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A Review Paper on Development of an IoT-Based QR Code Access Control and Payment System using Arduino and ESP8266

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Abstract: *In this research, we present the development and implementation of an IoT-based access control and payment system utilizing QR code technology, Arduino microcontroller, and ESP8266 Wi-Fi module. The system is designed to enhance security and streamline payment processes in various applications such as parking lots, public transport, and restricted access areas. The core components include an ESP camera for QR code scanning, a Liquid Crystal Display (LCD) for user feedback, and a pair of motors to control physical barriers. Upon scanning a QR code, the system verifies its validity and either grants access or denies it based on pre-set criteria. For valid QR codes, the system deducts a specified amount from the user's balance, displays the updated balance on the LCD, and operates the motors to allow entry. Invalid QR codes trigger an audio alert via a buzzer. The system communicates transaction data to a remote server using the ESP8266 module, ensuring real-time logging and monitoring. The project highlights the integration of hardware components with software modules to achieve a robust and efficient access control solution. By leveraging IoT technologies, the system offers improved security, real-time data processing, and automated transaction handling. This research contributes to the field of IoT-based automation by demonstrating a practical application in access management and payment systems, providing a scalable and versatile solution for modern access control challenges.*

Keywords: Automated payment system, Internet of Things, Arduino, ESP8266 WI-FI module, QR code access control

I. INTRODUCTION

A QR code-based metro pass technology makes public transportation easy and frictionless for commuters. Online pass purchases create a QR code upon approval. Instead of tickets and lines, travelers scan their QR code to enter a station or board a vehicle. This solution streamlines pass management and usage tracking, improves user experience, and integrates with digital platforms. The European Commission has promoted public transit (PT) as "a safe, efficient, affordable, and lowemission mobility solution for everyone" across Europe and beyond since 2002. To cope with PT limitations in urban areas, intelligent transportation systems (ITSs) will use ICTs to automate transportation data collection to make transport safer, more efficient, more reliable, and more sustainable.

To address this issue, real-time, reliable, and capillary information regarding the crowding state of PT rail or road vehicles (e.g., buses, trams, and trains) and their access infrastructures is needed. Yes, "the availability of real-time passenger demand data can significantly improve the performance of control models in the case of overcrowding." New modeling, planning, and management solutions that collect real-time crowding data and use them to improve QOS/QOE in PT systems are surfacing in the literature due to past needs. Crowd analysis/monitoring includes a network of physical sensors to detect crowds and estimate their parameters, while crowd control includes prediction, decision-making, and control strategies to manage crowd events. Crowd management is different from crowdsourcing/sensing. Crowdsourcing (also

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known as “sensing by the crowd”) in PT systems involves passengers submitting suggestions, concerns, and resources or products, such as peer-to-peer services. PT firms collaborate with passengers to fix problems or plan public transit using crowdsourced data to research and build user-preferred solutions. Instead, crowd management is based on "sensing the crowd," where PT companies analyze environmental data collected through networks of IOT sensor devices and/or user terminals for forecasting, choosing among several alternative options, and ensuring robust and safe PT system operation. During the COVID-19 epidemic, crowd management in PT systems became a major issue (see Section II). Emergency measures like reducing bus and train capacity to 50% were essential to prevent overcrowding during the acute outbreak phase. Since they divert many people to private vehicles, these methods are unsustainable. Since many scientists expect recurrent pandemic outbreaks in the future, PT system overload must be addressed better and more structurally. Modern AVL/APC/AFC systems in ITS systems collect a lot of vehicle and passenger data, but they are not always suited for real-time crowd monitoring and control.

1.1 PROPOSED SYSTEM

This project integrates multiple hardware components and software modules to create a functional and efficient QR code-based access control system as shown Figure 1. It showcases the practical application of IoT technology in improving security and automating payment processes. The system's ability to handle real-time data processing and network communication demonstrates a scalable solution for modern access control challenges. The system is designed for environments where secure access control and automated payment processing are essential, such as parking facilities, public transport systems, and entry points to secure areas. Users scan their QR codes using the ESP camera, and the system validates the codes to either grant access and process payments or deny access and provide feedback.

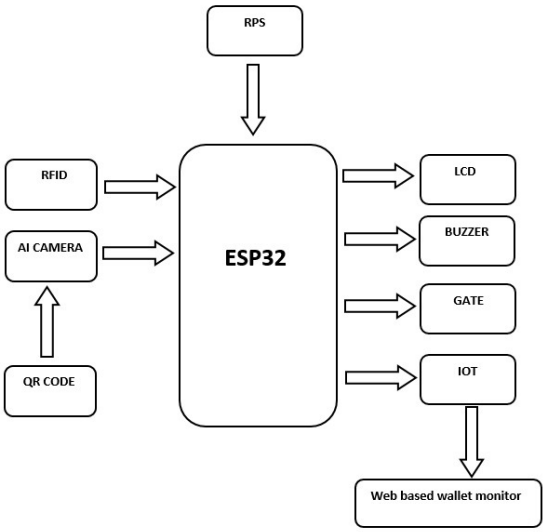

Fig.1: Block diagram of proposed system.

As shown in the above block diagram, the Arduino is interfaced with all the ESP camera which is used scan the QR code and sends the data controller. Once the microcontroller is powered up with the use of a 9v battery it is initialized and set to the basic settings, now the system is ready to proceed camera which scan the QR code of the product and display all the information of product in LCD display with the help of Arduino. Once the item is scanned user if authorized allow him to inside by opening dc motor if not it alerts with buzzer and automatically stops by closing dc motor all the data will display on lcd and send the same data into server. if the scanning process is successful the product details will be transferred to the microcontroller’s memory and then will be transferred to the LCD module to be displayed on the LCD screen. The entire working process is implemented by the software called Arduino IDE. The Proteus simulation software is used to check the simulation results before the hardware implementations.

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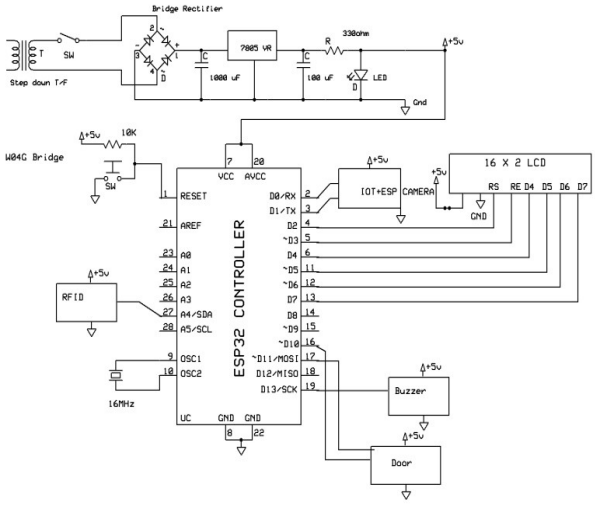

Figure 2. Schematic diagram of proposed system.

Here we are using this platform for the same. As we know that the java is a very powerful language which also rich in libraries so that to login, to balance check & to generate QR code we are using this language. First, we are creating a local server. At this server side, we create special identity like username & password for admin. For passenger only admin can fill a form which contain data like username, user ID, mobile number etc. and after registration profile and generating ID of a user, this system will automatically generate a QR code. After we register a particular user which will have users ID and QR code. User can add money to the wallet/ Add balance to a particular user ID. Whenever user will go by bus, they have to scan the QR code., thus here servo motor run motor smoothly. If exact condition matches then motor will driver and directly money will debit from users' wallet. The admin side (Transport Corporation) can keep track of traffic on the bus and can also track a particular user that on what day he/she is travelling etc.

II. RESULTS AND DISCUSSION

The circuit is powered on by providing a regulated power supply of 12V, which is then converted to 5V DC. The LED acts as an indicator for the 5V current; when 5V current is present, the LED lights up. This 5V DC current is distributed to every hardware component in the circuit. When the reset button is pressed after providing the regulated power supply, the LCD displays "IOT QR Metro Pass System".The EM-18 Reader Module is used to detect a card. If the card is valid, the balance is displayed on the LCD, and the DC Motor is controlled by the L293D motor driver. If the EM-18 Reader detects an invalid card, the output will be displayed on the LCD, the data will be posted to the server.

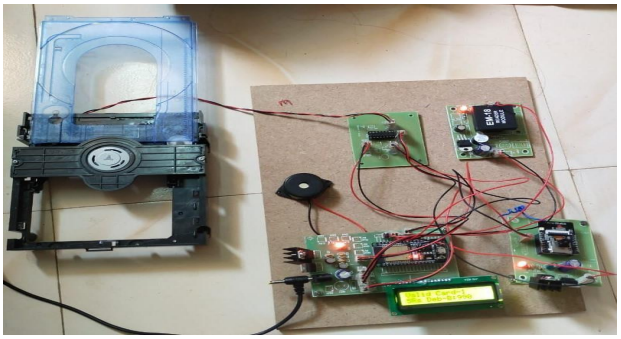

Figure 3. Output displaying on LCD.

The AI camera pins are connected to the ESP32, which scans the QR code. If the QR code is valid, the output is displayed on the LCD, and the DC Motor is controlled by the L293D motor driver. The gate automatically opens when the DC

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Motor moves forward. Both valid and invalid data are uploaded to a website using the ESP8266 IoT module. The website displays details of valid and invalid cards/QR codes, the balance amount, and the time.

III. CONCLUSION

In conclusion, the IoT-based QR Code Access Control and Payment System developed using Arduino and ESP8266 modules offers a robust and efficient solution for modern access management needs. By integrating QR code and RFID card scanning, real-time data processing, and automated transaction handling, the system enhances security and convenience in various applications such as parking facilities, public transport, and secure entry points. The successful implementation and functionality of this project demonstrate the practical applicability and scalability of IoT technologies in access control systems. Future improvements could focus on enhancing system security with advanced encryption techniques, incorporating biometric verification for multifactor authentication, expanding compatibility with various payment gateways, and optimizing the user interface for better accessibility and user experience. Additionally, integrating machine learning algorithms could improve the system's ability to detect and respond to fraudulent activities, further enhancing its reliability and effectiveness.

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