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Cover Page Footnote
Special thanks to Niels laCour and Alexandor Stepanov from the UMass Campus Planning Department and to the students in my Digital Technology Seminar, Kelly Ashton, Seth Morrow, Kuang Xin, Tim Young and Xiao Zhou.

Integrating Digital Data into Greenway Planning with Augmented Reality

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Introduction

Digital technologies, such as geographic information systems, are an integral part of the greenway planning process. A wealth of new technologies is evolving that provide improved data for planning and methods for evaluating the temporal and spatial qualities of a place. Augmented reality is a technology that can improve and enrich the user's greenway experience. Augmented reality (AR) systems merge computer-generated graphics with a view of the physical world by aligning or registering computer graphics with a place. (Azuma, 1997) AR systems do not create a simulation of the physical world; rather augmented reality takes a real object or space as the foundation and incorporates computer graphics that add contextual data, information and meaning to a real object or place to deepen a person's understanding. The paper will provide a clear background of augmented reality (AR), how it is being applied today, and describes the potential AR applications for greenway users. The goal is to provide greenway planners' with a vision for how greenways will be used and interpreted in the future by users of AR technology.

Background / Literature Review Current Applications of AR

Virtual reality is digitally created environment that can graphically represent an actual place or an imaginary world. This is the extreme end of Milgram's Reality-Virtuality continuum (Fig. 1) with the real world being at the opposite end of the spectrum (Milgram, 1994). Augmented reality lies in the realm of mixed reality with components of both the real and virtual worlds.

Fig 1. Milgram's Reality-Virtuality Continuum (Milgram, 1994).

An augmented reality system's three characteristics are that it: 1) combines real and virtual environments; 2) is interactive in real time and 3) registers information in three dimensions (Azuma, 1997). Every place and object has a history, a story and a context. By making information available to individuals interacting with those places or objects in real time AR provides a rich experience and furnishes people with a broad context for understanding the world around them. In AR, the virtual information must contain a spatial component that changes based on the real imagery we see on the display screen – when we move or turn the camera the virtual information must change accordingly.

The basic components of a device that can be used to display Augmented Reality information are:

- camera to capture the real world image
- compass to know direction that you're looking
- accelerometers (tilt sensors) in all three axes to determine the camera's orientation relative to the ground in real time
- global positioning system (GPS) to determine your position on the earth
- wireless internet link to retrieve information relating to your surroundings
- cpu and memory to run software (app) that accesses metadata about the place where you are with georeferenced coordinates (Boonstra, 2009).

Initial augmented reality systems were very cumbersome with separate components - head mounted displays with large global positioning systems and a computer in a backpack. Smart phones with high resolution displays, such as the iPhone, now contain all of these components in a single hand-held device. These phones run applications, referred to as apps, that access specific information about a place and display a virtual graphical image correctly registered with the view of the 3D environment surrounding the user. This registration is critical in an augmented reality system because people are sensitive to visual misalignments. (Rosten, 2009)

AR can be seen at a remote location as in the example of watching TV and seeing the yellow first down line in an American football game or the line with the distance from the ball to the goal in European football. The military uses AR in heads up displays in planes that show all the readings and controls virtually in front of the pilot to allow focus to be directed to the window at all times. Other AR techniques can be displayed using a web-cam on a computer. This paper focuses on portable devices that people take out into the landscape where their experience of reality is augmented with technology.

For augmented reality to work there must be geospatial information available for a particular location, known as geotagging, which usually consists of latitude and longitude coordinates, altitude, bearing, distance, accuracy data, time, date, and place name. GIS is the most widely used tool for creating and applying geospatial information. However geotagging is becoming ubiquitous with new cameras equipped with GPS automatically geotagging images and social media tools such as Twitter geotagging user's comments about a place through smart phones. It is important to note that as of May 2010 there is now Mobile GIS available on smart phones making all GIS data available wherever you are.

Approaches to Augmented Reality

There are three major approaches to augmented reality (AR), 1) location-based AR, 2) marker-based AR and 3) image recognition.

Location-based AR displays information based on your physical location derived from GPS and the direction you are viewing. The live video stream from the camera is augmented with simple annotations about the place you are viewing (Fig 1). Layar Reality Browser is the best known AR app and displays real time annotations on top of the live video image. While looking at the phone's display in an urban setting, a user can see houses for sale, popular bars and shops, or ATM locations (Boonstra, 2009). When you see a restaurant tag displayed on a building denoting the location, you can click on that tag and choose whether to go to the restaurant's web site to check out the menu or go to a review site that will provide you with other people's opinions about the food.

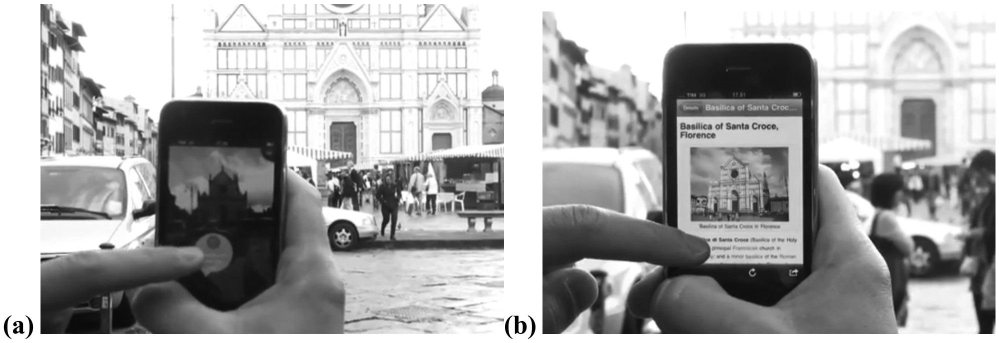

Fig 2. Smart phones allow for location-based AR information to be displayed by (a) pointing at a historic structure having it identified with an icon on the screen. By touching the icon (b), web-based information about the place is displayed. (source: Tuscany+ app for iPhone)

Marker-based AR: Markers (or fiducials) are simple, unique and asymmetric geometric graphics that are easy for computer vision software to recognize. QR Quick response codes (QR - a new bar code) are one type of marker. In AR the marker corresponds to a 3D object created with computer modeling software. The camera first records a live video stream and software scans the video for any markers. When a marker is found, the camera position is determined – direction and tilt - and a virtual 3D object (an *augmentation*) is created by the graphics software to match the viewer's perspective. This augmentation is integrated into the live video over the marker. It is important that the marker size be visible to the camera so that recognition can take place. One advantage of virtual images is that they can move and change colors and shape – an interesting concept for sculpture.

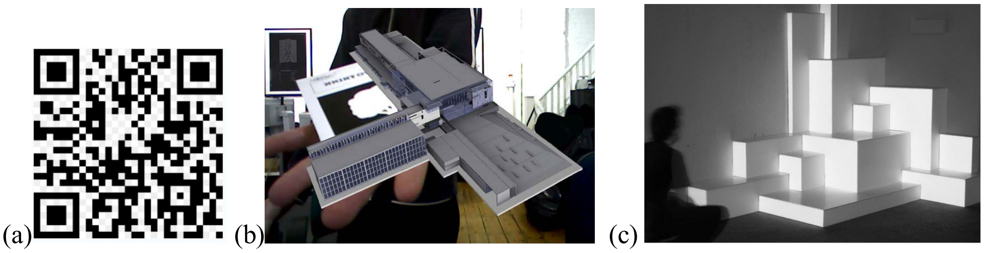

Fig 3. A QR code (a). A virtual 3D building appears in the place of the marker held in someone's hand (b). A virtual sculpture (c) requires a larger marker.

The imagery created by these types of AR relates directly to the location of the marker and is not dependant on the real world. If the marker moves, so does the computer generated object. As the camera moves around the marker, the viewer's perspective moves allowing you to view all sides of the object.

A more advanced method of marker-based AR is **Image Recognition.** This is a powerful tool that allows the hand held device to do a visual search on what you are looking at. Image recognition matches the object, scene or person that you focus on with your phone camera to a pre-existing image in a database in order to deliver content linked to that image back to the mobile phone (McKie, 2009). The application uses your georeferenced location to narrow its search. One visual search app is Google Goggles. If you were hiking around San Francisco and pointed your phone's camera at the Golden Gate Bridge, the app would give you a list of web sites relating to the bridge.

Golden Gate Bridge - Wikipedia, the free encyclopedia
The **Golden Gate Bridge** by night, with part of downtown **San Francisco ... Golden Gate Bridge** is the most popular place to commit suicide in the **United States ...**
http://en.wikipedia.org/wiki/Golden_Gate_Bridge
Seacliff Webcam - Weather Seacliff, **Golden Gate Bridge** (Seacliff

Fig 4. Google goggles visual results from the Golden Gate Bridge (left and center) illustrates visual search through image recognition and the proposed Rotterdam Market illustrates spatial alignment.

A combination of location-based and image recognition methods allows for the **spatial alignment** of virtual objects in the landscape. This method requires perfect registration meaning the computer must have accurate knowledge of the physical world and the spatial relationships between the world position and angle of the camera. Current GPS accuracy is not sufficient to provide this detail using hand-held devices. For this reason, current AR applications either use a mounted device on site or have you stand in a particular location to view the scene so that the virtual imagery aligns. Layar Reality Browser has a link to the proposed Rotterdam Market in the Netherlands by MVRDV Architects allowing you to view the building on its proposed site.

Potential AR applications for greenway users

There are three major categories of greenways (Fabos, 1995) that may be combined in any number of ways into a comprehensive system

1. Ecological - significant natural corridors along rivers, streams, coastlines or ridgelines, to provide for wildlife migration and appropriate nature studies.
2. Recreational – networks of trails for hiking through diverse and visually significant landscapes

3. Cultural and Historic – follow highways or waterways, and connect points of cultural or historic significance.

Hardin's First Law of Ecology, states "You cannot do only one thing". Planners understand the need for holistic thinking when locating a greenway by considering the potential of all three major greenway categories. Planners must also think about digital information in a similar way. The term “information ecology” marks a connection between ecological ideas and the dynamics of the increasingly complex and vital digital information environment. Davenport (1997) outlines “four key attributes of information ecology: 1) integration of diverse types of information; 2) recognition of evolutionary change; 3) emphasis on observation and description; and 4) focus on people and information behavior.” Augmented reality personifies this approach by not only weaving together multiple types of information, but by communicating that information in the place’s or object’s native context.

The 3 major greenway types each have an array of potential applications that are currently available that illustrate the ARs potential power.

AR for Ecological Greenways: There are some existing applications for nature studies that will provide people with a more interactive experience in the wild. There are AR apps for identifying trees by taking a picture of their leaves (Eisenberg, 2009, Fig 5a). By pointing a phone at the larger landscape it is possible to identify significant features, such as with Peak.ar. This app allows you to identify mountain peaks when hiking in the Swiss Alps. (Fig 5) In addition there are bird and animal guides that provide a wealth of information.

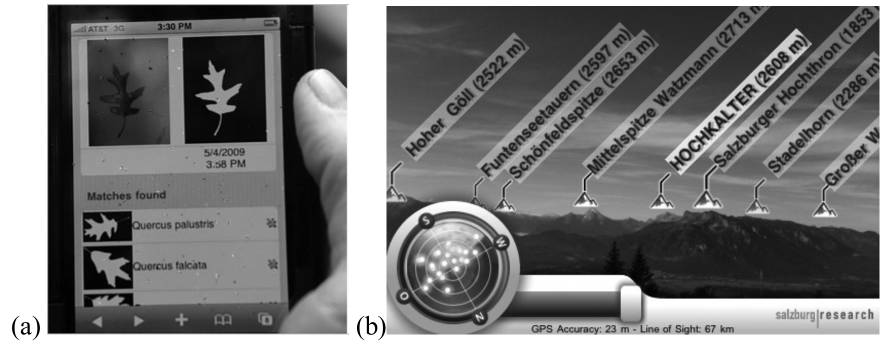

Fig 5. App for identifying trees (a) and image from Peak.ar by Salzburg Research.

AR for Recreational Greenways: For recreation and tourism, augmented reality might add audio commentary, location data, historical context, or other forms of content that can make a user’s experience of a thing or a place more meaningful. Rather than dealing with a static map, you can have an interactive guide that provides up-to-date information.

Mobilizy’s Wikitude World Browser allows you to link to any content on Wikipedia that is geotagged. Users aim the scenic viewer at the landscape and touch the points on the screen that interest them to access contextualized information in the form of text, images and video.

To find points of interest that may be off the beaten path, it will be possible to view Tweets generated by people within a certain radius of your current location. If there is some special view or interesting landmark that many people have commented on, you can see that on your device.

AR for Cultural and Historic Greenways: Some of the most exciting work in AR relates to cultural and historic buildings and landscapes. Scientists have recreated the ruins of Yuanmingyuan Garden in China in digital form as it appeared before being looted and burnt down by the Anglo-French allied forces in 1860. By holding up your smart phone you can see some of the key recreated features in context (Wang, 2006, Fig 6 a-b).

An internationally recognized icon, The Berlin Wall, has been recreated in digital form by software developers using Layar Reality Browser. Although the wall fell in 1989, tourists can follow the former border line from Brandenburg gate and experience German history in its original environmental context with the concrete wall and guard towers seen through the phone in their original position. (Fig. 6c)

With millions of people taking digital photographs and posting geotagged images on-line, there is a rich resource to harvest allowing you to see a place in any season or time of day. In addition, historical images such as old postcards can be matched to an existing location to see what a place looked like 50 or 100 years ago. It's a transformative way of how we experience images. (Aguera y Arcas, 2009 – Fig. 7**)**

Fig 6. The existing Yuanmingyuan Garden (a) and recreated site using AR (b). The Berlin Wall recreated through a phone app provides visual interpretation (c).

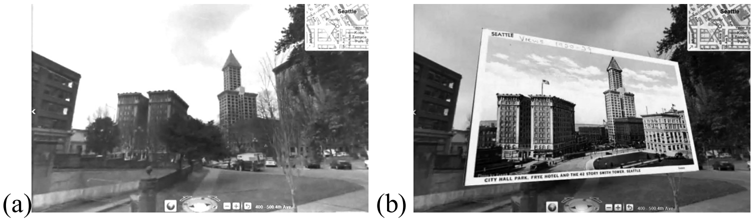

Fig 7. From an existing view (a), it is possible to overlay historical photos or postcards to see what a place once looked like(b).

Goals and Objectives

The goal is to make greenway planners aware of how the greenways they design are likely to be used in the future and to develop strategies for incorporating AR to enrich and inform the greenway user's experience.

At the Univeristy of Massachusetts Amherst, a team of students brainstormed how AR could be used on a university campus to inform people. Using AR as a way-finding and educational tool is the most common means to allow people to tour the campus on their own and discover information in context. The list of tours included arboretum tour with plant identification, public art, building identification with use, class gifts, location of food and drink, bathrooms, accessible routes and historical landmarks. Development on this effort is continuing and will be shown at the conference.

Conclusions

The wealth of data now available on the web is providing unprecedented opportunities for understanding not only the physical attributes of our world, but the visual characteristics. Planners can integrate three-dimensional models for visualization and real-time interactions with the data to bring in the fourth-dimension. Three dimensional and 4-D thinking are essential when you are looking at locations for a greenway or an intervention on the land that might be in the viewshed of a greenway.

Greenway planners must be cognizant of the developments occurring in digital technology and the ways in which future users are likely to participate in using greenways. This as an opportunity to make our decisions visible to the public: Why were certain areas targeted for protection? How do they relate to one another? What is the significance of this place?

Smart phones provide a seamless blending of atoms and bits. Instead of creating stagnant trail maps, planners will be able to use the dynamic nature of the web to make interpretation a way of truly immersing people in a place.

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References

Azuma, Ronald T, 1997, A Survey of Augmented Reality. *Presence: Teleoperators and Virtual Environments 6*, 355-385.

Aguera y Arcas, Blaise, 2009, "Augmented Reality Maps", TED Talks (http://www.ted.com), accessed February 11, 2010

Boonstra, Claire, 2009, "Layar", What's Next in Telecom, Mobile & Internet Communications: eComm, Europe 09, Keynote address accessed February 3, 2010.

Davenport, T., 1997, "Information Ecology: Why technology is not enough in the information age", Oxford University Press,

Eisenberg, Anne, 2009, "Digital Field Guides Eliminate the Guesswork", New York Times, http://www.nytimes.com/2009/05/10/business/10novel.html?_r=3

Fabos, J. Gy., 1995, "Introduction and overview: the greenway movement, uses and potentials of greenways", Landscape and Urban Planning 33, pp. 1-13

Lukas Gruber, Stefanie Zollmann, Daniel Wagner and Dieter Schmalstieg, 2009, "Evaluating the Trackability of Natural Feature-Point Sets", IEEE International Symposium on Mixed and Augmented Reality 2009, 189-190.

McKie, S., 2009, "Technology Face-Off: Augmented Reality vs Mobile Image", http://wireless.sys-con.com/node/1087364

Milgram, P. and A. F. Kishino, 1994, "Taxonomy of Mixed Reality Visual Displays", IEICE Transactions on Information and Systems, E77-D(12), pp. 1321-1329.

Mistry, P., Maes, P. and Chang, L., 2009, WUW - Wear Ur World - A Wearable Gestural Interface. In the CHI '09 extended abstracts on Human factors in computing systems. Boston, USA.

Portales, Cristina, Jose Lerma, Carmen Perez, 2009, Photogrammetry and Augmented Reality for Cultural Heritage Applications, The Photogrammetric Record 24(128): 316–331 December.

Rolston, Mark, 2009, "Beyond the Handset", What's Next in Telecom, Mobile & Internet Communications: eComm, Europe 09, Keynote address accessed February23, 2010

Wang, Yongtian, Yue Liu, Yu Li, Jinchao Lei, 2006, Key Issues for AR-Based Digital Reconstruction of Yuanmingyuan Garden, Presence: Vol 15:3