Smart door access control system based on QR code

Agrim Jain[1], Abhinav Panwar[1], Mohd. Azam[1], Ruqaiya Khanam[2,3]
[1]Department of Computer Sciences and Engineering, Sharda University, Greater Noida, India
[2]Department of Electrical, Electronics, and Communication Engineering, Sharda University, Greater Noida, India
[3]Center for Artificial Intelligence in Medicine, Imaging and Forensic, Sharda University, Greater Noida, India

Article Info

ABSTRACT

Wirelessly based security applications have exploded as a result of modern technology. To build and/or implement security access control systems, many types of wireless communication technologies have been deployed. quick response (QR code) is a contactless technology that is extensively utilised in a variety of sectors, including access control, library book tracking, supply chains, and tollgate systems, among others. This paper combines QR code technology with Arduino and Python to construct an automated QR code-based access management system. After detecting a QR code, the QR scanner at the entry collects and compares the user's unique identifier (UID) with the UID recorded in the system. The results show that this system is capable of granting or denying access to a protected environment in a timely, effective, and reliable way. Security systems can protect physical and intellectual property by preventing unauthorized persons from entering the area. Many door locks, such as mechanical and electrical locks, were created to meet basic security needs but it also helps to create a data files structure of the authorized persons.

Corresponding Author:

Ruqaiya Khanam
Department of Electrical, Electronics, and Communication Engineering
Center for Artificial Intelligence in Medicine, Imaging and Forensic, Sharda University
Greater Noida, India
Email: dr.kruqaiya@gmail.com

1. INTRODUCTION

Numerous organizations have found that automated forced assimilation and accessing control systems are critical in combating the security threats they encounter. This is a period when everything is connected to the system, and everyone can access data from anywhere on the entire planet. As a result, information hacking is a serious problem. Because of these risks, having some kind of personal identification (ID) to have access to one's own personal information is essential. At various points within the guarded space, various methods are introduced to track the individual's activity and limit their access to private zone. ID card and password techniques are the most regularly used standard individual ID systems.

An electric lock is a safe device that operates on electricity supply. Keyless entry electronic door locks have lately become the most popular security options, with keyless electronic door locks being installed in many households, workplaces, and academic institutions. The reliability with which authorized users may get authorization to access the doors inside a secure system that incorporates an interactive interface, like using a fingerprint or even a predefined passcode to enter it, is the system's key characteristic [1].

The biggest source of security risk is mechanical door lock keys, which are regularly lost, duplicated, or stolen. To address the issue, keyless door lock systems were actually developed; however, the system has significant software bugs. An attacker, for example, can enter the door by copying the access code

or password. Furthermore, current radio frequency identification (RFID) based solutions are expensive and complicated. As a result, the quick response (QR) scanner is seen to be the ideal technique because it is considerably cheaper and easier to use than RFID [2]. Aside from that, extra security measures like the monitoring system are necessary. The laboratory administrator will be unaware of what is going on in the classroom or laboratory without a monitoring system. Aside from that, in high schools, classroom security has become one of the most pressing concerns for many facilities departments. When lectures or instructors are not present and learners are required to study on their own, the classroom activity must be supervised. To avoid criminal behavior within the classroom, such as burglary and equipment abuse, it is vital to keep track of who has access to the room at any one moment. A smart door system has been introduced to increase security. As a result, the study's goal is to create a web-based security door for the university laboratory that uses a QR code system, while also allowing an authorized user to monitor students' attendance. The information storage system was created to track arrival and departure actions when accessing the security door via the web-based website server. To evaluate the system's functionality, the number of students and employees who entered the room during working hours was counted.

It's critical to secure the keyless door system to prevent intruders from entering the room without being noticed by a person with authority. It is important to preventing any unfavorable situations, such as classroom or laboratory equipment theft. According to Farooq et al. [3], a secure access control system based on RFID has been devised, with the RFID tag serving as the access system. The system needs to merge RFID technology with biometrics to perform the task. When the RFID scanner at the hostel's entry recognized the RFID tag, the system took a picture of the person and searched the database for a match. If both the card and the image obtained belong to the registered user, the entry door will be unlocked; otherwise, the system will trigger the alarm and notify security via GSM modem to resolve the problem. The disadvantage of this project is that while the RFID tag is lost, the cost of producing a new RFID tag is more, making it less cost-effective [4]. Moreover, the RFID system frequently involves a costly scanning equipment that is originally designed to scan and decode RFID tags. In way of comparison to RFID, the suggested QR code idea is far more accessible and affordable, and it can be printed on any surfaces, whereas RFID requires specialist coding to create the codes in the tag.

The QR system is simple to implement and has been used in a wide range of applications. In a similar effort, the author developed a QR-based attendance management system for tracking students' daily attendance [5]. The author contended that the QR implementation was user-friendly and cost-effective because there was no paperwork needed. A unique QR code was provided to each parking place in a related research by Rajesh et al. [6] with the purpose of immediately detecting the vehicle's placement to use a rapid sort method. According to the article's author, most firms want to provide better, much more cost-effective service, and the QR system is one of the best ways to do it. In addition to tracking the whereabouts of people and items, the QR system has been used to convey personal and confidential information [7]. To establish a secured QR code system for conveying personal information, the Rivest Shamir Adleman (RSA) cryptographic technique was applied. This approach may be utilized in a number of real-world settings, including the sharing of sensitive data. Above all, QR codes are popular due to their inexpensive cost, large data capacity, ease of use, and speedy decoding [8].

The operation of the present door access systems available on the market is insufficient [9]–[12]. This is due to the high initial and ongoing costs of most automated door access systems on the market, which most small businesses cannot afford. Small companies will prefer to take the risk of not having door access systems since they cannot afford them [10], [13]. This is extremely unsafe and possibly dangerous since any unauthorised individual can freely access and depart the company's premises.

2.   RESEARCH METHOD
2.1. System components
The access control system is made up of three main components: an Arduino, a servo motor, and a QR code reader. Other components are the light dependent resistor (LDR) and light emitting diode (LED). Each component serves a certain purpose and has a secondary function.

2.1.1. Arduino board
Arduino is a non-proprietary project that enables the creation of computerized devices and intelligent objects capable of detecting and controlling physical objects. Its UNO version is utilized here as a relatively small scale controller device to evaluate the functioning of the proposed access control system [14]–[21]. The accompanying Figure 1 shows a photographic image of the Arduino board.

Figure 1. Arduino board [9]

2.1.2. Servo motor

A servo controller is one of the most significant components of a control system and is commonly utilized. Servo devices allow strong devices to be operated by signals from lower-level control devices. The servo motor SG90 controls the movement of the door bar. The servomotor is supplied with power via an external connection. All of the gears are made of metal. The working voltage is between 4.8 and 7.2 volts. The accompanying Figure 2 shows a photographic image of the servo motor SG90, together with its distinguishing component measurements [20].
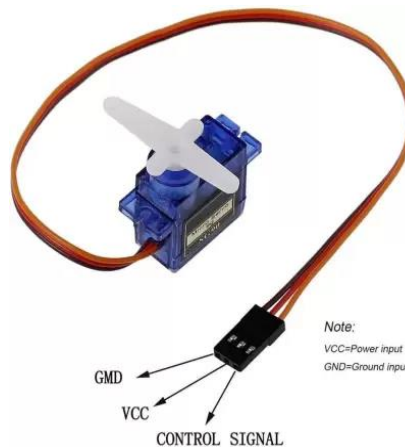
Figure 2. Servo motor SG90 [16]

2.1.3. Quick response code

It is a machine-readable image that could be read instantly using a camera. A QR code is composed of a succession of black squares and dots that indicate various sorts of data. The data is translated into a human-readable format when you scan this code with your smartphone [17]–[23].

a. Develop QR codes with Python's qrcode command: a QR code, is a two-dimensional bar code with a high readability and storage capacity. It is made out of black squares laid up in a square grid on a white backdrop. For creating QR code graphics, Python includes a module called "qrcode." Pip may be used to install it (pip install qrcode).

b. Approach:
- Import module
- Create Qrcode with qrcode. make () and it returns a PilImage object.
- Save into image
- Note: change name, system id and image name according to authenticate
- For example:

```
qr_code_maker.py > ...
import qrcode
img=qrcode.make("Name Agrim Jain, System ID 2020002047")
img.save("2020002047.jpg")
```

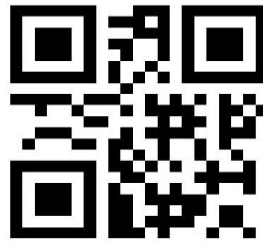Output shown in Figure 3 in the form of QR code image.

Figure 3. QR code

2.1.4. The light dependent resistor

The LDR is a resistor that is influenced by light. A LDR is a component having a variable resistance that varies depending on the amount of light it receives. Figure 4 shows a typical LDR.
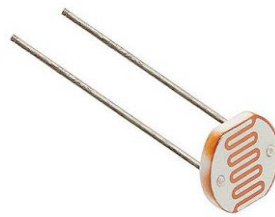

Figure 4. LDR [18]

2.1.5. Light emitting diode

A "LED" is a light-producing gadget. LED lighting gadgets emit up to 90% more light than incandescent bulbs. What are their responsibilities? LEDs, which are tiny light sources, are activated by such an electrical signal is received by a microprocessor, producing visible light. To avoid performance issues, heat generated by LEDs is stored in a heat sink. An image of the LED is depicted photographically in Figure 5. Figure 6 displays the whole circuit schematic for the Arduino-based door lock system project.
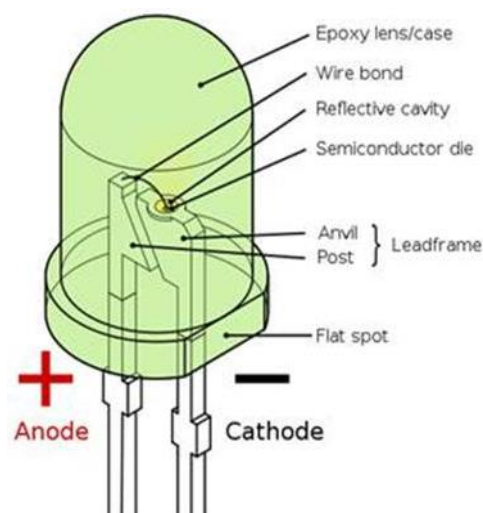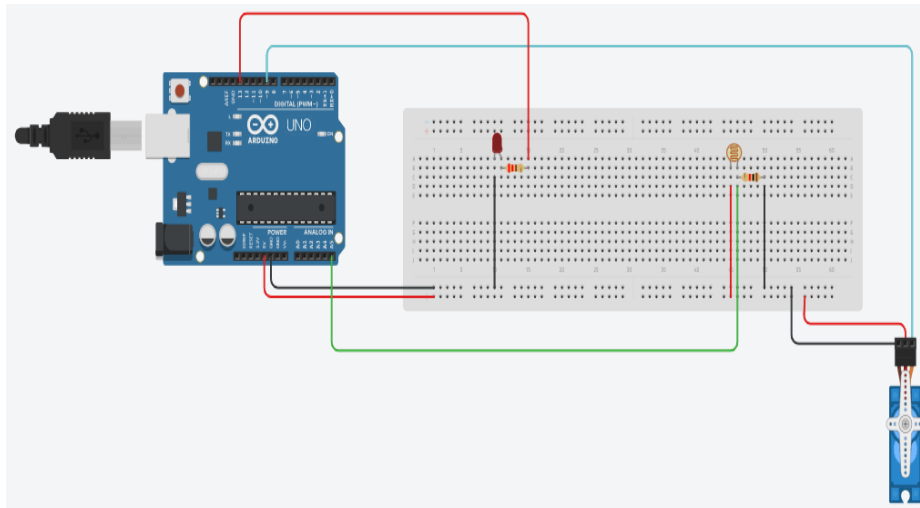

Figure 5. LED [19]

Figure 6. Proposed circuit diagram of door access system

2.2. Light emitting diode control by light dependent resistor

The LDR sensor is used to detect the quantity of light in the surroundings at the period and transmit the data to the Arduino. In Figure 7, the data will be transformed into discrete values ranging from 0 to 1,023 (where 0 represents maximum darkness and 1,023 represents maximum brightness), and the output voltage will be modified from 0 to 2.5 V/5 V (dim/high) by evaluating the receiver final value (0-2,023) towards the threshold value. In complete darkness, if the received value is much less than the threshold, the output will be 2.5 V (during night). As a result, the LED will glow at half of its maximum brightness, and then when the sun shines brightly (during day), the received value will be more than the threshold value, as well as the output voltage will be higher.
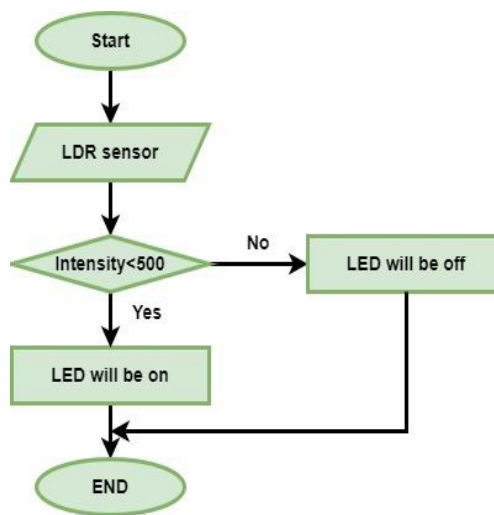

Figure 7. Flow chart of the LED control by LDR

2.3. Door control by servo motor

The servo motor opens the door when the QR code is recognized as valid. The servo motor is turned 90 degrees left to pull the door bar vertically and provide access to the open door condition. After a few seconds, the door closes automatically. In this example, the servo motor will turn 90 degrees towards the right, and the door lowers to shut the opening. Figure 8 displays the functioning of a door controlled by a servo motor SG90. A working prototype of a system is shown in Figure 9. It is to comprehend how a door opening system operates as well as the connection between the system and the door opening system.
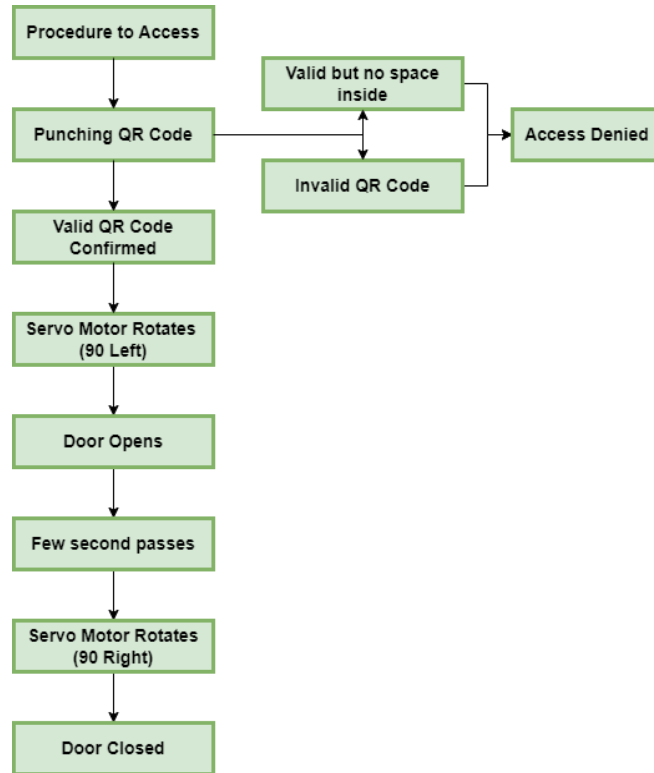
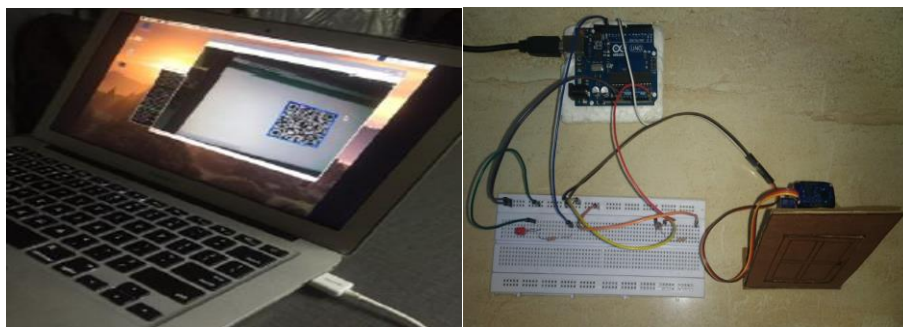Figure 8. Flow chart of the system operation of proposed system

Figure 9. Prototype design

3.   RESULTS AND DISCUSSION

Our technology, which we created, may be used efficiently in colleges to track and monitor students' attendance in a certain lecture room. It may also be utilized in office spaces to keep track of employees' arrival times at their employment. Even though the system may be customized to any guarded zone that only permits approved access, it is not limited to classrooms or office areas. A centralized database keeps track of all entries, allowing each user's frequency of access to be calculated. This system contributes to the reduction of technical human error as well as the manual paperwork connected with such restricted access. Figure 10 demonstrate prototype design of the proposed work.

Figure 10. System operation to get in for registered person

In Figure 10, this information is obtained from system about access time of registered persons of any organization or class. The above window tells us all the information of entered person such as name, ID, date and access time. In Figure 11, the system generated information is obtained from the system about exit time of registered persons of any organization or class. In addition to that the above window gives us all the information of exited person such as name, ID, date and exit time.

Figure 11. System operation to get out of registered person

Similarly, system will also generate all the information about entered person in order to retain time in the particular department or office. In Figure 12, this window reflects all the information of the employee's or students about their stay details such as name, ID, access time, access date, exit time and exit date as well using QR code. Most of the organizations have the similar type of system using RF card but in proposed system we are operating this system using QR code which more handy and no need to carry extra card for this purpose. Table 1 shows how much time a person spent their time in the organization. Although this table is only for demonstration purpose so that one can understand how the system works on getting the QR information from employee or student.

Figure 12. Proposed system operation with all information of a registered person

Table 1. Stay time of a person in the organization

S. No	Name	System ID	Access time	Exit time	Stay time
1.	Abhinav	2020002048	23:38:33	23:40:21	0:01:48
2.	Azam	2020002045	23:38:46	23:40:34	0:01:48
3.	Agrim	2020002047	23:39:00	23:40:47	0:01:47

Time format: hour-minute-second

4.   CONCLUSION

This work has demonstrated development of smart door access control system based on QR code for site security. The proposed security door system adopted a valid QR code to authenticate and/or deny entry to a room or building. It is also used for creating data files structure of authorized users. By the help of door system limited authorized users are able to enter. Control and transaction operations are handled by a centralized system. The door unlocks and the check-in information, as well as basic information about the user, is registered on the central server in real time since the user places the QR code in contact with the scanner. Majority of organization are using RF card access but the proposed system will use QR code from their mobile phones which would be handier and more comfortable without carring another device for that purpose and economical too.

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BIOGRAPHIES OF AUTHORS

Agrim Jain 🆔 🔍 SC ↻ is a third-year engineering student at Sharda University in Greater Noida, where he is studying information technology for his B.Tech degree. He has worked on several projects based on Java and Python. His main research interests are related to human interaction, cloud computing, database systems, app development, and privacy mechanisms in the Internet of Things. He can be contacted at email: Agrimjain9717@gmail.com.

Abhinav Panwar [ID] [G] [SC] [O] is an engineering student currently pursuing his CSE course at Sharda University, Greater Noida. He has completed his 12th from CBSE school in 2019 and achieved 91.8%. Currently, he is 3rd year student and has made several projects on Java-based language. He has also made a voice-based app for visually impaired person. He can be contacted at email: abhinavpanwartanu@gmail.com.

Mohd. Azam [ID] [G] [SC] [O] the author of this paper, is an engineering student currently pursuing his B.Tech. course (CSE) at Sharda University, Greater Noida. He is currently a third-year student and has worked on several projects based on Java and Python. His primary areas of interest in research include cloud computing, app development, and the Internet of Things. He can be contacted at email: azammustaqueem@gmail.com.

Ruqaiya Khanam [ID] [G] [SC] [O] received the B.Tech degree in Electronics and Communication from the University of Jamia Millia Islamia, Delhi, India in 1998 and M.Tech degree in Electronic Circuit and System Design from Aligarh Muslim University, Aligarh, India in 2004. She received the PhD degree in Electronics and Communication from Jamia Millia Islamia, Delhi, India in 2014. She is with Electronics and Communication Engineering Department, Sharda University, Greater Noida, India, where she is currently a Professor. Her current research interests include VLSI design and technology, high level designing using VHDL/Verilog, low power chip designing, image processing, biomedical signal and image processing, fuzzy logic processor design, and internet of things. She can be contacted at email: dr.kruqaiya@gmail.com.