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FREQUENCY ANALYSIS APPLIED TO TRANSPORTATION FREIGHT, GOODS AND SERVICES DATA

PROBLEM STATEMENT

There are many data sets collected in the study of transportation freight, goods, and services. In order to make these data sets useful for transportation planners and decision makers in improving or designing more flexible and efficient transportation systems, sophisticated data analysis must be carefully performed. One of such need is detecting the periodicity patterns in the data sets. A simple example of a periodicity pattern is the daily peak hours of the traffic counts, but there may be many hidden periodicity patterns that are not as easily observable. The recently developed tool of frequency analysis can be used to detect such patterns.

OBJECTIVES

The objectives of this research project are to develop the following:

- a quantitative analysis of transportation data sets (such as freight, goods, and services), in particular, the detection of hidden periodicities within the data set
- interpretation of the findings (periodicity patterns) and recommendations for planners and decision makers
- a guideline for applying the technique to other data sets
- a prototype of a user-friendly computer environment for detecting hidden periodicities based on frequency analysis techniques

FINDINGS AND CONCLUSIONS

A large collection of transportation data sets were studied, including the 2004 release of the 2001 National Household Travel Survey from Bureau of Transportation Statistics (BTS); the Waterbourne Commerce: Foreign Traffic Vessel Entrance and Clearances data set from the Army Corps of Engineers; the Airline data set that contains daily records of actual departure times, arrival times, origins and destinations for non-stop domestic flights by major air carriers from 1988 to 2004 (BTS); the Visit Florida data that summarizes travel patterns of Florida residents and domestic/Canadian visitors to Florida in years 2000 and 2001; and the data from a private company, Reebie Associates, that describes commodity flow among 247 market areas in Florida and 16 counties bordering on Florida. Researchers demonstrated the developed method of frequency analysis, concentrating on the Airline data set, in particular, the flight delay patterns.

The interpretation of the results from frequency analysis presented the most challenges. The applied approach can be summarized as a two-stage strategy in which the frequency analysis method is first used to do a preliminary and quick detection of possible periodicities (especially the hidden ones) in the data set. Then, from the detected periodicities, in order to explain the causes, researchers

developed a list of possible variables with similar periodicities and performed a detailed regression analysis and analysis of variance. The results from the regression analysis and analysis of variance were used to explain the possible causes for the detected periodicities.

A complete set of Matlab programs was developed for frequency analysis. A user-friendly interface is provided for easy use of the method in dealing with other transportation data sets.

BENEFITS

The proposed method has been successfully used to detect hidden patterns in airline flight delay data sets; it has also been applied to traffic volume data sets. This methodology has the potential to provide many applications in transportation planning and engineering. In the context of the transportation of freight and goods, if certain periodical patterns are detected, then this method would help engineers, planners and decision makers prepare for expected changes. For example, detecting periodical changes in freight movements would help to anticipate higher trucks demand at certain locations on the transportation network. This capability could help planners determine operation hours of trucks and the effect of trucks on the level of service of the roadways of interest; traffic engineers could adjust signal timing to meet the increased truck demand; and infrastructure engineers could anticipate the effect of increased truck movements and patterns on pavement conditions.

Indeed, there are a variety of other potential beneficial uses. For example, this method could be used to detect the patterns and locations of increased tourist activities from meaningful data sets collected during an extensive period of time, which would help decision makers and planners meet periodical increases in demand. A future application might include anticipating patterns in traffic crashes and thus identifying seasonal problems, which would aid emergency vehicles and personnel.

This research project was conducted by Xin Li, Ph.D., of the University of Central Florida. For more information, contact Huiwei Shen, Project Manager, at (850) 414-4911, huiwei.shen@dot.state.fl.us.