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Информационные технологии для оптимизации дорожного движения

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Аннотация. Статья посвящена теме оптимизации дорожного движения. В статье рассматриваются технологии и исследования, посвященные продвижению прогресса в этом направлении. Автор дает краткий обзор возможного использования пассивного Wi-Fi мониторинга, технологии глубокого обучения для умного зондирования потока на дорогах и приводит интересные тонкости взаимодействия между участниками дорожного движения.

Ключевые слова: оптимизация дорожного движения, отслеживание по Wi-Fi, модели мобильности, умная транспортная система, коммуникация и взаимодействие, использование дорог.

Information Technologies for Traffic Optimization

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Abstract. This paper is devoted to the topic of traffic optimization. The article examines the technologies and researches devoted to the promotion of progress in this direction. The author gives a brief overview of the possible use of passive Wi-Fi monitoring, deep learning technology for intelligent traffic sensing, and provides interesting details of interaction between road users.

Keywords: traffic optimization, Wi-Fi tracking, mobility patterns, intelligent transportation system, communication and interaction, road usage.

Introduction

The topic of traffic optimization is acute in modern time as roads are loaded with many users and the concept of smart city has become prevalent across different urban domains that apply information and communication technologies. With the rapid population growth and the unprecedentedly growing number of vehicles, intelligent transportation management has become critical for the sustainability of our cities.

The motivation of this paper is to investigate human mobility data and ways of interacting in today's traffic, to study essential technologies for urban transportation services and traffic applications.

Low-cost approach with high profit

Understanding human mobility through wireless sensing and social networks is now commonplace. Using a wide range of sensors, researchers and practitioners can collect data unobtrusively and cost-effectively. Hence, we can now more easily analyze human mobility at unprecedented spatial and temporal resolutions. This information is useful for many domains. For instance, mobility data can be used to understand patterns of human movements in urban settings. Network connectivity helps establish opportunistic linkages, which improves the connectivity and location detection of mobile devices. In traffic management, mobility data can be used to provide traffic reports and detect commuting patterns for planning of transport systems. Similarly, studying contacts among residents on their daily routes helps simulate the dynamics of disease transmission and detect site loads, among many other applications. These methods are useful to extract data about mobility-related domains such as tourism, visitors, interests, and site loads from social media, and compare it to the traditional sources.

To understand mobility at scale there is a community-based passive wireless tracking system that uses passive Wi-Fi tracking. This system was developed and tested in Madeira Islands, a medium-sized European archipelago in what is called in the wild: the deployment was conducted in real-world conditions without supervision from the research team, being subject to non-ideal placement and operation.

As mobility data is not easily available to local/regional authorities, this method is an alternative approach for stakeholders and small businesses as it provides a low-cost community-based infrastructure for gathering and sharing spatiotemporal data with citizens, visitors, local business, and planning organizations. One example of how such an infrastructure could be useful for local/regional planning is an opportunity to design new and improve existing roads and routes based on what places people visit. Even at the European level, telecom operators started sharing mobility data to help national authorities manage and monitor changes in mobility patterns. However, these telecom data are not easily available for local authorities in smaller communities and are not easily available in near real-time.

Deep learning for intelligent traffic sensing and prediction

It is significantly challenging to fulfill the computation demands by the big traffic data with ever-increasing complexity and diversity. Deep learning, with its powerful capabilities in representation learning and multi-level abstractions, has recently become the most effective approach in many intelligent sensing systems.

Sensors are the fundamental elements in traffic sensing, and wireless sensor networks are widely used to satisfy the requirements of real-time and accurate traffic sensing. A wireless sensor node usually consists of five critical functional modules as follows:

- A sensing module for vehicle detection and data acquisition.
- A wireless transceiver module for wireless data transmission.
- A local data processing module for converting physicochemical signals into traffic values.

- A memory module for storing sensing data and backup of system settings.
- A power supply module that consistently provides energy for the sensor.

The system of such sensors will provide complete information about what is happening on the roads, and deep learning technology will be able to process a large amount of data to provide such valuable information as prediction of traffic volume, speed, passenger demand, travel time, traffic anomaly, and urban mobility.

Communication strategies used by drivers and pedestrians

To understand how pedestrians interact with vehicles in a mixed traffic setting, and establish whether social norms influence this behavior, there exist a newly developed observational protocol, and a follow-on on-site questionnaire, applied at six observed locations, in three European cities.

The observation protocols identified 20 event categories, observed from the approaching vehicles/drivers and pedestrians. These included information about movement, looking behavior, hand gestures, and signals used, as well as some demographic data. These observations illustrated pedestrians and drivers rarely using explicit body language to communicate with each other, relying instead on kinematic cues (such as distance, speed, braking). Follow-on questionnaires reported that pedestrians rely on factors such as vehicle speed, and distance, to decide on road crossing, relying less on driver communications such as eye contact, or head/hand movements. The implications of these findings can be used to develop suitable external interfaces and communicate intentions by future automated vehicles.

Conclusion

Passive Wi-Fi monitoring is a good low-cost approach to examine human mobility patterns. Understanding human mobility patterns and knowing hot points of interest, we will have the opportunity to plan and improve transport systems, especially public transport systems, design and build efficient routes and roads.

Deep-learning models can assist different applications of intelligent traffic systems.

Explicit communication techniques, such as honking, flashing headlights by drivers, or hand gestures by drivers and pedestrians, rarely occurred. When contemplating a crossing, pedestrians were more likely to use vehicle-based behavior, rather than communication cues from the driver.

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