their daily activity in more secured and

reliable way as this system prevent them to go towards entrance door in most of the cases.

## REFERENCES


[1] Jayashri Bangali1 and A. Shaligram, "Design and Implementation of Security Systems for Smart Home based on GSM technology", International Journal of Smart Home, Vol.7, No.6 (2013), pp.201-208.

[2] Raqibull Hasan et al., "Microcontroller Based Home Security System with GSM Technology", Open Journal of Safety Science and Technology,, Vol. 5, pp. 55-62, June 15, 2015.

[3] Mehek Potnis et al., "Home Security System Using Gsm Modem", Journal of Engineering Research and Applications, Vol. 5, Issue 4, April 2015, pp.143-147

[4] Luay Fraiwan et al., "A wireless home safety gas leakage detection system", 1st Middle East Conference on Biomedical Engineering, Feb. 21-24, 2011, IEEE, DOI: 10.1109/MECBME.2011.5752053

[5] A. Aditya Shankar et al., "Finger Print Based Door Locking System", International Journal Of Engineering And Computer Science, Volume 4 Issue 3 March 2015, pp. 10810-10814.

[6] K.Wazed Nafi et al., "An Advanced Door Lock Security System using Palmtop Recognition System", International Journal of Computer Applications, Volume 56– No.17, October 2012.

[7] Ajinkya Kawale, "Fingerprint based locking system" International Journal of Scientific & Engineering Research,, Volume 4, Issue 5, May-2013.

[8] ADH Technology Company Ltd. "Optical fingerprint recognition embedded module", GT-511C3 Datasheet, March 26, 2013.

[9] Milan Verle, PIC Microcontroller, 1st edition, mikroElectrica, 2009.