Arduino Based Door Unlocking System with Real Time Control

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***Abstract*—The system proposed is a door unlocking system containing multiple doors any of which can be used to access a certain zone e.g. a laboratory or library. The system is implemented using a central server which contains a central database gathering all the information about the authorized personnel. The hardware components required are RFID reader, passive RFID tags, wireless transmitter & receiver (433 MHz) and an Arduino microcontroller. Software assistance of Arduino IDE and Processing Development Environment (PDE) are required for control. There is also provision for real-time monitoring of users' activities i.e. entry and exit. This is made possible by automatic synchronization of the system with a secured webpage via internet.**

Keywords—Internet of Things (IoT); Arduino; RFID; door locking system; secure access; ubiquitous computing; real time control

I. INTRODUCTION

The system proposed can be basically used for offices, laboratories and libraries where it is essential to keep a record of the people entering and exiting. Research on home automation systems include several such sophisticated systems. It has often been seen that sometimes it becomes necessary for the supervisor of a particular office or lab or library needs to monitor the people coming in or going out immediately when it happens. In line with this thought an automatic attendance system along with secure access through RFID door locking is proposed. The log is automatically updated in a dedicated webpage and hence can be accessed from anywhere and from any device supporting internet. The main focus is to design a simple, cheap system which can be installed easily and also can be fully customized based on application specific requirements.

Previous works has been mainly on Home Automation systems which have higher costs due to added sophistication like speech recognition [1], face recognition [2] [3], internet access at all the door, etc. Yong Tae Park et al [3] proposed a RFID based door lock system using ZigBee module for exchanging information. Md. Nasimuzzaman Chowdhury et al [4] introduced the feature of remote access via internet but the main constraint was also the cost.

The main aim of the proposed system is to design a cost effective, easily implementable system for attendance monitoring and at the same time it can be customized to meet various demands, for example certain people, say security guards can access the doors only between certain times.

The rest of the paper is structured as follows. First, the hardware components required is described and then a brief introduction of the system is given followed by a flowchart and a block diagram of the proposed system. Then we describe the basic working of the system along with snapshots of the actual webpage created. It will explain how a serial is being sent depending on the number stored in the RFID tag and the door from which it is accessed. Finally, in the conclusion the advantages of the system over the ones in market already are discussed and also improvements are suggested.

II. COMPONENT DESCRIPTION

A. Arduino UNO Microcontroller

Arduino UNO is used to control the operations of RFID reader at the doors as well as the transmitters and receivers. Arduino UNO is a microcontroller board which is based on the ATMEGA 328P [5]. It has 14 digital Input /Output pins, 6 Analog Input/ Output pins, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It also includes: Flash Memory 32 KB (ATmega328) of which 0.5 KB used by bootloader, SRAM 2 KB (ATmega328) EEPROM 1 KB (ATmega328). [6]

B. RFID Reader and Tag

A RFID reader needs to be installed at all the doors. It reads information on the "tag". Here we used a MFRC522 RFID reader [7] with a S50 Fudan card [8]. The reader has an operating frequency of 13.56MHz and the maximum data transfer rate is 10Mbit / s.

C. Wireless Transmitter and Receiver

Here a Radio Frequency Module (433 MHz) is used which has both transmitter and receiver [9]. Both the transmitter [10] and the receiver [11] work have a standard operating voltage of 5 Volt. Typical range of such modules is about 100 meters in ideal conditions.

D. Raspberry Pi

The server used here is Raspberry Pi 3(Model B) [12] on which both the Arduino and Processing sketches of the server

are run. Raspberry Pi 3B has a Broadcom BCM2837 System on Chip (SoC) running a 1.2GHz 64-bit quad-core ARMv8 CPU and 1GB of RAM. It includes 4 USB ports and an Ethernet port and also 802.11n Wireless LAN.

III. Brief Description Of The System

The central database contains all the information of the authorized users say their names, occupation, age and the serials which are written within their RFID cards or tags. The users are uniquely identified by the server by the serial assigned to card. When a new user is first registered to the system new serial is generated randomly and is burnt to the new card using RFID reader. Next time when this user approaches to enter through any door the new serial is processed in the same manner as it is already included in the central database.

When a user comes to entry point only the serial number is fetched from the card and it is checked that whether the serial is an authorized one or not. If the serial is authorized the entry request is accepted by the server. Accordingly, the door at that particular entry point is unlocked and after a specified time delay it is locked again giving some time to the user to enter. But if the serial is unauthorized access to that door is denied with an alarming sound (sound not included in the prototype). This entry-exit information is also stored in the central database in the form of a log file with date, time and door number.

The system can also be controlled manually for any emergency or at the time of any disaster such as fire or earthquake. Two buttons are provided at the server terminal. One for manual opening and another for manual closing of all the doors at a time.

There is also an online monitoring system. This allows the in charge of the system to monitor the check-in activities of the users as well as to control the status of each and individual door even when the person is out of station or out of that zone.

IV. Working Of The System

A. *Proposed structure of the system*

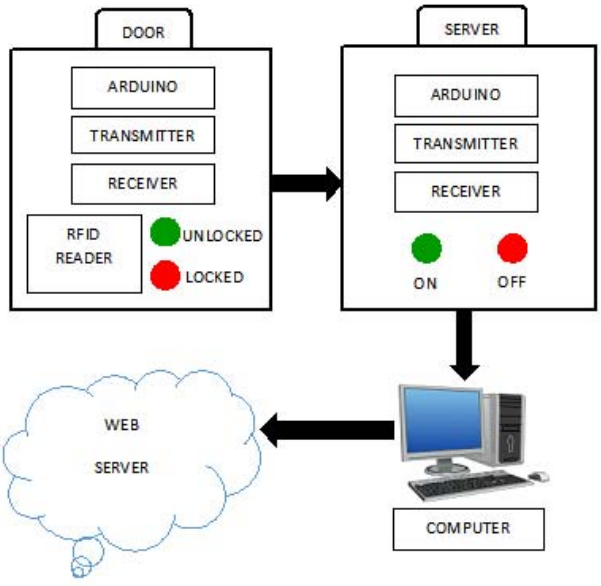


Fig. 1. Block Diagram of the Proposed System

B. *Process Flow of the proposed system*

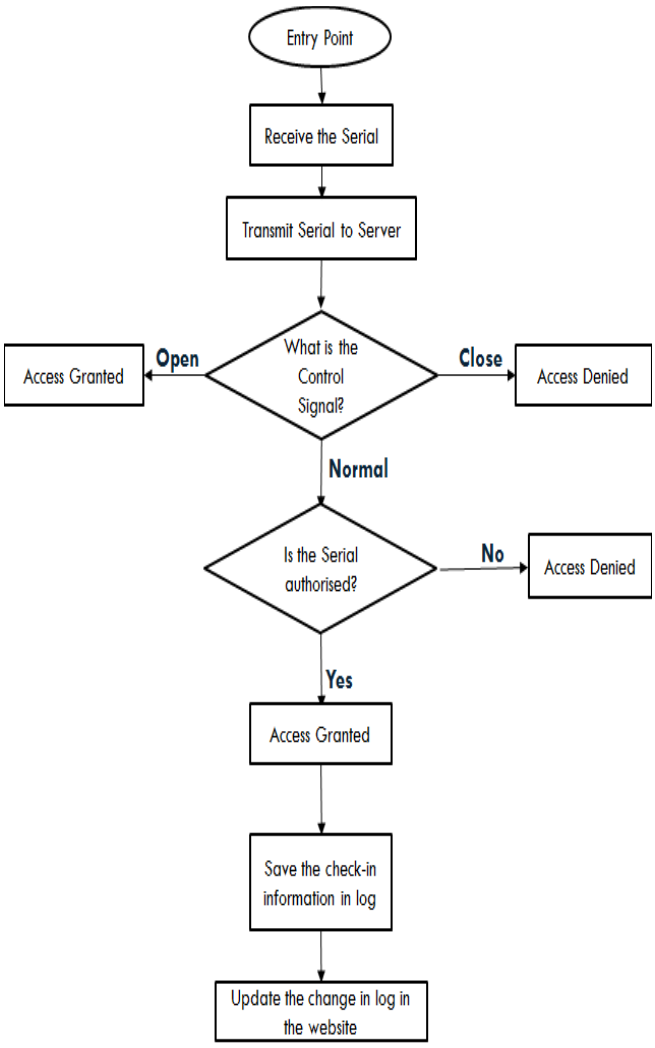


Fig. 2. Flowchart of the Working Algorithm of the Proposed System

C. *Detailed Description of the Operation*

1) Step 1: The RFID reader writes the door no. to the card or tag, then it reads the serial number contained by the card or tag as it is placed in close proximity of a few millimetres from the reader.

2) Step 2: Door no. is appended with the serial number.

SERIAL NUMBER: 12345678
DOOR NUMBER: 3

The door number is placed at the beginning of the serial number and the entire number is used for further processing. Here the door number is written to the card so that the information can be stored in the cards, if required later.

ENTIRE SERIAL SENT: 312345678

3) Step 3: The wireless transmitter sends the entire data to the server for further process and the receiver with the server receives it.
If the receiver is out of range, then we can use intermediate nodes having an Arduino and a transmitter and a receiver to extend the range of the system.

Algorithm 1: Operation of DOOR Arduino for processing RFID card information

```
1.  get message from server
2.  if message==0
3.    unlock door
4.    go to 22
5.  else if message==1
6.    lock door
7.    go to 22
8.  else if message==2
9.     normal operation resumed
10. else
11.    look for new card
12.    if card found
13.       read id from a specific block of the card
14.       write door number to another block
15.       serial=door number + id
16.       send serial to server
17.     get response from server
18.     if response==door number
19.        unlock door
20.     else
21.        keep door locked
22.  go to 1
23.  end
```

4) Step 4: Server passes the received serial to Processing and Processing checks it from the database if the serial is authorized or not.

TABLE I

DATABASE	
SERIAL NUMBER	**FURTHER INFORMATION**
12345678	**Name and other details**

CASE I
Coming serial: 12345678
After checking through Processing, serial number will be matched as it is authorized to the database.

CASE II
Coming serial: 12354678
After checking through Processing, serial number will not be matched as it is not authorized to the database.

5) Step 5: If the serial number is proved as authorized, Processing sends a specified data (door number) to the server through the serial port and the serial is unauthorized, Processing sends another specified data (0) to the server. If authorized Processing sends the name, ID, occupation and other details including the date, time, door accessed to the website www.doorcontrol.co.nf [13] which has a dynamic table showing the information which was sent. The website is protected by a username and password and from here we can co-ordinate and manage the status of the different doors as well as view the persons who entered particular doors and note the time of their arrival or departure.

Algorithm 2: Operations of SERVER Arduino

```
1.  get door status from processing (if changed)
2.  if door status='Open'
3.    send 0 to door
4.  else if door status='Closed'
5.    send 1 to door
6.  else if door status='Normal'
7.    send 2 to door
8.  get serial from door
9.  send serial to processing
10. receive verdict from processing
11. if verdict=door number
12.   send door number to door
13. else if verdict=0
14.   send 0 to door
15. go to 1
16. end
```

Algorithm 3: Processing algorithm for authorization and synchronization with web server

```
1.  obtain database from website
2.  obtain door status from website
3.  if door status='Open'
4.    send 'Open' to server Arduino
5.  else if door status='Closed'
6.    send 'Closed' to server Arduino
7.  else if door status='Normal'
8.    send 'Normal' to server Arduino
9.  receive serial from server Arduino
10. retrieve door number and id from serial
11. check in database for match
12. if matches
13.   send verdict=door number to server Arduino
14.   save data to log file
15.   upload log file to webpage
16. else
17.   send verdict=0 to server Arduino
18. go to 1
19. end
```

6) Step 6: Server generates necessary control signal for the door and again through the wireless transmitter the signal is sent to the door and action is taken accordingly.
Here, the control signal is generated in terms of LED blinking.

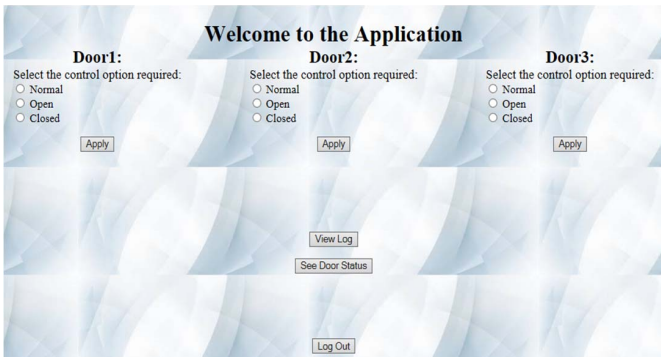
Green LED corresponds to the unlocking of the door and the Red LED corresponds to unauthorized access, whereby the door remains locked.

7) Step 7: However, if there is any emergency then a button for manual unlocking of all the doors is provided which sends a dedicated signal to all the doors.

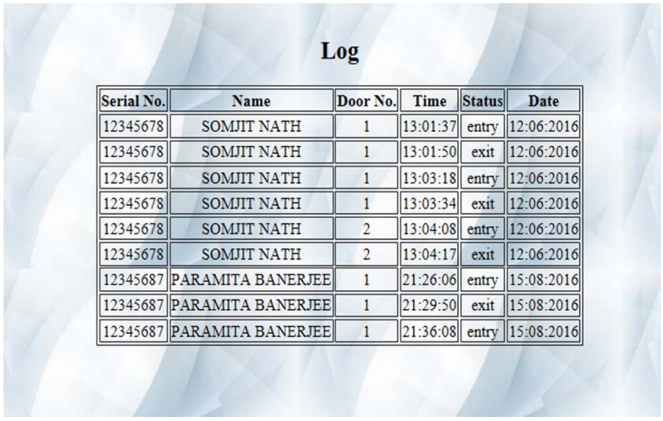
V. Snapshots Of Website

(www.doorcontrol.co.nf)

MAIN PAGE



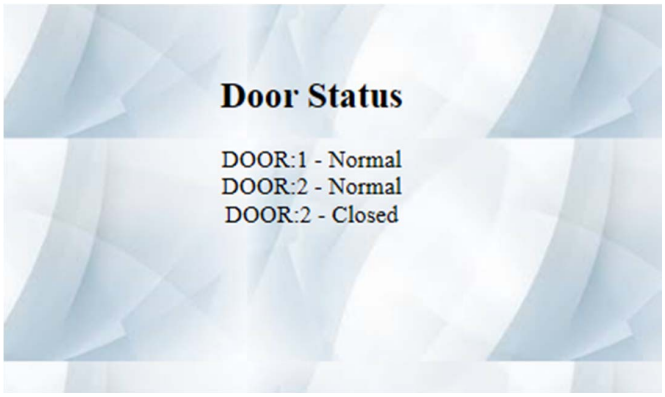
LOG TABLE (LIVE)



Log

Serial No.	Name	Door No.	Time	Status	Date
12345678	SOMJIT NATH	1	13:01:37	entry	12:06:2016
12345678	SOMJIT NATH	1	13:01:50	exit	12:06:2016
12345678	SOMJIT NATH	1	13:03:18	entry	12:06:2016
12345678	SOMJIT NATH	1	13:03:34	exit	12:06:2016
12345678	SOMJIT NATH	2	13:04:08	entry	12:06:2016
12345678	SOMJIT NATH	2	13:04:17	exit	12:06:2016
12345687	PARAMITA BANERJEE	1	21:26:06	entry	15:08:2016
12345687	PARAMITA BANERJEE	1	21:29:50	exit	15:08:2016
12345687	PARAMITA BANERJEE	1	21:36:08	entry	15:08:2016

DOOR STATUS



VI. Comparison with Previous Works

TABLE II

TITLE	FEATURES
Smart digital door lock for the home automation (2009) [3]	• digital door lock with ZigBee module and RFID as base station • it is controlling the other ZigBee and sensor modules
Building A Smart University using RFID Technology (2008) [14]	• RFID unit at each door • smart attendance management using RFID tag
Access Control of Door and Home Security by Raspberry Pi Through Internet (2013) [4]	• remote access of any door via internet • raspberry-pi as central controller • high cost of each door unit
A Digital Door Lock System for the Internet of Things with Improved Security and Usability (2015) [15]	• door lock system using internet of things • authentication using image identification
Proposed System	• RFID unit with radio frequency trans-receiver at each entry point • Arduino Uno as base station • Raspberry-pi as server computer • auto generated log table using check-in and check-out information • remote monitoring via internet • manual control at emergency situations • full customization • low cost

VII. Conclusion

The system has many advantages. It is easy to install. Here we can remotely control the status of the door as well as check the Entry/Exit logs. Since the size of the database depends on the memory capabilities of the server (which is a Raspberry Pi 3 in this case), a large number RFID tags can be registered for use. Also, full customization of the system is available (for example, if we want the Security Personnel to be allowed entry between 6pm-9pm, it can be programed accordingly). Also, Fire control is provided to unlock all the doors in case of emergency. Range can be extended by using intermediate nodes. Commercially available RFID locking systems are dedicated for controlling a single door whereas this system can be installed to control even a multistoried building if adequate number of intermediate nodes are introduced. It is also a low cost system. However, the system fails to work if a transmitter, operating at the same frequency of the system, transmits data in the range of operation of the system. This problem can be averted by using a unique frequency and baud rate. Additional work needs to be done to replace the entire RF transmission by Wi-Fi transmission to prevent the problem stated above.

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