Real-Time Automatic Generation of Traffic Management Strategies for Major Events

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Started: 10/2016
☒ ongoing ☐ finished

Motivation
Transportation system is a critical infrastructure for the movement of people and goods. However, major events such as unexpected incidents or planned special events put its reliability at high risk. Traffic management strategies for these exceptional situations are usually derived from manuals and checklists, which only provide a set of general recommendations to the operators and organizers. However, due to their unique nature, major events could be rarely predefined, and thus, a list of actions which mostly relies on the experience of local authorities will not take into account the spatiotemporal needs of various road users. Admittedly, the existing systems lead to implementation of management measures that are only partially suitable for the situation.

Objective
The main goal of this research is to minimize the spatiotemporal impacts of major disruptions through an advanced traffic management system that is able to automatically generate the measures in real-time. The potential benefits of emerging technologies such as connected vehicles and proliferation of Big Data will be investigated as they are likely to become more prevalent in next years. In working toward this goal, the following research questions are formulated:

1. How can the major events be identified?
2. Which methods and models could be used to predict the near-future state of a large-scale urban road network?
3. What are the required infrastructure to bridge Big Data and machine learning to real-time traffic management?
4. What is the impact of the proposed methodology on transportation resilience?
Methodology
The core of this research is composed of two main components: first a non-recurring congestion identification algorithm, and second, a framework to generate traffic control strategies in real-time. It is essential to distinguish major events i.e. non-recurring extreme congestion from recurring congestion, which occur regularly on the network. For this purpose, two performance indicators will be developed using the concept of Macroscopic Fundamental Diagram (MFD) [1]: (i) a congestion index, which reveals the level of congestion, (ii) a singularity index that indicates the probability of the observed congestion considering its spatiotemporal characteristics. In order to obtain smooth MFD, the network must be divided into homogenously congested sub-networks. Bringing the affected subnetworks under scrutiny will improve both the computation time and the accuracy of the method.

The second part of the work could be summarized in a four steps approach, similar to [2], which is illustrated in Figure 2:

5. Modelling the current situation
6. Generating traffic control strategies
7. Optimization of the selected strategy
8. Information dissemination and update system

Fig. 1: Identification of major events using MFD

Fig. 2: Framework of the proposed methodology

It is necessary to develop a hybrid system hybrid system to predict near future traffic state. More specifically, a system that uses data-driven methods during normal condition and adopts model-based approaches during non-recurring congestion. The overall architecture of such a system that relies on the intersection distributed computing and dynamic traffic control systems has been introduced in [3].

Contributions
The main contribution of this research is to improve the state-of-the-art real-time traffic control. Instead of selecting the most suitable strategy from a pre-defined set of measures, the measures will be optimized according to the situation in real-time. Moreover, digitalizing the traffic management through application of Big Data is another contrition of this work.

References