The Advantages of Passive Mobile Positioning As a Type of Community Sensing for Analyzing Space-Time Behaviour of a Citizen

Kaisa Vent
Vanemuise 46-244
Tartu, 51014 Estonia
vkaisa@ut.ee

UbiComp '13, September 08 - 12 2013, Zurich, Switzerland

Author Keywords
Passive mobile positioning; crowdsensing technologies; space-time behaviour;

ACM Classification Keywords
J.4 Social and behavioral sciences: Sociology.

Introduction

The problem of spatial decision-making and choice behaviour has a long-standing tradition in geographic research. One can identify numerous approaches for studying the aforementioned, time-geography being one of them [1]. At the heart of time-geography there is the notion of space and time [2]. Space can be seen in both ways: acting as a restrictive unit and at the same time offering opportunities for different activities related to meaningful places. Allan Pred has made an effort in integrating time geography with the theory of structuration. He argues that place always involves an appropriation and transformation of space and nature that is inseperable from the reproduction and transformation of society in time and space [3]. From this point of view it becomes necessary to study human behaviour in time-space context in order to understand how cities "work" and how do they influence human behaviour.

Space-time behaviour of citizens forms a basis for understanding how people interact with the city and how do they perceive the urban environment. The immense popularity of mobile phones has opened up new sources of sensor data that can be used to measure individual and community phenomena in terms of space and time. Passive mobile positioning is a type of community sensing that is independent from mobile phone users, thus minimizing respondent burden and maximizing the amount of data available from the source. Therefore, passive mobile positioning can be considered valuable source for providing location data about large number of citizens in order to study their space-time behaviour in urban environment.

Discussion

There are different aspects one could focus on, while studying human interaction with urban environment. Studying different kinds of places citizens visit, time spent there and the frequency of visitation gives the idea how the urban space is being utilized and what is attractive to citizens. Analyzing movement patterns gives the idea of how built environment can interact with personal choice behaviour. So far the data for these kinds of travel behaviour studies has mostly been limited to short time periods such as day or two, this on the other hand sets limitations to the understanding of temporal variations and rhythms in activity-travel behaviour [4][5]. Some personal and social discretionary activities related to places in the urban environment can be considered occurring in a longer time frame such as week and in some cases even have seasonal variability. Short duration surveys often include rather detailed view of person's daily activity schedule, however it might not bring out the regularities over longer period of time due to the dissimilar patterns on a survey day [6]. On the other hand, traditional survey methods such as travel diary and questionnaire survey offer limited applications due to small sample sizes [7], small response rates [8] and missing activities and trips [9] [10]. Questionnaire data has been good source for examining respondent's socio-economic attributes, however its major limitation while studying places and activities related can be the fact that with only using questionnaire data we might produce inaccurate results due to the inadequate or insufficient data respondents provide during the questionnaire survey. Aforementioned limitations are therefore the main reason why travel behaviour research is heading towards using more passive data collections methods, that would leave respondents with less responsibilities and give researchers the possibility to gather accurate data for longer periods of time.

Passive mobile positioning data is location data that is automatically stored in the databases of mobile operators when person uses a mobile phone [11]. Each record in the database is related to the specific network cell where the call was made and also contains information about time when the call was made, which allows researchers use this kind of information for example in transportation and tourism studies. The precision of the location information using passive mobile positioning method is dependent on the location itself – dense urban areas host more cell sites than rural areas, making the accuracy range between 0,8 km^2 to 120 km^2 respectively [12].

Question that is often raised while talking about mobile crowdsensing is the aspect of privacy. On one hand people tend to be more cautious with the data they share about their everyday movements, on the other hand it can be difficult to provide the security people ask for. One way of trying to get rid of the privacy issue

is the anonymization which removes any identifying information from the sensor data before sharing it with a third party. However typically it would still be possible for a person to infer the frequently visited locations of an individual and derive their personal details [13]. Ganti et al. have discussed the different possible ways of privacy preserving bringing out the cryptographic techniques to transform the data as the most promising ones.

Conclusions

In past two decades mobile phones have become increasingly popular allowing researches to use them for crowdsensing on a scale larger than ever. Passive mobile positioning is one valuable way of gathering location data about large number of people without burdening them with questionnaires and extra devices they have to carry with. Mobile positioning also allows longitudinal surveys, bringing out the seasonal rythms of space-time behaviour of a citizen in urban environment. Privacy issues have so far been the greatest concern using such data, however techniques for providing privacy are being constantly improved.

References

[1] Timmermans, H., Arentze, T. and Joh, C.-H. Analysing space-time behaviour: new approaches to old problems. *Progress in Human Geography 26,* 2 (2002), 175-190.

[2] Golledge, R. G., Stimson, R. J. Spatial behaviour: a geographic perspective. New York, Guilford Press (1997).

[3] Pred, A. Place as historically contingent process: structuration and the time-geography of becoming places. *Annals of the Association of American Geographers 74,* 2 (1984), 279-297.

[4] Goodwin, P.B. The usefulness of travel budgets. *Transportation Research A* 15 (1981), 97–106 .

[5] Kitamura, R. An analysis of weekly activity patterns and travel expenditure. In: Golledge, R., Timmermanns, H. (eds.) Behavioural Modelling in Geography and Planning (1988), pp. 399–423. Croom Helm, London.

[6] Spissu, E., Pinjari, A. R., Bhat, C. R., Pendyala, R. M., Axhausen, K. W. An analysis of weekly out-of-home discretionary activity participation and time-use behavior. *Transportation* 36 (2009), 483–510.

[7] Stopher, P. R., Greaves, S. P. Household travel surveys: Where are we going? *Transportation Research Part A* 41 (2007), 367-381.

[8] Wilson, J. Measuring personal travel and goods movement (Transportation Research Board Special Report 277). Transportation Research Board, Washington, DC (2004).

[9] Pearson, D. A comparison of trip determination methods in GPS-enhanced household travel surveys. In: *84th Annual Meeting of the Transportation Research Board*, Washington, DC (2004).

[10] Wolf, J., Oliveira, M., Thompson, M. Impact of underreporting on mileage and travel time estimates – results from Global Positioning System-enhanced

household travel survey. *Transportation Research Record* 1854 (2003), 189–198.

[11] Ahas, R., Aasa, A., Aunap, R., Kalle, H. and Mark, Ü. Mobile Positioning in Space–Time Behaviour Studies: Social Positioning Method Experiments in Estonia. *Cartography and Geographic Information Science* 34, 4 (2007), 259-273.

[12] Järv, O., Ahas, R., Saluveer, E., Derudder, B. and Witlox, F. Mobile phones in a traffic flow: a geographical perspective to evening rush hour traffic analysis using call detail records. *PLoS ONE* 7, 11 (2012), e49171.

[13] Ganti, R. K., Ye, F. and Lei, H. Mobile Crowdsensing: current state and future challenges. IBM T. J. Watson Research Center, Hawthorne, NY.