An HCI solution for sustainable driving: IDA– The Intelligent Driver Assistant

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Abstract
One of the problems modern cities are currently facing is the increased traffic flow and heavily congested parking places. To reduce the time and traffic caused by finding available car parks we propose IDA – the **I**ntelligent **D**river **A**ssistant. IDA promotes sustainable driving by helping motorist to find quickly suitable parking in Singapore. The search is based on distance proximity and parking fee. In contrast to other applications, IDA uses speech to interact with the driver and becomes an active helper during the navigation by checking periodically the chosen car park availability. In case the number of free places drops to a critical level drivers are re-directed to another close-by parking. The application was showcased during a public event and received positive feedback from test users.

Author Keywords
Interaction design; multimodal interaction; speech recognition; smart parking.

ACM Classification Keywords
H.5.m. Information interfaces and presentation

Introduction
Urban traffic experts estimate that 30% of vehicles on the road in downtown areas of major cities are searching for a parking place and spend in average 7.8 minutes to find one [1]. This increases the traffic

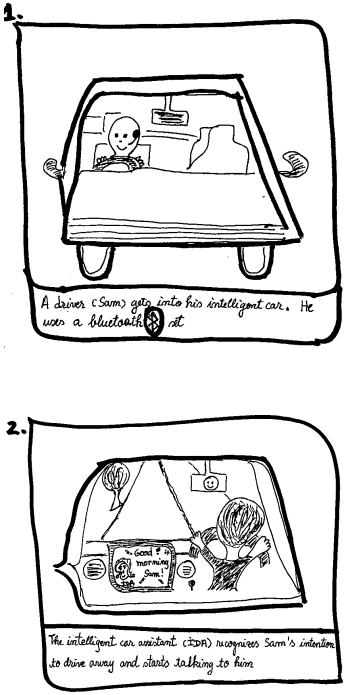


Figure 1 Handmade storyboard sequence

congestion, fuel expenses and time waste for all drivers on the road. Despite being ranked on the top for smooth traffic flow, efficient road network, road quality and public transportation, Singapore is confronted during peak hours with heavy traffic jams. To help drivers avoid such stressful situations we have started developing an interactive application for smart parking assistance. The paper presents the application work in progress and covers interaction design aspects, use cases, as well as first feedback from a public audience.

Related work

For the past two decades, traffic authorities in many cities have been concerned with finding solutions to decrease emissions, fuel consumption and traffic congestion. As a result, many intelligent transportation systems (ITS) have been developed to address these issues. Smart parking systems are one of them. From a functional perspective smart parking systems can be divided in 5 different categories [5]:

1. Park guidance information (PGI) systems - are tools aiming to reduce parking search traffic by monitoring car parks and directing drivers to available lots [2]. Examples of PGI systems are SFPark [7] and Streetline [8].

2. Transit-based smart parking – is a technology similar to PGI. The main purpose of transit-based parking is to encourage commuters to park their vehicles at train stations and use the public transport. An example for this category is BART, a transit-based smart parking project at San Francisco Bay Area [6].

3. Smart Payment Systems – are tools meant to replace traditional parking meters. They make parking payment easier using contact methods (debit, credit cards), contactless methods (smart cards, RFID cards) and mobile phone services [8].

4. E-parking systems - are advanced technologies combining streamline parking reservation and payment systems. Drivers make their reservation request via phone or internet and pay when leaving. Examples include Parkme [4], MobyPark [3], etc. Some systems also use data analytics and prediction algorithms [1].

5. Automated Parking – is a complex technology that allows drivers leave their car to be parked automatically by a computer system. A variety of vehicle detectors are installed in this system [5].

Introducing IDA

IDA is a smart parking system that builds on the PGI technology. However, IDA extends common PGI systems by offering suggestions based on parking fee or proximity to destination. Additionally, IDA includes two more novel features for a smart parking system. These are:

1. Use of natural language

The interaction between the application and the driver is done using speech dialogues. This feature complies with current traffic regulations in Singapore[1] enabling the application to be used safely while driving.

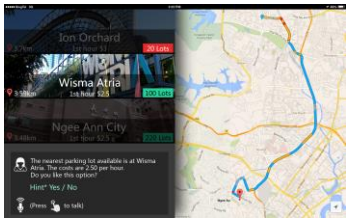
2. Ability to react to changes in the car park occupancy

Unlike E-parking systems which reserve lots for a nominal fee, IDA takes a more sustainable approach:

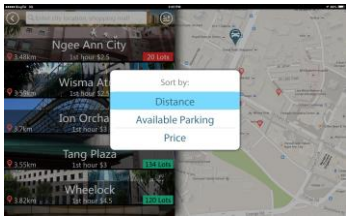
[1] Under the Singapore law it is strictly prohibited the use of mobile phone or tablets while driving

A. Interface cover

B. Info parking & map



C. Manual setup



D. Floor map & sms sending

Figure 2 IDA screen shots

after the parking decision is made IDA keeps monitoring the car park availability following a once-per-minute check-up routine. If the number of lots drops to critical level, i.e. less than 20, IDA redirects the driver to another parking place. In this way, drivers save costs and parking resources are optimal allocated, i.e. parking lots are not kept empty for reservations while other drivers (with no reservation) are struggling to find an empty spot increasing the traffic in the nearby areas.
Furthermore, the application includes several interconnected modules responsible for:

- Collecting and managing parking availability. The data is obtained from the Singapore Land Transport Authority (LTA), and it is periodically updated and stored in a server data base.
- Processing speech and dialogues, as well as generating responses in natural language using a text-to-speech (TTS) module.
- Assigning parking lots on the car park floor map. Currently, the assignments are only simulated. However, in the second milestone of the project live data will be retrieved from each car park floor to update the map.
- GPS and google maps interfacing which enables the application to detect the driver location and calculate the nearest distance from the car park to the intended destination.
- Keeping track of parking place details. The application is able to send per sms the parking lot details.

Interaction design

Figure 1 illustrates a sequence from IDA's storyboard. The application is designed to turn on once the driver starts the car engine. In a short dialogue IDA greets the driver and asks about the driving direction and parking intention, i.e. the driver might not be in need for a car park (figure 2A). Upon driver's positive confirmation IDA searches in the data base for suitable car parks and makes three car parks suggestions.

The information is spoken (only the first suggestion) and graphically displayed on the screen. The screen is divided in two parts (figure 2B): the left upper part shows the name of the car park, the number of available lots, the distance to target location and the car park fee; the left lower part contains the dialogue history. On the right side, the screen displays the google map navigation to the car park.

The car parks are by default ranked on the distance proximity to the driving location. However, the driver can change the setup configuration using speech or the touch screen, as shown in figure 2C.

If the driver dislikes the suggestions, he/she can request other parking locations up to 3 times before IDA turns into manual mode. In the manual mode the driver can search by himself for available parking once the car is standing.

If the number of available parking places is less than 20, the color turns into red (figure 2B). The application warns the driver immediately and offers parking alternatives.

When the driver reaches the car park, IDA displays – on the right side of the screen - the floor map where the empty lots are marked in green. On the left side

the driver can request the application to send him/her an SMS with the exact parking location (figure 2D).

The driver has the option to switch off the application at any moment in time by saying: "*Dismiss*".

Demo at a public event

The first IDA prototype was presented to the public during an official event[2] held at Continental Singapore in November 2014. Four teams with 2 members each performed the demonstration using two different cars. Due to the flux of visitors and short time allocated for demonstrations it was difficult to organize an elaborate system evaluation. However, the demo performance allowed us to observe the visitors and gather the following observations:

- In general, the application received positive feedback and visitors seemed interested to test it: most of the visitors remained seated after the demonstration for another 8-12 minutes asking questions about additional features, development process and future commercialization
- When the speech recognition performed well, people tended to ask out of domain questions, probably in an attempt to test the application limits. This observation is important for the future dialogue development. On the other side, user expectations need to be kept at reasonable levels.
- Many visitors were foreigners living in Singapore. As such, they spoke well English, but had a different accent as the local one. This caused some speech recognition problems, as our system was trained using Singaporean speech data.

[2] The event was occasioned by the opening of a new R&D extension building

Future work

In the future, the application will also integrate indoor navigation inside the car park to guide drivers to the empty spots. The speech recognition will be enhanced with additional English accents while the vocabulary will be enlarged to allow more complex dialogue structures. Two user studies are in preparation: one short term study involving 100 users to evaluate the user experience while driving; and a long term study concerning sustainability effects achieved by daily application use.

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References

[1] Geng, Y. and Cassandras, C. (2012). A new "smart parking" system infrastructure and implementation. *Procedia Social & Behavioral Sciences, 54*, 1278-1287
[2] Griffith, E., 2000. Pointing the way. ITS International March/April, 72.
[3] MobyPark, http://www.mobypark.com/, 19-01-15
[4] ParkMe, https://www.parkme.com/, 19-01-15
[5] Patil, M. and V. N. Bhonge. Wireless Sensor Network and RFID for Smart Parking System. International Journal of Emerging Technology and Advanced Engineering. Vol. 3, Issue 4, April 2013
[6] Rodier, C. J. and S. A. Shaheen. Transit-based smart parking: An evaluation of the San Francisco bay area field test. Transportation Research Part C, (18):225-233, 2010
[7] SFPark http://sfpark.org/. 19-01-15
[8] Streetline. http://www.streetline.com/ 19-01-15