

Implementation of Cost-Effective RFID based Smart Parking Management System with Enabled GSM Feature



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ABSTRACT

The existing parking management systems require man power to supervise the operations and it also requires manual recording of data in excel sheets and on paper. For huge parking, scenario is very hectic to keep track of and the human error also comes into the picture. Because of all these issues, automation of the parking management system is required. Nowadays, the modern world requires smart cities and the smart cities require automation techniques in its various aspects. The use of Radio Frequency Identification known as RFID technology reduces human efforts as well as errors. That's why the RFID based smart parking management system has been proposed to solve the issues related to parking management. The proposed system in this paper consists of different technologies as well as some new enhancements which are namely, the use of GSM module, hour based money deduction, providing driver the choice of his preferred parking slot at the entry and sending the SMS of driver's chosen parking location to driver's registered mobile number which would be helpful if at the time of leaving, the driver forgets where the car was parked. This makes the existing systems more treacherant, user-friendly and at the same time, the proposed system also manages to be pretty thrifty. The approach in this paper realizes intelligent yet cost-effective management of parking lot and the paper also tries to realize the Smart cities mission of the Government of the republic of India.

Key words: RFID, Smart parking management system, OCR, LPR, GSM, Ethernet Shield, Arduino, Cloud Server, MIAFARE

1. INTRODUCTION

RFID is one of the most fundamental technologies that enables wireless data transmission. Although it has been known for a very long time, has not been very often used in industry. The reason is it was expensive and nonstandardization among the manufacturing companies. It took a long time for it to be widely utilized. This technology is older than bar codes. For the first time, RFID was used in World War II for airplane identification [1]. In 1994, RFID technology was used by all rail cars in United States for identification. RFID tags are better than bar codes as they have longer life. The situation is changing in the present time. RFID systems are being used at very large scale throughout the world. 8.9 billion tags were sold in 2015 and 10.4 billion in 2016 and it is forecasted that RFID market will rise to \$13.2 billion by the year 2020 [2].

2. PROPOSED SYSTEM

In the proposed smart car parking management system, initial stage is to detect the arrival of the car. Various systems can be used to perform this task such as 2.45 GHz Broadband Monopole RFID Reader [3], Battery Assisted Passive (BAP) system [4] etc. After detecting the car presence, a RFID card/tag reading system is required. The same systems which are mentioned above can be used for that purpose. Many advancements have been proposed in RFID reading process which can be used in the system like separable RFID Antenna for Variable Range [5] and RFID Sensor with Frequency Modulation [6]. At the entry, driver would be asked to choose the preferred parking slot on the screen installed there. An overview layout of parking lot will also be provided on screen which would help the driver to choose the parking slot as well as to navigate to that slot after choosing. There would be a GSM module connected too. Which would send an SMS of driver's chosen parking slot to the mobile number which is registered in the system. That SMS would be helpful if at the time of leaving, the driver forgets where the car was parked. In that case, the driver can check the SMS and find the car out which is very useful in the case of big multilevel type of parking lot where drivers often forget their parking location. Then comes the stage of maintaining a database. It can be done with the help of an online server using cloud link [7] for this purpose, Ethernet shield can be used. Online database maintaining would be fast as compare to other methods which is advantageous for the system. If the user is not registered in the database, LPR (License Plate Recognition)/OCR (Optical Character Recognition) system is needed to recognize car number plate [8,9]. At the time of exit, driver's balance would be deducted according to hours for which the car was parked inside. If the driver is an unregistered user, he/she would be required to pay money to go out. To control all these activates, a microcontroller like Arduino or Atmel 8051 family is required. A boom barrier which can be opened and closed based on the signal from microcontroller will also be used in the system.

So overall, the proposed system in this paper consists of different technologies as well as some new enhancements which are namely, the use of GSM module, hour based money

deduction, providing driver the choice of his preferred parking slot at the entry.

3. STRUCTURE AND DESIGN OF THE SYSTEM

Cost-analysis of the proposed system was done and the flowchart of the working of proposed system was also made.

A. Components used in the proposed system are,

1) *Microcontroller like Arduino UNO R3*: It is needed to control all the processes which are required to be done in the system. It costs around INR 450. Atmel 8051 family microcontroller can also be used. From several models of Arduino, the use of Arduino UNO R3 is preferable because it is the most cost effective according to the required application.

2) *GSM module*: It is needed to send SMS to driver’s registered mobile number. There are various such modules available. But considering the needs of the system, ELEMENTZ SIM900A GSM module has been used. The cost and reliability factors are taken into consideration for choosing it which costs around INR 900.

3) *RFID card reading system and RFID cards/tags*: RFID card reading system can be 2.45 GHz Broadband Monopole RFID Reader [3] or it can be a comparatively cheaper option MIFARE [10,11,12] MFRC522 13.56MHz system which costs around INR 250. Some ideas are also proposed to use UHF e-tag reader system [13,14].

4) *Ethernet shield like W5100*: It is needed to maintain the database on cloud link. W5100 is chosen for the proposed system because its operation is sufficient for the requirements. It costs around INR 550.

5) *LPR (License plate recognition) / OCR (Optical character recognition) system*: This system is required when the user is not registered in the system but still the user needs to be given access in the parking. This type of system can be designed according to the sequence of steps as shown in figure 1.

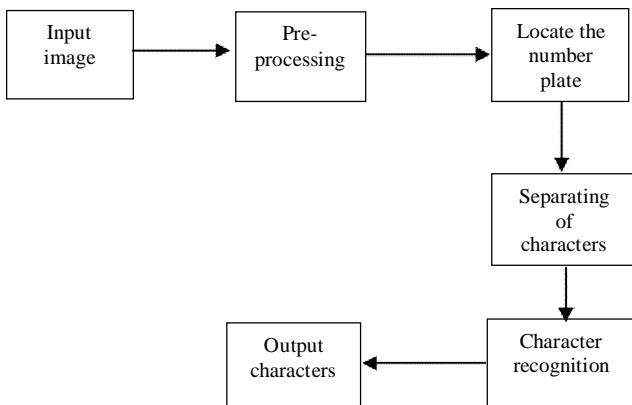


Figure 1: LPR/OCR layout

B. The flowchart of final proposed system in the paper is as shown in figure 2 and figure 3,

1) At the Entry:

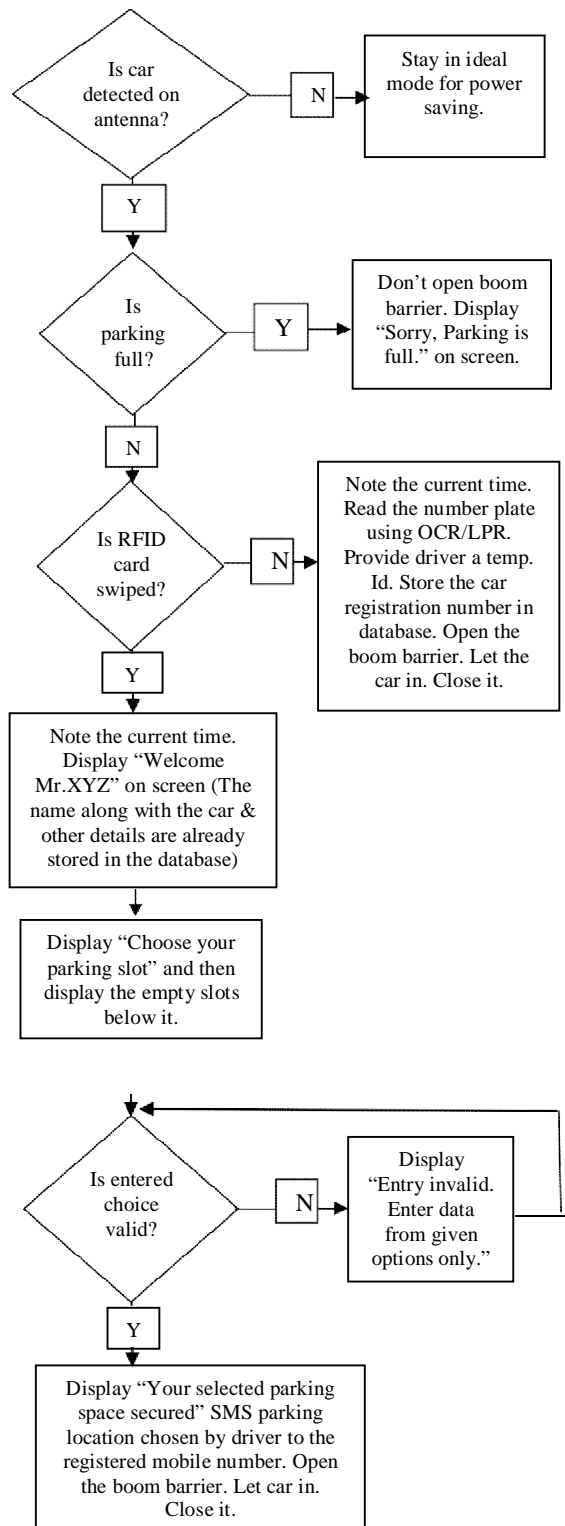


Figure 2: Flowchart to be followed at the entry

2) *At the exit:*

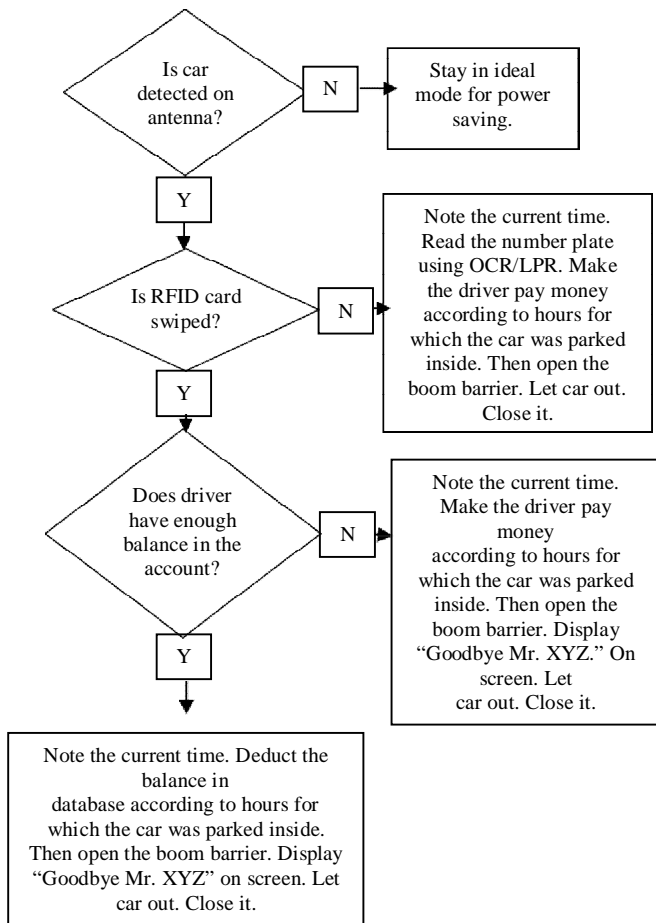


Figure 3: Flowchart to be followed at the exit

Hence the overall proposed system can be made in only INR 2150 excluding the price of boom barrier, CCTV camera and a screen because they are considered as prerequisites for installing this system as shows in figure 4. The price of RFID tags/cards is also excluded because it is very low since they will be provided to every driver who registers in the system (figure 5). (For MIAFARE reading system, it can be as low as INR 30-40.) So our proposed system is pretty much cost-effective.

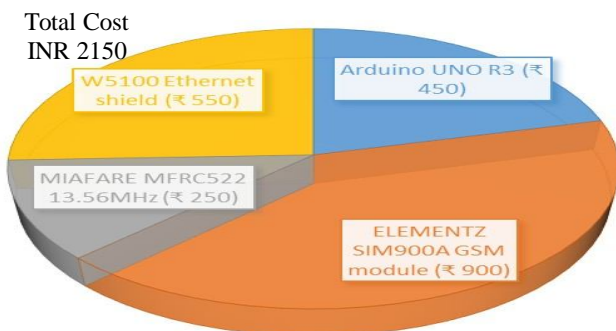


Figure 4: Cost analysis of various components used

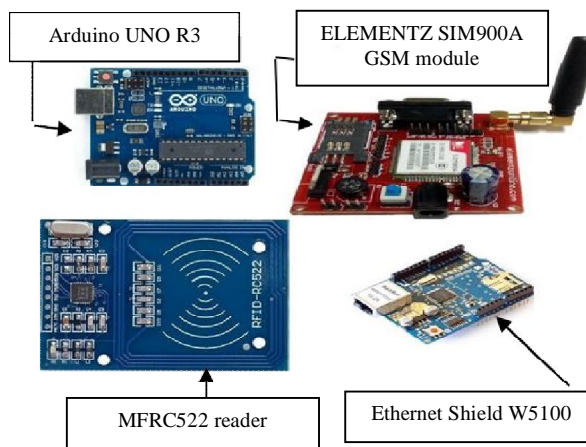


Figure 5: Components used

4. PROTOTYPE

To practically test it, a prototype system was made using Arduino UNO R3 and MFRC522. A servo motor was used to simulate the working of boom barrier. The code was written which can successfully,

- Keep track of total cars parked inside.
- Won't allow other cars when the parking capacity is full.
- Stores driver's name along with the other details & display his/her name on the screen while entering and leaving.
- Keep track of driver's balance. It will be deducted according to hours for which the car was parked when the driver tries to go out.
- Provides driver a choice when he/she comes at door that where the driver wants to park. Driver would be given choices of parking slots which are empty right now and he/she can choose preferred parking slot. (If driver enters different choice than the provided options mistakenly or mischievously, system will display that it is a wrong choice & driver would have to enter the choice again).

As shown in figure 6 and figure 7, the images of the system which was made followed by the images of results which were obtained on the serial window of Arduino IDE.

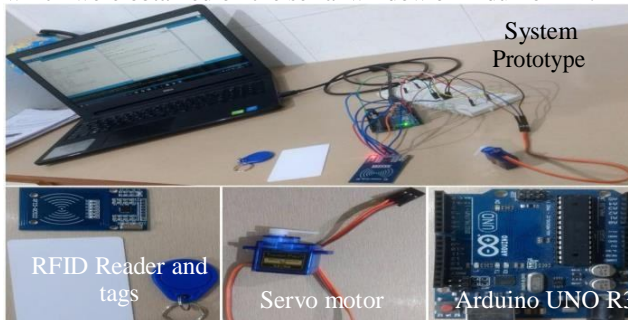


Figure 6: System connections and components used in it

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UID tag : E5 77 AA D5
Authorized access

Welcome Mr. Yuvraj Zala !

Number of parkings left in your account after this one
6

Choose where you want to park from these options
1
2
3

2nd parking space secured for you. Please park at your chosen place only

The hour noted at the time of entry
0

UID tag : E5 77 AA D5
Authorized access

Visit again Mr. Yuvraj Zala !

The hour noted at the time of exit
0

UID tag : 35 4E D4 65
The parking is full !
    
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Figure 7: Display on the serial window of Arduino IDE

5. CONCLUSION

The paper focuses mainly on the changes, innovations and integration in RFID based parking management systems and on designing of a prototype of the proposed system so that we can combine and use effectively several technologies like the ones mentioned below

- *RFID*
- *OCR/LPR*
- *GSM*
- *Maintaining database using cloud server*

The proposed system suggests innovations like hour based money deduction, giving driver the choice of preferred parking slot at the entry and sending the SMS of driver’s parking location to the registered mobile number. This system can further be modified to book the parking slot through an app based system. The cost analysis of the system which is proposed in this paper suggests that it is very cost-effective to be used even in small parking lots. Thus, the proposed system is able to take benefit of those 4 in-demand technologies and still it manages to be affordable to be used even by low-budget consumers.

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