HFX Parking: A Novel Approach to the Parking Problem

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UX Research Paper

ABSTRACT

Parking has always been a challenging problem in North American regions as they are not tracked by a single entity. According to research, a motorist spends an average time of four days a year finding a parking spot. [1] To solve this problem, we have tried towards developing a prototype of a mobile application to mitigate the issues faced by Haligonians (people living in the HRM region). After researching the existing applications in the market, we have come up with three key features of a mobile application to help people with their parking needs. Further, we have conducted studies on those features where users will perform each task and we observed them. We then interviewed users to see what problems they are facing while using the application, and what new features they are looking forward to. This helped us design the initial design of our application followed by a low-fidelity prototype. The prototype was then rigorously assessed by doing a cognitive walkthrough study with a user persona (Abby). The results of this walkthrough will act as major feedback to our application design and will offer us recommendations to solve the issues in the low-fidelity prototype which will later furnish into a high-fidelity prototype that will be ready for user testing.

Author Keywords

Parking Application; User Experience; Building Prototype

INTRODUCTION

Americans spend an average annual cost of $345 per driver in wasted time, fuel, and emissions while searching for a parking spot. [2] Considering this crucial issue, we decided on including a pre-booking feature in the application where the user can book a parking spot before arriving at the location.

Here, the first step involves searching and viewing the parking spot at the desired location. Once the user decides the parking spot based on its proximity to the destination and its per-hour cost, the user can proceed to book the spot for a timeslot or navigate to that spot.

According to research, American drivers overestimate parking time to avoid tickets, averaging to 96 hours a year, or an extra $896 in parking payments. [2] We introduced an option for the users to extend the timeslot, so they do not necessarily need to move their car to another spot or go out to throw some more coins into the parking meter.

The application supports a range of payment modes – credit/debit card, PayPal, Apple Pay, Google Pay, and gift cards. A wide range of payment options was included after interviewing people about the problems and issues they face in the existing parking applications.

The application's low fidelity prototype was evaluated using a cognitive walkthrough approach, and certain minor and severe issues were pointed out. Issues were fixed in the high-fidelity prototypes that were created independently by four individuals.

BACKGROUND

A fair amount of work exists in the area of detecting whether a parking spot is occupied at a point in time. There are some approaches related to built-in sensors deployed in parking garages. [3] Another line of work makes use of ultrasonic sensors already available in passenger vehicles to determine the state of occupancy of parking spots adjacent to the vehicle. [4] Some researchers have discussed the technique of image processing to detect the occupancy of parking spaces based on image data collected from various sources. [5]

Recent research works have proposed systems that consider the privacy of drivers. When a driver parks a car, an anonymous e-coin payment for the expected parking duration is made which is linked to a random identifier that is linked to the onboard RFID device. The parking officer can query the onboard device to check whether the payment has been made. [6]

One assumption that we have made in this research and prototyping process is that a method to detect the occupancy of a parking spot has already been established in the city. Based on that, the user can view free parking spaces in the application, and book the parking spot in advance.

THE PROBLEM AND APPROACH

There are a couple of problems associated with the parking situation in North American countries:

1. Precise data about parking availability by time and place is limited.
2. Parking behaviour varies from one city to another in a country.
3. Parking availability is highly variable from one time and place to another.

Figure 1. Contextual Inquiry Layout

All these problems make it difficult for the centralization of parking into a single application. Moreover, people face immense issues while searching for a parking spot, and they waste a huge amount of time doing so. After finding the parking spot, the car cannot be parked at the same place for too long, or else the driver gets a parking ticket. This leads to another problem – people are not able to extend their parking session remotely.

To solve these issues, we first interviewed a few individuals about their current parking experiences, their approaches to finding a parking spot, their experience with any of the existing parking applications, and what would they like a parking application to do. After gathering all the observations, we organized those using an affinity diagram (Figure 2. Affinity Diagram) and did a pilot study to narrow down the features we had to include in our parking application.

A low fidelity prototype was first developed based on the observations, and it was evaluated using the cognitive walkthrough approach. Some minor issues were found in the prototype, and the four researchers worked individually upon fixing the issues found in the cognitive walkthrough to develop high fidelity prototypes.

LEARNING ABOUT PARKING IN HRM

Being international students, with no former insight regarding the parking situation in HRM, our first approach was to gather as much information as possible from reliable sources. Therefore, to gather insights and learn about the parking scenario in HRM, we took sources such as actual people who drive in HRM, our general observations, and reliable online sources into account.

Our foremost approach was to perform a contextual inquiry with people who drive in HRM and would be able to give us insights about their experience as well as frustrations.

To perform a contextual inquiry, it was required for us to find out applications relevant to parking that the users may or may not have already used and get feedback from that. Need not mention, the contextual inquiry is a process where users are observed in their natural context and are asked questions to fill in the gap in one's observation [7]. Each observation is noted and used further in the creation of the software.

However, being unable to find a single parking application that contained all our desired features, we built a small-scale prototype of our own (Figure 1. Contextual Inquiry Layout) for the contextual inquiry.

CONTEXTUAL INQUIRY PROCESS

As mentioned earlier, we build a small-scale prototype of our own to perform a contextual inquiry. This prototype contained screen captures from mobile applications named HotSpotMobile [8] and BestParking [9], both of which provide an active service in HRM.

A. Defining Tasks to be Performed

Based on our previous studies, we defined the following tasks to be performed during the contextual inquiry:

1. Booking a monitored parking spot
2. Viewing parking spots
3. Extending an ongoing session
4. Payment

Task 1, booking a monitored parking spot, allows users to book a parking spot in advance to their arrival. This would help save users from the hassle of being unable to find a parking spot during rush hours or while in a hurry. Such parking spots are monitored; therefore, it would be ensured that the spot remains available for a user for the period they might have booked it.

Task 2, view parking spots, allows users to view parking sessions in a particular area around the city. This includes both monitored and unmonitored parking spots.

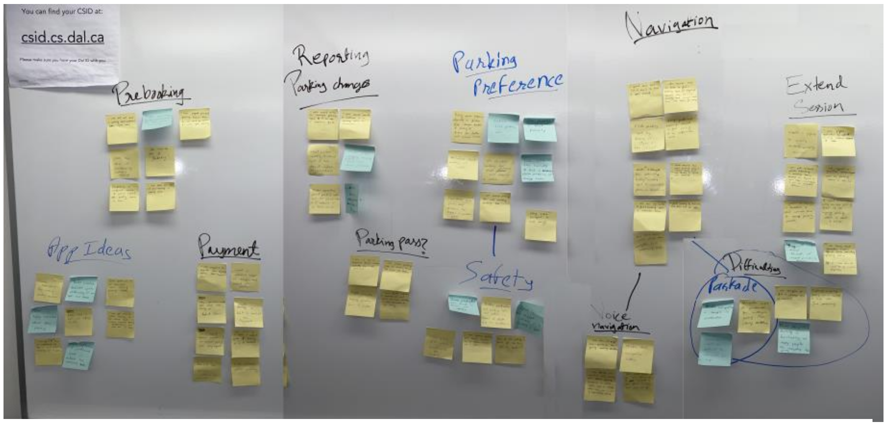

Figure 2. Affinity Diagram

Extending an ongoing session, task 3, allows users to extend the time for their ongoing parking session. Meaning, it would let the users extend the ending time for an ongoing session.

Lastly, task 4 is paying for a chosen parking spot. Being an important task in the given context, we defined it specifically along with our other tasks. However, it is incorporated in the tasks such as viewing (task 2) or booking (task 1) a parking spot.

B. Location, Equipment, and Study Instruments

The entire study took place in the Goldberg Computer Science building. Like our users, we performed the contextual query on our peers. Along with the contextual query, we asked the users questions regarding smartphone apps for parking and their experience regarding parking in HRM. We defined various themes for interview questions largely based on the tasks we defined for the contextual query. Each observation was noted in the coding and task observation sheets.

Due to the simplicity of the process, the equipment used in the process was a paper-based prototype for the contextual query, sheets to take notes, and pen/pencil. On the completion of the process, we used a computer to make a final copy of the results.

C. Process

Each process took about 15-20 minutes with the majority of the time being utilized in the contextual query and interview.

Here, each researcher was assigned a role based on their strengths. Researcher 1 explained the study to the participants and asked interview questions while researchers 2, 3, and 4 noted down the observations and answers.

Need not mention, each participant’s anonymity was maintained. Their name, gender, and all other personal information were not noted down. Instead, they were referred to as P1, P2, and so on. Also, they were given the liberty to skip any question they did not feel comfortable answering.

1. The participant was welcomed to the interview room.
2. Researchers explained the study to the participant assured to maintain their anonymity.
3. Participant provided their consent to participate in the study.
4. The participant proceeded with the contextual query first where researcher 1 explained them relevant scenarios created based on the defined tasks.
5. Researcher 1 requested the user to think out loud while performing tasks to help researchers note the observations better. Meanwhile, researchers 2, 3, and 4 noted down the observations.
6. On the completion of the contextual query, the participant was asked for their feedback and further was requested to answer a few interview questions based on their parking and driving experience in HRM. Here, researchers 2, 3, and 4 noted down the answers and occasionally stepped in to ask further relevant questions.
7. On the completion of the interview, the researchers thanked them for their time and participation.

RESULTS AND DISCUSSION

To conclude our observations and interview answers, we decided to create an affinity diagram (Figure 2. Affinity Diagram) based on the results. To conclude our observations

To generate an affinity diagram, we noted down each observation concisely on a stick note. Further, using these sticky notes and continually updating a cloud-like structure on the whiteboard, our affinity diagram was created, which allowed us to get favourable insights.

After breaking the observations into different themes, we came up with basically twelve different themes, namely, Pre-booking, Reporting parking changes, Parking preferences, Navigation, Extend session, App ideas, Payment, Parking pass, Safety, Voice navigation, Parkades, and difficulties.

Based on these themes and user insights, we decided to focus on features such as pre-booking monitored parking spots, extending a parking session, viewing various kinds of parking spots, and payment using a wallet. Further, we disposed of certain features such as reporting parking changes, parking pass, voice navigation, and parkades. While certain themes such as difficulties, safety, and navigation allowed us to understand user behaviour and persuasions. Themes such as safety gave us an insight that users were cautious about their safety while parking during nighttime or in an unknown neighbourhood. We also got to know that incorporating privacy into our system was essential.

PROTOTYPE DESIGN

To design a low-fidelity prototype, our team performed a contextual inquiry as discussed in the previous section. This led us with some very useful data about the state of mind of the current users. It helped us study the current scenario and deduce the satisfaction of the users in the features that currently exist. While doing so, we did market research and gathered information that helped us make some important design decisions. As the results of the contextual inquiry suggest, people like the idea of having features such as pre-book a parking spot, extend a parking session, navigation, adding safety measures in the app, and accepting payments through digital transaction platforms such as PayPal. The users like the idea of being able to pre-book a parking spot so that they do not need to roam around to find a free parking space. The users also have a keen interest in extending a parking session because they do not need to physically go anywhere to extend the time of parking. They also felt the need to have a navigation functionality so that they can know where a parking space is when they are in an unfamiliar place and have no idea about the routes in their surroundings. According to the users, they would like it if the payment method is extended to digital wallets such as PayPal and the users can pay using debit/card cards as well. Also, they are concerned about safety measures because cars are not cheap. They need to have a medium of communication that will help them when their car's safety is at risk in situations like theft. After going through the feedback, we decided to implement the pre-booking feature, navigation, introduce PayPal, Google Pay, and Apple Pay payment methods along with the ability to pay by debit/credit cards, and to provide the users with enough details about the parking space which they will book using our app before they proceed to checkout.

Prototype

A low-fidelity prototype has been created to test users and improvise our application. The prototype has been sketched by the team members and includes 3 key features that are selected from a pool of possible user features. The features that have been included in the prototype are:

1. Book a paid parking spot
2. Extend a parking session
3. Pay for a parking session

These features have been incorporated in the prototype because they align with the features that the users from the study liked. The low-fidelity prototype created using these features can be used as a means to perform a cognitive walkthrough. To do so, users will be given three tasks to perform in this prototype. The first task (book a paid parking spot) deals with finding a paid parking spot using our low-fidelity prototype and booking it for a set time frame. The task involves user activity in the home screen of the application where they choose to find a parking space, a search screen where the user can search for a location where the parking space has to be booked, a time selection screen where the user can specify the start and end time of the parking session, a map view (as shown in Figure **3**) that shows the available parking spaces in the location and time frame specified by the user, and a booking confirmation screen that acknowledges the users about the booking made by them.

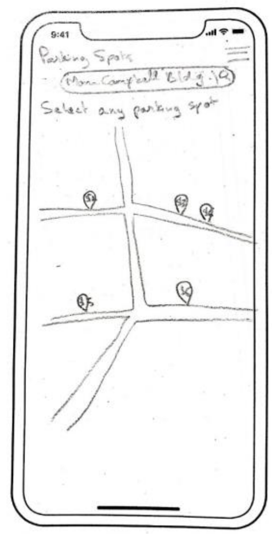

Figure 3**. Book a paid parking spot (map view)**

The second task deals with browsing an active parking session and extending it for a few more hours. It involves user activity in the home screen of the application where they choose to view their parking sessions, a sessions screen where they can see their active/past parking session and extend an active session, a session extension screen (as shown in Figure **4**) where they can specify the hours to extend, and a confirmation screen asking the user to confirm the extension.

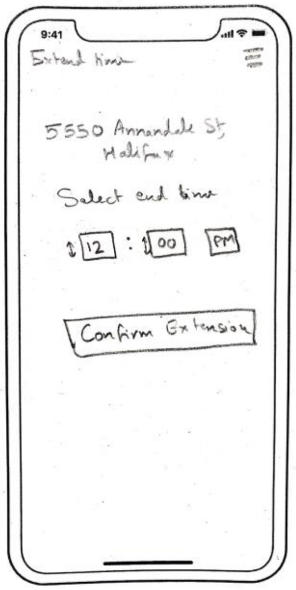

Figure 4**. Extend a parking session (session extension screen)**

The third task deals with browsing an active session and paying for it by the means of a saved debit card. It involves user activity in the home screen of the application where they choose to view their parking sessions, a sessions screen where they can see their active/past sessions and pay for an active session, a payment screen where the users can select a payment method (as shown in Figure **5**), a card selection screen where they can select a saved debit card from the list, and an acknowledgement screen to show to payment confirmation to the users.

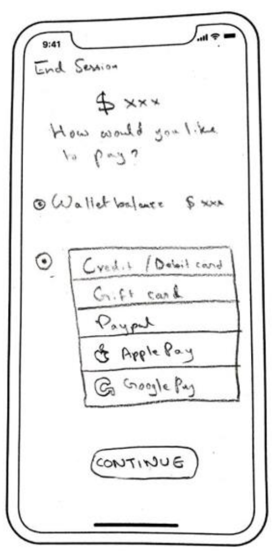

Figure 5**. Pay for a parking session (payment method selection screen)**

COGNITIVE WALKTHROUGH

The purpose of performing a cognitive walkthrough is to examine whether a user with or without technical knowledge can use our application or not. To do so, Abby (a persona with little to no background in computers and mobile devices) was given three tasks to perform using the low-fidelity prototype. Our evaluators evaluated the prototype in the participants' (Abby) perspective. The evaluations are performed for every step that a participant performs. To evaluate whether Abby can perform a task or not, the usability outcomes and the severity level of the issues are mapped by asking three questions:

- Will the correct action be sufficiently evident to the user (Abby)?
- Will the user (Abby) notice that the correct action is available?
- Will the user (Abby) associate and interpret the response from the action correctly?

The participant (Abby) was asked to perform three tasks:

1. Book a paid parking spot near Mona Campbell building.
2. Extend time for an ongoing parking session by an hour.
3. Make a payment using a saved debit card for a parking session that has been completed.

To measure the usability of the prototype, this approach can prove to be an efficient one because it lets us test our application design with a wide range of user perspectives. It is cheap and can be conducted easily because of the use of personas in place of real users [10]. The major benefit is that a cognitive walkthrough does not need to have a final design and can be used in early stages with the help of sketches which are cost-effective. Also, the feedback of this evaluation technique can be further used to improve the application design before it is tested by the real users.

RESULTS

The results of the cognitive walkthrough suggested that the design of the low-fidelity prototype was not optimal because of the issues faced by the participants using Abby's persona. Overall, the results suggest that Abby may face some difficulties in completing all three tasks. The application design that relates to the booking feature introduces one minor, one minor to moderately-severe, and one severe issue. These issues relate to searching for a location, selecting a parking spot, and booking the selected parking spot. The application design that relates to the payment feature introduces one moderately severe, and two highly severe issues. These issues may somehow lead Abby and other users to believe that they are incapable of doing the tasks and may decrease their confidence. The design that relates to the session extension feature introduces three minor issues due to the lack of explanatory information which may confuse the users while performing the tasks. There are some good things about the design but there are a greater number of things that make the design unusable by the average users. These issues had to be addressed to make the application successful and maintain the user pool once it is launched.

DISCUSSION

The analysis of the results of the evaluation was performed by merging the evaluations of the evaluators. This led us to know the number of issues that the users face and prioritize them by their severity levels. Overall, there are five minor, two moderately severe, and three highly severe issues. Altogether, these issues can make Abby and other users lose focus while using the application and lower their confidence in the system. They might think that either they are incapable of using the system and blame themselves or lose interest in the study due to their inability to complete the tasks because of bad application design. This data tells us that the design of the application needs numerous changes to improvise it and make the user experience better. To do so, several recommendations (refer to Table 1) have been made that will be implemented in the design to improve it and solve the issues in the current design.

Table 1 Recommendation from the study

Recommendation	Target Issue to be solved
Set titles in screens	Lack of information
Introduce an onboarding tutorial	Insufficient knowledge about the application's features
Give details about the parking spot after it is booked	Lack of acknowledgement
Rename the 'END' button with 'PAY' in the sessions screen	Severe issue of not being able to find the option to pay
Give details about the transaction after a payment	Lack of acknowledgement
Give details about the session extension	Lack of acknowledgement

OVERALL DISCUSSION

In this project, the first step for us was to understand the current state of the art systems that help users find parking using their smartphones. For that, we decided on a set of key features and found existing mobile applications that were widely used and provided those features. The features we focused on include finding and pre-booking a paid parking spot, extending the time for an ongoing parking session, navigating to a parking spot using maps, and performing payment operation for a completed parking session. We then came up with a paper-based prototype using snapshots from the existing mobile applications to carry out a study with users to perform the selected tasks. We asked users to perform actions for booking a parking spot, extending a current parking session, and making payment for a completed parking session using the paper-based prototype. This approach helped us in understanding issues faced by users while using the application and helped in understanding user mindset, expectations, and assumptions in a better way. The results of this study helped us in identifying some issues and getting suggestions around key features of the application. We created an affinity diagram from these results, and we deduced the following:

- The application should have minimal design and it should always keep users informed about the system status using proper labels.
- Users would like to have more payment options such as Google Pay, and PayPal.
- The application interface needs to be simple and more clear following consistency and standard conventions for the key feature of extending a current parking session.

Based on results from this study, we created a low fidelity prototype by making sketches of mobile application screen on paper. The next step was to run a cognitive walkthrough study on this low fidelity prototype to find out design issues and reiterate through the prototype before finalizing the design and coming up with a high-fidelity prototype. We ran a cognitive walkthrough study with Abby, a user persona with little to no background in computers and mobile devices.

In the cognitive walkthrough, we had three main tasks of the application: pre-booking a parking spot, extending the current parking session, and making payment for a completed parking session. Users of this study were required to perform each of the tasks using the low fidelity prototype designed. While performing each step in a task, users were asked three questions, whether they knew what to do, how to do it, and whether they were able to understand feedback from the system. Based on answers to these questions, we found out issues with the current design and divided them into high or low severity issues. The outcome of this study is the low, moderate, and highly sever issues found from user input. These issues are already discussed in detail in the result section of the cognitive walkthrough.

The final approach for us was to consider the user suggestions and improve on the design to reduce the severity of the design issues before coming up with a high-fidelity prototype. This is to make sure that there are fewer iterations when we create a high-fidelity prototype because it is both costly and time-consuming to create compared to the low fidelity prototype. The overall impact of both studies and how it will help us in coming up with a better prototype are summarized in the conclusion section.

CONCLUSION & FUTURE WORK

We have presented a low-fidelity prototype of a mobile application that helps users find and book parking, extend an ongoing parking session, and pay for the completed session. Our prototype is less prone to design issues as we have incorporated user suggestions and reiterated our design to reduce the severity of issues found during both studies. The final prototype has a minimal design, well-defined labels, and it follows consistency and standards by adhering to design principles. The suggestions and issues found after the analysis of results of the cognitive walkthrough will be extremely helpful in designing a high-fidelity prototype that is flexible, understandable, less prone to errors, and will require fewer iterations before designing a mobile application. Although the results of this project are reliable, they might still not suffice to move ahead with a high-fidelity prototype design as both studies conducted had very few participants. An application's target audience is the most important factor while developing it and the more naïve users test the application, the more valuable feedback we can get. There is also a dire need for expert feedback on both studies as they can give constructive criticism that can redefine certain aspects of the design. These factors might lead to a compromise in terms of accuracy and completeness of feedback and suggestions for both studies. However, this can be reconciled through an extensive user testing of the high-fidelity prototype followed by beta testing to make sure that the final product will be a mobile application that will be widely adopted by the target audience and it will suffice its purpose to help users with their parking challenges.

We look forward to working on safety and privacy in the future to make sure that user privacy is not hindered. As discussed earlier, we may include the anonymous e-coin payment system which is linked to the onboard RFID. The parking officer can directly check the payment status by querying the onboard system. This does not reveal any user data to the system.

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PLAGIARISM STATEMENT

PERSONAL DECLARATION

"This paper constitutes original work by done by ME and my group (names and student numbers filled in below). The paper consists entirely of ideas, observations, information, and conclusions composed by the group, except for statements contained within quotation marks and attributed to the best of the group's knowledge to their proper source in footnotes or references. Direct quotations make up a very small proportion of the text and are appropriately cited. Material paraphrased from a source (e.g., print sources, multimedia sources, web-based sources, course notes or personal interviews) has been identified by a numerical reference citation (ACM or IEEE). All of the sources consulted and/or included in the report have been listed in the Reference section of the paper. All drawings, diagrams, photos, maps or other visual items derived from other sources have been identified by numerical reference citations in the caption. No part of the document has been submitted for any other course."

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