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Search for a global positioning system device to measure person travel

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Abstract

In the late 1990s, global positioning system (GPS) devices began to be used as a method for measuring personal travel. Early devices were for in-vehicle use only and derived their power from the accessory socket of the car. In the early 2000s, the first wearable devices appeared, using battery power from rechargeable batteries. The early wearable devices were heavy and ungainly, and success in having people use the devices was limited. In 2005, the Institute of Transport and Logistics Studies (ITLS) and NeveITS pioneered the use of a much smaller device with its own internal battery, similar in weight and dimensions to a mobile telephone. Subsequent to the initial deployment of this device, there have been further advances in the sensitivity of the antenna/receiver and we have developed with NeveITS a number of improvements to software. Most recently, another device called a Starnav, has been developed for ITLS in Taiwan, and offers further sophistication and user friendliness than the Neve devices. This paper describes these GPS devices and demonstrates the capability of these devices to provide detailed and accurate data on travel movements. We provide a brief description of the software we have developed and continue to improve for analysing the resulting data. The latest technologies for GPS devices indicate the potential to replace many conventional methods of data collection that are flawed because of known errors and inaccuracies.

Keywords: Global positioning system (GPS); Travel survey; Data processing; Trip identification

1. Introduction

By the time this paper is published, it will almost certainly be out of date, because of the rapidity with which advances are taking place in the technology that underlies this paper. At the time of initial writing, we are anticipating delivery of the next generation of global positioning system (GPS) device, for which testing

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and full-scale roll out is expected to have occurred and be reflected in the final version of the paper that will be published. Nevertheless, new developments are taking place continually and are of a nature such that it is desirable to take advantage of them as rapidly as possible to improve the capability of these devices to measure person travel.

Transport research often requires data on the geographic and temporal aspects of travel and the performance of the transport system. However, most people can provide only rather inaccurate data about where they go, and often do not provide accurate information about when they travel or how far they travel and what duration their travel takes in interview surveys (Stopher, 2004). In addition, the transport analyst needs accurate information about travel speeds at different times of the day in various locations and also may desire precise information about routes travelled through the networks. Before GPS devices became available, obtaining such data was extremely difficult, if not impossible. GPS, especially in conjunction with an appropriate GIS, offers the capability to obtain very precise information about where a person, vehicle, or consignment is at a given time, what route is being travelled, how fast the object of concern is travelling, where the object started out on the travel, and where it goes. This information is provided at a level of accuracy of plus or minus a few meters for location, and to the nearest second or less for temporal data.

In the mid-1990s, the US Federal Highway Administration (FHWA) undertook a proof-of-concept test of the use of a GPS device to measure travel behaviour (Wagner et al., 1997). Since then, GPS measurement of travel has escalated rapidly. Initially, GPS devices were restricted to use in a car, because they had no integral power supply and needed to be powered from the car itself, and did not include storage to permit logging of a large number of position points. The earliest devices comprised a GPS antenna/receiver that was connected to a personal data assistant (PDA), and required the respondent to enter data as his or her travel proceeded, also called "Active GPS". Following the successful proof-of-concept test, a number of independent studies used either the same GPS/PDA devices developed for FHWA, or other off-the-shelf devices. Doherty et al. (2001) developed an activity based electronic questionnaire (CHASE) for PDAs. This allowed users to input information to complement the tracking data. Such a system was used in a travel survey in Flanders in 2004 (Kochan et al., 2006).

At the same time, the Dutch also developed a GPS device, with its own battery power. This was designed to be able to be taken on a bicycle (Draijer et al., 2000) and represented the first "wearable" device. However, this device weighed 2 kg, making it rather heavy to carry on a bicycle or walking.

In the next few years, work in the US began on developing passive GPS devices (Stopher, 2001; Stopher and Bullock, 2001; Stopher et al., 2002). These are devices that require no input by the survey respondent during use. The devices were designed to be on while the car's accessory socket was live, and to be off when power was no longer provided (Wolf et al., 2001, 2003). Such devices still, however, remained in-vehicle devices, because they did not have any power supply of their own.

An in-car GPS device was also used in a road-pricing experiment in Copenhagen during 2001 and 2002 (Schönfelder et al., 2007). In this study, roughly 400 cars were equipped with GPS data loggers for a period of 10–12 weeks. The GPS monitoring was accompanied by a telephone based before-and-after survey consisting of attitude questions and SP instruments. A Swedish study also used in-vehicle GPS devices to examine the safety effects of in-car speed information systems (Hultkrantz and Lindberg, 2003). This device measured the location and speed of the vehicle by GPS, looked up the speed limit from a network database, and informed the driver of speed violations when they occurred.

In procedures pioneered by the Institute of Transport and Logistics Studies (ITLS), the additional information that was previously captured on the PDA was collected in a prompted recall survey (Stopher et al., 2005b). In subsequent work at ITLS, the prompted recall survey was also developed into an internet survey, with animation of each trip, to allow respondents to indicate if there had been an intermediate stop that was not detected by the researchers, or to indicate that what was presented as two trips was really one (Stopher and Collins, 2005).

A wearable version of the GPS device was subsequently developed from the in-vehicle device. This device consisted of the same recording box used in the in-vehicle device, which was carried in a small bag, together with a battery pack, and an antenna/receiver about the size of a standard computer mouse, which was mounted on the bag strap, so that it would sit on the shoulder of the wearer. The device weighed close to 300 g, thus representing a significant improvement over the Dutch wearable device, but still representing a significant device weight.