

An Advanced Parking Navigation System for Downtown Parking

A Practical Implementation

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Abstract

Private vehicle penetration rate in urban area is rising at a higher rate than ever. Consequently, finding parking space has become drivers' daily headache. This research aims to mitigate the problem through establishing a real-time and intelligent navigation system between drivers and parking spaces. Adopting a two-sided matching algorithm, the system matches the drivers to their most appropriate parking spaces based on their real-time locations and parking preference, and thus preventing multiple drivers from being guided to the same parking space. This research will first build a fully functional, performance optimized backend to implement the two-sided matching algorithm and then develop a native APP on multiple mobile platforms (ideally both iOS and Android). The APP will guide drivers to parking spaces according to their preference by considering their real-time position and traffic condition information. For demonstration, parking space occupancy will be simulated through a randomized algorithm since real-life parking data fetching requires sensor installation and serial communication, which is beyond the scope of this research. User-testing will be held among NYU Shanghai community, and hopefully outside users as well.

Research Question and Significance

Research Question

How to prove a two-sided matching algorithm can efficiently help drivers to find their appropriate parking space while utilizing limited parking resource.

Significance

Finding parking space is becoming a nightmare for drivers in urban area. For instance, drivers in some major cities may have to wait up to 14 min to find an available parking space (see Shoup 2006). As Caliskan (2006) pointed out, 44% of the traffic is searching for parking spaces in the district of Schwabing in Munich, which causes 20 million Euros in waste every year. To reduce drivers' cruising time, this research implements an advanced parking navigation system that can guide drivers to open parking spaces and substantially reduce their cruising time for parking.

Though many studies have focused on developing an advanced parking navigation system, most of the existing systems are not ready for practical implementation. Shin and Jun (2014) developed a smart parking navigation system in which drivers are guided to their most preferred parking lot. In this system, a parking utility function considering driving duration, walking distance, parking cost, etc. is defined to measure the appropriateness of parking lots. Idris et al. (2009) proposed a navigation system where drivers can be guided to the nearest empty parking space utilizing a wireless sensor network and an ultrasonic sensor. Ayala et al. (2012a) presented a gravitational approach to guide drivers to parking spaces. Leephakpreeda (2007) applied fuzzy knowledge-based decision making to guide drivers to the best parking spaces. The above systems are not ready for practical implementation, due to expensive computation, strong assumptions or the need for disclosing drivers' private information (see, e.g., Shin and Jun 2014; Ayala et al. 2012a, c; Idris et al. 2009; Leephakpreeda 2007). What

is worse, these systems may guide multiple drivers to the same space, which will inevitably intensify the parking competition. Consequently, the adoption of a parking navigation system in reality is still limited. This research aims to make use of two-sided matching algorithm to achieve practical implementation of an advanced navigation system.

Project Design and Feasibility

Week 1

Analyze use cases, create class diagram, determine design patterns

Week 2 - Week 3

Data preparation and database design

1. Real parking lot occupancy data fetching/ randomized generation
2. Road traffic condition & signal control data acquisition Chinese Navigation System: Amap, aka Gaode Map
3. Driver positioning through GPS
4. Data organization and database design

Week 4 - Week 5

Backend Implementation

1. Two-sided matching algorithm optimization and implementation
2. Client-server communication protocol and API implementation
3. Performance optimization

Week 6 - Week 7

Frontend Implementation

1. UX/UI design and Interface building
2. Data visualization
3. Performance optimization

Week 8

Project conclusion and presentation

Group Partner Plan

Partnership Experience

Zheng and Fangqing have rich partnership experience over their undergraduate studies. They worked on the same project as Research Assistants under NTSI-LAB in NYU Abu Dhabi. They also did multiple class projects together in Natural Language Processing, iOS Programming, Database Design & Web Implementation, Parallel Computing, Computer Graphics, Sensor Body, & Motion and Communication Lab. Some of the works they did together have the chance to participate in public showcases.

Work Division

Zheng and Fangqing will mostly work on the research together as they will both be staying around campus over the summer with Prof. Chen. Specifically, Zheng will contribute more to the software sphere of this research and Fangqing will focus more on the hardware sphere.

Communication Plan

Zheng and Fangqing will both base in Shanghai over the summer. In the rare moments when they cannot meet in person, they will communicate with each other through email and social media.

Background

Zheng is student pursuing a double major in Computer Science & Interactive Media. He learned design patterns, use-case analysis, and software development through his studies in Software Engineering, where he made a cross-platform campus app for NYU Shanghai - NYUSHER from scratch with a group of students. In his previous CS courses, he built a Chat System with Online Programming, which supports multi-client chatting and online Battle Pong gaming. This semester, Zheng is taking iOS Programming and Parallel Computing, where he learns XCode IDE, Objective-C & Swift through building multiple iOS applications that support high concurrency. Zheng's experience in software development will enable him to build a fully-functional, user-friendly and performance-optimized application for his research in the intelligent parking navigation system. Zheng is actively seeking graduate studies in the realm of autonomous vehicles, smart city, and intelligent transportation. Doing this research under the guidance of Prof. Chen will give him precious experience in applying what he learned in CS courses to solving real-life problems, and thus make him a stronger candidate. Following his passion, this research can also be an excellent start for Zheng's future career in this field.

Fangqing is also double-major in Computer Science and Interactive Media Arts. As a hybrid of engineering and coding, the main focus of her current researches and future graduate studies is to create digital intelligent plans for applications with practical uses. Following her passion for applied technology, this research project for her is another attempt to optimize a daily-used system with optimal algorithms. Her rich experience working with motion detection sensors, embedded systems, and serial communication, along with her great programming skills of Objective-C, Swift, C++, Java, Python, enables her to develop a practical navigation system proposed in the project. Apart from software developing courses such as Software Engineering, and iOS Programming, she also learns Databases Design and Parallel Computing which are required for high-concurrency programs.

Feedback and Evaluation

Prof. Chen will schedule weekly or biweekly face-to-face meetings with us, and keep in touch via email whenever needed. It's especially convenient for us to work with Prof. Chen because both of us will be staying in Shanghai around campus for the whole summer. Also, by holding general user-testings among NYU Shanghai community and internal progress meetings on app functionalities with Prof. Chen, it's easy for us to evaluate and optimize our system based on user feedback and Prof.Chen's suggestions.

Dissemination of Knowledge

The first approach is to seek opportunities to publish a paper about our research. Secondly, since we are planning to hold user-testing, we will spread our app and gain valuable feedback among NYU Shanghai & broader NYU community. We also plan to participate in the Undergraduate Research Symposium to promote our research. Lastly, we will take detailed video & photo documentation to submit to DURF committee.

Reference

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