Mobile Device Data for Origin-Destination Travel Trends

Exploratory Advanced Research . . . Next Generation Transportation Solutions

For the project "Data Analytics and Modeling Methods for Tracking and Predicting Origin-Destination Travel Trends Based on Mobile Device Data," the Maryland Transportation Institute (MTI) at the University of Maryland worked with data provider partners such as mobile phone companies to determine if accurate and reliable origin-destination (OD) products could be developed from mobile device location data. The team was dedicated to developing transparent evaluation and open-source algorithms that can build more public trust toward the data and relevant products and get the research community more involved in the new technology. The Federal Highway Administration's (FHWA) Exploratory Advanced Research (EAR) Program funded the study.

Mobile device data can be collected with minimal public burden and cost, and the team wanted to see how this data can supplement traditional methods of data collection to enable a more nuanced understanding of the needs of the traveling public and how best to address those needs. The team also wanted to shed light on the processes involved in going from anonymized raw location data to OD tables. OD patterns can be incredibly helpful for transportation planners because they show planners where to invest funding for infrastructure projects, how to invest in each mode of transportation, and how to manage local transportation systems and operations.

Data on OD can include where people travel and what transportation mode they use. At the national level, OD data can help transportation planners learn about intercity transportation patterns, such as how many people travel to Washington, DC, from New York City or Los Angeles by driving, flying, or traveling on intercity bus. A local-level example is planners using OD data to evaluate the effectiveness of policy aimed at encouraging walking or bicycling.

"I can see this research as having an immediate impact because agencies and the private sector can leverage these emerging data sources and improve their decisionmaking—which improves our quality of life overall," said Patrick Zhang, FHWA's research manager for data and policy in the division of travel monitoring and surveys.

Federal and State agencies have gathered similar information before, through surveys, but agencies only undertake travel surveys every 5 to 10 years, and so the data can be outdated. By using mobile device data, decisionmakers can receive more timely information, with larger sample size, about how people and goods move across the country and within their cities.

The Research in Action

To test the feasibility of using mobile device data as a reliable way to collect and analyze OD patterns, the researchers sought to collect location data, which can be culled from a variety of sources, including global positioning systems (GPS) embedded in the phone, communication data between cell phone towers and mobile devices, and data from location-based services such as weather or mapping apps. The researchers for the study looked at the OD patterns of freight movement in addition to passenger travel, and they also used data from trucks' GPS equipment.

To protect privacy, the input data used in the research was anonymized and did not include sensitive individual-level information that would allow anyone to trace it back to individual persons. The end products of the project are OD tables aggregate at large zone levels (e.g., metropolitan area to another metropolitan area). The researchers tested the validity of the products against the Baltimore metropolitan region.

U.S. Department of Transportation

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Mobile device location data sources. © Maryland Transportation Institute.

The researchers developed algorithms to impute travel information that wasn't directly collected from the original location data. For instance, they imputed travel modes by studying speed and trajectory data with multi-modal transportation network data (e.g., bus stops, train stops, road network, and transit routes). Trip purposes were imputed through analyses of daily travel patterns, duration and location of trips, and integration with point-of-interest data.

Information such as income, age, and gender also are important for travel analysis. The research team therefore developed machine learning algorithms to impute socio-demographic information based on data from the U.S. Census. The end products of this research project can help researchers and planners understand the different travel patterns and needs of different demographic groups, such as groups categorized by age or income level.

The researchers developed the data and methodologies to be transparent so that other researchers, transportation planners, and the general public can understand how the researchers arrived at their conclusions and could use the same approach for their work. The transparency in data quality, methodology, and validation is the key feature that differentiates the product of this research from the state of the practice. The researchers have developed novel algorithms that better address well-known issues of mobile device location data, such as sample bias; inconsistent number of location observations among devices; trip identification challenges; imputation of trip purpose, mode,

EXPLORATORY ADVANCED R E S E A R C H

What Is the Exploratory Advanced Research Program?

The EAR Program addresses the need for longer term, higher risk research with the potential for transformative improvements to transportation systems. The EAR Program seeks to leverage advances in science and engineering that could lead to breakthroughs for critical, current, and emerging issues in highway transportation by experts from different disciplines who have the talent and interest in researching solutions and might not do so without EAR Program funding.

To learn more about the EAR Program, visit http://highways.dot.gov/research/exploratory-advanced-research. The website features information on research solicitations, updates on ongoing research, links to published materials, summaries of past EAR Program events, and details on upcoming events.

and socio-demographic information; and weighting and expansion. This project is the first study that has developed U.S. national-level OD products for person and truck travel based on mobile device location data. FHWA and the research team intend to make all algorithms funded by FHWA open-source at the end of the project.

Learn More

For more information about this EAR Program project, contact Patrick Zhang, FHWA Office of Highway Policy Information, at 202-366-1941 (email: patrick.zhang@dot.gov).