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From Adversity to Serendipity

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research, experience and successes in
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QR Code based application approach for issuing smart curfew passes[‡]

Herath H.M.G.G.K.^{1,2*}, Etulgama H.M.R.B.¹, Rathnathilaka R.W.M.D.D.B.¹,
Herath H.M.K.G.C.B.¹

1 Circlebook Company, Kandy, Sri Lanka

2 Sri Lanka International Buddhist Academy, Kandy, Sri Lanka

ABSTRACT

Due to the number of curfew violations increasing almost up to 62,000 within the first two months (Hapuarachchi, 2020), it is observed that an effective and robust method is required to prevent people from misusing the issued curfew passes as well as to avoid the use of forged curfew passes.

It is found that most of the curfew pass violations are possible because of the way the officers must interact and validate the information. Another most common way is the use of forged curfew passes (DailyFT, 2020), which are very difficult to identify since the existing version of curfew pass is printed on regular paper, which could be easily faked using a household printer.

Key words: QR code, Curfew pass, Curfew violations, Identification system, Smart pass, Management system

1. INTRODUCTION

Since it is an essential and crucial task to prevent the general public from gathering and practice social distancing in order to curb the spread of COVID-19 (Hapuarachchi, 2020) while maintaining the critical services of the country, it has been quite a challenge for the police to distinguish essential service personnel from the general public on the roads. Due to the number of curfew violations increasing almost up to 62,000 within the first two months (Hapuarachchi, 2020), it is observed that an effective and robust method is required to prevent people from misusing the issued curfew passes as well as to avoid the use of forged curfew passes. In this case, identifying these violations is a challenging task and ineffective use of police officers' precious time in these harsh times.

The solution is to store the data in a centralised database, which can be accessed by the officers in the field very quickly without having to use any special equipment or expertise.

We propose to build a low-cost yet reliable system to store the information of issued curfew passes in a centralised database and to print a QR code (DailyFT, 2020) along with the pass, which will allow the officers on the road to quickly scan with their smartphone and extract the information from the database and validate. This will allow some corollary advantages as well, which will be discussed later in the paper.

2. RELATED WORKS

This section will investigate the technology related to the QR code and introduce the curfew pass issuing system's technology.

[‡] Short Communication

* Corresponding Author: H.M.G.G.K Herath

Circlebook Company, Kandy, Sri Lanka

kanishka1995ssck@gmail.com

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2.1. QR Code

The QR code is a two-dimensional bar code matrix type that displays the black and white plaid pattern information. In China, Japan, Korea, the United Kingdom, and the United States, the QR code is mainly used, and the name is derived from the 'Quick Response' trademark of Denso Wave. By overcoming the capacity shortcomings of conventional bar codes, extended-form two-dimensional bar codes, and contents with length and width information, character data can be stored in addition to numbers. Typically, it is used by reading it with a dedicated digital camera or scanner (Denso Wave Inc., 2019).

Conventional bar codes can store one-dimensional numbers or text information. In contrast, QR codes can store even more information by providing two-dimensional horizontal and vertical directions in which character details such as alphabets and Chinese characters can be stored in addition to numbers. For the size of the QR code, the program's version is determined by the volume of text, the type of character, and the mark for error recovery, and the cell is fixed by the resolution of the printer or scanner. The version consists of 1-40 and has a predetermined number of cells for each version. A quadrangle point that forms the QR code is a cell. There are 21 cells horizontally and 21 cells vertically in the cell starting with version 1, and 4 cells are expanded with each version increase, and in version 40, 177 cells per 177 cells are set to be contained. Figure 1 shows the structure of the QR-code.

QR-code is divided into different zones, including quiet region, locating pattern, timing pattern, orientation pattern, format information, version information, data, error correction keys, etc., in order to scan data. All info, including numbers, English characters, Chinese characters, Korean characters, symbols, binary and control code, etc., can be processed by QR-code. Up to 7,089 characters (numbers) with one code will convey the quantity of information.

Recently, the improved QR-code iQR-code was developed. More data volumes than the current QR code can be saved by iQR-code. Besides, the iQR-code will produce smaller codes than the current QR-code. It can save up to 80 per cent higher information quantities if it has the same size as QR-code. If it has the same information quantity, it can generate 30 per cent smaller information size quantities (Yu et al., 2013).

The error correction level for the QR-code is up to 30 per cent of the whole code, which means that the code can be restored with this percentage of the smeared or corrupted area. This is boosted to 50 per cent with the iQR-code, on the other side.

2.2. Existing curfew pass issuing and identification system

It is found that most of the curfew pass violations are possible because of the way the officers must interact and validate the information. Most of the violations are happened by carrying unauthorised personnel other than the allowed people in the curfew



Figure 1. Structure of the QR Code

pass. To validate, a police officer must manually go through each person's identification documents and compare them with the issued curfew pass, which requires interacting closely with the people. This method is prone to result in errors while sparing valuable time. Another most common way is the use of forged curfew passes (DailyFT, 2020), which are very difficult to identify since the existing version of curfew pass is printed on regular paper, which can be easily faked using a household printer. To verify a pass, a police officer must contact the police station and confirm there manually.

An integrated curfew pass management system (Park & Moon, 2007) that automatically handles the issuing and authentication processes using such technologies has been widely researched and developed due to auto-recognition technology such as RFID sticker, card biometric technology such as fingerprint recognition, facial recognition, etc.

The automated curfew pass management framework (Josphineleela & Ramakrishnan, 2012) based on RFID is a system that automatically aggregates the specifics of the given curfew pass when the smart card attached to the RFID tag is recognised by the reader mounted at the security checkpoint and provides efficient confirmation of a curfew pass compared to the previous manual process. The scheme, though, is costly to install and requires challenges such as the opportunity to loan the smart card, fraud, and the downside of not recognising the pass when the smart card is missing or not in possession.

An automatic fingerprint-based curfew pass tracking device is a system that aggregates the specifics of the given curfew pass by identifying the fingerprint of individuals using a fingerprint reader is a trustworthy technique that can recognise the User without the issue of being misplaced, loaned, or stolen. However, it has the drawbacks of being costly to construct like the RFID-based system and a significant disadvantage of being unhygienic.

A client-server framework was built along with facial recognition methods to boost the

authentication of the individual cardholder in a previous electronic validation system (Lee, 2010) based on the smart card, which automatically handles the validation of the corresponding pass by recognising the facial information of the User with the support of a neural network. It has demonstrated more than 92 per cent reliability due to evaluating the CS context system to validate the developed system.

Due to unmanned service, such an automated device reduces the time to verify the curfew pass. It has the benefit of checking the authenticity of the pass by itself over the Internet. However, there is an expensive issue with the implementation expense of installing the device to structure the integrated system since it needs different devices such as RFID readers, fingerprint readers, clickers, etc. Besides, complications such as not being remembered when the smart card is missing or not in possession, loaning of cards or using counterfeit cards, and a complicated validity check situation due to the devices' malfunction, such as reader error faulty cards, may be present. See Table 1.

An electronic curfew pass validation scheme that strengthens and supplements existing systems' drawbacks is suggested in this article.

3. DESIGN OF SMART CURFEW PASS SYSTEM

The smart curfew system's main challenge is to reduce the system installation effort, implementing tamper prevention techniques, and avoiding machinery breakdown.

The features suggested in this paper are recognising the curfew pass by using the QR code where the pass is automatically processed by recognising the police station's QR code. This does not require extra reader transactions for the authentication scan to be completed and has no installation fee. Since the pass is accepted using the police officer's smartphone, the curfew pass's probability of breach is very little.

Table 1. Comparison results between RFID, Barcode and QR

Characteristic	RFID	Barcode	QR
Reads per Second	200	2	8
Read Range	25 feet	2 inches	>14 inches
Read/ Write	Yes	No	No
Anti-collision capabilities (simultaneously read capabilities)	Yes	No	Yes
Cost	> 40 LKR	0.5 LKR	< 0.1 LKR
Reusability	More	Less	Less
Human Intervention	Less	More	Less
Line of sight required	No	Yes	Yes
Read Speed	200 milliseconds	< 1 second	< 500 milliseconds
Dirt Influence	No effect	Very High	Less
Security	More	Less	More

Figure 2 shows the flowchart of the proposed smart curfew pass system in this paper.

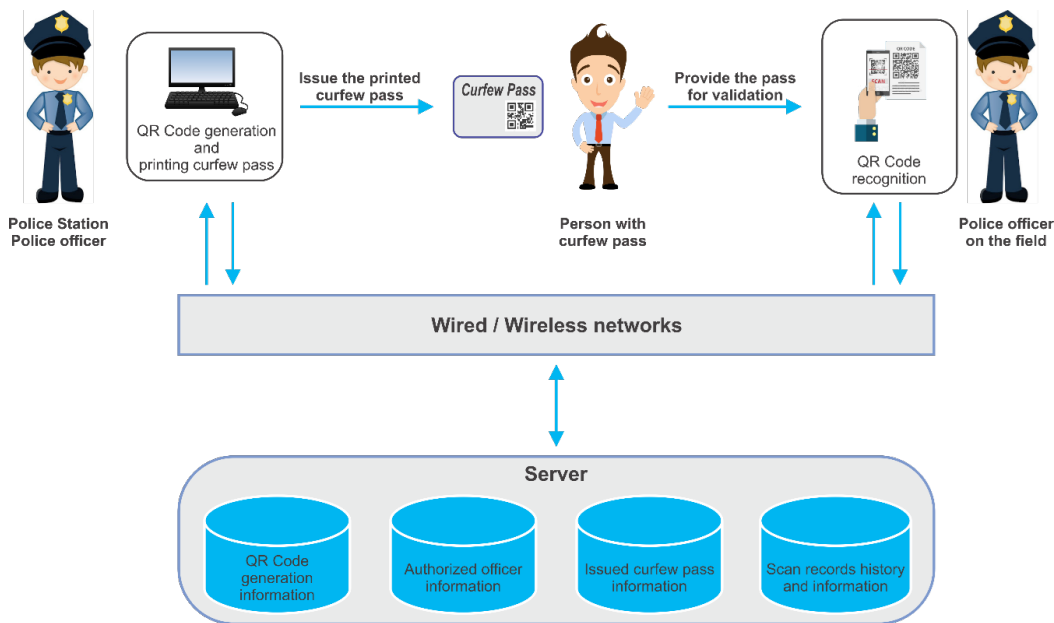


Figure 2. Flow of the Smart Curfew System

3.1. Design of QR Code Generator and Reader

The QR code generator and readers are widely used and developed. However, the QR code generator and readers previously created do not encrypt the QR code contents, so it is at risk of leakage.

In the proposed centralised server, the QR code generator produces the QR code. It stores information about personal identity information for validation control within the QR code created at that time (ID number, Face photo, validity period, etc.). It produces a unique QR code any time a pass is given to avoid QR code misuse. The information inserted into the QR code will also be used for encryption by the seed encrypted algorithm. The contents of the QR code could not be identified unless a dedicated reader is used. The QR code is generated on the server by the issuing police station, and the police officer may choose the media to display the generated QR code, such as on a printed curfew pass.

By obtaining the information embedded in the QR code after the QR code is accepted, the QR code reader sends the obtained information and the officer's identity to the server. After processing the transmitted data and after updating the data, the server renews the database to fulfil the User's condition.

3.1.1. Design of Database for Attendance Management System

The database structure for configuring the system consists of *Police_user*, *User*, *Curfew_Pass*, and *Vehicle*. First, *Police_user* is a table to check whether the User is valid or whether the person accessing is a station officer or a field officer. When the software is executed to use the suggested method, it cannot log every time the authentication is first accessed.

Curfew_Pass is a table containing the pass information, the given station, the number of the Vehicle, and in the case of the *User*, it is a table containing the information of individuals requesting the smart pass, identity information

and the purpose of the curfew pass, and the *Vehicle* is a table containing vehicle information and used as the primary data in the *Curfew_Pass* table to list the vehicle data.

The server generates the QR code based on the *Curfew_Pass* table, and the QR code generates a link to accessing the data of this table.

Figure 3 shows the database structure of the proposed smart curfew pass system in this paper.

4. DEVELOPMENT OF SMART CURFEW SYSTEM USING QR CODE

The framework introduced in this paper is enforced with a server-related program, the application program of station officers, and the field officers' application program. For the server-related program, the Linux-based apache server was used, MySQL for the database and PHP was used to build the web interface.

On request from the station officer, the QR code is created on the server, and for protection, seed algorithm is used for encryption and inserted into the QR code. The android-based field officers' software was separately built using the eclipse for the application program.

It can be tested for generation and status. In the field officers' mode, QR code recognition and validity stats can be checked.

4.1. Application Program for Police Officer on the field

The configuration of the main menu screen of the field officer's application is shown in Figure 4, displaying the curfew pass information.

4.1.1. Application Program for Generating Curfew Pass

The configuration of the main menu screen of the field officer's application is shown in Figure 5, Figure 6, Figure 7, which consists of user authentication, generation of QR

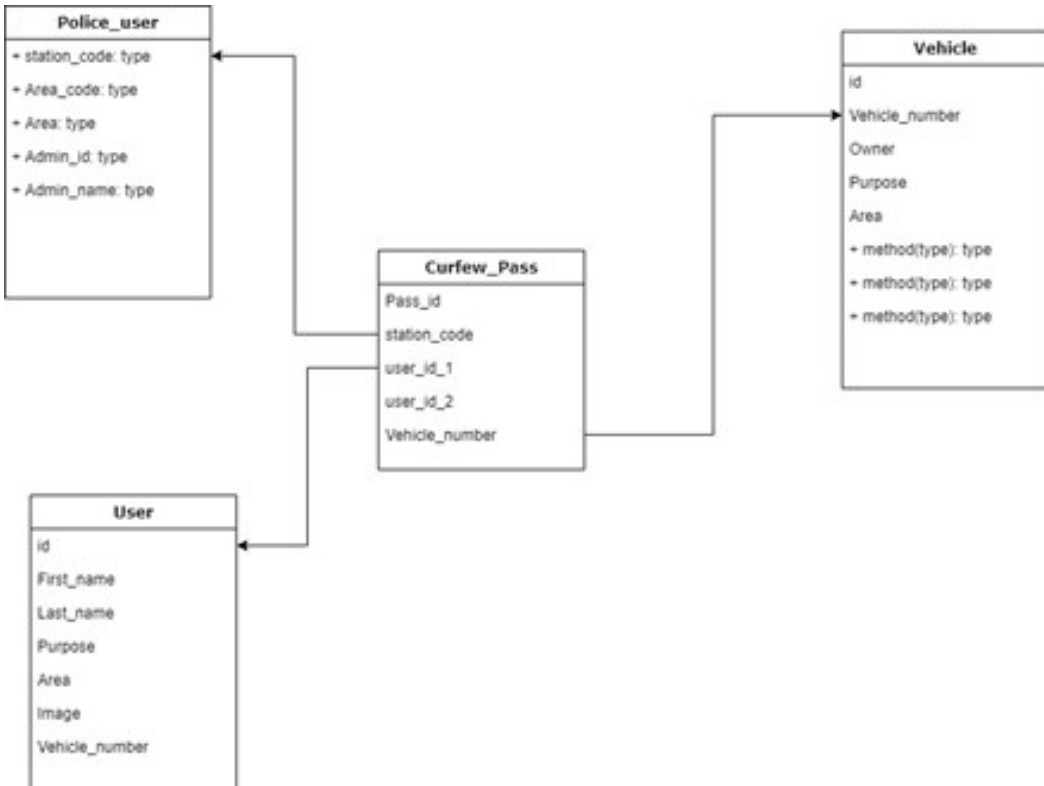


Figure 3. Database Structure

code, displaying curfew pass information and termination of the program.

5. CONCLUSION

There are problems with the previous curfew pass issuing and identification system, such as fake pass generation, pass misuse by loaning the pass to their mates, system recognition rate, and failure to recognise fakes due to weak verification methods.

In this paper, a smart curfew pass method using the QR code was suggested to improve such issues. For the validity check, the proposed system does not require a separate purchase of the QR code generator. Besides, to recognise the created QR code, it does not require a separate purchase of the QR code reader. Since the application developed in the proposed system can be accessed by police officers on the ground using their smartphones to be used as a reader, there are no costs incurred for buying the equipment to be used for generating or reading, so it is economical as

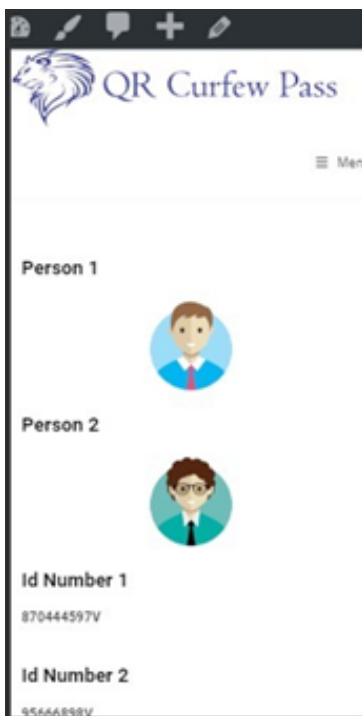


Figure 4. Mobile Application

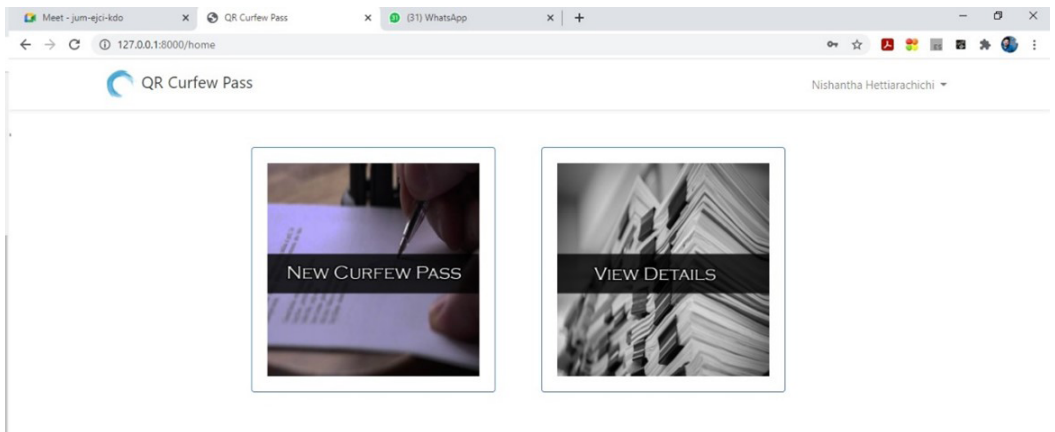


Figure 5. Main screen of desktop application

Figure 6. Data collection screens

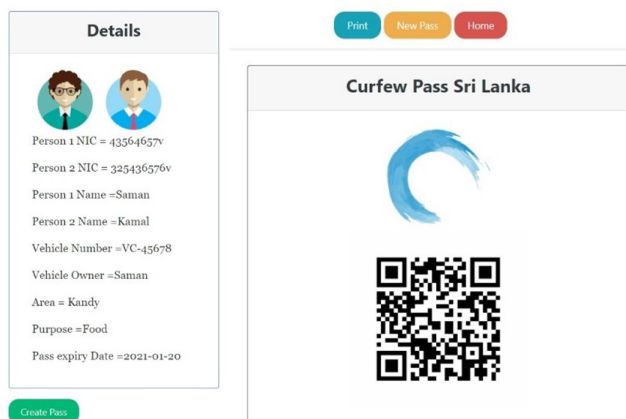


Figure 7. Generated Curfew pass

it does not raise the construction costs when installing the system. To solve the issue of “fake pass generation,” the QR code is encrypted in the proposed framework, and the server is implemented with different security features.

Even if parts of the code are contaminated or impaired, the QR code has a higher recognition rate than the bar code where it can still be recognised, decreasing the case of not being able to recognise due to code damage.

The future study aims to strengthen the framework proposed to be extended to any situation connected to several access control and management systems.

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