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Park IT- QR based vehicle security

Paritosh Patil[1], Shrinivas Shah[2], Pooja Shivale[3], Murali Parameswaran[4]

[1-4]*Department of Information Technology, Ramrao Adik Institute of Technology, Maharashtra, India*

Abstract—*Every housing society faces the problem of unauthorized parking and vehicle security. To solve this problem, we propose an IoT and computer vision-based system. The proposed system tends to solve this issue by the approach of unique QR- code assigned to each residential family owning vehicle. Only after scanning the QR-code at security gate, the vehicle be allowed inside the society. The in/out time will be generated in log. This is an affordable solution to the problem of security of vehicles in residential societies keeping in mind the convenience of its users. Its primary feature is the identification of vehicles as residents or non-residents. Some of its secondary features will also involve visitors/non-residents verification and certain notification.*

Keywords: Android, QR, IoT, Open CV.

1. INTRODUCTION

In growing urban societies, parking is a huge concern owing to limited parking space. Security of the vehicles can be compromised if any outside vehicles are allowed inside the society without any authorization. If any unauthorized person is allowed inside the society premises, it will lead to security concern of the residents of the society and will also cause illegal capturing of parking space of legitimate owner. Currently there is only a security guard at the gate to ensure that no outside vehicles are allowed inside the society. However, this method is not entirely fool proof as there is a high chance of human error. There is manually filled log record of all the vehicles entering and exiting the gate. Here we introduce a QR code-based vehicle entry, which generates a unique QR code for each member owning a vehicle. Every time user wants to enter the society gate, he/she has to point the QR code towards the camera which scans the code. If the user is legitimate, only then entry is allowed inside the society premises. In case if new vehicle parks inside the society they have to temporarily register to gain access. This ensures security of the society as well as prevents illegal parking. The important functionality which distinguishes our system from currently available systems are: A unique encrypted QR code for each vehicle owner, which ensures that any outsider cannot replicate the same code and try to enter the society. This is a very important functionality considering the security of the residents of the society. An android application is developed to display the QR code which ensures that the code is recognized even in low light conditions or bad weather. Since every resident of the society has a mobile handset, the android application provides a convenient way to the user to use this system. It minimizes the requirement of security guard as the opening and closing of gate is automatic. This also eliminates human error as the logs are digitally generated. This provides an accurate and error free timestamp of every person entering and leaving the gate. We have used Android as a platform to develop an app where user has to register and hence is checked for authorization. A QR code is generated only after authentication and authorization of the user. To capture the QR code we have used Pi camera, which uses Raspberry Pi as a micro-controller to operate. To process and identify the QR code we have used Open CV library.

1.1 EXISTING SYSTEM

We studied a few applications on similar topic which have been already developed to check its limitations and find a scope to improve them.

In QR code on moving car recognition system, the author attached a QR code to the car windshield. The system recognized QR from a moving object like car. A video file was recorded with the car moving at various speeds and then analyzed video files. The limitation of this system is that, since the object is moving, the system was not able to accurately scan the moving QR code. This was hence not a very ideal condition considering the accuracy and reliability [1].

In IoT based Airport Parking system, to facilitate IoT over an Ethernet network, an Ethernet shield was used. To view the availability of parking space, the user needs to login into airport website using username and password. Limitation of this system was that since the user had to always access the website, there were concerns regarding the ease of use, accessibility and the security of user's data [2].

In IoT based smart parking system, the author proposed a smart parking system based on cloud integration. The system consists the use of an IoT based module which detects the availability of parking spot. A mobile application is used as an interface to book a parking slot. In this system however, there was no mechanism to check the legitimacy of the user. This proposed serious security concern [3].

In Smart anti-theft system, the authors proposed a system to monitor the movement of any vehicle using IoT. To do the monitoring, a Global Positioning System (GPS) and Microcontrollers were used to do the job conveniently. Mobile application was used to check the motion of the car and control the fuel line in case of extreme emergency. The system however only tracks the movement of the vehicle. There is no provision to grant a space for parking and to check whether the user is indeed a legitimate user or not. [4].

In Smart Parking Using IoT Technology, the authors proposed a parking system that reduces traffic in the parking area by giving the functionality of finding vacant parking spaces and locating them. To enhance the security and also to help user find the location of the car, computer vision was used extensively to detect number plate characters and use it

to identify vehicles. To remove the hassle of the payment process at the entry/exit gate of the parking area a mobile application-based parking payment was developed to pay parking fees. The system uses number plates to identify the vehicle, however, in bad weather conditions or during dark, the camera won't be able to capture the number plates. The system hence won't be able to any other functions if it cannot identify the vehicle in the first place [5].

2. AIM OF THE PROJECT

In a given residential parking lot, characterized by a grid consisting of space to park an average sized car, an identified user should be guided to pre-assigned space/slot with suggestions to reach the slot efficiently. The other constraints of the problem are vehicle security (prevention of unauthorized access). In the case of unknown user/non-residential car, alternative temporary assignment of spaces needs to be computed, while guaranteeing availability if feasible.

3. METHODOLOGY

3.1 PROPOSED SYSTEM

The proposed system's main goal is to achieve better security with simplistic approach. Firstly, an Android app is developed where user has to create an account and setup a password. The user is then authenticated with the registered flat number. After this an encrypted QR code is generated for that particular user. All the user information and QR code generated is stored in "Fire-base", which is a cloud- based database service. This QR code is unique and cannot be used by any other user. This QR code is scanned using a Pi camera which is connected to a Raspberry Pi micro controller. The scanned image is sent to an image processing library named Open CV [8].

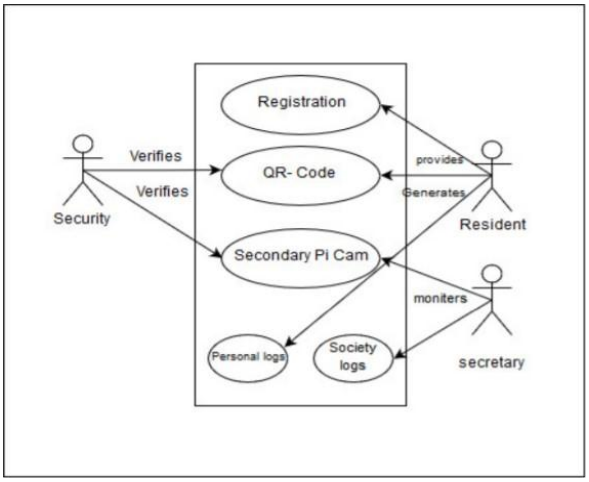

Fig-1: Use-Case Diagram

This processes the image and identifies the different shapes of QR code. It then stitches together these shapes and decodes the message in the QR code using "pyzbar" library. This is an in-built library present in Open CV which is used to decode the QR. Once the QR is read and identified, it is compared with the records in the Fire-base storage. If the decoded QR and the data in the Fire- base storage match, it is confirmed that the user is legitimate. After the confirmation, a message is sent to the servo motor attached to the gate to perform opening action and hence the vehicle is allowed entry.

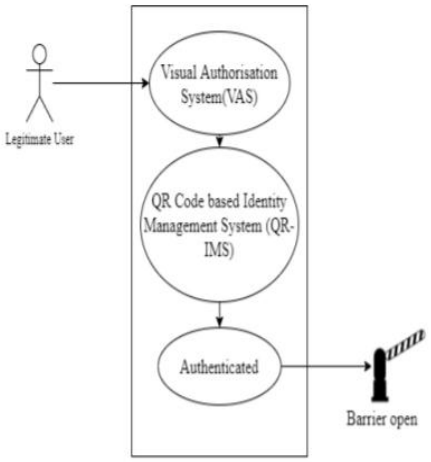

Fig-2: Use-Case diagram: Legitimate user

In Figure 2, when a legitimate resident of the society attempts to enter through the gate, the user first has to generate a legitimate QR code in their mobile phone. The Visual Authorization System (VAS) scans the QR code. The QR code-based Identity Management System (QR-IMS) then validates this scanned QR code and checks the authenticity of the credentials. When a legitimate QR code is scanned and t h e credentials are valid, only then is the barrier opened for the user.

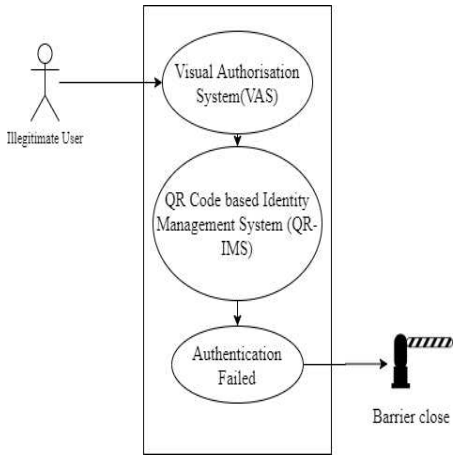

Fig-3: Use-Case diagram: Illegitimate user

3.2 HARDWARE AND SOFTWARE REQUIREMENTS

For capturing the QR code details, a combination of hardware components consisting of Raspberry Pi [7] and Pi camera is used. Pi camera captures the QR code while Raspberry Pi processes the image. For operating the gate, servo motor needs to be controlled. This is achieved by programming Raspberry Pi.

As the primary audience for our test-bed were using basic smartphones, Android based phone was the most accessible platform that met the cost as well as user ability. These constraints compelled us to develop the application using android studio [6] so that the app is compatible with the usage of most of our targeted users. Kotlin is used for developing the android application. The main reason for selecting QR codes for authentication and authorization purpose is the versatility and the ease of use. They are easy to understand and use by users who may not be technically sound. QR codes can store a legitimate user's data and generate a pattern which can be decoded by the Visual Authorisation System (VAS).

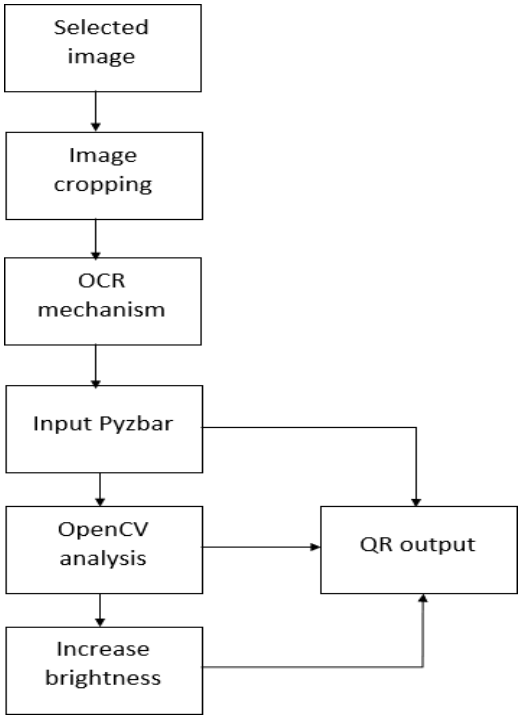

Fig-4: Block diagram

The user just has to register once and the credentials are recorded, hence it does away with the hassle of typing and registering more than once. After this it is just a matter of pointing the QR code in front of the camera for a legitimate user to be identified.

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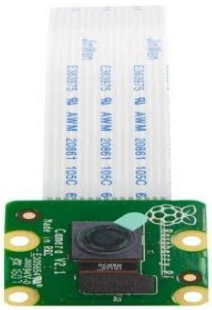

Fig-5: Pi camera

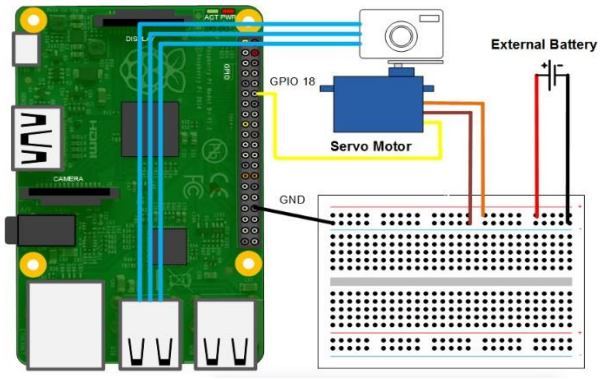

Fig-6: Test-bed

Fig-7: QR code

4. RESULTS

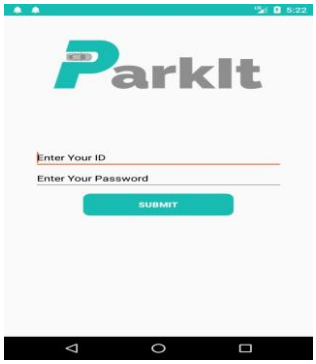

Fig-8: Qr code generation

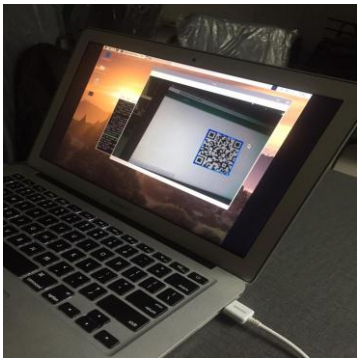

Fig- 9: Qr code scan

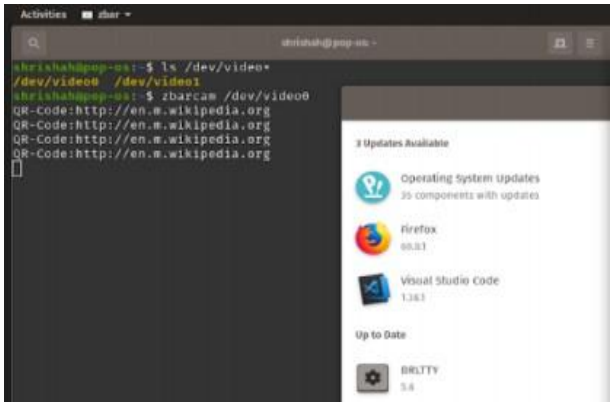

Fig-10: OpenCV output

A test-bed was implemented to validate that the secure application in fact works as designed. Raspberry Pi kits, Android phones and other hardware were used to set up the test bed.

Open CV library and terminal is used for identifying legitimate user. The QR code scanned through Pi camera is processed using Open CV and pyzbar library. The Open CV library identifies the shapes and sizes of the QR and arranges them to identify the refined image. The pyzbar library is used to decode the image into text. This text is shown in terminal and compared with Fire-base database record.

Theorem IV.1. Park-IT enables opening of gate only for authorized personnel.

Proof- The opening of gate functionality is enabled when the QR code passed as input matched one of the QR codes in explicit allow list. As the model assumes that only authorized users can generate legitimate QR code in their own mobile handset, which also include their personal mobile device authentication mechanism, the only way a legitimate QR code can be entered is when a legitimate registered user shows it to the system.

If let's assume that an unauthorized personnel presented a legitimate QR code, it implies that the QR code was either guessed with a probability of $1/\ 2^{2953}$, or the person generated an authentic code without gaining credentials of user. As the probability value is too small in the first case, and the code generated is only with the help of authentic code, (thereby making the person an authentic user); it is clear by contradiction that the user allowed entry is a legitimate user.

5. CONCLUSIONS

The system recognizes authorized user with the help of a QR code. This ensures that only legitimate users can enter the society. The system also makes it compulsory for outsiders to register in the app, making sure that no outside vehicle stays in the society for long duration. This ensures security of the society as well as prevents illegal parking. In future, our system will also be able to guide the vehicles to the allotted empty parking space. Also, we will try to integrate the functionality of renting the parking space whenever it is empty so that the owner of parking space can generate revenue.

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