The AGI Foresight Study - The UK Geospatial Industry in 2015

An Expert Paper

GIS and Augmented Reality in 2015

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Scope

The last 12 months has seen a turning point in terms of bringing geographically aware augmented reality to mobile devices. Significant developments in locational technology such as the inclusion of a built-in digital compass, GPS (Global Positioning System) and accelerometers into mobile phones have allowed not only location but also heading, and pitch to be detected and therefore incorporated into data display systems. These built-in technologies have brought augmented reality to the hands of the masses, and the phones themselves have sparked a market driven boom in fusing augmented reality with location-based services (LBS). Currently applications are in their infancy and mainly focused on specific topics such as 'show me where the closest x is'. This however represents the tip of the iceberg with the addition of GIS into the mix there is notable potential for the industry.

Current Position

In 1965 Sutherland proposed a new 'ultimate display', superimposing computer generated objects on the real world. Sutherland believed that the ultimate display might let us understand our own natural world better. Since Sutherland introduced the concept of the ultimate display, various definitions have been proposed. Backman, (2000) believes that augmented reality is another visualisation technique and is defined as a combination of the real scene viewed and a virtual scene generated by the computer in which the virtual objects are superimposed on the real scene. Vallino, (1998) believes that augmented reality could be considered the ultimate in immersive systems because researchers have proposed augmented reality solutions in varied domains, including medicine, entertainment, military, engineering, design, robotics, and tele-robotics. He also insisted that augmented reality does not simply mean the superimposition of a graphic object over a real world scene, but rather requires detailed knowledge of the relationship between the frames of reference for the real world, the camera viewing it, and the user. Azuma, (1997) defined augmented reality as systems that have three characteristics: they combine real and virtual elements, they are interactive in real-time, and they are registered in 3-D. In addition, Azuma defined a boundary of augmented reality such that non-interactive media such as film or 2-D overlays are not included. However monitor-based interfaces, monocular systems, and see-through head-mounted displays are included within his boundary of augmented reality. Milgram and Colquhoun, (1999) explained their definition of augmented reality by using a reality-virtuality continuum. As detailed in figure 1, Milgram and Colquhoun explain augmented reality using a concept of 'mixed reality', which encompasses both augmented reality and augmented virtuality.

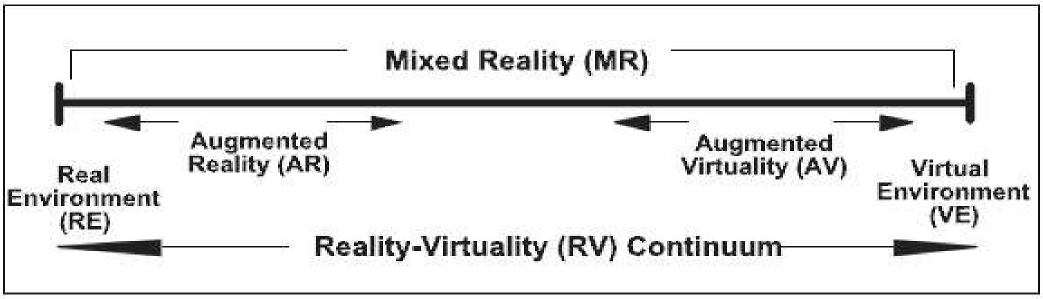

Figure 1 Reality-Virtuality Continuum, (Milgram & Colquhoun 1999)

The first augmented reality by Sutherland in 1968 was head-mounted, as we illustrate in figure 2. Indeed, up until the recent implementation of mobile based augmented reality systems the use of headsets to obtain an enhanced view of the real environment has been the principle display medium for augmented reality applications, allowing 3-D computer-generated objects to be superimposed on their real-world view, (Rolland & Fuchs 2000).

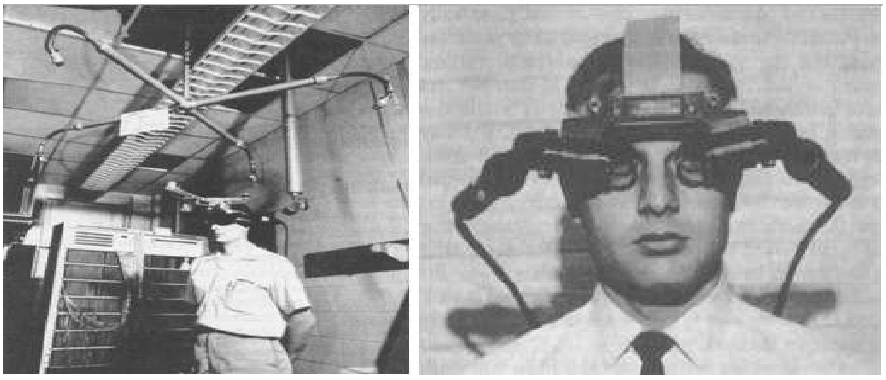

Figure 2 The first head-mounted display by Ivan Sutherland in 1968, (Ivan, 1968).

These head-mounted displays required expensive equipment, limiting augmented reality to specialist laboratories and research institutions. Indeed, it could be argued that this is where augmented reality predominantly stayed until the release of mobiles phones with the three required components for effective augmented reality – a digital compass, GPS and accelerometer. Most notable is the inclusion of these components in Android-based smart phones and the iPhone 3GS. The combination of these devices along with in built camera output to the screen has energised the augmented reality field. These advanced handsets have brought augmented reality applications to the palms of our hands, and several augmented reality applications are already available which can be used in our everyday lives.

UK-based Acrossair has recently launched an augmented reality application -'Nearest Tube' - that leads users to the nearest tube (subway) stations in London and New York, we illustrate the interface in figure 3.

Figure 3 Nearest Tube (Subway) application, (Acrossair 2009).

Operating on the iPhone 3GS, Nearest Tube is typical of the current applications, which make use of fixed location data with the current surroundings acting as a background to the interface. Acrossair has refined the concept further with its latest version of its 'Acrossair browser' which displays data on properties to let, restaurants, and entertainment events based on their location. Linked to Google Maps, the user can spin around, select a restaurant that is shown on their mobile handset screen, and the location of the restaurant will be provided on Google maps, we further illustrate the concept in figure 4.

Figure 4 Architecture of Acrossair's augmented reality applications.

Layar is one of the first augmented reality applications on the Android platform. The application displays information from any of the current 111 layers residing on their server, representing the most comprehensive augmented reality application to date and indeed the closest to an 'on-site GIS'. Figure 5 provides and insight to the service architecture of Layer, in essence the move from Layar to a professional augmented reality GIS is timely, we explore the implications of this move and the future of augmented reality and geography in the next section.

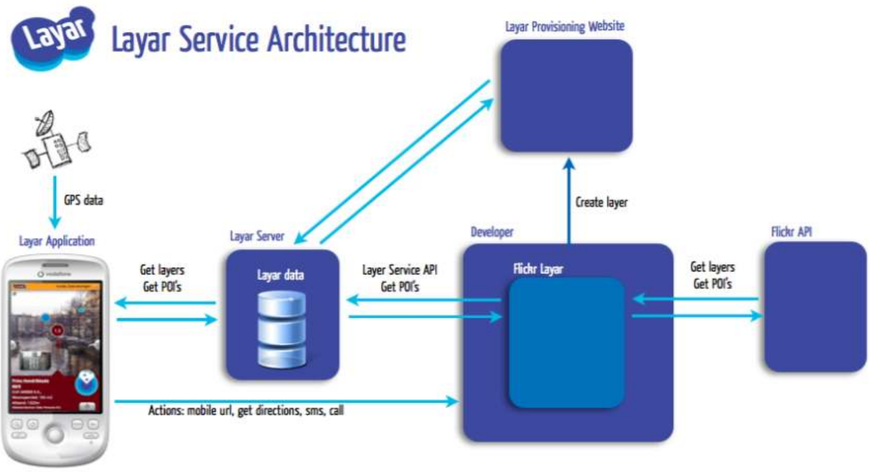

Figure 5 Layar Service Architecture, (Layar, 2009)

Anticipated Changes

The use of augmented reality to display related data in the real world using mobile devices is very much in its infancy. Current iterations are plagued by issues of accuracy with GPS signals in urban areas being often in excess of 70 metres out using the small systems embedded into mobile devices. As such location based services such as 'Yelp', a website that collects shop and restaurant reviews for cities in North America, Ireland and the UK (Giles, 2009) are limited in their use.

Advances in computer vision hold the key to the problem of GPS accuracy with trial systems already in development, most notably 'EarthMine' which allows a combination of GPS data and building recognition to achieve sub metre accuracy. By 2015 we envisage that image recognition, especially in large urban areas, will become the norm opening the way for sub-metre GIS functionality. As such simply 'pointing a mobile device' and retrieving any amount of data will become the mainstay of location dependent applications. We envisage that many of these will be focused on a mix of social networks and tagging applications with data both supplied by, and served to, the users. The neo-geography approach to data and software development is arguably driving the current high rate of innovation in the geographic data domain. We see this continuing with small companies releasing low cost applications that rival the output of larger companies with a focus on mobile location based services.

It is a notable challenge for GIS to adapt a new visualisation technology such as augmented reality. However, it is an unavoidable general trend under the industries environment which emphasises both mobility and real-time data capabilities. In order to adapt augmented reality as a new visualisation method in GIS, several key elements need to be considered. There is currently not a standard augmented reality GIS data model which considers both geo-coordination and geographical topology. In order to stimulate to use of GIS on mobile augmented reality environment we need to define a data framework and standard for mobile augmented. The definition of standards is a controversial topic and it could well be argued that a standard data format will emerge when one of the industry leaders pushes forward the concept. We envisage Google releasing an augmented reality application in the short term future, complete with data integration.

2015 Scenario

When managing a city there are a lot of invisible or hidden facilities (such as gas pipes, water pipes, sewer pipes, and communication cables) that need to be taken into consideration. In order to manage these facilities, Urban Information Systems (UIS) have been widely used to date. Augmented reality and mobile communication technology are a perfect match for bringing UIS into the field. Severe gas pipe explosions and the cutting of communication cables during excavation works are still far too frequent, even in major world cities. These accidents are caused by a lack of information, as well as the invisibility of the underground facilities. This problem could be solved by a fusion of UIS data and augmented reality. While a worker is excavating a road, 3-D UIS data could be projected through an augmented reality system that would enable a worker see the location of such underground facilities.

We illustrate this scenario in figure 6, detailing an efficient way to display smart chips and sensor networks in a ubiquitous environment using augmented reality. Although there are a lot of attempts to develop GIS or LBS service models using augmented reality in a ubiquitous environment, there is not much discussion about how we can efficiently display such an intelligent and complex ubiquitous environment. Current 3-D GIS data technology is still expensive and time consuming to produce. When you are in the urban environment there is no longer a need for a 3D City model the data can simply be displayed using augmented reality.

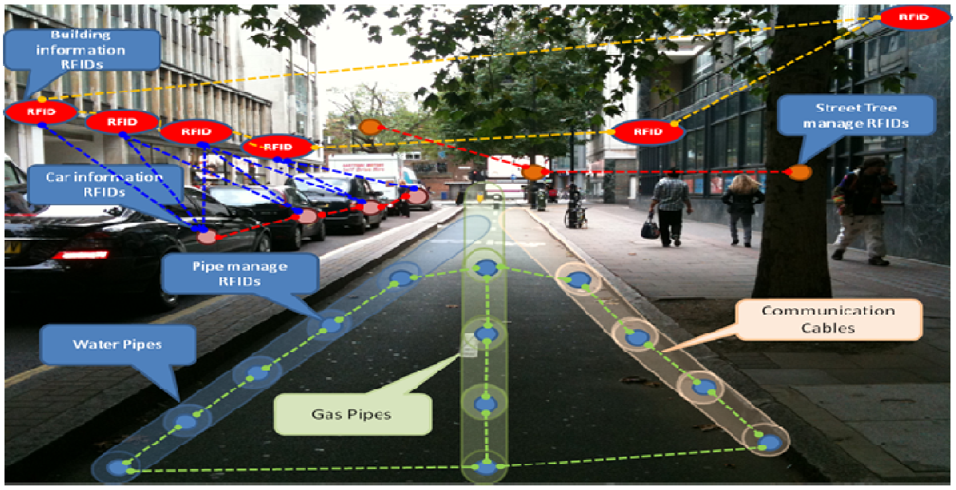

Figure 6 Augmented Reality Urban Information System

The UIS essentially provides professional users with access to the 'hidden city' of utilities, combine this with predicted increased processing powers of mobile devices and you move towards a scenario of real-time spatial analysis on an augmented reality GIS screen.

In short, sub-metre accuracy is required for augmented reality applications to become 'useful' in a professional stance. This accuracy will be reached via image recognition technologies in the next five years which combined with a lightweight data transfer standards will enable a fully fledged augmented GIS system to develop.

Summary of 5 key points

- Augmented reality is in its infancy but has notable potential for mobile GIS.
- Mobile devices are central to the technology.
- A new data standard may be required to ensure the efficient display of GIS data in an augmented reality system.
- Augmented reality will become a mainstream technology in the next five years.
- Image recognition or additional tagging is crucial for sub-metre data visualisation.

References

Acrossair, *Nearest Tube* [Online], Available: http://www.acrossair.com/acrossair_app_augmented_reality_nearesttube_london_for_iPhone_3GS.htm.

Azuma, R. T. 1997, 'A Survey of Augmented Reality', *Presence-Teleoperators and Virtual Environments*, vol. 6, no. 4, pp. 355-385.

Backman, A., *Augmented Reality* [Online], Available: http://www.cs.unu.se/kurser/TDBD12/HT00/lectures/ar.pdf.

BMW Homepage, [Online], Available: http://www.bmw.com/com/en/newvehicles/5series/touring/2007/allfacts/ergonomics/_shared/img/ergonomics_hud.jpg.

Giles, J. 2009, 'Augmented Reality gets off to a Wobbly Start', New Scientist, No.23, Issue 2726

Layar, *Layar Technical Overview* [Online], Available: http://layar.com/api/.

Milgram, P. & Colquhoun, H. 1999, 'A Taxonomy of Real and Virtual World Display Integration', *Mixed Reality-Merging Real and Virtual Worlds*, no., pp. 1-16.

Sutherland, I. E. 1965, 'The Ultimate Display', in *IFIP Congress*, Citeseer, New York, NY, pp. 506-508.

The-Economist 2009, 'Reality, Improved', *The Economist*, September 5th 2009, vol. 392, no. 8647, pp. 14-15.

Vallino, J. R. 1998, Interactive Augmented Reality, University of Rochester.