TOYOTA Project:

Design for the next generation mobility service in suburban areas

Sponsor

Toyota will lead the way to the future of mobility, enriching lives in the world with the safest and most responsible ways of moving people. In the near future, cars are expected to connect with people and communities and take on new roles as part of the social infrastructure. New areas, such as AI, autonomous driving, robotics and connected cars, are becoming especially important. Toyota aims to reach the ultimate goal of sustainable mobility, creating a mobile future society with full of smiles.

Project

Rapid suburban sprawl in metropolitan areas in Japan has led to the rapid development of peripheral satellite cities. High-speed railway networks and motorways have significantly contributed to improving the connection between established metropolitan areas and these new peripheral cities. But at the same time, due to rapid population growth, sprawled suburban areas with small-scale residential developments were built without schematic road network planning.

As a result, key functions of the city for the citizen's lives, such as commerce, administration, and schools, are diffused to suburban area, on the premise of using private cars. But such developments are not sustainable or desirable as the population ages and as energy conservation becomes more important. In principle, a higher quality of life can be achieved if key city functions are aggregated in city centers around the main railway stations. This requires better and more efficient public transportation networks in conjunction with small personal mobility.

Mobility-as-a-Service (MaaS) describes an integration of different transportation modes and towards mobility solutions that are consumed as a service. Mobility innovation, often called as CASE (C: Connected, A: Autonomous, S: Sharing, E: Electric) could be fully or partially implemented as MaaS. Wider range of demonstration programs and commercial based services are being provided to improve safety, efficiency and convenience of transportation.

Expectations

There are many studies on MaaS as implementation of CASE, particularly for metropolitan areas where other multiple transportation modes such as rails, metro and buses are available.

But at the same time, other areas, where private cars are dominant transportation mode, are not thoroughly investigated. Mobility services for non-metropolitan areas could be different from that for metropolitan areas, due to differences in population density/distribution, transportation demand, and public transportation network.

As an example, Tsukuba city, a city with a population of 237,000 people, and located 60 km northeast of Tokyo, has a private car dependent transportation system. In this project, we organize two groups of students as Group-1 and Group-2 in which the students will design MaaS for practical cases, in particular for university campus and hospital guests, through analyses on existing person-trip and other related data sets.

Group-1: Mobility service for university campus:
University of Tsukuba has a relatively large campus area and a large number of students. The present major transportation modes are buses, bicycles and walks. Students are expected to build a practical planning model to optimize the MaaS for University of Tsukuba campus.

Group-2: Mobility service for hospital guests:
University of Tsukuba Hospital is an advanced treatment hospital in this region. There is a strong need for transportation service for hospital visitors, since the hospital is a few kilometers away from a major transportation hub. Students are expected to build an efficient MaaS planning to optimize the mobility service for hospital guests considering characteristics of several types of patients.

The problems setups and formulations may be different for these targets and the two groups will work independently during the GRIPS-Sendai program. However, exchanging ideas and discussions between these two groups will be highly encouraged and we expect some universal idea for MaaS in the future society. Although there already exist several approaches for this kind of problems, students are expected to find totally new mathematical approaches, descriptors, formulations, solvers, visualizations, operation plans, etc. to be fit for our future society with highly sophisticated mobilities. This project includes sight visits to a mobility exhibition center in Tokyo and University of Tsukuba.

Recommended Readings and References

(More references will be added later)

[1] Toyota Motor Corporation. Toyota e-Palette Concept Opening Video. 2018. https://youtu.be/bniK9Eqgnw4

[2] Toyota Motor Corporation. Toyota e-Palette Concept Basic Function Video. 2018. https://youtu.be/7nhY0eHUUEo

[3] OECD/International Transport Forum. Shared Mobility: Innovation for Liveable City. 2016.

https://www.itf-oecd.org/itf-work-shared-mobility
[4] GRIPS-Sendai 2018. Toyota Group Final report: Data-Driven Models for Predictive Control of Toyota's e-Palette Mobility System. 2018. *(to be provided later)*

Requirements

We welcome applications from motivated team-players who have knowledge and practical skills of one or more of the followings:

- Mathematical statistics
- Optimization
- Operations research
- Programing language (Python, C, or MATLAB)