City information delivered to Mobile Digital devices

Reflection on contemporary potentials and problems

André Brown, Michael Knight, Yu-Horng Chen and Ghousia Saeed
The University of Liverpool, School of Architecture, Liverpool L69 7ZN, UK.
http://www.liv.ac.uk/abe

The work described here builds on work reported previously on wireless access to digital city models. This paper presents a set of elements that contribute to such models. We look in particular at the issues of ground plane modeling, user location, user-device interface and information layering

Keywords: *city modeling; wireless; interface.*

Background

The increasing spread of wireless data networks makes the use of mobile computing devices in a city context more viable. In the UK certain cities have been selected as pilots for a comprehensive wireless infrastructure and Liverpool is one of those cities. It is inevitable that this technology will form the basis for many new applications as transfer rates increase and costs fall. PDAs, mobile phones with PDA features and palmtop computers are becoming used more widely, and are available with an increasing number of capabilities at affordable prices. However, it is important to examine any new service in light of the real value it will add to the various groups of potential users.

Initial work on a mobile city information system with integral 3d model and associated database of building related information has led to the development of a prototype system for Liverpool (Berridge and Brown, 2002), and this is available at www.liverpoolarchitecture.com. The information on buildings in Liverpool was provided through a combination of expertise and knowledge of the city by staff in the School of Architecture involved with this project and the Liverpool Architectural Society (LAS). The School of Architecture provided text, 2D digital images and the 3D model of the city. LAS provided text, 2D images and enhanced local information.

The key goal of the research is illustrated in Figure 2. There are numerous web-accessible descriptions of cities, which may allow access to information

Figure 1
Appearance on a pda

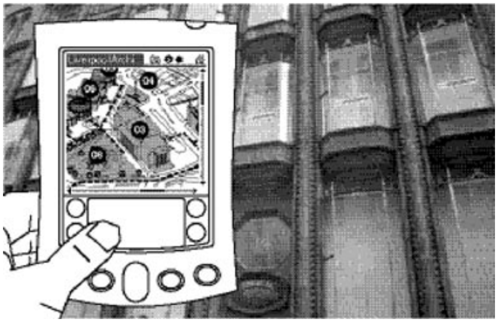


Figure 2
View showing, potentially, what users would see on site: a searchable, graphical and textual information system delivered to a PDA.

on architecture, art, culture, entertainment, transport and so forth, in a particular city over the Internet. Conventional media such as books and guides provide another source of information that can be carried around the city during a visit. What we are developing, is a combination of those two forms of media: a city information system accessible on site via an interactive wireless portable device such as a PDA or similar.

Initial work has established a set of research problems that need to be addressed to make a system such as the one outlined above work effectively. The issues discussed in this paper are as follows:

- Can we achieve a positional accuracy that is close enough to avoid problems of mis-location of the user i.e the pda tells the user that they are in a different location to their actual location –they may be around the corner from the location indicated by the system? This involves local enhancement to GPS and assessing the level of problem due to obscurity near tall buildings.
- How do we best store the text, graphics and 3D model data, in an associated way in a digital database, to optimise speed of delivery to mobile devices, whilst giving a suitable richness of information? Do we use a Psudo3D model technique already present in the test system or is there a better alternative?
- Given the limited screen size of mobile devices how is the text, 2D and 3D information best composed and delivered to the device so that the user can understand the architectural information? This will involve testing the prototype with groups from different backgrounds.
- How far can we push current communications and wireless technologies to deliver information on architecture specifically, but more broadly on other arts and other city information? Can we make such systems easy to use in practice, whilst adding features such as automatic positioning, route planning and direction sensitivity.

Some issues addressed and suggested ways forward include the fact that the 3d representation technique at the core of navigation in our early developments was very small in terms of file size. Consequently, it can be transmitted quickly across wired and wireless networks, with, effectively, no time or cost overhead when compared to a 2D map.

However games engine technology now gives the potential to create richer interactive 3d representations such as those in Figure 3. On a pda the appearance of the model would be closer to the actual appearance of the building, as shown in Figure 4.

But does such a representation improve the quality of information in terms of understanding and clarity of location in the real model. This question of the effectiveness of the interface between the user and the portable device is currently being addressed.

Figure 3
Alternative model representations of buildings in Liverpool using games engine technology to drive the model.

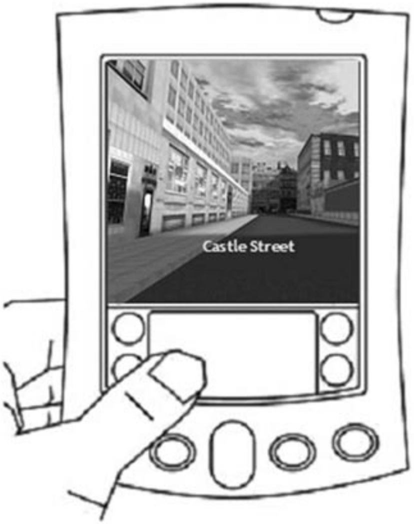


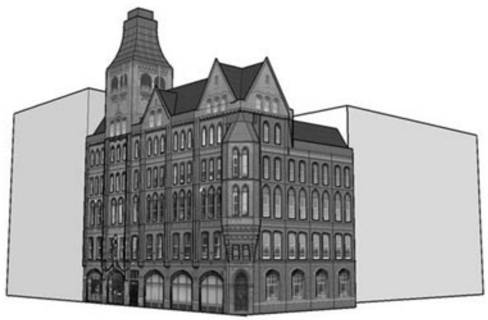
Figure 4
PDA with games engine representation of Liverpool model.

The User- Portable device interface

When using desktop monitors and projector screens, we may have better representation, graphic rendering and resolution, and accuracy of the buildings and surroundings. With a big screen and a working area are available, it is easy to display texts, graphics, and positions on the same screen at the same time. Nevertheless, these implements are fixed and heavy. It is not convenient to carry them while navigating and wayfinding within city. 'Portable' and 'light' are both potential advantages of PDAs, mobiles, and palmtop computers. With the development of technology, the functions and performances in rendering graphics and wireless communication have improved a lot. Early work has shown that it is possible to deliver useful city information to mobile devices (Rakkolainen et al., 2001; Berridge and Brown, 2002). Moreover, these devices have the potential to improve wayfinding and navigation in cities. However, due to the limitations in data arrangement and the size of screens, and wireless communication PDAs, mobiles, and palmtop computers cannot deliver the same quantity and format as desktop devices .

When it comes to representation of buildings and the environment, some researchers pointed out that 3D representation is better than 2D maps on city modelling (Umlauft et al., 2003), and some researchers have utilised VRML as a tools to present interactive city models (Burigat and Chittaro, 2005; Bourdakis and Day, 1997). At Liverpool we have investigated the effect of different forms of representation from Sketchy line model, to Non-photorealistic, and then Near-photorealistic representation (Hannibal et al., 2005). Diverse representations of the environment have different effects and uses, but many focus large format representations, and desktop monitors are one of the examples. However, when we deliver a description of an urban environment to small-screen devices, it is still uncertain whether such devices can contain the functions large screen devices can.

The screens of PDAs, mobiles, and palmtop computers are smaller (ranging from 1.3 inches to 4.5 inches) than those desktop monitors and projector screens have. It is impossible to shift the city information system layout directly from a big screen to a small one. That is, when texts, graphics, and the other necessary information are placed in the same position, it is hard or impossible to read and interpret any information provided on the screen. Therefore, it is necessary to investigate how to arrange the texts, graphics, and the necessary information and what kind of resolution and representation is better for users to understand and recognise the city models and the information.



Figures 5:
Model of Liverpool building created using Sketchup and Quest

Our current investigation focuses on different representations through small-screen devices, and utilises SketchUp and Quest3D as modelling tools to scale up a 3D city model. By comparing different types of representations and viewpoints, pseudo-3D model and real 3D city model, it is possible to investigate what kind of representation delivers the best understanding and recognition of city models.

Positional Accuracy and Terrain modelling

Location determination and then routing information by wireless mobile computing devices has received increased attention during the past few years and hence a lot of research and work is being done in this area. According to the UMTS Forum, the worldwide size of the mobile location services market is expected to increase from 0.7 billion US$ in 2003 to 9.9billion US$ in 2010 (Giaglis, Kourouthanassis, Tsamakos, 2003).

One of the aims of this aspect of the project is to combine the real-time real world position data of a user with 3D virtual world of Liverpool architecture. “We want to achieve something different: in our virtual city, if you walked around a building or stepped back from it, the virtual representation of the building would change in exactly the same way as your view of the building would if you traced the same path around it in the physical city…” (Brown, 2001). Hence working in the 3D virtual models of the Liverpool city requires more accuracy in terms of position, routing and direction information.

There is continuous research and work being done during the last few years in the field of precise and reliable position estimation through technology of mobile computing, but as far as positional accuracy of the devices present in the market is concerned, devices are sometimes only accurate to a few meters and especially near corners these devices can lead to the user being given incorrect location information in the virtual world: “Due to propagation effects like small-and large scale fading (shadowing) we can not expect uniqueness of the signal power levels” (Burigat and Chittaro, 2005). Further work will establish how positional, routing and direction information can be provided most effectively to mobile devices using wireless communication with Liverpool, Capital of Culture 2008 as a target.

“Many factors affect the accuracy of geolocation technologies, especially terrain variations such as hilly versus flat and environmental differences such as urban versus suburban versus rural” (Djuknic and Richton, 2001). It is possible to improve GPS accuracy for the purpose at hand, using terrain model of Liverpool city in this project. The work is being done to find the positional accuracy by terrain modelling – as it may be one of the solutions: “…while height aiding can augment the GPS solution by utilising a digital terrain model (DTM), thereby reducing the number of satellites required to determine a position” (Li, Taylor, Kidner, 2005).

The next stage of investigation in this area is to examine positional accuracy so that the user, while on a Liverpool tour, can locate themselves sufficiently accurately on the position in the virtual world shown on the hand-held device. The system will need to provide a clear route and direction to the next destination without confusion and disorientation.

Concluding remarks

We have set out some of the issues that are relevant and need further development in order to advance and refine the current system. In general terms the development of the system described has the potential to be part of a broader set of changes that we are witnessing that constitute, according to Weiser and Brown, (1997) ‘ubiquitous’ and ‘calming’ technologies. As wireless networks in cities become more widespread and refined digital architectural applications should respond to, and take advantage of the potential for ubiquity that this presents.

The system described here is applied to the field of Architecture. However the system can be readily extendible to other areas of Arts and Culture. We are investigating potential to extend the system (in the field of English) to describe writers in and written work on Liverpool, and (in the field of History) to the description of growth of Liverpool as a mercantile city. The ultimate aim is a multi-layered or multi-dimensional system with research from other disciplines feeding data into the system. The digital representation of the physical environment is one layer but beneath that each research field becomes a new layer. Thus, below each building or landmark would sit a set of layers of information on the History, Literature, Art, Architectural significance and so on associated with that location in the city.

References

Berridge P. and Brown A. G. P.: 2002, A Touring Machine, In Proceedings of [design e-ducation] 20th Conference on Education in Computer Aided Architectural Design in Europe, Warsaw, Poland, pp. 488-493.

Bourdakis, V. and Day, A.: 1997, A VRML Model of Bath, In Coyne, R., Ramscar, M., Lee, J. & Zreik, K. (Eds.), Design and the Net, europIA Productions, France, pp. 13-22.

Brown A.G.P.: 2001, 'A city in the palm of your hand' , Research Intelligence, (10), http://www.liv.ac.uk/researchintelligence/issue10/a.html, (Accessed: 16/01/2006)

Burigat, S. and Chittaro, L.: 2005, Location-aware Visualization of VRML Models in GPS-based Mobile Guides, In Proceedings of Web3D 2005: 10th International Conference on 3D Web Technology, New York, USA, April 2005, pp. 57-64.

Djuknic Goran M. and Richton Robert E.: 2001, "Geolocation and Assisted GPS", IEEE Computer, 34(02), 123-125. http://ieeexplore.ieee.org/search/wrapper.jsp?arnumber=901174 (accessed: 28/04/2006)

Giaglis G.M., Kourouthanassis P., Tsamakos A.: 2003, Towards a classification framework for mobile location services, Mobile commerce: technology, theory, and applications , pp. 67-85 , http://portal.acm.org/citation.cfm?id=766980&dl=ACM&coll=ACM (accessed: 28/04/2006)

Hannibal C., Brown A.G.P. and Knight M. W.: 2005, An assessment of the effectiveness of sketch representations in early stage digital design, In International Journal of Architectural Computing, 3(1), pp. 107-126.

Li Jing, T.G., Kidner D.B. , (2005), Accuracy and reliability of map-matched GPS coordinates: the dependence on terrain model resolution and interpolation algorithm, Computers and Geosciences, 31(02), pp. 241-251

LoL@, http://lola.ftw.at/homepage/, (Accessed: 15/01/2006)

Rakkolainen, I., Vainio, T., Kupila, H., Majahalme, T. and Salmenpera, H.: 2001, A GPSbased 3D City Info for Mobile Users, in: Proceedings of SCI 2001 Conference, Orlando, 2001.

Umlauft, M., Pospischil, G., Niklfeld, G. and Michlmayr, E., LoL@, a Mobile Tourist Guide for UMTS, in: Werthner, H. and Veit, E., eds., Information Technology & Tourism, Cognizant, USA (to be published). http://lola.ftw.at/homepage/content /a40material/

Weiser and Brown: 1997, The Coming Age of Calm Technology, In Denning & Metcalfe (Eds), Beyond Calculation: The Next Fifty Years of Computing. Springer – Verlag, pp.75-85.