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| 就讀學校 | Al-tarbia Al-namothajia Schools TNS |
| 指導教師 | HASIL MOHAMMED ALASMARI |
| 作者姓名 | Juri Sultan Albosaili |

Abstract

Our vision aims to raise the quality of life and we had planned smart cities from scratch but what about the current cities the residents of Riyadh suffer from extreme traffic and spend hours circling the block searching for a open park which wastes time money and is bad for the environment. 30-50% of traffic is causing by not being able to park and due to Riyadh lack of proper city planning and rapid increase in inhabitants especially after allowing women to drive and as the car being the main way of transportation finding a open park could be a nightmare for some. We have approached this problem from the technological perspective by developing a free application for Riyadhs inhabitants that's main goal is to navigate each driver from their current location to the best open park possible in the shortest time possible but what distinguishes us from similar apps in the literature is that we provide the time of departure for each park as well as the ability to book such parks even if it is ahead of time via a interactive live map. The technology's that we used are the cellar censor that will track the users location and the ultrasonic sensor to track the occupancy of the parking in case the driver doesn't have the app but in which case will not be able to provide booking features. We have struggled in the lack of expertise and experience and in motivating the drivers to input correct data about there time of departure we also didn't have enough time to validate our project For future work we will validate our project and we plan on making the detection of the time of departure automatic as well as covering all kinds of parks. We plan on expanding the scope of target users to include institutes as well because with time the app will have collected enough data to help institutions provide better parking such as rush hours parking scope percentage of booked parking etc we also plan on benefiting more from the cellular sensor to link data with the persons phone like certain access to private parks like disabled parking or home parking or private hotel offices parking etc

1. Introduction

The 11th goal of the SDGs states that we need to build sustainable cities and communities [1]. One of the Saudi vision goals is to build smart sustainable cities like the famous project NEOM [2].

One of the biggest problems we face in Riyadh daily is heavy traffic. Traffic in Riyadh is caused by many factors such as the rapid increase in population, especially after women gained the right to drive and cars being the main way of transport. Cars as the primary (and sometimes the only) mean of transport combined with densely populated areas causes a shortage in parking spaces in comparison to the number of vehicles. Studies showed that in a worldwide traffic dense environment, 30–50% of the vehicles on the road are looking for a parking space. Based on previous studies, drivers spend between 3.5 and 14 minutes every day looking for a parking space [3] and that trip of wandering around costs them 345\$ per year [4].

Finding a parking spot is a worldwide crisis that affects a large segment of the community and can have major environmental and economical impact. Furthermore, the frustration and stress of drivers, accidents, lost business opportunities, and increased air pollution are all examples of the consequences of not finding a parking spot.

This project aims to develop a mobile application that can assist residents of Riyadh city in locating and navigating to the nearest available parking spot. It also aims to provide city planners with the necessary data to build better and smart cities. Our application will help in decrease the amount of time drivers spend searching for a park, as well as simplify the parking process through a smart parking system.

2. Problem Description

Not finding a spot may lead drivers to park in inappropriate places which will lead to other problems such as more traffic and the inability to use the full capacity of the road due to the cars parked on the sides. An American study showed that a common driver spends about 17 minutes searching for a parking spot, and that time costs each driver 345\$ per year.[4] In addition, wandering around looking for parking spots has an impact on the ecosystem as the fuel that is consumed has a tremendous impact on the environment.

Here in Saudi Arabia, the problem is even worse since the number of drivers has increased more than double in a very short time after allowing women to drive, leaving no room for city planners to accommodate this change. This calls for an effective solution to solve the parking crisis in Riyadh as soon as possible. Another factor is the lack of any public transportation and the climate that we have does not encourage people to walk or use bikes. Even with the absence of the aforementioned factors, our roads are not designed and equipped for walking or cycling.

3. Goal and Objectives

Our goal is to develop a free and easy smart platform for the residents of Riyadh that assists them in locating and navigating to the best available spot in the shortest amount of time, and reduce air pollution caused by carbon emission of cars looking around for parking spot.

Our objectives are as follows:

- Decrease the amount of time an individual spends searching for a car park.

- Simplify the parking process for individuals through a smart parking system.

- To create a pleasant and motivating environment to encourage drivers to be more collaborative by scheduling their time of departure so that other drivers can book it.

4. Background

There are different types of technologies used in smart parking systems such as cameras and sensors. A camera in a simple definition is a device that can collect all the visible light of the spectrum and focus it on one point to create a sharp image using the physical properties of glass and chemical properties of lanthanum. We can program machines to gather data from these images such as recognizing phases or in our case cameras could be used to detect the occupancy of the park or specific data for some features like the car's plate like the Saher's camera. An advantage of cameras is that it can read plate numbers using real-time data. However, quality of images can be affected by the

weather. The ultrasonic sensor is another technology used in smart parking systems. It works by emitting a sound that is at a frequency above the range of human hearing and measures the time it took the ultrasonic wave to come back. Ultrasonic sensors are cheap, efficient, and precise. It is also the most commonly used sensor in smart parking systems. Nonetheless, ultrasonic sensors are hard to apply in big spaces. The cellular sensor is based on the wireless network. Cellular sensors are in every person's phone. However, these types of sensors are not effective alone for a car parking system as not everyone are using our application on their phones. Finally, satellite images are also used in smart parking systems as they are easy to apply, but no real-time data about the park's vacancy can be provided.

5. Domain Analysis and literature review

There have been many efforts to solve the parking crises. A survey was made to examine smart parking systems in IOT-enabled cites [8]. The goal of that paper was to give an overview on the technologies and sensors that are used in the literature and emphasize the reliability and privacy concerns of those systems. It gives readers an insight of the current state of smart parking systems by viewing the used technologies and the implication difficulties and comparing to other surveys. The authors classify the smart parking systems while considering soft and hard design factors. They also outline open research issues in the current state of smart parking systems and recommend a conceptual hybridparking model.

Another research study provides a comparison between state-of-the-art sensors that are used in smart parking systems in terms of performance [9]. The goal was to give the reader an extension of state of the art technologies used in smart parking systems and analyze off-the-shelf sensor devices in terms of their detection accuracy and power consumption by giving an in-depth review of technologies used for smart parking detection realization focusing on performances of most popular sensors used nowadays as well as power requirements analysis for supporting the sensing infrastructure. Results show that from the power consumption perspective photodiode is the best sensor but it lacks detection accuracy so the best score in terms of accuracy and consumption is the 3 axis followed by the ultrasonic and to cope with high energy consumption is to use a drop in signal strength which indicates of parking space occupancy. Results also show that based on the architectures of IoT systems, lowest consumption is for LoRa devices. Further, an analysis of power consumption of commercial LPWA-based Smart parking sensor device is provided along with battery estimation lifetime, which is especially important for the deployment of future smart parking solutions and this paper helps us estimate which sensor is best to use.

We searched for and reviewed related apps that offer similar features to our proposed solution or aims to tackle a similar goal of ours (i.e. smart parking systems). We found five similar apps in Apple app store. Below in table 1, we compare the different features of those applications in relation to our proposed application. As you can see, the main feature that distinguishes our system is that we not only view the free parking spot but we also provide when the park will be available and the ability to book it. Our app is also able to locate the best open park possible depending on the user's location and destination and navigate them from their current location to their desired park.

| criteria / Apps | smart parking | swap a park | park me | park cardiff | smart park miami | my App |
|---|---------------|-------------|---------|--------------|------------------|--------|
| Search for a open parking place in the range of the destination | yes | yes2 | yes3 | yes4 | yes5 | yes6 |
| provide real-time data for the parking,s occupation | yes | yes | yes | yes | yes | yes |
| navigate the driver to a open park | no | no | yes | no | no | yes |
| auto search for a replacement park | no | no | no | no | no | yes |
| free parking reservation feature | no | yes | no | no | no | yes |
| this park will be open in - minutes feature | no | yes | no | no | no | yes |

| | | | | | | |
|---|-----|-----|-----|-----|-----|-----|
| provides a map of all the open and or yet to be open Parkes | yes | yes | yes | yes | yes | yes |
| is made for our free parking environment | no | no | no | no | no | yes |
| provides info about the open parks nearby regardless of which institute the park is under | yes | no | no | no | no | yes |
| works on any parking theme Indore outdoor | yes | no | yes | no | no | yes |
| locates the best park for each user on the map | no | no | no | no | no | yes |

6. Methodology

Design since research [6] involves the design of an artefact which is created to solve a problem. When a researcher uses DSR there are 2 main things that are done: the design of the artefact and the investigation of the artefact in context. The DSR framework is mainly 2 cycles: the engineering cycle and the design cycle, which involves 3 activities: problem investigation, treatment design, treatment validation. The engineering cycle is a bigger cycle that involves the designing cycle except that it continues further to treatment implementation and treatment evaluation to the real-world context.

7. Proposed Solution and Core Application Features

The proposed solution takes the form of a smart platform for the residence of Riyadh which offers to locate the best parking spot for each user depending on their location and destination and previous choices. The user takes such as the average distance from the destination the user parks from and other factors as well as the other available parks. The app allows users to book a park of which's drivers time of departure contributes to their estimated arrival time and navigate the drivers to their desired park in the shortest time possible through paths that are specifically designed to decrease the collision between cars to decrease the traffic at the entrance and exits. Via a free mobile app that residents can download

The technologies that are used in the smart platform IOT (cellular – ultrasonic). GPS and navigation systems. A machine learning algorithms that can learn from the user's choices in parks to give better recommendations and which places have a higher demand for parking by majoring how much time the parks are full in the day and year and the percentage of the taken parks that are booked and the number of searches for the place and the size of the range of which people who seek that place park during peak hours to give the place a scale that both people and those in charge can benefit from to build a bigger park or to better schedule there time to go early or just go with a taxi. The algorithm will also work on finding a replacement park that is nearby the one the user desires encase that one got taken. The cellular sensor for now will collect the user's location and for future work will be used to send a code to that person, in particular, or to link that person's phone with data like their car pallet or the health state (disability) to allow certain access to private parking like your house property or an airports parking for people who will leave there cars or your personal park at a hotel or an office... etc
 why I chose the cellular it is because it is the only sensor that can track the person's location which is proportional to making the features possible.

Core features:

- locate the nearest available park and prioritize them like the Parkes that people will go to appear red
- navigate the person to their desired park
- book parking spots depending on the time of departure like searching for someone that will leave there park when u will arrive
- search for a park by the destination name
- list your park for others to book Additional features

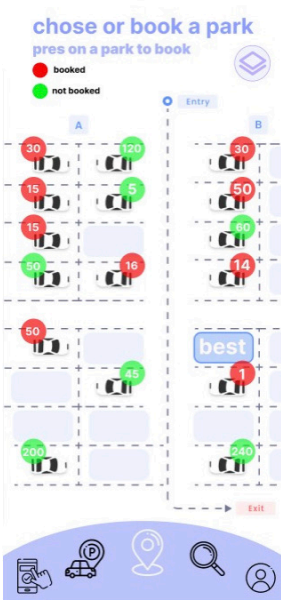
- provide authorities with the necessary data to plan smarter cities such as what is the farthest place someone who searched for a certain place parked

8. User Interface Mockups

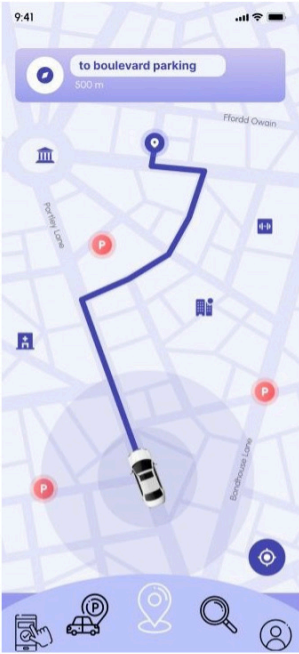
User interface



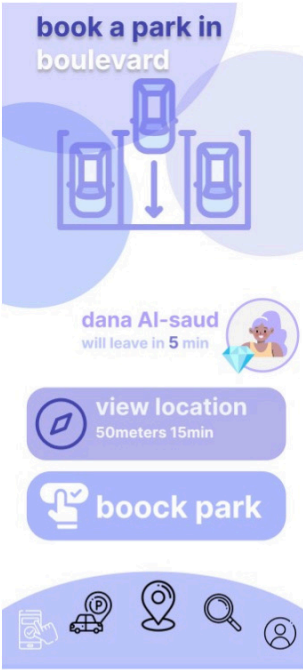
This is the first thing the user sees it is an interactive map of the user's current location there are buttons on each place that offers parking when clicked on will view the parking of that place



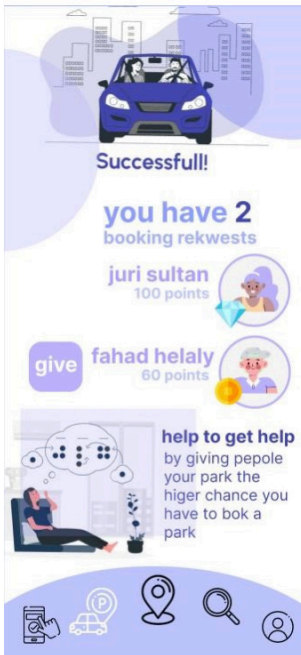
Here is the parking the best park for the user is highlighted it is defined by knowing the user's location and destination the occupied parks are represented by a small figure car with the time of departure on top green means the park isn't booked red means it is and users can book either one and the other selects who to give it to users can also filter the shown parks by clicking on the layer button they can choose to view empty parks only or not booked parks only or that will be open in --- minutes



The app also can navigate the user to their desired park from their current destination



When users book a park it will appear in the booking section and users can see the person's profile and the park's location



When people want to book the user's park it will appear in the my park section and users can see how many people can book their park and prioritize by the user's levels which will determine the number of points they will get which will also rise their score and so when they book a park the renter will more likely choose them

9. Challenges and limitations

Challenges: During our research we faced several challenges one is our lack of experience in sensors and we didn't have enough time to validate our project placing a sensor on each park is a complicated proses I also struggle in motivating people to download the app people might input wrong time of departure or not at all

People might not list their time of departure

People might leave before or after their scheduled time of departure

We need permission to attach sensors

Privacy concerns about location tracking

Very small experience in coding and UI UX

Limitations

- we will be focusing on the striped parks we will not be covering the parks that are on the streets
- we will only be covering a small part of Riyadh
- we have no experts in programming
- we didn't have enough time to properly analyse the field

10. Conclusion

In Riyadh, a lot of people struggle to find an available parking spot. This project aims to solve this issue by developing a smart platform for the residence of Riyadh that offers to locate the best park for each user. This app will also help institutes plan better cities because with time the app will have gathered enough data to give a scale for each place like the times of peak hours during the day and the year by majoring the percentage of occupied parks also the percentage of the bookings in occupied parks.


For future work, we plan on benefiting more from the phone sensor by linking certain data with the person's profile like their car pallet or if they have disabilities or certain access to private parks like their house or their hotel room or their booked airport park, etc. We also plan on covering all kinds of parking spaces both that are specifically identified and the ones on the street. We plan on validating our app and going through the DSR cycle several times before we are ready to publish our app.

References

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Appendix

Proto-personas

| | |
|--|---|
| <p>Juri collage College student</p>  | <p>Factors Student Part-time job Drives herself Poor income Likes to go out with friends Has no problem walking short distance Goes out during climax Goes to multiple places a day Cant wait or search for parking to long</p> |
|--|---|


Needs

- to be on time for class
- go out during breaks from her job
- go to the supermarket and pharmacy
- go from place to please quickly
- park near her job so she can go out on breaks • visiting a lot since she lives alone obstacles
- gets late because she didn't find a parking spot
- her car is far away so she can't go to places on breaks
- hast to search for a long time
- hast to park in inappropriate places a student can't afford the cost of gas

| | |
|--|--|
| <p>Talat 43 Personal driver for a family of 10</p>  | <p>Factors</p> <ul style="list-style-type: none"> Drives for a living Drives a lot of people to different destinations Hast to get them all on time Waits for them at the parking place Knows the place really well but needs to find an empty spot Can wait for an empty spot Is forced to go out in traffic |
|--|--|

Needs

- To manage all of his tasks on time
- To park nearby
- To deal with traffic
- To redoes his consumption of petrol
- Tasks
- Can't find an open spot
- Waists a lot of time and money
- The places are far away from each other he can't walk to far • Can't get everyone to their destination

| | |
|---|---|
| <p>Hamed 40 Parent and husband & a teacher</p>  | <p>factors</p> <ul style="list-style-type: none"> Drives his kids to school Drives his family to places malls and junk Goes out to get essentials Gets everything the hose needs Goes to work can't be late His children cant walk to much he must park near by |
|---|---|

Needs

- To get his kids from and to school
- To park nearby because groceries are heavy
 - He gets coffee before work
 - To find an open spot shortly
 - Tasks
 - Can't find a spot

- Walks with have things to get to the parking
- Is naturally late can't afford to look for a spot

【評語】 190038

The author proposes a car-parking service, of which the goal is to help the driver find a parking space and to navigate the driver to the suggested parking space. However, the system has not been implemented and thus no performance measurement results are presented in the project.