International Journal of Contemporary Computer Research (IJCCR), Vol.1 Issue.1 (June, 2024)

# IOT-DRIVEN SMART PARKING SYSTEM FOR URBAN MOBILITY SOLUTIONS

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*Abstract*— **A car park is a space designated for parking cars. They are often spaces with permanent surfaces. Car parking is a feature of most cities in which cars are a means of transportation, especially shopping centers, sports stadiums, and other places, and is often characterized by large car parks. A multistory car park is a type of car park that is constructed from several floors and is usually used in public places frequented by people, such as commercial areas. And so that if the proposed idea in this research is implemented on the ground by linking the parking lots to each other with sensors linked to a router, through which the target group can be notified of the presence of a parking lot on a specific floor and the parking number, by scanning the parking barcode when entering the parking lot. By the target group, we mean citizens people of determination - and pregnant women drivers.**

***Keywords- Smart Parking, IoT, IPARK Intelligent, Tracker Mobile Based App, Agile Model Methodology Introduction***

## I. INTRODUCTION

The movement, alignment, and organization of cars is a true expression of the nature of society, and the one who realizes this fact is the person coming from outside the components of society, "the visitor" to the country, as the first impressions the visitor took is the traffic and the nature of the streets, and in light of that, he realizes the nature of the society coming to him. Statistical studies indicate that there are 1.2 billion cars in the world on the roads, with an annual increase of 6.45%, at a time when the demand for available spaces and their investment as commercial complexes increases, which leads to an increase in demand for parking spaces in various places, especially commercial areas. Due to the severe shortage in the provision of public squares and parking, parking on the sides of the streets has become random and unorganized for long periods, which negatively affects the owners of shops due to the lack of parking spaces for the customers of these stores for shopping purposes, which is usually a short period.

The first use of the system was in Paris [1,2]. The system at the time consisted of a multi-story concrete structure with an internal elevator to transport cars to higher levels, where there were people lining up the car. With the advent of the 1920s, a pinwheel similar to an automated parking system for cars appeared in place of people who were working to assist in parking, which became popular for its ability to park eight cars and for its simplicity Paternoster mechanically in its use in many places including in the interior buildings. With the installation of automated parking system parking with a capacity of more than 1,000 cars, the automated parking system saw a huge surge of interest within the United States in the late 1940s and 1950s, and in 1957 new systems of this type were installed, as some of these systems are still in operation. However, interest in this system has waned in the United States due to frequent mechanical problems and long waiting times for people to retrieve their cars, and interest in this system has resurfaced within the United States in the 1990s, so there are currently 25 projects (representing approximately 6,000 parking holders) In 2012, it is noted that while the benefit of this system in the United States decreased until the nineties of the twentieth century, countries in Europe, Asia, and Central America have used it, but more technically since the seventies of the twentieth century, when nearly 400,000 liquidators were established. Parking in Japan only in the early nineties, but currently, it is estimated that there are about 1.6 million car parks in 2012 AD.

In 2019, 8 students from Abu Dhabi University launched a smart electronic application called "Al-Adly Park" that collects and analyses parking data across the country and sends it to drivers instantly to help them find their parking space easily and conveniently. In 2016, civil facilities and facilities in Jeddah and Makkah witnessed the implementation and installation of the first smart car park in the form of a mechanical wheel in Saudi Arabia. It is considered a smart car park that accommodates 16 cars, on a floor area of about 30 square meters, which is the space that accommodates two cars [3,4].

In 2019, the eastern region smart parking project is among the distinguished projects that the Municipality is currently working on within the smart city business model, as it includes an investment of 20,000 smart parking spaces distributed between parking on main roads and multi-floor parking in Dammam metropolis, and the project will provide 300 jobs in various fields. In 2018, the project of Al-Anoud Charitable Society created smart parking spaces that would help these parking spaces utilize more than 20,000 parking spaces in the capital, Riyadh

a) A smart parking application using wireless sensor networks by Sangon Lee, Doki Yoon, and Amitabha Ghosh. by a Research Group in Autonomous Networks in the Department of Electrical Engineering at the University of Southern California, Los Angeles.

b) IoT-Based Intelligent Parking System Abhirop Khanna, (UPES) Sage Anand, has created a working paper on this project. At the University of Petroleum and Energy Studies Dehradun, Uttarakhand.

c) IPARK Intelligent Location Based Parking Guidance VANETs Without Infrastructure the working paper of this project was carried out by: Hui Zhao, Li Lu, Chao Song,YueWu [5,6].

## II. Parking Space Finder Application

The Parking Space Finder Application which is part of Iris-Net proposed a wide-area sensor network architecture, in which video cameras, microphones, and motion detectors are used to detect the occupancy or availability of parking spaces. Using web technologies, users can acquire the processed information that is published on the web and generated by feeding all these sensor data. However, as mentioned earlier, video cameras generate a large amount of data that incur high energy expenditure and communication bandwidth, both of which are limited in sensor networks [7, 8].

## III. IoT Based Smart Parking System

In recent times the concept of smart cities has gained great popularity. Thanks to the evolution of the Internet of things, the idea of a smart city now seems to be achievable. Consistent efforts are being made in the field of IoT in order to maximize the productivity and reliability of urban infrastructure. Problems such as, traffic congestion, limited car parking facilities, and road safety are being addressed by IoT. I present an IoT based cloud integrated smart parking system. The proposed Smart Parking system consists of an on-site deployment of an IoT module that is used to monitor and signalize the state of availability of each single parking space [9, 10].

The concept of Smart Cities has always been a dream for humanity. Over the past couple of years, large advancements have been made in making smart cities a reality. The growth of the Internet of Things and Cloud technologies have given rise to new possibilities in terms of smart cities. Smart parking facilities and traffic management systems have always been at the core of constructing smart cities. I address the issue of parking and present an IoT based Cloud integrated smart parking system. The system that we propose provides real time information regarding the availability of parking slots in a parking area. Users from remote locations could book a parking slot for them through the use of our mobile application. The efforts made in this paper are indented to improve the parking facilities of a city and thereby aim to enhance the quality of life of its people. [11, 12].

## IV. Incremental Model

The incremental Model is a process of software development where requirements are broken down into multiple standalone modules of the software development cycle. Incremental development is done in steps from analysis design, implementation, testing/verification, repeat as shown in Fig. 1.

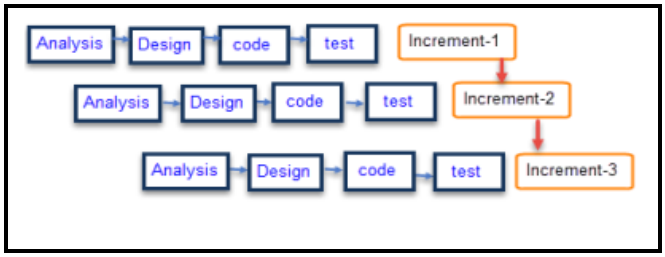


**Figure 1. Incremental Model**

The basic idea behind this method is to develop a system through repeated cycles that produce a series of releases that are referred to as “increments”, with each increment providing more functionality to the customers. After the first increment, a core product is delivered, which can already be used by the customer. Based on customer feedback, a plan is developed for the next increments, and modifications are made accordingly. This process continues, with increments being delivered until the complete product is delivered [13, 14].

This model combines the elements of the waterfall model with the iterative philosophy of prototyping. It is developed to overcome the weaknesses of the waterfall model. It starts with initial planning and ends with deployment with the cyclic interactions in between. Increment process models are effective in situations where requirements are defined precisely and there is no confusion about the functionality of the final product [15,16].

## V. System Analysis

System analysis is a management method that helps in designing a new system or improving an existing system. System analysis is the process of collecting and clarifying facts, identifying problems, and using the information to recommend improvements to the system.

Since the goal of the application is the ease of use and providing an interactive interface, a comprehensive analysis has been carried out to gain insight into the needs and behaviors of different users. The application is made convenient and easy to use for the end user. A car park is a space designated for parking cars. They are often spaces with permanent surfaces. Car parking is a feature of most cities in which cars are a means of transportation, especially shopping centers, sports stadiums, and other places, and is often characterized by large car parks. The multi-story car park is a type of car park that is constructed from several floors and is usually used in public places frequented by people, such as commercial areas [17, 18].

It is a system that links the parking spaces with each other through sensors linked to the wireless network through which the target group can be notified of the presence of a parking spot on a specific floor and with a specific number, by scanning the parking barcode upon entering the parking lot. The system consists of several main components:

The components of the proposed system:

a) Position sensors
b) Controller
c) A special router for the position.
d) A server through which the data of the situation is processed.

## VI. VSYSTEM DESIGN & RESULT

### A. Data Flow Diagrams

A Data Flow is a type of diagram that represents a workflow or process. A flowchart can also be defined as a schematic representation of an algorithm, which is an incremental approach to solving a task.

The Data Flow shows the steps as boxes of different types and arranges them by connecting the boxes with arrows. This graph shows a solution model for a specific problem. Flowcharts are used to analyze, design, document, or manage a process or program in various fields as described in Fig. 2.

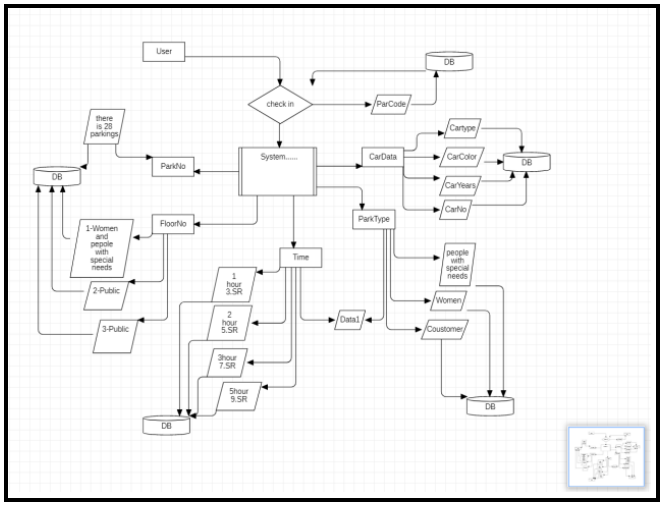


**Figure 2. Data Flow Chart**

### B. Use Case

In the Unified Modeling Language (UML), a use case diagram can summarize the details of your system's users (also known as actors) and their interactions with the system. [8] To build one, you'll use a set of specialized symbols and connectors. An effective use case diagram can help your team discuss and represent:

- Scenarios in which your system or application interacts with people, organizations, or external systems.
- Goals that your system or application helps those entities (known as actors) achieve.
- The scope of your system

While a use case itself might drill into a lot of detail about every possibility, a use-case diagram can help provide a higher-level view of the system. It has been said before that

"Use case diagrams are the blueprints for your system" They provide a simplified and graphical representation of what the system must actually need to do.

### C. Entity Relation Diagram

It is a graphical representation of an information system that shows the relationship between people, objects, places, concepts, or events within that system. The first step in designing a database is to develop an Entity-Relation Diagram (ERD). The ERD serves as a map or representation from which a relational database may be deduced as can be seen in Fig. 3.

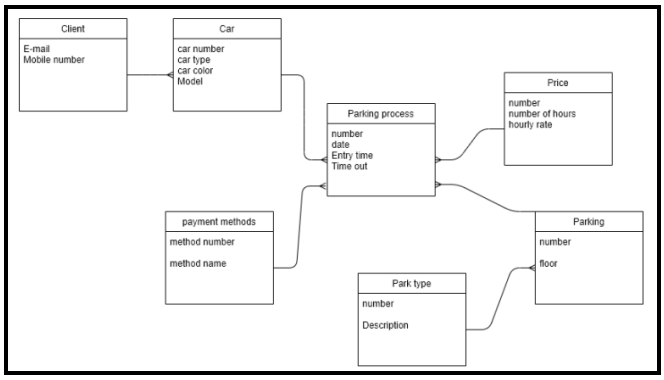


**Figure 3. Entity Relation Diagram**

### D. Forms (graphical user interface), Application Map

a. The welcome screen is the first screen in the system. It is an interface that will appear for a few seconds in the system. A parking image has been placed, because the system's idea is for smart parking, and a welcome message has been placed and the address of the system (Smart Parking System).

b. Barcode screen: It is the screen through which the user can enter the application by reading the barcode using the mobile camera A welcome message has been placed, as well as an explanation of how to use the application, and a barcode reading code has been placed. Clicking on it will open the mobile camera and read the barcode.

c. Car screen through this screen, as seen in Fig. 4, the user will enter his car data such as the license plate number, car type, color, and model, and there is also an expressive image that this screen is related to the car and finally there is a next button to move to the next screen, which is the parking type selection screen.

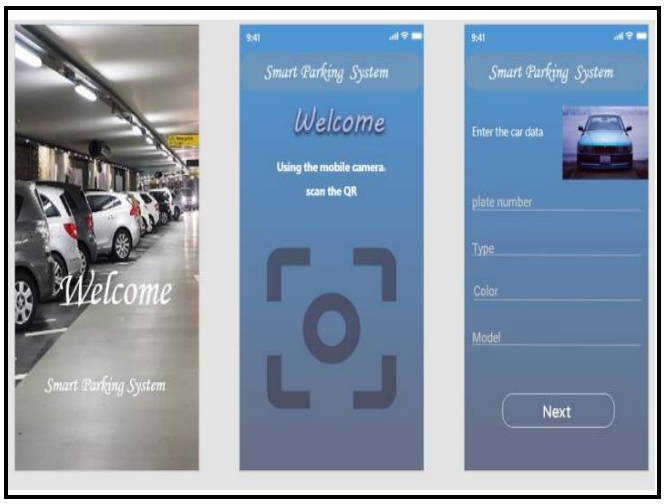


**Figure 4. Screen a, b, c**

d. Location Park, Choose the location of the park where you want to park the car which is highlighted in Fig. 5.


**Figure 5. Screen d**

e. Position type, The types of positions are designed in the form of buttons and will be programmed in the type of Radio button, where the user chooses one type of parking and there are also next and previous buttons. Next move to the parking time setting screen and the previous one to return to the car data screen.

f. Screen Standby Time. The times are designed in the form of buttons and will be programmed in the type of Radio button, where the user chooses one time, where the number of hours and the price of the hours is clarified, and there are also next and previous buttons. Next move to the floor setting screen and the previous one to return to the parking type screen.

g. Floor screen, The floors have been identified and designed in the form of buttons, and they will be programmed by the type of Radio button, where the user chooses his floor depending on the type of situation screen, where the first floor is selected for people of determination, pregnant women, the second and third floor for the year, and there are also next and previous buttons. Next move to the parking number setting screen, and the previous one to return to the parking time screen as can be seen in Fig. 6.

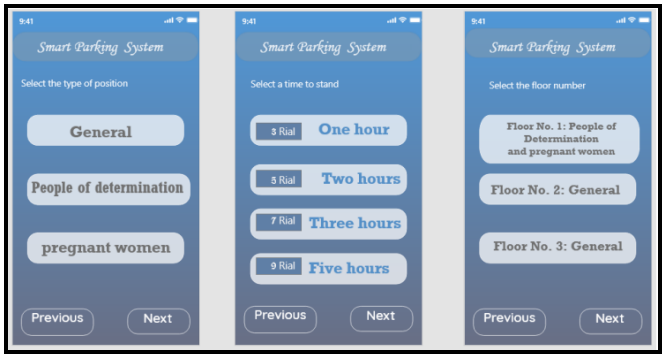


**Figure 6. Screen e, f, g**

h. parking screen, Here, two screens will be explained because they are the same system in design and programming, and they are two screens for choosing the empty parking number, where we will program the toggle button positions, which is similar to the on and off status, to clarify the status of the parking if empty or full, where the orange color indicates that the parking is full and the green color the position Empty parking spaces for people of determination and parking spaces for pregnant women for the first floor. The second floor is divided into long parking times and short parking times.

I. client screen, It is the screen in which the contact information of the customer is recorded, which is the mobile number and e-mail, and the data is recorded after the process of determining the position, parking time, and reservation. It also contains a Next and Previous Next button to complete and select the payment process and Previous to return to choosing the parking number which is shown in Fig. 7.


**Figure 7. Screen h and I**

Payment screen, It is the screen on which the payment process will be determined, and it is also designed in the form of buttons and will be programmed in the type of Radio button where the user chooses one payment method and the payment will be made upon exiting the parking lot after the end of the parking period.

k. Fig. 8 shows the end screen, it contains a thank you letter, confirmation of the reservation process, and a message notifying that the price will be doubled in the event of a delay in the date for a specific departure date. It contains an exit button to exit the site and a previous button to return to customer data.

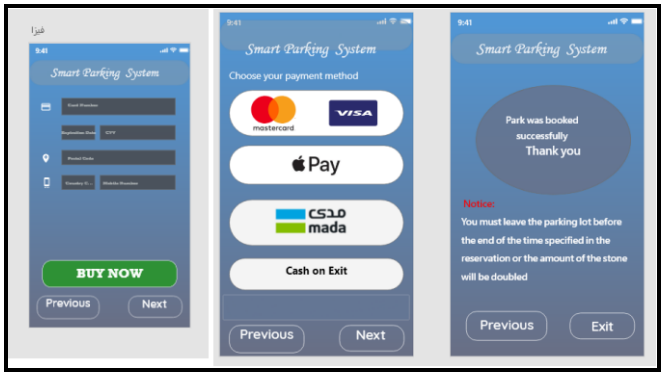


**Figure 8. Screen j and k**

## VII. SOFTWARE TESTING

### A. Purpose of Software Testing

To Improve Quality: Software testing helps in finalizing the software application or product against business and user requirements. It is very important to have good test coverage in order to produce high-quality software and make it sure that it's performing well and as per the specifications.

- For Verification & Validation: Once the system is ready to use for the end users, they should be able to operate it without any complaints. In order to make this happen the tester should know how the customers are going to use this product and accordingly they should write down the test scenarios and design the test cases. This will help a lot in fulfilling all the customer's requirements.

### B. Stage of tests

There are four main stages of testing that need to be completed before the software can be cleared for use unit tests, integration tests, system tests, and acceptance tests:

*I. Unit Testing*

During this first round of testing, the program is submitted to assessments that focus on specific units or components of the software to determine whether each one is fully functional. The main aim of this endeavor is to determine whether the application functions as designed. In this phase, a unit can refer to a function, individual program, or even a procedure.

*ii. Integration Testing*

Integration testing allows individuals the opportunity to combine all of the units within a program and test them as a group. This testing level is designed to find interface defects between the modules/functions. This is particularly beneficial because it determines how efficiently the units are running together. Keep in mind that no matter how efficiently each unit is running, if they aren't properly integrated, it will affect the functionality of the software program. In order to run these types of tests, individuals can make use of various testing methods, but the specific method that will be used to get the job done will depend greatly on the way in which the units are defined.

## VIII. SYSTEM TESTING

System testing is the first level in which the complete application is tested as a whole. The goal at this level is to evaluate whether the system has complied with all of the outlined requirements and to see that it meets Quality Standards. System testing is undertaken by independent testers who haven't played a role in developing the program. This testing is performed in an environment that closely mirrors production. System Testing is very important because it verifies that the application meets the technical, functional, and business requirements that were set by the customer.

## IX. ACCEPTANCE TESTING

The final level; is conducted to determine whether the system is ready for release. During the Software development life cycle, requirements changes can sometimes be misinterpreted in a fashion that does not meet the intended needs of the users. During this final phase, the user will test the system to find out whether the application meets their business' needs. Once this process has been completed and the software has passed, the program will then be delivered.

## X. CONCLUSION

A car park is a space designated for parking cars. They are often spaces with permanent surfaces. Car parking is a feature of most cities in which cars are a means of transportation, especially shopping centers, sports stadiums, and other places, and is often characterized by large car parks. A multi-story car park is a type of car park that is constructed from several floors and is usually used in public places frequented by people, such as commercial areas. I cover software configuration and implementation of any custom functions as per the design documentation. After business process refinement, the development of the first version begins. Then he mentioned the custom build configurations, in addition to that all the application interfaces have been developed and finally we move to the coding stage with the aim of translating the system design into code in a specific programming language to implement the design in the best possible way to produce a working software application. Application testing of different types and methods will be performed in the system.

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