Time -Geographic Methods For Analyzing GPS Data

Mei-Po Kwan
Department of Geography, Ohio State University
kwan.8@osu.edu

For transportation researchers and geographers interested in understanding human behavior in space-time and its complex relationship with the urban environment, the possibility of collecting and using GPS data offer new opportunities and pose many challenges at the same time. Recent studies that use GPS data of individual trips indicate that GPS may allow the accurate reconstruction of individuals' activity-travel patterns with considerable space-time details (Murakami and Wagner, 1999). The reconstructed patterns (as revealed preference of travelers) can be used for various purposes, including the study of route planning and route choice behavior, activity scheduling involving complex space-time trade-offs, the daily and weekly temporal rhythms of activities or trips (e.g. cycles and repetitions), and responses to real-time information as in the context of Intelligent Transportation Systems (Kwan, 2000; Zhou and Golledge, 2000). Further, as the precise space-time trajectories of walking trips can be recorded, transport problems of the mobility-impaired population subgroups - such as the vision-impaired or the elderly people - can be analyzed in great space-time details.

GPS data may also enable the development of a whole range of new analytical and modeling methods useful to transportation researchers and geographers. Given the recent development and application of time-geographic GIS-based methods in many areas of human spatial behavior, it is now possible to analyze and model individual travel behavior in relation to a realistically represented urban environment - in the form of a comprehensive geographic database of the study area that includes information about all land parcels and all street segments (including segment-specific travel speed and turn restrictions). GIS-based geocomputation and 3D geovisualization of activity-travel diary data are examples of the methods useful for the analysis of GPS data (Kwan and Lee, 2004).

Several difficulties still remain for future studies that attempt to use GPS data. First, discontinuities or gaps in GPS data cannot be entirely eliminated due to the problem of "loss of fix" that can happen under certain circumstances (e.g. loss of signal inside certain areas of a building). As past studies indicate, dealing with this data discontinuity problem may require considerable time and effort during the data preparation phase of a study. Second, although comprehensive data can be collected if all of the activities and trips an individual undertakes throughout the survey period are recorded, users of GPS may not keep their devices on throughout the day for various reasons. This will introduce gaps in the data and make it difficult to achieve completeness in GPS data. Third, the activity a user is doing at a particular time cannot be easily recorded with GPS devices. Although linked devices or integrated devices (e.g. PDA) had been used to record and link activity data with the location data generated by GPS devices, collecting complete and reliable data

is still very difficult. Fourth, the ability of GPS devices to reveal and record people's geographical position raises serious concern about privacy when using the technology.

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