Designing IDA - An Intelligent Driver Assistant for Smart City Parking in Singapore

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Abstract. A current problem modern cities are facing is the increased traffic flow and heavily congested parking places. To reduce the time and traffic caused by finding available parking we propose IDA, an **I**ntelligent **D**river **A**ssistant. The main objective of IDA is to help drivers to find suitable park places, to online monitor car park availability and to redirect drivers when the number of free available spots drops to a critical level. Unlike other parking applications, IDA uses speech to interact with the driver and becomes an active helper during the navigation process by adjusting dynamically the parking decisions based on the traffic situation. The paper presents the current work in progress, interaction design aspects, uses cases, as well as a first user feedback received during a public event where IDA was showcased.

Keywords: multimodal interaction design; speech recognition; smart parking

1 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 congestion, fuel expenses and drivers' time waste. For the past two decades traffic authorities in many cities have been concerned with finding solutions to this problem and as a result, many intelligent transportation systems (ITS) and smart parking technologies have been developed.

Despite being ranked on the top for smooth traffic flow, efficient road network, road quality and public transportation [2], 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, first feedback from public audience and future work directions.

2. IDA- an intelligent driver assistant

IDA is a smart parking app that builds on the park guidance information systems[1] (PGI). However, IDA extends common PGI systems by offering suggestions based on parking fee or proximity to destination. Additionally, IDA' makes a new contribution to the existing parking systems by adding two novel features. 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 enabling drivers to safely use the app 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: after a parking decision is taken 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 - parking lots are not kept empty for reservations while drivers with no reservation are struggling to find an empty spot driving around and increasing the traffic. Furthermore, the app includes several interconnected modules responsible for:

- **Collecting and managing parking availability** - the data is obtained from the Singapore Land Transport Authority (LTA); it is periodically updated and stored on a data base server
- **Processing speech and dialogues**, as well as generating responses in natural language using a text-to-speech (TTS) module.
- **Assigning parking lots on a floor map** - currently, the assignments are only simulated; this feature will be implemented in the second project milestone
- **GPS and google maps** interfacing which enables the application to detect the driver location and calculate the nearest car park distance
- **Keeping track of parking details** - the app can send on request the parking details per SMS

3. Interaction design

The IDA's story board is depicted in figure 1. The app 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 (figure 2A). Upon driver's answer IDA starts searching the data base for suitable car parks and makes three 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 car park name, number of available lots, distance to target location and parking fee; the left lower part contains the dialogue history. On the right side, the screen displays the google map navigation to the car park.

[1] Park guidance information (PGI) systems are technologies that monitor car parks and direct drivers to available parking lots

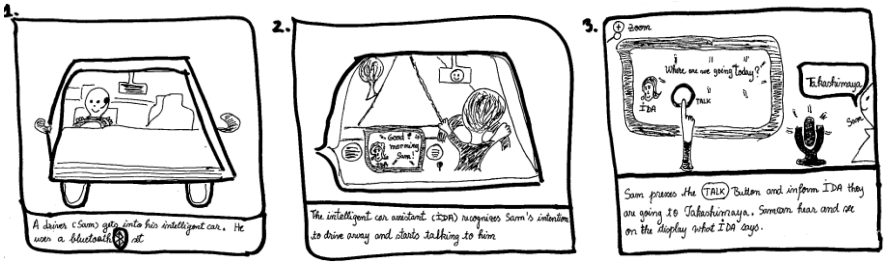

Fig. 1 IDA story board

The car parks are by default ranked on the distance proximity to the driving location. However, the driver can change this setting using speech or the touch screen, as shown in figure 2C. If the driver dislikes the suggestion, he/she can request other parking locations up to 3 times. After the third rejection 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 label designating the car park lots turns into red (figure 2B). The application warns the driver on the spot 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*".

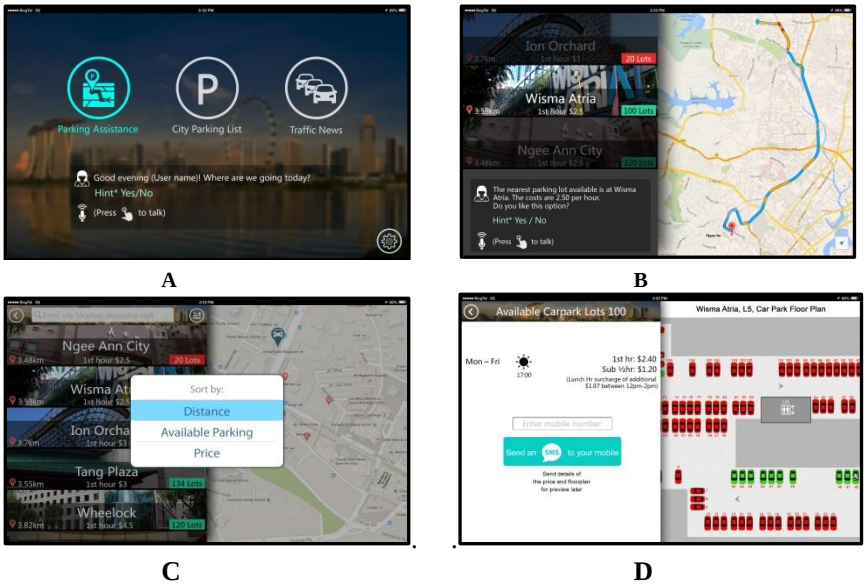

Fig. 2 Screen shots IDA

3.1 Ida's personality

To shorten the dialogue and enhance the user experience we designed some personality features for IDA through the use of humor. When the driver keeps rejecting IDA's parking's suggestions as being "*too expensive*" the system shows disapproval: *"Expensive? This is cheap lah! If you want cheaper go Malaysia! Anyway, don't have cheaper! Sure you don't want?* The surprise effect is increased by the fact that IDA uses typical Singlish - a local colloquial English variant - words and expressions when she gets upset. IDA also gives similar responses to undecided drivers who keep asking for the "*next*" option: "*Again next? You drive me crazy! This place is nice and cheap! Why not taking?*". IDA's dominant personality shows up each time the driver persists in rejecting her suggestions for more than 3 times in a row, i.e. just before turning into manual mode. In cases where the noise level reaches a critical level hindering the automatic speech recognition (ASR), IDA asks the driver to speak louder or to turn off the radio. While for native English speakers IDA's remarks might sound rude they are very common for local Singaporeans being used in the daily slang. As such, they do not hold negative connotations.

4. Demo at a public event and future work

The first IDA prototype was presented to the public during an official event. Due to the afflux of visitors and the short time allocated for demonstrations it was difficult to organize a more elaborate system evaluation. However, the demo allowed us to observe the visitors and gather some important observations. In general, the application received positive feedback and visitors seemed interested to test it; after the demo we received an overwhelming amount of questions regarding additional features, development process and future commercialization. When the ASR 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. Another observation refers to the fact that 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 ASR problems, as our system was initially trained using Singaporean speech data. In the future, we are planning to enhance the ASR module with additional English accents and enlarge the vocabulary to allow more complex dialogue structures. Additionally, an indoor navigation module will be integrated to guide drivers inside the car park. Also, two user studies are in preparation: one will evaluate the user experience while the other one will focus on sustainability effects achieved by daily application use.

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