A Touring Machine

BERRIDGE Philip and BROWN Andre

CAAD Research Unit, School of Architecture and Building Engineering, The University of Liverpool, UK
http://www.liv.ac.uk/abe/caadru/   p.berridge@liverpool.ac.uk

Contemporary developments in wireless communication and increases in the power and connectivity of hand-held devices present us with increasing opportunities to provide access to computing resources irrespective of geographical location. This increase in portability opens up a range of opportunities to allow access to important data on site. The work described here aims to increase the accessibility of data relating particularly to cities by integrating a palmtop device into a complementary suite of web-based tools. Central to the project are a database of underlying city data and a 3D model of the city.

Keywords: Mobile computing; information systems; web-based multimedia; city modelling.

Context

Currently, there is a range of both web-based and mobile city information systems. Many of the web-based systems, such as Virtual Glasgow (Maver *et al*, 2000) (iris.abacus.strath.ac.uk/glasgow/) and Virtual Cheltenham (www.ralphski.co.uk/3nge/), use VRML or other specialised web plug-ins to allow access to the 3D model and city data. A number of mobile city information systems, without 3D graphic capabilities have also been developed such as CitiKey (www.CitiKey.com) and Citysync (www.citysync.com). More recently there has been experimentation and development of mobile city guides with 3D capability such as those by Belz *et al* (1998) and Raposo *et al* (1997) and the Deepmap project (Coors and Wiedmann, 1998). Rakkolainen *et al* (2001) have developed their system to visualize real-time Global Positioning System (GPS) data through VRML worlds. Our work parallels and augments such recent developments by integrating associated digital technologies.

An initial programme of our research focussed on presenting information on significant buildings in Liverpool over the Internet using a number of different technologies (www.liverpoolarchitecture.com/tours). At the core of this work is a database of historic buildings that can be interfaced over the web in four ways; server generated web pages, interactive multimedia city architecture tours, a 'city navigator', and palmtop based tours (Berridge, Brown and Knight, 2002). The database methodology suits the multi-modal approach of the project as it removes the need for multiple keying of the building data making content updates easier to manage.

The web-based tools

Many of the current web implementations of three-dimensional models require specialised browser plug-ins which provide a high level of functionality but have a small installed user base outside the CAAD and product design fields. We believe that at present this limits their usefulness,
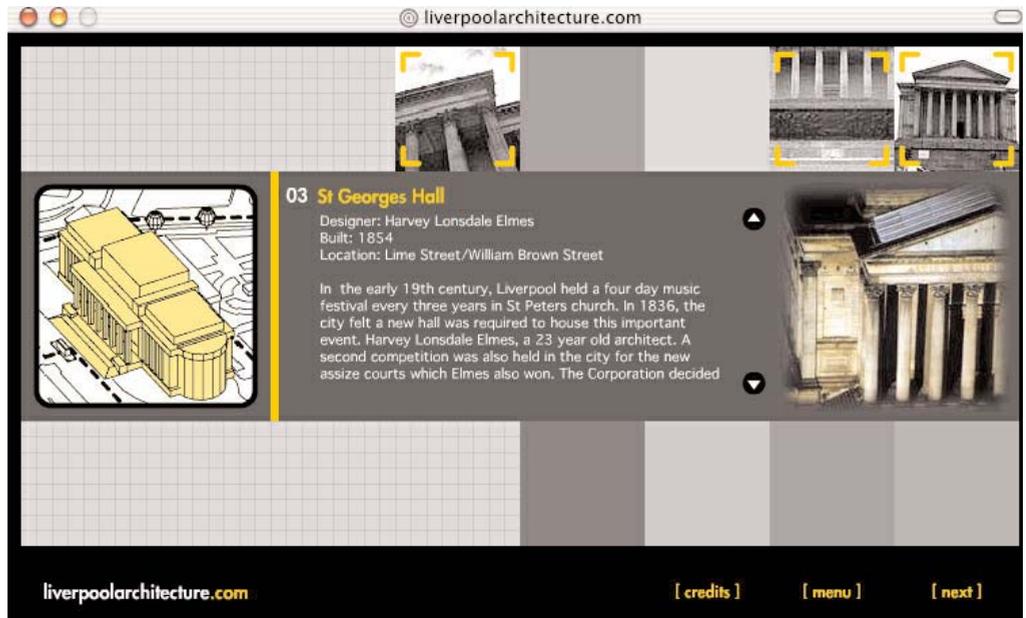
Figure 1. The interactive web-based multimedia tours.

as functionality does not exist for the user if that functionality is not useable. Our interactive web-based multimedia tours use Macromedia Flash technology to display a pseudo-3D model of parts of the city enabling users to navigate along predefined routes. Our early work has been developed through the practical example of two tours covering buildings in the east and west business districts of the city of Liverpool. Each building was represented as a simple 3D model (wireframe and hidden line) with supplementary images and text taken from the underlying buildings database (figure 1).

The 'city navigator' tool explores the use of a 3D representation as the user interface to a database. The model provides users with an overall view of the city that they can freely navigate around, selecting buildings to access their database entry. Within the model, landmark and featured buildings were modelled using simple primitives to provide a good level of contextual information whilst minimising download times.

Palmtop integration

Part of the project has been the customisation of the tours for mobile users. This work aims to exploit existing handheld computing technology and has centered on allowing access via a palmtop device so that users can view building information as they undertake a physical tour.

Much of our recent research has concentrated on using readily available, low-cost and generic technology to provide access to virtual worlds and 3D models at a city wide and building specific level (Knight and Brown, 1999). This current strand of the research applies the same strategy to providing access to three-dimensional city models and underlying information about cities and buildings via a palmtop device. The key point of this approach is to make the data accessible to

the greatest number of potential users.

Both our initial and enhanced palmtop prototypes use AvantGo software for viewing the data. The software is a specialist HTML browser and is installed as standard on many palmtop devices.

The disconnected vs. the connected

Over recent years, as wireless communication and palmtop technologies have improved, delivering wireless content has become a viable proposal. The more recent mass production of integrated mobile telecommunication and palmtop devices has also served to increase the potential number of wireless content users. Despite these continuing developments there is still a large subset of palmtop users who have legacy devices with no means of wireless communication or who simply do not use their device's wireless capabilities.

The AvantGo content browser facilitates both wireless and static hand-held devices by allowing data to be viewed in both connected and disconnected modes. In connected mode data is taken directly from the Internet, in disconnected mode the user must choose the data they wish to install when they synchronise their device via an Internet connected desktop PC. The latter creates a stand-alone portable system that has performance benefits, as it does not rely on wireless networking. It is, however, limited as it does not allow dynamic interaction with the database on location (Davies *et al*, 1998).

As stated above, a core objective of our work is to maximise the potential user base of our palmtop-based system. Due to this, both our initial and enhanced prototype have been developed as disconnected systems.

The initial prototype

Our initial palmtop prototype facilitated on site access to the east and west business district tours (Berridge, Brown and Knight, 2002). Whilst on location in the city users could choose the tour they required and follow the on screen directions from building to building. The user could also access data, such as architectural and historic facts, on individual buildings.

In this implementation each building was represented by a view of a simple 3D model and a few paragraphs of descriptive text. As with the other web-based tools all the building data was extracted from the database.

Although the initial prototype system provided useable access to the tours via a palmtop device its functionality was limited. In particular the system did not have a view of the overall cityscape model and individual building data was hard to access.

The enhanced prototype

The enhanced prototype builds on the initial system. As before, users can access the tours with the system providing data on each building and a description of the route between buildings. However, the new prototype also includes quick access to individual buildings and a 3D city-navigator (figure 2).

The palmtop 3D city-navigator provides access to a scrollable pseudo-3D model of the city, which the user can move around by clicking and dragging or by using the scroll bars. The city-navigator shows each of the buildings contained in the database within the overall context of the city. Landmark buildings are also represented. The use of this 3D computer visualisation assists user wayfinding by making it easier for users to follow a route through the city when compared to symbolic 2D maps (Rakkolainen *et al*, 2001).

In addition to allowing users to see the context of each building and the routes between them, the 3D city-navigator also facilitates direct access to individual building data. The user can click on a modelled building to link to a screen containing that building's data. If the building is part of an installed tour then directions to the next
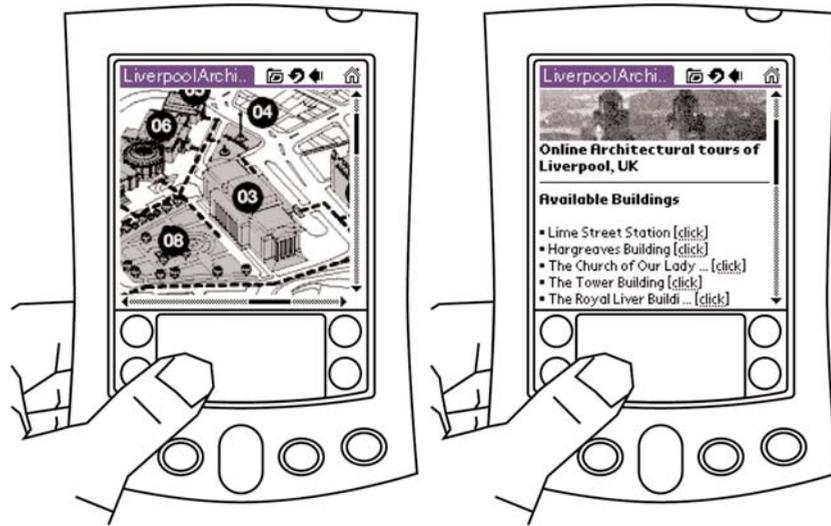
Figure 2. The palmtop-based 3D city-navigator (left) and a screen showing the installed buildings (right).

building and a graphical route path are also displayed. The pseudo-3D model of the city, therefore, provides a graphical interface to the underlying database.

The enhanced prototype also provides a text-based list of installed buildings with hyperlinks to the building data.

Customisation

One of the key limitations of our initial prototype was the absence of end-user customisation features. On this initial system when the database content was downloaded to a palmtop it followed the specification stored by a default user profile on the web server. This ensured that all users had remote access to the two business district tours. Users could not change the data they downloaded, however, if the default profile was changed on the web server then each user's installation would be updated to the new content the next time they synchronised their device. The two tours required approximately 450K of available memory on the user's palmtop device.

Although this is not excessive, if the user did not have sufficient memory available then they could not install any of the data.

The enhanced prototype allows each individual user to customise the building data they install on their palmtop. When a user installs the system a default data set is downloaded to their device, this consists of the 3D city-navigator and the data for each building on the business district west tour. The basic installation requires 339K of available memory. When the user first accesses the system they are presented with a prominent link to the customisation screen. If activated this allows users to personalise their installation by adding or removing a complete tour, adding a group of buildings or removing a group of buildings (figure 3). Users can also choose not to customise their installation.

The customisation screen informs users as to what tours, if any, they have installed and displays a form that allows them to add or remove tours. The form is customised by the system so that only tours that are installed can be removed and only

Figure 3. Palmtop customisation allows tours (left) and individual buildings (right) to be added or removed.

tours that have not been installed can be added. The screen also has links to two further forms that allow users to add or remove buildings. The form for adding buildings allows the user to select new buildings they wish to install. Buildings that the user has already downloaded are not shown. The form for removing buildings lists only the buildings that the user currently has installed on their palmtop. However, buildings that are a part of an installed tour are marked by an asterix. If the user removes one of these buildings then the tour it is a part of will no longer be accessible.

In addition to the main customisation tools described above buildings can also be added via the 3D city-navigator. When a user clicks on a modelled building that is not installed a simple form is displayed allowing the user to add that building to their installation (figure 3).

As the enhanced prototype has been developed as a disconnected system, when one of the user customisation forms is submitted it cannot be sent directly to the web server. The prototype uses the AvantGo forms manager to store the form submissions and then sends them the next time the user synchronises their device. During a synchronisation forms are submitted prior to the revised content being installed, this ensures that the new content reflects the users form submissions. User preferences are stored in a database on the web server.

Conclusions

Our suite of Internet and palmtop-based tools allows users to access historical and architectural information on buildings in Liverpool using widely available and appropriate technology. The incorporation of the pseudo-3D model into our enhanced palmtop prototype adds value by both making the data more accessible and improving wayfinding.

The system also opens up a degree of portability by allowing users to browse a customised installation of the buildings database whilst on location in the city. However, although the disconnected nature of the system increases the potential user base, it also limits the system's functionality as users can only update their installation when they synchronise their device via a

desktop PC. Whilst on location a user cannot access data on a building they have not already downloaded.

In order to overcome this limitation and more effectively balance the often disparate requirements of functionality and potential user base maximisation the next phase in system development will focus on a customisable hybrid environment. This would install a core set of data on the user's palmtop with additional data available via wireless communication technology if available.

The system's capability has also been limited by the reduced set of HTML and JavaScript commands available within AvantGo. However, on balance the ubiquitous nature of AvantGo made it an appropriate development platform because, as already stated, functionality does not exist for the user if that functionality is not useable.

Finally, we are currently working with a number of local and regional organisations to adapt the techniques in order to provide access to other types of city and building data. One such potential application is a GPS equipped, palmtop-based vacant property finder to aid strategic city development.

Acknowledgements

References

Belz, C., Jung, H., Santos, L., Strack, R., and Latva-Rasku, P.: 1998, Handling of Dynamic 2D/3-D Graphics in Narrow-Band Mobile Services, in Virtual Worlds on the Internet, IEEE Computer Society, pp147-156.

Berridge, P. and Brown, A.:2002, One City to go, in Proceedings of the 7th International Conference on Computer Aided Architectural Design in Asia, Prentice Hall, Malaysia, pp. 57-64

Coors, V. and Wiedmann, B.: 1998, Using Wearable GIS in outdoor applications, in Proceedings of the Symposium on Interactive Applications for Mobile Computing, IMC'98, Rostock, Germany, November 1998, http://www.egd.igd.fhg.de/~imc98/Proceedings/imc98-SessionMA4-1.pdf

Davies, N., Mitchell, K., Cheverst, K. and Blair, G.: 1998, Developing a context sensitive tourist guide, in Proceedings of the First Workshop on Human Computer Interaction for Mobile Devices, Glasgow, Scotland, May 1998, http://www.des.gla.ac.uk/~johnson/papers/mobile/HCIMD1.html

Knight, M. and Brown, A.: 1999, Working with Virtual environments through appropriate physical interfaces, in Brown, A., Knight, M. and Berridge, P. (eds), Architectural Computing: From Turing to 2000, University of Liverpool, September 1999, pp. 431-436

Maver, T., Petric, J., Ennis, G. and Lindsay, M.: 2000, Visiting The Virtual City, in Proceedings of SIGraDi'2000 - Construindo (n)o espacio digital (constructing the digital space), Rio de Janeiro, Brazil, 25-28 September 2000, pp. 135-139.

Raposo, A., Neumann, Magalhães, L., and Ricarte,I.: 1997, Visualization in a Mobile WWW Environment, in Proceedings of WebNet 97 - World Conference of the WWW, Internet and Intranet, November 1997.

Rakkolainen, I., Vainio, T., Kupila, H., Majahalme, T. and Salmenpera, H.: 2001, A GPS-based 3D City Info for Mobile Users, in Proceedings of SCI 2001 Conference, Orlando, USA, August 2001. http://www.uta.fi/hyper/projektit/tred/