

Chapter 10

Probe People and Vehicle– Based Data Sources Application in Smart Transportation

Sina Dabiri

Virginia Tech, USA

Kaveh Bakhsh Kelarestaghi

ICF Incorporated LLC, USA

Kevin Heaslip

 <https://orcid.org/0000-0002-3393-2627>

Virginia Tech, USA

ABSTRACT

Smart transportation is a framework that leverages the power of Information and Communication Technology for acquisition, management, and mining of traffic-related data sources. This chapter categorizes them into probe people and vehicles based on Global Positioning Systems, mobile phone cellular networks, and Bluetooth, location-based social networks, and transit data with the focus on smart cards. For each data source, the operational mechanism of the technology for capturing the data is succinctly demonstrated. Secondly, as the most salient feature of this study, the transport-domain applications of each data source that have been conducted by the previous studies are reviewed and classified into the main groups. Possible research directions are provided for all types of data sources. Finally, authors briefly mention challenges and their corresponding solutions in smart transportation.

INTRODUCTION

The rapid growth of various components of a city, including e-government and IT projects, technology, governance, policy, people and community, economy, built infrastructure, and the natural environment, has created a vast complex system (Chourabi et al., 2012; Saadeh et al.; 2018). Such a complicated

DOI: 10.4018/978-1-7998-0301-0.ch010

system brings about a variety of challenges and risks, ranging from air pollution and traffic congestion to an increase in the unemployment rate and adverse social effects. Making the cities “smart,” using Information and Communication Technology, is one solution to manage the urban troubles and enhance cities’ livability, workability, and sustainability (Council, 2013). Although the concept of the smart city is not novel, academics from different fields have defined this term in ways that are not consistent. For example, smartness in the marketing language focuses on users’ perspectives, whereas the smart concept in the urban planning field is defined as new strategies for improving the quality of life and having the sustainable environment (Nam and Pardo, 2011).

A general framework of the smart city contains three layers. These layers include (1) data collection and management, (2) data analytics, and (3) service providing (Zheng et al., 2014). As shown in Figure 1, the smart city includes multiple functions such as the smart economy, smart governance, smart people, smart transportation and mobility, smart environment, and smart living (Batty et al., 2012). Notwithstanding a strong interconnection between these functions, this survey considers only “smart transportation.” It should be noted that the three steps in the smart city architecture are applied to smart transportation as well.

Modern transportation systems are comprised of streets, railways, subways, traffic signals, vehicles, bicycles, and buses. The system moves people around the city for the commute to work/school, shopping, traveling, and leisure activities. The evolution of transportation networks in cities around the world gives rise to significant challenges. The principal challenge is traffic congestion due to a dramatic increase in transportation modes and population. Besides the direct adverse effects of traffic congestion on users, such as longer trip time and road rage behaviors, it also has long-term negative impacts on energy consumption and air quality (Smit et al., 2008), economic growth (Sweet, 2011), public health (Levy et al., 2010), and traffic crashes (Wang et al., 2009).

In this chapter, we investigate the currently available data sources that studies have used to develop with novel solutions to address challenges in transportation. A data source, in this study, is referred to as the technologies and systems that have the potential to collect traffic data. Data measured in the laboratories or collected by hiring subjects for a specific experiment are not within the scope of this survey. Accordingly, we are seeking to answer the following questions: What are the potential probe people and vehicle data sources in smart transportation? What type of technologies and methodologies are utilized to extract and collect transport-domain data from each traffic data source? What are the transportation-related applications associated with each traffic data source?

In pursuit of answering the first question, we categorize traffic data sources into three groups: 1) probe vehicles and people data, 2) location-based social networks data, and 3) transit data with the focus on smart cards data. The probe people and vehicle group, which refers to those moving sensors that receive spatiotemporal traffic data, are subdivided based on the technology used to collect the data: Global Positioning Systems (GPS), mobile phone cellular networks, and Bluetooth. Figure 1 illustrates the structure of the traffic data source categorization. Accordingly, the specific objectives of this study are to, first, briefly describe the operational mechanism of the technologies as mentioned above for generating traffic-related data. Secondly, for each data source, we systematically review the transport-domain applications, aiming to classify the past studies into the main groups. For the sake of feasibility, we concentrate on only representative examples in each of those main groups rather than attempt to cover all existing models exhaustively. Thirdly, about each data source, some possible areas for future research are provided.

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