Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 109C (2017) 698–703

Procedia Computer Science

www.elsevier.com/locate/procedia

The 8th International Conference on Ambient Systems, Networks and Technologies (ANT 2017)

Robust routing based on urban traffic congestion patterns

Lamia KARIM[a,b], Abdellah DAISSAOUI*[c], Azedine BOULMAKOUL[a]

[a]Computer Science Department - Faculty of Sciences and Technology (FSTM), University Hassan II, Mohammedia, Morocco
[b]Higher School of Technology EST Berrechid, Hassan 1st University, Morocco
[c]Multidisciplinary Research and Innovation Laboratory (LPRI), Moroccan School of Engineering Sciences,Casablanca, Morocco

Abstract

In your daily journeys, you are driving from a departure location to another destination location situated in the road network. There are a number of alternative routes that you could use. For each section of the network, we know the travel time required under normal traffic conditions to move from one endpoint to the other. What we do not know is the occurrence of incidents that slow down traffic and cause traffic congestion and therefore delays. This work considers the development of simple traffic model based on the semi-microscopic traffic assumption. The simulator based on the proposed model makes it possible to estimate the travel time on a road link. From variables, provided by simulator we can derive travel time index and therefore to characterize the traffic state of the urban transportation network. Another objective of this paper is to determine a robust itinerary in an urban transport network, taking into account the dynamic aspects of traffic congestion.

Keywords: traffic modeling, urban congestion, travel time, robust path.

1. Introduction

Traffic congestion in transport networks in large metropolises is an undeniable socio-economic problem on the incomes of many countries of the world. In this context, the understanding of the various operations of regulation and

* Corresponding author. Tel.: +212 6 62 18 59 91
E-mail address: daissaoui.abdellah@gmail.com

10.1016/j.procs.2017.05.380

traffic management is important for successfully managing the complexity of congestion phenomena in the networks. Congestion could be defined as excessive. The marginal costs that impact society on the marginal costs of efforts to reduce its effects. Factors that cause congestion can be related to microeconomic considerations for road infrastructure. They may also be affected by macroeconomic phenomena related to demand for road use and depending on a set of realities related to modes and volumes of traffic. Random variables like weather, visibility, driver behavior are major factors explaining intensities for congestion. Current Intelligent Transport Systems offer solutions to manage traffic congestion. They are intended to equip existing vehicles and infrastructure with smart sensors. The effectiveness of a proactive and cooperative transport system will absorb traffic growth; improve its security and energy efficiency. They facilitate the mobility of people and could reduce 10% of road deaths and 25% of the time and cost of transport. Intelligent Transport Systems (ITS) gives promising solutions to reduce traffic congestion in major cities.

Predicting traffic congestion has been the subject of several research works offering different models. These have been developed on the basis of general prediction methods and theories. They were then modified in order to adapt them to the stochastic and non-linear nature of this phenomenon. These techniques include a non-exhaustive list of the following: statistics, time series, the machine learning techniques, Bayesian networks, genetic algorithms, fuzzy logic and hybrid approaches. The most widely used model in the literature to address this phenomenon is the ARMA (autoregressive and moving average). Another model proposes the decomposition of network flows as scaling coefficient and applies ARIMA to predict traffic congestion. The Markov and Gray models also predict traffic congestion[1]. Genetic algorithms were also used for predicting network traffic. A comparative study aims to determine the optimal method in the prediction of short-term traffic congestion between three methods is given in[2,3]. Another approach proposes a model based on recurrent neural networks in association with Boltzmann machines[4], aims to predict the propagation and the dissipation of this phenomenon. Swarms intelligence paradigm specially the ant-type has largely contributed to solving complex problems. Ant colonies algorithms are inspired by the behavior of ants or other species forming a super-organism, which are a family of Doriogo optimization meta-heuristic[5]. Several works have been proposed in this research topic, see Ando et al[6], Kurihara et al[7], Jiang et al[8], Kurihara[9]. In this paper, we propose a system based on the semi-macroscopic traffic modeling. The main objective of this work is to develop a flexible simulation of traffic on an urban transport network and to estimate and to predict travel times. These travel times are the costs considered for the road sections which are the input of a robust algorithm to find the optimum path according travel time criteria from an origin to a destination of the network. The structure of this work is organized as follows. Section 2 provides a brief semi-macroscopic simulation model that can work together or substitute for real-time data collector. In Section 3, we present the research approaches in the field of the robust shortest paths in dynamic graphs. The system architecture and related software components are explained in Section 4. The conclusion of this work is given in section 5.

2. Semi-macroscopic traffic model

Traffic flow may be considered as the flow of a continuous stream. Just assume that every moment and every spatial point is an infinitesimal portion of the vehicle. The fundamental traffic diagram describes the most important quantitative characteristic of traffic flows. Typically it defines a relationship between density and traffic flow.$\delta = \phi(\rho) = \rho \times v$. It is obvious that traffic flow phenomena depend strongly on the road occupancy rates. As the density ρ is sufficiently small, the average speed v is practically independent of ρ, this is explained by the fact that the vehicles are too far apart to interact with each other. Therefore, at low density of vehicles, traffic is practically free. However, from practical experience, vehicles must move more slowly with increasing density, when the forward movement of vehicles is severely hampered by others due to the reduction in the average distance between them. Lighthill Whitham-Richards model and kinematics waves[10]

The model Lighthill Whitham-Richards (LWR) is based on the assumption that the flow is a function of the density, $\delta = \phi(\rho) = \rho \times v$. The model equations are summarized as follows:

$$v_w = \frac{\phi(\rho_2) - \phi(\rho_1)}{\rho_2 - \rho_1} \quad (1) \qquad \begin{cases} \frac{\partial \rho}{\partial t} + \frac{\partial(\rho \times v)}{\partial x} = 0 \\ \delta = \phi(\rho) = \rho \times v \\ v = \psi(\rho) \end{cases} \quad (2)$$