Chapter 16

Obtaining Public Transport Level-of-Service Measures Using In-Vehicle GPS Data and Freely Available GIS Web-Based Tools

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ABSTRACT

In this chapter, the authors present a procedure to obtain some Level-Of-Service (LOS) measures, such as waiting times, travel times, and their variability, at any spatial and temporal aggregation level for dense bus networks using freely available map and geographic software. The proposed methodology is highly flexible, as it can accommodate either fixed or variable space-time aggregations. It can handle vast amounts of GPS data yielding LOS results relatively quickly. Furthermore, it can be implemented at relatively low cost in terms of software requirements using freely available software. An illustration of the proposed procedure and its results to obtain LOS measures such as travel times and their variability among bus stops and waiting times for every bus stop are reported using the geographic location of bus stops and offline GPS data available (every 30 seconds) for all operating buses in Santiago’s public transport system.

INTRODUCTION

Severe congestion and unexpected traffic conditions can degrade the performance of a public transport system. Collecting and processing detailed level-of-service (LOS) data is important for evaluating system performance, implement management strategies to mitigate possible problems in the system, and estimate relevant information to be provided to users. LOS information about vehicle occupancy, travel times, and arrival times at stop levels is relevant for public

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Transport operators need online LOS information to support their real-time control strategies such as holding (Osuna & Newell, 1972; Eberlein et al., 2001; Zhao et al., 2006), station skipping (Fu et al., 2003; Sun & Hickman, 2005; Cortés et al., 2010) and boarding limits (Delgado et al., 2009). Transport planners use offline LOS information to guide their decisions about fleet size planning and vehicle scheduling (Ceder, 2007). Public transport users make their journey decisions based on past experience and published information about travel and waiting times obtained from prior LOS data, when available.

The incorporation of information technology has renewed attention on vehicle LOS performance measurement techniques. Specifically, in-vehicle GPS technology provides the possibility of using public transport vehicles as probes for estimating network LOS performance measures more accurately (Storey & Holtom, 2003). Trying to minimise one of the most important attributes of modern public transport systems, the uncertainty associated with travel time variability, GPS measures are used when headway control strategies are implemented and vehicle arrival time at stops are estimated to be presented to users. Reducing travel time uncertainty has been found to be more valuable by users than reducing average travel times (Bates et al., 2001; Li et al., 2010; Arellana et al., 2012). Even though GPS vehicle positioning represents a good and inexpensive opportunity to collect substantial amounts of useful data for accurate LOS measuring, there are some practical difficulties associated with data processing (Bullock et al., 2005). Handling these rich data can be labour intensive, time consuming and challenging, especially in highly dense networks. Therefore, systematic, inexpensive and easy to apply techniques to process information quickly and display LOS outcomes efficiently are required.

The main aim of this paper is to describe a procedure designed to obtain important LOS measures, at any spatial and temporal aggregation level, in the case of dense bus networks using freely available map and geographic software. Specifically, we are interested in estimating accurate waiting times at stops and travel times among stops and their variability, for different temporal aggregation levels, using offline GPS data collected in a large city as main input for the procedure.

The remainder of the paper is arranged as follows. First, a brief review of relevant literature regarding procedures to obtain LOS measures from GPS data is presented. This is followed by a description of the data and then by a description of the procedure using data available for all operating buses in Santiago’s public transport system. Finally, some conclusions and directions for further research are given.

Handling GPS Data to Obtain LOS Measures

Several authors have proposed different techniques to obtain LOS measures at different aggregation levels from GPS data. To our knowledge, there are no published techniques to obtain relevant LOS measures from GPS data for different time periods at bus stop level using freely available map and geographic software. Quiroga and Bullock (1998) proposed a popular GIS-based procedure for conducting travel time studies that requires fixing either the distance segments or defining fixed time periods for speed calculations. A more flexible procedure, without commercial GIS software requirements, was recently proposed by Cortés et al., (2011) for bus speed monitoring using a time-space diagram grid for each given route, where each grid element is defined by a rectangle of previously fixed distance and time edges. Although this time-space diagram grid can be set to any time period and distance segment, it