Summary of Results
Foresight Observatory for International Markets

May 2011

The Future of Augmented Reality

Key ideas

1. Current augmented reality applications include indoor and outdoor visualization in architectural and building applications, augmented assembly and maintenance, learning applications, hybrid media and entertainment.

2. Experimental results show that an augmented reality assembly system can increase efficiency, reduce assembly times, accelerate learning of assembly tasks and improve quality assurance on the factory floor.

3. Augmented reality technologies will play a major role in boosting ubiquitous media and world browsing. Using augmented reality technologies makes it possible to render information accurately in the real-world view and to find this information by browsing the environment with a device equipped with a camera (e.g. a camera phone).

4. The basic set of technologies and tools for world browsing is already available. In the near future these technologies will allow users to associate practically any information with physical items and real-world views, and to retrieve and interact with this information.

Introduction

It has been predicted that augmented reality (AR) will be the area of innovation most likely to alter research, fields of industry and the way we live our lives. Sometimes confused with the concept of virtual reality, augmented reality represents the other end of a reality-virtuality continuum: whereas virtual reality has no actual elements of reality, augmented reality mixes virtual objects with the real world. It operates in real time and is interactive, and the virtual objects it brings to reality are in 3D. In short, augmented reality superimposes virtual objects onto users' view of the real world to provide a new visualization technology for a wide range of application areas. Related concepts and technologies include augmented virtuality, mediated reality and diminished reality.

Augmented reality research is highly active and many applications and demonstrations have been reported. The VTT Technical Research Centre in Finland has worked towards creating a common roadmap in augmented reality as a member of the Intuition Network of Excellence (NoE) and the EuroVR Association. This roadmap provides the following list of AR applications (http://kb.eurovr-association.org/index.php/WG2.2_Research_Roadmap):

- Service and maintenance
- Training

- Construction
- Medicine
- Cultural heritage
- Support for the disabled and the elderly
- Television
- Remote navigation/teleoperation
- Interaction with the physical environment

What follows is a description of the some of VTT's research areas in augmented reality and a description of some important technical enablers and visions of the future.

Business Opportunities and Reality with Augmented Reality

Building and Construction

A good example of the potential of augmented reality in building and construction is the work being done to allow direct two-way access to 3D CAD information and 4D building information model (BIM) information to mobile users at construction sites.

With the technologies developed, virtual models can be correctly matched and augmented to the real situation at the site and real-world data can be linked back to the building model at the office. In addition, a set of completely new kinds of functionalities and interaction with complex building model data is supported. Some examples include:

- Photorealistic augmented visualisation of 3D building models.
- Augmented display of information, 2D drawings and plans of manufactured parts.
- Immediate comparison with timetables and plans at the construction site.
- Display of subsequent building steps as well as the current building situation.
- Location-based feedback to the BIM model from the construction site.

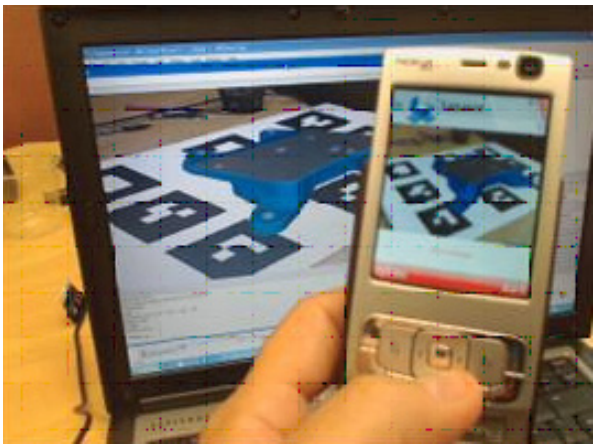
Applications and demonstrations have been developed for exterior and interior use, and applications have been created for marketing and presentation purposes. Besides construction site follow-up and visualisation, safety issues and building life-cycle management are also addressed.

The system's benefits for application users are photorealistic augmented visualisations of architectural plans, mobile access and feedback to digital building data during and after construction, improved communication and increasingly versatile use of BIM models.

Augmented Assembly

Augmented assembly is another research area at VTT and involves applying AR technology to increase assembly efficiency. By using this AugAsse system, workers see additional graphic information superimposed on their view of the real world (see Figure 6). Graphic instructions, text/symbols and virtual objects are used to inform workers about assembly tasks. Experimental results showed that an augmented reality assembly system can increase efficiency, reduce assembly times, accelerate learning of assembly tasks and improve quality assurance on the factory floor.

Figure 1: AugAsse system supporting assembly work using augmented reality. Later versions of the system support multimodal interaction through speech and gestures, as well as mobile interaction (on the right).



Interior Design

Interior design is one of the fields in which augmented reality is already being used to create new business opportunities and enhance existing processes.

Augmented reality enables people to visualise virtual furniture models in real spaces, such as their own living rooms. VividAR, a new augmented reality service based on VTT's AR-technology, was launched for consumers this spring. Over 30 furniture manufacturers are involved in the service that allows consumers to upload an image of their own living room and then play around with different furniture options, three dimensionally moving sofas, chairs and other objects in their virtual living room to get a feel of what the design will look like in real life. VividAR and similar applications for professional interior designers are already changing the world of interior design. Using real photographs of an interior streamlines design processes greatly by making initial modelling of a room much less time consuming. Providing consumers and designers alike with the opportunity to effortlessly move furniture around their virtual room has already become such a crowd-pleaser that it is safe to say that in interior design augmented reality has already become reality.

Meeting Avatars

In addition to the above application examples in construction, assembly and interior design, augmented reality is used for many other purposes as well. A joint project between VTT, IBM and Nokia allows the use of avatars, i.e. virtual characters, in work meetings.

The system is called ACME, which stands for Augmented Collaboration in Mixed Environments. ACME allows the inclusion of avatars in the actual conference room, so that objects in the virtual environment can be viewed and moved in a new way to mirror gestures and motions as events in the virtual world.

With ACME, virtual conferences will become much more real and communication will be moved up to the next level in terms of attractiveness and usefulness.

Entertainment Paves the Way for Education

In addition to showing a great deal of promise for construction, interior design and virtual meetings, augmented reality also has a great deal to offer to the world of entertainment. As of February 2010, Dibidog, a cartoon that runs on the Finnish children's TV channel Sub Junior, is proving to be quite popular as a 3D augmented reality pet in addition to being just a well-known TV-series.

Dibi becomes 3D with the help of certain magazines published by Scandinavia's leading publisher, Aller. With a standard webcam, a child points at a marker printed in the magazine and Dibi appears to come to life in the child's own environment.

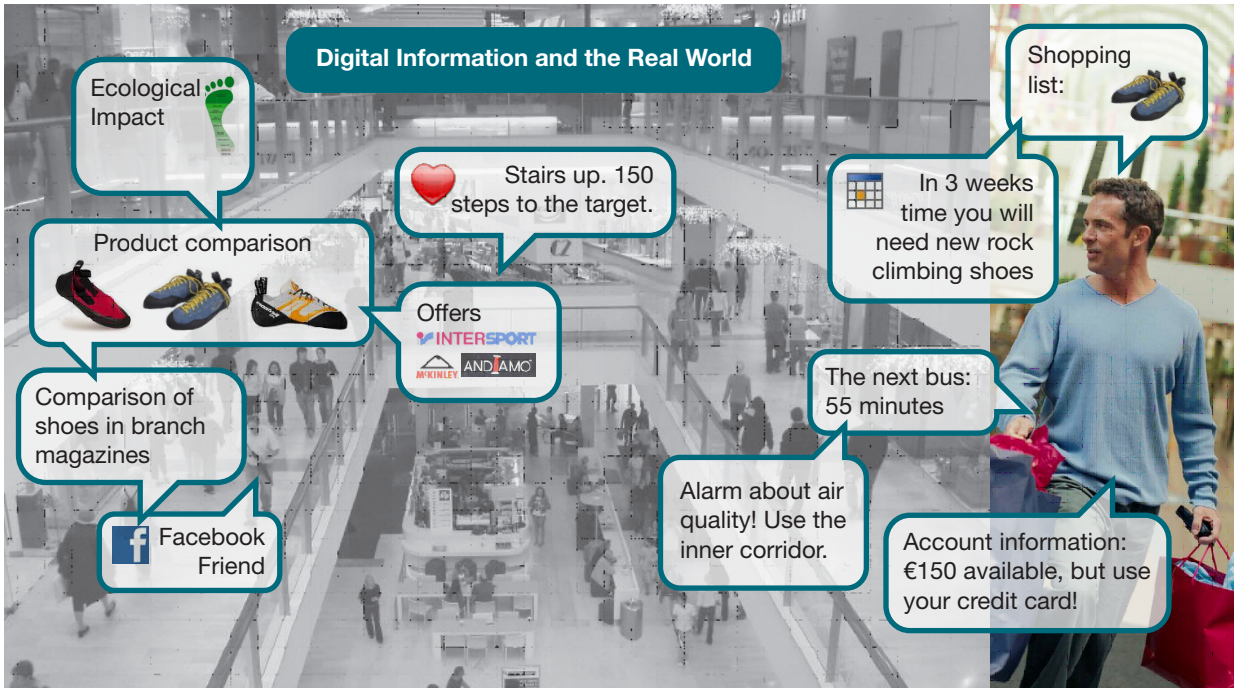
Today, Dibidog has high business potential in entertainment. In years to come, the next generation of augmented reality applications will move on from being merely intriguing and entertaining to educating the young. We already have hybrid books that combine printed and digital learning materials through a cell phone - where children can take a photo of their textbook and receive links with related material to the subject at hand. When augmented reality is added to this scenario, the prospects for education are great.

From Location-Based Services to World Browsing

Location-based services (LBS) were predicted to have a prosperous future some ten years ago. This has generally appeared to be true, although the take-up time has been longer than expected. There are many reasons for this, such as the challenges of supporting mobility, inadequate accuracy in positioning and difficulties in acquiring user context. These obstacles are become less significant and recently there have been some advances in important technical areas, such as those made in near field communication (NFC) and the augmented reality technologies described above.

The original concept of location-based information has extended to more ubiquitous media, which is available according to user context and preferences. In this view, the physical world acts as an

Figure 2: World Browsing.



access point and a means of acquiring information from the environment. The following figure illustrates this idea, which is also known as world browsing.

In addition to electronic contactless access methods such as NFC, augmented reality technologies will play a major role in boosting ubiquitous media and world browsing. Using augmented reality technologies makes it possible to render information accurately in a real-world view and to find this information by browsing the environment with a device equipped with a camera (e.g. a camera phone).

The vision of world browsing (enhancing the physical world with digital information) has been known for quite some time. Many names have also been used for basically the same vision and its various implementations, such as digital graffiti, invisible post-its, geo-notes and information shadows (Burrell, 2001, Espinoza, 2001, Griswold, 2004).

A huge amount of content is already available on the Internet and can be accessed using mobile devices and infrastructure. The success of ubiquitous media services depends on the quality of the content and its delivery according to user context and needs. New content classification methods (typically applying the abovementioned feature detection algorithms) and social content provision and filtering will generally increase the value of content for users. However, new content description and production tools will still be needed.

Augmented Reality in 2020

Current augmented reality applications include such things as indoor and outdoor visualization in architectural and building applications, augmented assembly and maintenance, learning applications, hybrid media and entertainment (for more information and examples, see www.vtt.fi/multimedia). Augmented (or mixed) reality makes it possible to combine real-world views with virtual objects and information in a more seamless way than is possible with NFC and other electronic means.

In the future, ubiquitous media services supporting world browsing will scale up from providing mobile access to small, helpful pieces of information (such as the latest news and the time the next bus will come) to browsing the environment in space and time for interesting digital annotations and useful virtual information, experiencing environments enriched with digital sets and

props, and even becoming immersed in a totally virtual world instead of physical reality.

The basic set of technologies and tools for world browsing is already available. In the near future they make it possible to associate practically any information with physical items and real-world views, and to retrieve and interact with such information. This will result in a plethora of new world browsing applications and services ranging from entertainment to professional use. Due to the availability of these technologies, a revolutionary step is being taken in the way information is produced and consumed.

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