

Innovative Smart Car Parking System with NFC Access

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Abstract— Innovative Smart Car Parking System (ISCAPS) integrated with e-Valet technology is proposed in this project. The e-Valet function works just like how a valet parking would design to function. It ensures parking slot availability for the customers. Before that, the smart phone has to be installed with the android apps to fully enjoy the functions of ISCAPS. By using this mobile app, customer can reserve parking lot in advance, to enable him/her to park at a later time. Instead of using the normal conventional “Season Passes” or tickets, ISCAPS makes the use of Near Field Communication (NFC) function of smart phone as a parking ticket. NFC module is widely used in today’s smart phones and thus can be used to eliminate the need for parking token or cards. On the other hand, the automation and space management is managed by the ARM microcontroller by controlling the mechanical motors in transporting the cars to appropriate place. With the mobile apps, communication will occur when the smart phone is placed near the NFC reader. Therefore, customer only has to tap the smart phone on the designated reader to enter the car park and tap again on the way out to complete payment. Arm microcontroller is used as the brain of the system and control the input output of the system. Further, vehicle searching program is embedded in the system, which helps customers to indicate their vehicle when forgotten. With the proposed ISCAPS, the use of RFID (Radio Frequency Identification) cards and paper tickets will be reduced resulting low cost, more convenience and eco-friendly.

Index Terms—ARM CORTEX M3, LCD Display, NFC Breakout board PN532.

I. INTRODUCTION:

• AIM:

The project aims at developing an automated parking system for cars. This proposed system improves the recently used parking system by enhancing its security features and simplifying the parking process by eliminating the need for manual intervention. The parking system uses Near Field Communication (NFC) technology for authentication and owner car identification. NFC is a technology with the set of standards for smart phones and similar devices to establish radio communication with each other by touching them together or bringing them into close proximity, usually no more than a few inches. NFC Module is widely present in today’s smart phones and thus can be used to eliminate the need for parking tokens or cards. On the other hand, the automation process and space management is managed by the ARM microcontroller by controlling the mechanical motors in transporting the car at an appropriate parking space.

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• OBJECTIVES:

1. Automation
2. Authentication using NFC
3. Easy to use
4. Security
5. Efficient parking space management
6. Uncongested parking
7. Easy in parking maneuverings
8. Independence on human
- 9.

• NFC:

What is NFC?

Near field communication (NFC) is a set of standards for smart phones and similar devices to establish radio communication with each other by touching them together or bringing them into close proximity, usually not more than a few inches. Newly and anticipated applications include contactless transactions, simplified setup of more complex communications such as Wi-Fi, and data exchange. Communication is also possible between an NFC device and an unpowered NFC chip, called a "tag". NFC came out of RFID. RFID (radio-frequency identification) is the technology used by shipping companies and in superstores to keep track of goods. It uses concept of electromagnetic induction in order to transmit information or communication. NFC is similar technology to RFID, but standardized for consumer smart phone. NFC standards are defined by a association called the NFC Forum, which includes companies such as Philips, Nokia and Sony. In case, if your phone has NFC as a feature it can be used to transfer data to other phones or to NFC readers that either touch or are momentarily held close together.



Fig a: NFC technology logo

How does NFC work?

NFC is a means of sending data over radio waves. In that case, it is similar to Wi-Fi or Bluetooth, but unlike those protocols (and like RFID) NFC can be used to induce electric currents within passive components as well as just send data. In general, it is faster than Bluetooth. Indeed the two are closely linked. For example, Samsung Beam uses NFC to pair devices,

and then with help of Bluetooth technology transfer data takes place .NFC can work with passive devices that don't require their own power supply, such as in case of travel card readers. NFC's data-transmission operating frequency is 13.56MHz. NFC can transmit data rates either at 106, 212 or 424 Kbps (kilobits per second). NFC standard works in three modes of operation: the peer-to-peer mode that lets two Smartphone swap data, a read/write mode in which one active device picks up info from a passive one, and card emulation, in which an NFC device such as a Smartphone can be used like a contactless credit card.

• AUTOMATED CAR PARKING SYSTEM:

An Automated Car Parking System is a mechanical system designed to minimize the area and/or volume required for parking cars. It is similar to a multi-story parking garage that provides parking of cars on multiple levels stacked vertically to maximize the number of parking spaces while minimizing land usage. However, this Automated System utilizes a mechanical system to transport cars to and from parking spaces (rather than the driver) in order to eliminate much of the space wasted in a multi-story parking system. It resembles more to an automated storage and retrieval system for cars.

II. SYSTEM ARCHITECTURE:

The parking system is fully automated and can be called as a robotic valet parking system. The driver takes the car into an entry (transfer) area. The driver along with the passengers exits the car. The driver taps his NFC tag or NFC enabled smart phone at an automated terminal nearby. The NFC Reader terminal reads UID (unique identity number) code of the NFC tag or NFC enabled smart phone then sends the commands to microcontroller and microcontroller assigns an empty parking slot.

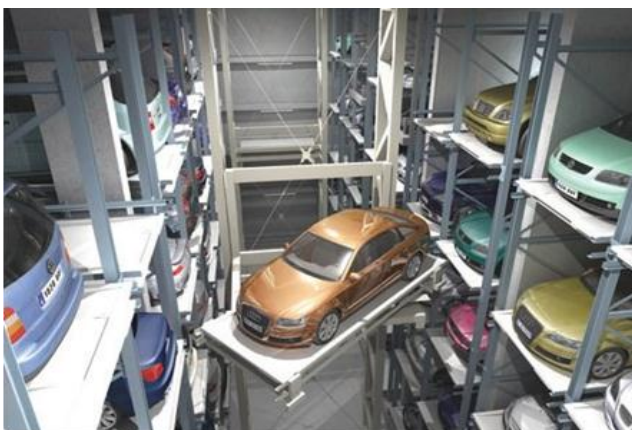


Fig b: Parking system architecture

When driver have left the entry area, the automated mechanical system lifts the car and transports it to a pre-determined parking space in the system. For linear motion, the rack and pinion mechanism is used to transport the car to the parking slot. The structure of the parking garage is circular therefore the linear motion along X-Y direction and rotational motion in X plane is used to park the car. The driver retrieves a car by again tapping his smart phone into an automated NFC reader terminal. According to the parking

period, the driver makes the payment and the system calculates the payment to be collected accordingly. The Parking System then lifts the car from its parking space and delivers it to an exit area using the same rack and pinion mechanism. The retrieved car is been oriented according to the exit route to eliminate the need for the driver to back out. Thus the proposed fully automated Parking System theoretically eliminates the need for parking attendants by using NFC as means of Authentication and owner car identification.

III. WORKING PRINCIPLE:

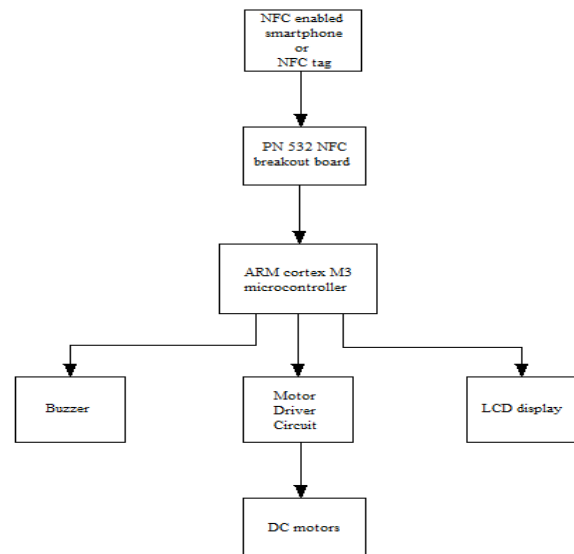


Fig c: Block diagram

While parking the driver places his car at the specified location at the entrance of the parking lot. He then brings his NFC tag near (5cm approx.) the NFC reader module controller. The NFC reader module is based on PN 532 breakout board which consists of PN 532 reader/writer IC. Every tag has its own 7 byte unique identity number (UID) which is used for authentication.

The NFC breakout board gives this 7 byte identity number to ARM Cortex M3 microcontroller using Serial Peripheral Interface (SPI) mode. ARM microcontroller compares this UID with other UID stored in the memory. If there is no match of UID the microcontroller understand that there is a new car which needs to be parked else it understands that the car which has already been parked and needs to retrieved. After storing the UID in the memory, microcontroller calculates the nearest empty slot. Accordingly it gives commands to the motor driver circuit and the LCD interfaced with cortex M3 will display “Parking at the slot”. The motors are driven by motor driver circuit according to the commands received and the car is parked at the nearest empty location assigned by cortex M3. After the car is parked at particular slot, the LCD will display “Parking Successful”. While retrieving the driver will bring his NFC tag near the NFC reader module and the microcontroller again initiates the comparison process of UID. During this process if UID match is found then the microcontroller understands that the car

needs to be retrieved. The cortex M3 again gives commands to the motor driver circuit repeats the process only this time to retrieve the car. After the car has been successfully retrieved, the LCD will display "Thank You".

The whole ARM cortex M3 programming is executed in high level language using software Kiel uvision IDE.

IV. ADVANTAGES:

- i. As every NFC tag has a unique ID, the system cannot be deceived by a forged ID.
- ii. Parking space width and depth (and distances between parking spaces) are drastically reduced since no allowance need be made for driving the car into the parking space or for the opening of car doors (for drivers and passengers).
- iii. No driving lanes or ramps are needed to drive the car to/from the entrance/exit to a parking space.
- iv. The parked cars and their contents are more secure since there is no public access to parked cars.
- v. Minor parking lot damage such as scrapes and dents are eliminated.
- vi. Driving around in search of a parking space is eliminated, thereby saving time and reducing fuel consumption and thus the engine emissions.

V. LIMITATIONS:

The user needs to carry NFC enabled smart phone otherwise a NFC tag need to provided to the user which becomes an additional liability to the parking system.

- i. The initial cost of setup is high.
- ii. Since there is a single entry and exit point there will be traffic congestion if several cars arrive simultaneously.

VI. FUTURE SCOPE:

While working on the evolution of the system and exploring the ways in which the system can be designed, we come to know few new features that could be added through little alterations in the system. Following are few things that can be done with modifications.

- i. NFC parking meter can be integrated in the system which can be used to make payments using NFC enabled smart phone. The payment is done through a credit or debit card associated with the mobile phone number.
- ii. Multiple entry and exit points can be constructed to reduce the traffic congestion thereby saving time.

VII. CONCLUSION:

Thus we have provided a comprehensive review of our Automated Car Parking System. It helps us to information about the shortcomings of current parking systems. Authentication makes the system hassle free for the user as he need not take care of additional parking tokens as his NFC enabled smart phone works like one. Even though the initial cost of setup is high, it is efficient and capable as it provides fully automated system with better space management than conventional systems.

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