A fresh look at navigation and parking

Associate Professor Akira Kawai, from Shiga University, and Masahiro Kenmotsu, from the Nara Institute of Science and Technology, form part of a KAKEN-supported team working on navigation and parking technology.

How did the proposal for the KAKEN project on navigation and parking guidance come about? What gaps in our knowledge were you trying to address?

AK: A lot of research has already been done in relation to the parking guidance method in order to maximise parking space utilisation rates at car parks. Most of these apply specifically to the parking positions of the vehicles entering the spaces. However, in reality, there are many cases where the vehicles entering do not follow instructions, and the availability of spaces changes constantly, so most of the guidelines are not practical. In this study, we will focus not only on the parking lot utilisation rate but also on the number of vehicles moving within each area, to ensure even distribution of vehicles, thereby reducing the traffic in the parking lot and shortening the time required for parking.

Can you talk a little about your own research background and how you came to be involved in this research project?

AK: My research area focuses on intelligent transportation systems, especially inter-vehicle communication and vehicle mobility. So, vehicle research is of particular interest to me. The idea for this project was sparked during a visit to a shopping mall near my house. While I was caught up in a parking lot and managing a case of road rage, I thought it would have been nice to have parking guidance available.

Have you been working in partnership with any technology providers or academic institutions?

AK: I am a senior researcher at the Japan Safety Society Research Center (JSSRC), which was jointly created by Shiga University and Asis Nissay Dowa Insurance Co., Ltd. Not only can companies use big data on vehicle driving for research but using this data can also offer huge benefits because it will allow the incorporation of opinions from a business perspective, potentially paving a way forward for more realistic research.

This project was supported by KAKEN and awarded the 2018 IPSI/IEEE Computer Society Young Computer Researcher Award. Can you talk about the importance of awards like this to progressing with research?

AK: As a result of the award, consultations on joint research and practical application greatly increased, not only from other researchers but from companies as well. This has had a huge positive impact on research. Above all, our research team was greatly encouraged. To be honest, we launched this research project with curiosity and inspiration, but I was unsure if it was really worth it. I feel really encouraged by the response we have had. It is extremely valuable to know that our research direction and method are on the right track. I think the biggest difficulty in this research was whether our chosen direction is correct or not.

DEVELOPING NEW METHODOLOGY

Associate Professor Akira Kawai, who is based at Shiga University in Japan, has been working with colleagues on a KAKEN project that seeks to leverage real-time positional information to help guide drivers to free spaces within parking lots. Kawai began this work when he was based at the Nara Institute of Science and Technology (NAIST). ‘The concept for this study arose from my frustrating experiences at a huge car park at a shopping centre near the NAIST,’ he says. ‘There was a huge capacity of 2,000 spaces, these were not all easy to access and congestion frequently built up, making the use of space inefficient.’

As a result, the car park management industry has taken an interest in research into parking guidance. Parking guidance has been developed to help improve efficiencies in car parks, guiding drivers to specific spaces using GPS technology to highlight free spaces near their location detailing the most efficient way to get to that spot.

FACING THE CHALLENGES

As with any research, the path to parking guidance solutions does not always run smoothly. One of the challenges is that this method uses the global optimisation method, which does not necessarily offer the best parking suggestion for each vehicle. ‘Thus, where a vehicle does not adhere to parking suggestions, it appears to be a nuisance to others following the method,’ Kawai observes. ‘Emphasis is placed on providing more accurate suggestions by improving the sensor technology and suppressing the adverse effect even if there will be some noise nodes.’

In addition, the researchers found that vehicles moved in different ways when in different environments. ‘The movement of a vehicle in the parking lot is different from its movement when driving on the road. There is uncertainty,’ points out Kawai. ‘The situation in the parking lot is very complicated, some vehicles do not follow the guidelines.’ He notes that not only do drivers enter zones in different frames of mind, but they also place their vehicles in different, sometimes unpredictable modes. ‘We want to create models of different drivers and reproduce a more complex structure as much as possible,’ he adds.

Easing parking congestion

Researchers from Shiga University are developing parking guidance to reduce traffic congestion and total parking time in some of Japan’s largest car parks. Traffic congestion in parking lots is a common phenomenon across the world and larger commercial facilities with multiple parking areas may be particularly affected as many users struggle to gain access to sought-after parking spots close to their destinations. These popular zones often see traffic jams forming as many vehicles arrive within these regions, while less popular areas may remain free from congestion. This creates a very uneven distribution of traffic, with motorists in popular areas becoming trapped and unable to leave bottleneck regions.

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in which we can apply the results to these services,’ says Kawai.

Where research has already been carried out in this area, existing studies focus primarily on the interests of the parking providers, with the priority on making the most effective use of parking space. ‘While some studies have targeted users’ goals of finding spaces as close to the store entrance as possible or minimising the time taken to find a space, neither approach has taken into account extending opportunities for users to reselect parking routes when guidance fails,’ notes Kenmotsu. ‘This offers users the worst possible service and usually leaves them stuck in a traffic jam.’ While existing parking guidance methods have proven popular and even won awards, the team feel that there is room for significant improvement in terms of reducing walking time, predicting the occupancy rate, scalability and incorporating smartphones to enable user feedback.

Kawai’s group seeks to develop a route guidance method that addresses these points and guides users through a parking route that minimises total parking time as well as walking time rather than pinpointing a parking space. ‘In this way, the total time taken is reduced regardless of where the vehicle is parked, avoiding heavy traffic,’ explains Kawai. ‘This also benefits car park operators by improving overall space utilisation rates.’

IMPROVEMENTS IN TIME
One of the main advantages of the group’s proposed method is that noticeable improvements in parking time are achievable, even with only 10 per cent of vehicles cooperating in the scheme. The team were surprised by these results that showed that even with an overwhelming majority of vehicles not following guidance, significant advantages were noted. ‘Conventional parking lot navigation methods often require all vehicles to be under application control,’ says Kenmotsu. ‘With our method, it can be effective even if the introduction rate is low and it can also be used for vehicles that have not had the system installed. I was really pleased with these findings.’

Looking forward, the team hope to further the impact of their work. ‘Our key goals include improving the accuracy of the recommended routes, improving scalability (combinations of routes become more complex as the parking lot grows larger) and reproducing realistic behavioural patterns of the drivers in the programme,’ concludes Kawai.

PROJECT INSIGHTS
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Associate Professor Akira Kawai graduated from the Graduate School of Information Science and Technology, Osaka University, and obtained his PhD in information science in 2008. He is an Associate Professor of the faculty of Data Science at the Shiga University. His research areas include vehicular communication, mobile computing and elderly care system. He is a member of the Information Processing Society of Japan (IPSJ) and IEEE Computer Society.

Masahiro Kenmotsu works at the Toyota Motor Corporation. He received his BE degree in engineering from Osaka University in 2010 and his ME degree in information science from the Nara Institute of Science and Technology in 2012. His research interest is intelligent transportation systems.

The cell automaton simulation model of the proposed park guidance method