Is the use of 'mobile computer technology' appropriate for locating people with dementia?

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Summary

This paper discusses ethical and viability issues relating to safer walking technology using a mobile phone. This technology is used to locate people with dementia when they get lost (or wander). In particular, the paper highlights problems of accuracy and availability when using GPS based techniques to locate a person, especially when that person is in a built up area or indoors. Experimental results are presented that suggest Wi-Fi based positioning offers a possible solution in such situations. The paper is presented in the context of a larger project that is considering a wider range of ethical and viability concerns.

KEYWORDS: safer walking technology, dementia, positioning, GPS, Wi-Fi localisation

1. Introduction

Dementia is a term that describes a collection of symptoms that result from damage to the brain. These symptoms can be caused by a number of conditions, the most common of these is Alzheimer's disease (NHS, 2014), which is a progressive brain disorder that damages and eventually destroys brain cells. Common symptoms of dementia include memory loss, difficulty remembering routes and becoming confused in unfamiliar places (NHS, 2014). Dementia affects over 830,000 people in the UK and the cost to the economy is £23BN per year (Alzheimer's Research UK, 2014). This is predicted to grow by 40% over the next 12 years ((Alzheimer's Society Report, 2014). Associated risks of the disease include physical harm, emotional distress and premature mortality. It is reported that 40% of those with dementia get lost at some point and about 5% get lost repeatedly (McShane et.al, 1998). Furthermore, 1% of people with dementia die while lost and half of those who are missing for more than 24 hours die or are seriously injured (McShane et.al, 1998; Koester, 1992; Rowe and Bennett, 2003).

This paper details the initial stages of a research project that is concerned with the development of safer walking technologies for use by people with dementia to facilitate greater independence. The idea is to develop a mobile application (to run on a smart phone) that will allow a person who is lost to be located, while preserving as far as possible that person's right to privacy. It is acknowledged that using modern tracking technology to monitor those with dementia is not novel. Systems exist that alert carers when a patient moves outside set boundaries and allow that patient to be located at any time or place. The novelty of this project is that it aims to tackle known viability and ethical issues that current systems or technical solutions presented in the literature do not properly address. This paper deals mainly with viability and in particular the issue of reliable positioning.

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2. Ethics

Tracking is a contentious issue that divides opinion, but current safer-walking technical solutions rarely address the ethical and human rights issues associated with tracking persons with dementia (Zwijsen et al., 2011; Schaathun et al., 2014). In the article Geoslavery (Dobson and Fisher, 2003), tracking is subjected to some scrutiny. The chilling notion that technology will allow a master to control their slave is discussed. The paper refers to Orwell's 1984 where he states that "surveillance can confer control" and questions who will decide when the patient is sufficiently impaired "to warrant such control". Mason (1986) discusses invasion of privacy and talks about how degradation of privacy may creep up on us. This theme is continued by Welsh (2003) who states that "Electronic surveillance has insidiously seeped into the fabric of society". It seems that they were right, and this may have already happened to some of us. Large parts of society now voluntarily check in and checkout of places to let everyone know where their location. For example, to date the Foursquare website has had 6 billion check-ins in which a person's location is shared (Foursquare, 2014). Welsh (2003) also discusses the connotations of criminal surveillance, again mentioning the Orwellian prediction of repression and social control.

In relation to dementia, the dilemma is this: Where is the greater breach of rights? Is it a locked door resulting in the loss of liberty or is it monitored autonomous movement using technology that can lead to loss of privacy. Landau et al. (2010) made a preliminary analysis of the thoughts of cognitively intact older people that concluded that they favoured the latter. In another study, little objection was found by the actual users of the technology, but the alternative of moving to a nursing home is used to possibly explain this (Zwijsen et al., 2011). McKinstry and Sheikh (2013) are more cautious, stating that it is potentially useful, but that further research is required to find the most suitable people to which this technology is best suited.

3. Viability and positioning

Key viability issues, such as battery consumption and GPS accuracy/availability, are also largely ignored in the literature. The project to date has considered the known limitations of GPS and sought to adopt alternative as a compliment GPS positioning. Future work will address the energy consumption problem by developing procedures that minimise GPS and network activity, therefore reducing battery load.

3.1. GPS

GPS has 'profoundly changed contemporary navigation, surveying and mapping techniques' (Karimi, 2004). However, accuracy largely depends upon the number of satellites that are visible to the receiver. In one study it was found that the phones surveyed were accurate within 10 metres 95% of the time. (Menard et Al., 2011).

In order to test GPS accuracy and availability a working application has been developed. A standard HTC One mobile phone was used for all testing. Results were visualised and analysed via web pages developed using PHP, JavaScript and Google Maps API. When accessing GPS data on the phone accuracy readings are given, and there is a 68% probability that the true location is inside a given distance. (AndroidAccuracy, 2014). Our tests returned a higher probability, with most results falling within less than 10m of the true location (Table 1). It is known that adverse weather conditions have a detrimental effect on GPS signals (Gregorius, 1998). Our tests included taking readings on an overcast day with heavy rain. Results confirmed the relationship between accuracy and satellite availability (Figure 1).

Table 1 GPS measurements: reported and actual accuracy

		Accuracy (metres)			
		Reported			
Description	n	Min	Ave	Max	Actual
From a window in a built up area	79	17.9	31.6	34.2	≤10
Moving in a car	151	2.8	5.5	24.3	≤5
Rural, in poor weather	182	3.6	29.3	67.9	≤10

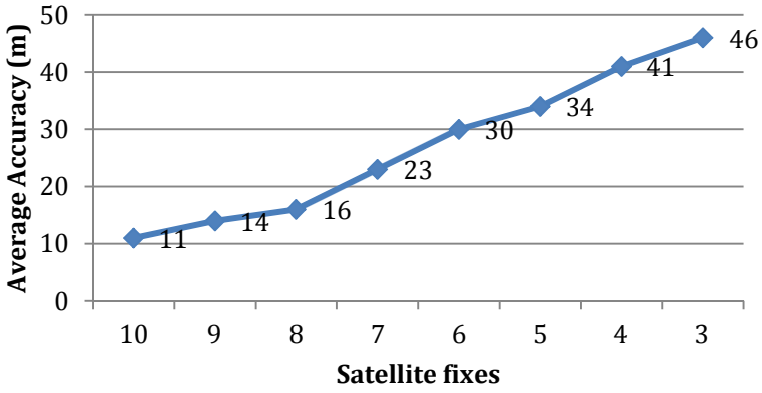

Figure 1 Reported accuracy and the effect of the number of satellite fixes

The biggest problem found with GPS in this scenario is its inability to work indoors. Although our tests confirmed that it does work near windows, they confirmed that indoors GPS reception generally fails. Figure 2 shows locations outside a shopping centre, no fixes were available when walking inside the building.

Figure 2 GPS fails indoors

3.2. Wi-Fi

Wi-Fi based positioning makes use of the ever growing number of wireless access points in urban (and, to a lesser extent, rural) areas. If the position of a wireless access point is known (and increasingly this is the case via services offered by the likes of Google) then it is possible to locate a mobile device in range of that access point. Signal strength may be used to more accurately determine

location, and if multiple access points are in range triangulation may be used to pinpoint with some accuracy. We did not develop the triangulation algorithm, but our experiments confirm that this method gives indoor and outdoor location that would be of use in locating a person. Indoor tests were carried out to assess this at a major shopping centre in Cardiff; almost all of positions returned located successfully using this method, with only 5 erroneous results found out of 84 fixes.

Figure 3 Wi-Fi positioning works indoors

For means of comparison, two points were tested in challenging GPS locations (marked X1 and X2 in Figure 4). As expected GPS location fixes were confused by the tall buildings (circled yellow), whereas a Wi-Fi fix was possible. Using this and other tests it was concluded that Wi-Fi, as a location providing mechanism provides useful results in locating persons indoors, in urban area and in built up rural locations.

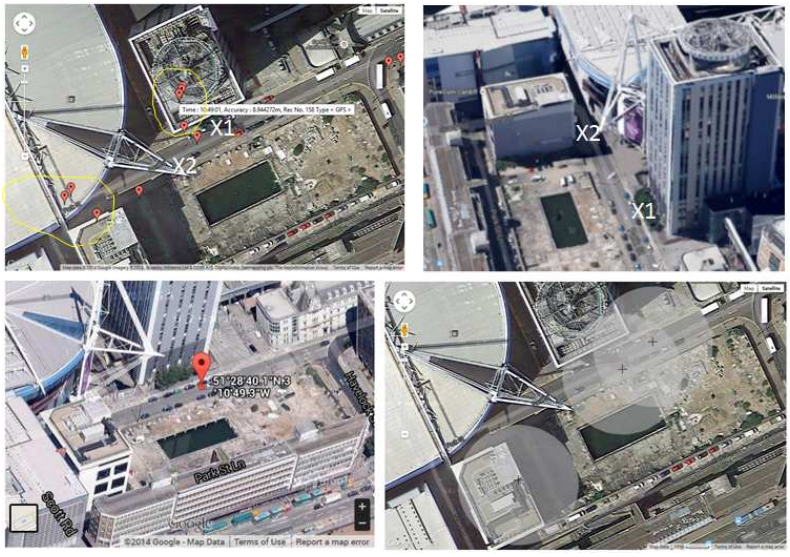

Figure 4 Wi-Fi outperforms GPS in some outdoor scenarios

4. Conclusion

Initial results reported in this paper suggest that Wi-Fi based positioning, used in combination with GPS methods on a mobile phone, can be used to accurately and reliably assist in locating a person who is lost not only outdoors, but increasingly indoors. The paper has also initiated discussion relating to ethical and rights issues that exist when considering tracking people with dementia.

The project is at an early stage and future work is expected to concentrate on the following areas:

- One of the research questions to be addressed is this: is it possible to effectively locate a person carrying a phone without constantly tracking every movement (and thereby invading privacy)? It is proposed that a mobile smartphone may be used to determine if normally experienced activity is taking place, and that it should be possible to trigger secondary actions if abnormal activity is recognised.
- Another aspect of the work will investigate ways to make the primary carer of a patient the sole recipient and custodian of stored data, thereby reducing propagation of sensitive information.
- A further issue to be investigated is that of the stigma that is attached to tracking technology, due to its association with electronic tagging. The research will consider if devices that may be worn, such as GPS and Wi-Fi enabled watches, are a suitable proposition that may reduce this problem.
- Some key viability issues, such as battery consumption, are also largely ignored in the literature. Even the most modern smartphones have limited battery capacity and as the patient could wander at any time it cannot yet be described how a charging routine may be implemented. Depending on the severity of symptoms it may be that the responsibility of keeping a charged phone with the patient would remain with a spouse or close carer. This may potentially limit usefulness to when the carer lives in very close proximity with the patient and is able to supervise. As this contrary to the ideal requirement of providing autonomous movement research is necessary to look at ways of addressing this such as in the adoption of wearable technology or by mitigating the problem, by for example by developing energy management alerts or procedures that minimise GPS and network activity, therefore reducing battery load.

5. Biography

Steve Williams is a student just having completed his M.Sc. in Mobile computing. His research interests are in the area of the Internet of Things, Digital Identity, GPS location, Wi-Fi location, assistive technology and in interdisciplinary collaboration.

Mark Ware is a Reader in GIS. His research interests include automated cartography, GIS and disaster management, Open Source GIS and mobile GIS.

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