

Developing a methodology for validating pedestrian counts from Wi-Fi sensors to aid in quantifying the ambient population

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Abstract

Typically, populations have been quantified through the use of censuses and household surveys, which capture the place of residence of individuals. This data fails to capture the fluctuations in populations which occur temporally, especially in urban areas which often experience an influx of workers. The ambient population is defined as the number of persons within a defined outdoor geographical area, at a given point in time, excluding those located on modes of transport or at their place of residence. Wi-Fi sensors are one way in which estimates of the number of people in an area can be gathered. The sensors provide footfall figures by tracking a 'count' each time a Wi-Fi probe request is received. Wi-Fi probe requests are regularly broadcast by mobile devices in order to advertise their presence and actively discover Wi-Fi access point in proximity (Freudiger, 2015).

Estimates of the ambient population are a key development in understanding the structure of cities and urban dynamics. Urban dynamics are the changing movements of people, objects and information in a city and an understanding of their components is an integral element of city management and planning. The United Nations (2014) estimate that two thirds of the global population will be living in cities or other urban centres by 2050. The predicted increase of the number of individuals living cities increases the urgency of developing approaches to quantify the ambient population. Estimates of the ambient population are essential to the sectors of retail, housing, transportation and emergency management. As highlighted by Ahola et al (2007), current risk management models do not take into account the temporal fluctuations in population location during different times of the day. The inclusion of estimates of the ambient population would improve the reliability of evacuation plans and resource allocation. Estimates of the ambient population can be a valuable asset for local government from an economic perspective, including aiding in the assessment of whether locations are performing well in terms of visitor numbers and retail spend. Socio-economic proposals by local governments for the staging of events and financial support can be fortified by estimates of population and can provide indications of the success of events held in an area.

Previous endeavours to quantify the ambient population have been bound by the absence of complete appropriate datasets at fine temporal scales. The 2011 UK Census captured information regarding the workday population, which provided estimates of people in an area during working hours when people who work outside of a geographical area were omitted from the counts. While this information is able to supply a general indication of the proportion of people that work in area, it does not capture fine fluctuations or non-work activities such as shopping or leisure activities. There is no single dataset which provides information regarding the location of people when not in the home on a daily or hourly basis, but there are a number of new datasets produced by recent technologies, such as Wi-Fi sensors and geo-located social media posts, which could be utilised in conjunction with one another in order to provide estimates of the ambient population.

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This project is a component of a larger project which will attempt to develop a novel methodology for integrating datasets to provide an indication of where people are likely to be located at different times of the day, week or month

Existing work has validated counts from Wi-Fi sensors through the development of an adjustment factor which is based on the difference between counts manually conducted and those from sensors. The presentation of this work aims to facilitate discussion as to whether manual counts are able to accurately validate pedestrians counts from big data.

The issues with manual counts include:

1. Ensuring that the zone being measured is exactly the same, for example Wi-Fi sensors capture people within a certain radius of an access point with Wi-Fi enabled devices. While manual counts would include people who do not own mobile devices, or own them but do not have Wi-Fi enabled, there is no guarantee manual counts could capture the same geographical area.
2. A lack of resources to enable manual counts to be repeated in different locations and at different times to ensure the accuracy of counts
3. An inability to know whether a person has dwelled in area, which can be detected through the examination of MAC addresses in data from Wi-Fi sensors

Despite these issues associated with manual counts, there is little discussion of alternative methods which could be utilised, nor is there a consensus as to if manual counts are to be used for validation, how many records are needed and whether they need to be conducted at regular time intervals in order to capture the temporal variations we wish to examine.

The main points for discussion are:

1. Are manual counts the best method for validation?
2. If they are the most appropriate method, should counts be conducted at different times of day and days of the week in order to capture temporal fluctuations?

References

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