Global Navigation Satellite Systems (GNSS) Equipped Public Transport Buses as Information Sentinels

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SUMMARY

The ability to predict, plan and prepare for the different usage patterns and traffic/road user load is very important to city transport planning, logistics & haulage industry, as well as emergency planning and other sectors. Increasingly around the world public transport buses are being equipped with GNSS receivers to help provide accurate timetable "countdown" information to awaiting passengers at bus stops or via mobile apps. This information if analysed at different levels of abstraction and correlated with other data sources such as road works, sporting events and other activities can provide useful insights which can enable forward planning and resource allocation.

In this regard a short feasibility project was conducted in the UK as part of the IMPETUS University partnership between the University of Nottingham, Leicester and the Transport Systems Catapult. For the project, GNSS data from Transport For London (TFL) buses was collected and analysed. Utilising bus data produces an additional level of complexity due to stopping at bus stops along the route. However analysing the stopping pattern can also provide useful information of user demand and usage pattern. There are over 8500 buses in London serving over 190 routes. Therefore a vast amount of data is collected daily by TFL's iBus system.

For this short feasibility study the area of interest was narrowed down to ten routes passing in and around the Wembley area. Two weeks data from before and during the FA football cup final was collected. Geo-tagged door event data was collected along with the number of satellites for that epoch. Also GNSS position data every 5sec was extracted from the database along with the velocity. Complementary data on roadworks in the area was also collected.

Data parsing and cleaning first had to be performed before any further analysis could be conducted. The bus data collected was ‘dirty’ – fragmented data, gross errors, multiple repeated data in particular with the door event data. After cleaning, the number of door events was aggregated into 2hour and 30mins bins, plotting this over time for each route, showed clearly the daily usage trend such as rush hour period. The pattern of the “normal weekend” vs “FA cup weekend” was compared. The door opening duration was also computed from the data and aggregated. Distinctive change in pattern between the data sets could be observed. Independent Component Analysis (ICA) was used to try to extract common features from the routes was tested with mixed results. Empirical modelling of the data for each route by curve fitting to a 5th degree polynomial was also tested. The velocity and headway (distance between buses) was also analysed.

The number of satellites in view when the bus stops and the door opens/closes at each bus stop is recorded. Using this data a map of the satellite visibility corridor was created. This information is useful not only to buses but to other vehicles utilising GNSS navigation.

Bus route data is complex and difficult to analyse as it is affected by a myriad of factors. Attempting to isolate cause and effect is difficult. Though this feasibility study shows that the data can give insights to enable prediction for adequate service provision.