Chapter 32

Travel Time Data Collection

32.1   Introduction

Travel time can be defined as the period of time to transverse a route between any two points of interest. It is a fundamental measure in transportation. Travel time is also one of the most readily understood and communicated measure indices used by a wide variety of users, including transportation engineers, planners, and consumers. Travel time data is useful for a wide range of transportation analyses including congestion management, transportation planning, and traveler information. Congestion management systems commonly use travel time-based performance measures to evaluate and monitor traffic congestion. In addition, some metropolitan areas provide real-time travel time prediction as part of their advanced traveler information systems (ATIS). Travel time data can be obtained through a number of methods. Some of the methods involve direct measures of travel times along with test vehicles, license plate matching technique, and ITS probe vehicles. Additionally, various sensors (e.g. inductance loop detectors, acoustic sensors) in ITS deployment collect a large amount of traffic data every day, especially in metropolitan areas. Such data can be used for travel time estimation for extensive applications when direct measurements of travel times are not available [19].

Travel time, or the time required to traverse a route between any two points of interest, is a fundamental measure in transportation. Travel time is a simple concept understood and communicated by a wide variety of applications for transportation engineers and planners. Several data collection techniques can be used to collect travel times. These techniques are designed to collect travel times and average speeds on designated roadway segments or links.

Following are the different techniques available for the travel time data collection.

- Test Vehicle Techniques

- License Plate Matching Techniques

- ITS Probe Vehicle Techniques

- Emerging and Non-Traditional Techniques

32.2   Test Vehicle Techniques

Travel time data using active test vehicles in combination with varying levels of instrumentation: manual (clipboard and stopwatch), an electronic distance measuring instrument (DMI), or a global positioning system (GPS) receiver. It involves the use of data collection vehicle within which an observer records cumulative travel time at predefined checkpoints along a travel route. Then this information converted to travel time, speed, and delay for each segment along the survey route. There are several different methods for performing this type of data collection, depending upon the instrumentation used in the vehicle. These vehicles are instrumented and then sent into the field for travel time data collection, they are sometimes referred to as "active" test vehicles [16].

Advantages

- Advanced test vehicle techniques (e.g., DMI or GPS use) result in detailed data.

- Low initial cost.

Disadvantages

- Sources of possible error from either human or electric sources that require adequate quality control,

- Data storage difficulties.

32.3 License Plate Matching Techniques

Travel times by matching vehicle license plates between consecutive checkpoints with varying levels of instrumentation: tape recorders, video cameras, portable computers, or automatic license plate character recognition [16].

Advantages

- Travel times from a large sample of motorists, very simple technique.

- Provides a continuum of travel times during the data collection period.

Disadvantages

- Travel time data limited to locations where observers or video cameras can be positioned;

- Limited geographic coverage on a single day

- Accuracy of license plate reading is an issue for manual and portable computer

32.4 ITS Probe Vehicle Techniques

Travel times using ITS components and passive probe vehicles in the traffic stream equipped with signpost-based transponders, automatic vehicle identification (AVI) transponders, ground-based radio navigation, cellular phones, or GPS receivers [16].

Some vehicles are equipped with dynamic route guidance (DRG) device which act as roving traffic detectors, a non-infrastructure based traffic monitoring system. Such vehicles, which are participating in the traffic flow and capable of determining experienced traffic conditions and transmitting these to a traffic center, are called probe vehicles. To determine its position and to register experienced traffic conditions, a probe vehicle is equipped with on-board electronics, such as a location and a communication device. By means of the location device, the probe vehicle keeps track of its own geographic position [16].

Through the communication device, the probe vehicle transmits its traffic experiences via a mobile communication link to a traffic center. For instance, each probe can transmit traffic messages once every
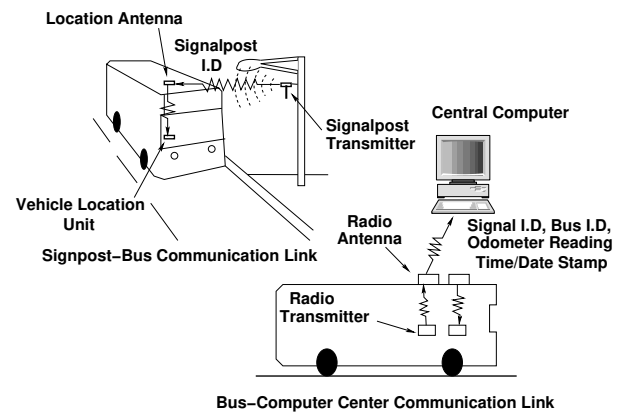

Figure 32.1: Signpost-Based AVL Communication Processes, Source: Travel Time Detection Hand Book, [16]

time interval containing its location and its speed at the instant of transmission. In this traffic center the traffic data received from probe vehicles is gathered, and combined with data from the other monitoring sources, and processed into relevant traffic information. It is very useful for Advanced Traveler Information system (ATIS).

Advantages

- Low cost per unit of data

- Continuous data collection

- Automated data collection

- Data are in electronic format

- No disruption of traffic

Disadvantages

- High implementation cost

- Fixed infrastructure constraints - Coverage area, including locations of antenna

- Requires skilled software

- Not recommended for small scale data collection efforts

ITS probe vehicle data collection systems

1. **Signpost-Based Automatic Vehicle Location (AVL)** - This technique has mostly been used by transit agencies. Probe vehicles communicate with transmitters mounted on existing signpost structures shown in Fig. 32.1 [16].
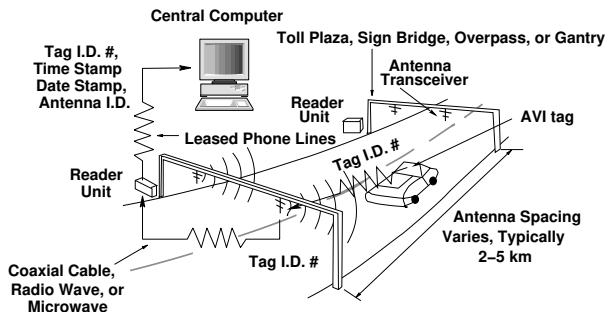
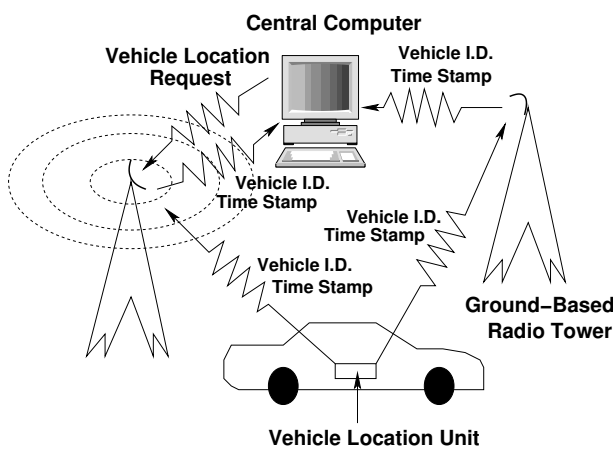Figure 32.2: AVI Vehicle-to-Roadside Communication Process, Source: Travel Time Detection Hand Book, [16]

Figure 32.3: Ground-Based Radio Navigation Communication Process, Source: Travel Time Detection Hand Book, [16]

2. **Automatic Vehicle Identification (AVI)** - Probe vehicles are equipped with electronic tags. These tags communicate with roadside transceivers to identify unique vehicles shown in Fig. 32.2 and collect travel times between transceivers [16].

3. **Ground-Based Radio Navigation** - It is used for transit or commercial fleet management, this system is similar to the global positioning system (GPS). Data are collected by communication between probe vehicles and a radio tower infrastructure as shown in Fig. 32.3 [16].

32.5 Cellular Geo-location

This experimental technology can collect travel time data by discretely tracking cellular telephone call transmissions. Cellular telephones are also useful to collect travel time data. Two techniques have been applied using cellu-

lar technology: cellular telephone reporting and cellular geolocating [16].

32.5.1 Cellular Telephone Reporting

An operator at the central control facility records each driver's identification, location, and time, by monitoring the time between successive telephone calls, travel time or travel speed between reporting locations are determined. It is useful for assessment of current traffic conditions and for collecting travel time data during delays or accidents. The cellular telephone reporting method is recommended for short-term studies with low accuracy requirements.

32.5.2 Cellular Geolocation

The cellular geolocating methodology discreetly tracks cellular telephone calls to collect travel time data and monitor freeway conditions. This technique utilizes an existing cellular telephone network, vehicle locating devices, and a central control facility to collect travel time data. All vehicles equipped with cellular telephones are potential probe vehicles. The system automatically detects cellular telephone call initiations and locates the respective probe vehicle within a few seconds.

Advantages

- Driver recruitment not necessary

- No in-vehicle equipment to install

- Large potential sample

Disadvantages

- Low accuracy

- Privacy issues

- Infrastructure dependent

32.6 Emerging and Non-Traditional Techniques

Emerging or non-traditional techniques are based on using "point" vehicle detection equipment, such as inductance loop detectors or video cameras. Travel time estimation algorithms have been developed based upon measurable point parameters such as volume, lane occupancy, or vehicle headways. Image matching algorithms are used to match vehicle images or signatures captured at two consecutive observation points. Following are some of the methods used in emerging techniques [16].

32.6.1 Extrapolation Method

Estimates average travel time by spot speeds, applied for short roadway segments between detection devices. It is more suitable for low accuracy application. The most accurate method to measure vehicle speed with loop detectors is to place two detectors in series, which is referred to as "speed trap" or "loop trap". The accuracy of inductance loop speed traps is dependent upon the trap length, inductance loop wire type, and consistency in design. Many inductance loop detectors are single loops; primary application is to collect vehicle counts and lane occupancy. Many research attempts have been made to utilize speed-flow relationships to estimate vehicle speeds from single loop detectors. The following 32.1 and 32.2 equations have been used to estimate spot speeds from single loop detectors [16].

$$Spotspeed = \frac{volume}{laneoccupancy \times g} \qquad (32.1)$$

where,
g = speed correction factor (based upon assumed vehicle length, detector configuration, and traffic conditions).

$$Traveltime = \frac{LinkLengthinkm}{Spotspeedin\frac{km}{hr}} \times 3600\frac{sec}{hr} \qquad (32.2)$$

32.6.2 Vehicle Signature Matching

Calculates travel time by matching unique vehicle signatures between sequential observation points. These methods can utilize a number of point detectors such as inductance loop detectors, weigh-in motion sensors, video cameras, and laser scanning detectors. Vehicle signatures between two consecutive locations to provide a link based travel time and speed. It provides alternative to ITS probe vehicle based on travel time measurement, in which a probe vehicle is identified and matched between two locations using a unique identification number.

Vehicle signature matching had been investigated using a number of different point detection devices, mostly with inductance loop detectors. Several algorithms are available to capture vehicle signatures from a loop detector frequency detuning curve. Different types and classes of vehicles provide different types of signatures. The unique features of a vehicle signature are then compared to signatures within a given time frame at a downstream location. The signature is matched when a large number of feature correlations have been found within vehicle signatures at the downstream location. The vehicle signature matching technique does not match every vehicle signature captured, but potentially match a large enough percentage as to be significant [16].

32.7 Summary

Detailed travel time estimation by different techniques has been discussed in this chapter. Also travel time estimation by vehicle technology and emerging techniques such as vehicle signature have also been discussed in this chapter.

Exercises

32.1. In the absense of any automated equipments, how would you conduct a survey to get travel time data in a stretch of road.

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