Congestrian: Monitoring Pedestrian Traffic and Congestion

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Abstract

We propose the development and deployment in the wild of a sensor network that will monitor pedestrian traffic rates and congestion. Three types of sensor are envisaged; fixed video cameras, wearable pedometers and GPS devices. The data captured data will facilitate applications such as route planning avoiding congested areas and warning the elderly and infirm of particularly congested areas. Processing of rates of travel and destinations will enable different types of pedestrian to be identified and plotted dynamically such as tourists, shoppers and individuals simply trying to get from A to B quickly. Looking beyond the immediate empirical scope of this workshop, we indicate how such a system could be deployed to take advantage of the benefits afforded by the Personal Smart Space of the EU FP7 PERSIST project and the Community Smart Space of the EU FP7 SOCIETIES project.

Author Keywords

Pervasive computing; Crowd sourcing; Smart city; Sensors.

ACM Classification Keywords

K.4.1 Public policy issues; K.4.2 Social issues.

Introduction

Much time and effort has been devoted to easing traffic congestion within our cities and the pervasive systems community has made significant contributions to this work [1, 3]. Many of the solutions currently being adopted are designed to discourage use of private vehicles and encourage more use of public transport and pedestrianisation. An inevitable consequence of such policies is increased volumes of pedestrian traffic. Clearly this can create problems of pedestrian congestion which can have an adverse effect on people as they go about their daily lives and the monitoring of pedestrian traffic levels is likely to become as important in the future as the monitoring of vehicular traffic levels is today.

Accurate monitoring of pedestrian traffic will facilitate crowd management and also enable busy people to plot fast routes around the city. Additionally, the increasing number of older citizens, who can find very congested areas quite threatening, could be assisted in avoiding them and freed from the worry of encountering bustling crowds unexpectedly. Given these obvious benefits, not to mention benefits to the disabled community, there is a surprising paucity of published research in this area.

The applications of pedestrian traffic monitoring are not limited to simply assessing traffic volumes and congestion. We believe that rates of travel, in conjunction with information on location, can be used to identify at least three different types of individual. Busy locals will travel quite swiftly and stop at locations for long periods (over four hours, say) which are not obvious attractions. Shoppers will travel more slowly, stopping at locations for short periods (typically less than an hour) which can be associated with shops, bus stops, etc. Finally, tourists tend to meander like shoppers but they stop at locations for longer periods (order of hours) which are known to be popular attractions.

Aggregated data about the types of pedestrian populating our streets at different times of the day and at different times of the year can inform infrastructural decisions such as pedestrianising roads, widening pavements, the location of bus stops, new businesses (both retail and non-retail), tourist information points, etc.

In order to collect the data necessary for these innovations we propose three types of sensor system. At fixed locations around the city, where traffic levels are known to be high, video cameras can be permanently installed at just above ground level with a horizontal aspect. This will readily enable the counting of legs that pass through their view and thus estimation of traffic volume at that location. Furthermore the speed of travel of those legs can also be determined quite simply to provide an estimate of traffic speed.

The second and third types of sensor work in tandem and would be carried or worn by individual pedestrians. They are a pedometer for measuring footsteps and a GPS sensor to record location. As these individuals perambulate around the city, crowd sourcing can be used to aggregate their data and build up a picture of how fast people are travelling in various parts of the city and along particular routes.

Future integration with existing platforms

The basic sensor network proposed here for use in the workshop could benefit significantly from integration with established platforms such as the Personal Smart Space (PSS) developed by the PERSIST consortium [5] and the Community Smart Space (CSS) being developed by the SOCIETIES consortium [6].

The PSS paradigm [4] provides a mobile user with a fully personalisable context-aware framework which can learn their preferences in different situations whilst protecting their privacy and pro-actively initiating actions based on their predicted behaviours.

For a pedestrian attempting to traverse a familiar city, a PSS could assist in them in avoiding congested locations or obstacles which they prefer to avoid such as kerbs if they are wheelchair-bound. They could also be notified, in real-time, about changed circumstances along their usual route such as temporary pavement obstructions.

For the pedestrian visiting an unfamiliar city, or even a local pedestrian who is on leave or holiday in their home town, interesting attractions or events could be brought to their attention as they perambulate. In the case of the local resident, whether they are going about their daily business or on leave could be inferred by their travel behaviour – a quick and direct pattern of travel or a slower and more vicarious travel pattern.

The CSS paradigm [2] extends the PSS idea from the individual to communities of users who can share a variety of digital assets. This can range from services they access, through sensor and other context information which they capture, to their interests, preferences and personal ratings or appraisals of things they have encountered – both digital and physical.

Individuals with similar profiles, preferences or goals can be discovered and invited to connect with each other. Criteria for such invitations can include context information such as being in proximity with each other which would suggest that they are, at least, experiencing similar conditions. By combining proximity with other information, such as preferences or interests, along with the locations and dates of scheduled events further inferences can be made, such as that they are attending the same event and might benefit from further sharing of additional details relating to that event.

The CSS paradigm facilitates the formation of communities of such individuals and enables themnto share their experiences and make recommendations to each other.

A community of pedestrians all reporting data from pedometers can be used by crowd sourcing applications to build up a dynamic picture of areas of a city from a pedestrian perspective which can be shared with them all. Further aggregation of such data through higher level communities would enable whole cities to be mapped and this could provide invaluable information to urban planners and those tasked with crowd management and other pedestrian traffic challenges.

Conclusion

We believe the empirical work proposed above is feasible to undertake during the workshop. The sensors proposed for this deployment are not immutable. Other mechanisms which could ascertain pedestrian traffic volumes and speeds would be equally acceptable. Integrating the sensor network with Personal and/or Community Smart Spaces would be a longer term ambition but would, in the viw of the authors, deliver many further benefits.

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