Mobile Mixed Reality
The Vision

Any time you combine digital information with the real world, you end up somewhere within the spectrum of technologies collectively known as Mixed Reality. From enhancing online maps with real-world photos or other media, to interacting with a video game by simply waving your hands in the air, Nokia believes the line where digital information ends and the real world begins, is becoming increasingly blurred.

Mixed Reality in Everyday Life

On one end of the Mixed Reality continuum is augmented reality, a technology that enhances the world around us by overlaying important data, usually in real-time. One can immediately bring to mind the image of a fighter pilot looking through his visor's Heads-Up Display (HUD) at a view of the sky enhanced with real-world information, such as the target, altitude and horizon data. This type of technology has been used in specialized areas for years, but now is becoming much more commonplace, though many may not identify it as advanced technology in its daily context.

In American football, viewers are now treated to a dynamic yellow line drawn across the playing field, which marks the first down line. Players pass over and around this line as if it were actually drawn on the field itself, but it is just an illusion created by banks of computers, and geo-synced video cameras bolted to the stadium floor. In international football, or soccer, this technology can show on-pitch information such the distance a defender must stand back from a free kick. The technology to do this is relatively new, but has become such an integrated part of the viewing experience that "football" fans, of all types, simply can't do without it.

On the other end of the Mixed Reality spectrum, video game makers have started using augmented virtuality in various ways to enhance the gaming experience. New controllers from companies such as Nintendo, Microsoft and Sony enable players to interact with games by tracking real movement in 3D space, providing a more intuitive, natural and overall fun gaming experience.
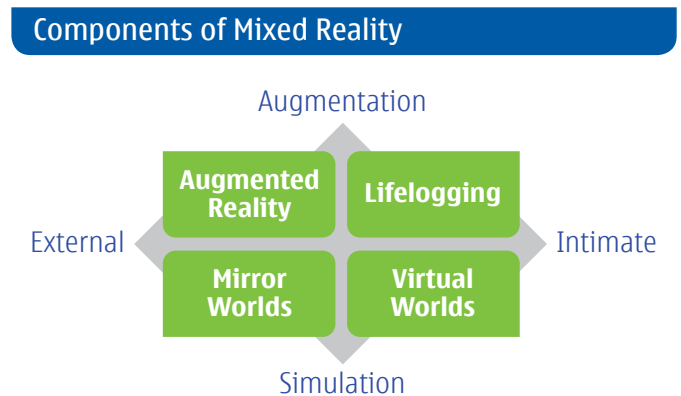
Mobile Mixed Reality

Researchers at Nokia have started pushing the boundaries of Mixed Reality by making it mobile. A phone becomes a "magic lens" which lets users look through the mobile's display at a world that has been supplemented with information about the objects that it sees.

The various rich sensors that are being incorporated into new phones such as GPS location, wireless sensitivity, compass direction, accelerometer movement as well as sound and image recognition enable a new dimension of understanding and interacting with the world around us. Contextually tied to time, place and user, the information provided will be invaluable. Like other mixed reality implementations it won't be long before we can't live without it.

Virtuality Continuum
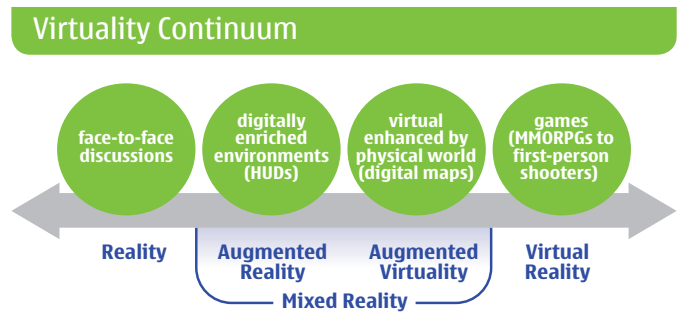
Ranging from 100% Reality to 100% Virtual, the Virtuality Continuum is a term used to define the spectrum in which people can interact with each other, and with digital information. From face-to-face conversations in the real world, to single player video games on the other end in a fully virtual world, the shades of "Mixed Reality" in between include Augmented Reality and Augmented Virtuality.

More information: http://en.wikipedia.org/wiki/Virtuality_Continuum

Components of Mixed Reality

Depending on the focus and integration of the digital aspects of the technology, Mixed Reality can fall within several broad component areas as described by the Metaverse Roadmap Project: Augmented Reality is demonstrated in environments where information is used to enhance a real-time display, reflective Mirror Worlds where real-world images are used to enhance a virtual world, Lifelogging where data from your real environment is recorded and displayed virtually, and Virtual Worlds where your environment is completely digital, but your interactions with others may be real.

More information: http://www.metaverseroadmap.org/

The Work

The various projects at Nokia Research Center that fall under the Mixed Reality umbrella represent an effort to capitalize on increasingly powerful mobile hardware to enable new ways of interacting with the world around us, in real time. The mobile phone can be used to connect the physical world with vast amounts of relevant online information by gathering rich sensor data and using it to contextualize and filter data depending on the user's modality.

Nokia Image Space

Nokia Image Space is a prototype online service that lets users share their travel experiences through photos, sounds and other media content. Users upload their media and can then explore, and share, the location online, navigating picture-by-picture as well as viewing the relationships with other shared content in the same vicinity. By tracking various sensors such as time, location and compass direction, Image Space is able to contextualize the content, place it in the proper place and direction in its virtual 3D world, and allow exploration of the user's location based on community contributions.

Available on the mobile or via the web, the service is a fusion of sensors and computer imaging, which creates an interactive mirror world that allows users to collaborate in a variety of ways including messaging, comments, tagging, ratings and more. Using the online Flash-based application, users find an immersive experience, which often leads to unexpected discoveries of the world around them.

Image Space displays the content in several unique ways that help users understand their surroundings. The "Scenes" functionality is a dynamic collection of images that allow the user to move in space and time from one place to another. A birds-eye view allows the users to see all the images in a given location, as well as the direction they were taken. The 3D view lets users view a particular landmark from various angles, with images stitched together to simulate a real three dimensional image. And filters provide a unique way of viewing locations, such as at nighttime images or during specifics seasons.

Mixed Reality View

By combining data from a variety of mobile phone-based sensors (e.g. camera, GPS, compass and accelerometer), Mixed Reality View is a prototype application created by NRC which allows users to browse their surroundings for interesting or useful objects using a live heads-up camera view. The users simply point their phone's camera, and look "through" the display, just like taking a video. Objects of interest visible in the current view are highlighted on-screen, while the presence of peripheral objects are indicated by the top bar, giving the users 360° degree awareness.

Objects can be gathered from existing Point-Of-Interest databases, or created by the user. They can be associated with physical objects, like buildings and monuments, or featureless spaces like squares and parks. Once selected by the user, objects provide access to additional information from the Internet and hyperlinks to other related objects, data, applications and services.

Zap!
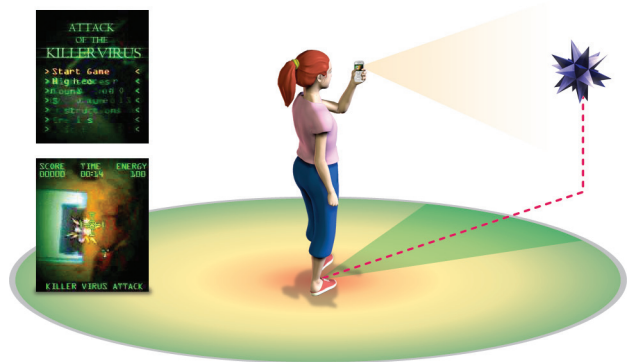
With Jamba's Attack of the Killer Virus, players use the camera and display on their mobile phone to see dangerous viruses in their environment. Moving the phone brings the viruses between the cross hairs to be shot. But watch out - some viruses even sneak up from behind, requiring full 360° movement from the player. The first mobile game of it's kind.

Everyday Virtuality

A winner of multiple Emmy Awards for technical achievement, the Virtual Yellow 1st and Ten Line makes use of Sportvision's video overlay technology, to create the illusion that a yellow first-down line is painted on the field, allowing players to cross over and stand on it. First introduced in 1998, 1st and Ten allows viewers to see the necessary distance for a first down as plays progress, making it an integral viewing component for fans. The virtual 1st and Ten line has become a must have staple of every football telecast.

Mirror Worlds
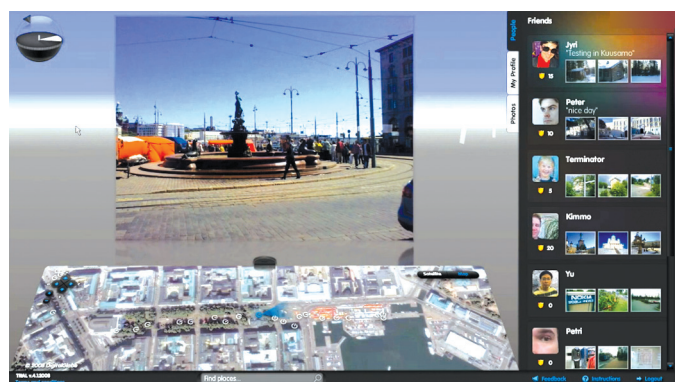
Nokia Image Space is an online community service to share a journey with your friends. It helps users to experience and understand the spatial relationships of places by letting them navigate through locations by browsing interlinked photos. With commenting, tagging, hyperlinking and more, Image Space creates an exciting mirror world where users can collaborate in new ways.

More information: http://research.nokia.com/imagespace

The Work (continued)

Ubiquitous Imaging

Modern mobile phones have become powerhouses of visual computing. It's increasingly common for them to have high-quality color displays, dedicated graphics processors, powerful digital cameras for both still image and video capture, fast CPUs and modern programming environments. The Ubiquitous Imaging project at NRC is taking advantage of this power to push the computational limits of what can be done entirely on the device, using the phone's camera and display.

Extracting interest points from the image in front of you enables quick searches for similar images, even when seen from different viewpoints under different lighting. By combining this information with sensor hints such as location and direction, the results can be processed to provide an amazing number of new applications and functionality.

For example, basic points of interest can be identified and marked in real time. Image results can be warped to better match a users point of view. Walking tours can be created using images taken at street level. Personal photos can be cleaned, focused and highlighted by comparing it to similar photos taken by others. Images can also be combined to create panoramas with unlimited viewing angles. And landmarks can even be automatically extracted from online image collections.

Gaze Tracker

Mobile devices are becoming increasingly more powerful, are gaining advanced features, and as a result can display much more information on densely packed screens. However, this creates a problem in terms of interaction and usability, as more focus has to be given to the mobile user interface, taking it away from the environment – which can be at best inconvenient, or at worst dangerous. This has prompted Nokia to research interactive, wearable Near-to-Eye Displays (NED) to augment mobile user interfaces.

In a head mounted display, the image from a small LCD is enlarged by optics located close to the eye, which gives the user a virtual image of a certain size and at a certain distance. Initially large and cumbersome, NEDs have become lighter and more convenient to wear. Interactivity is added through the capability of detecting where the user is looking at, or "gaze tracking", by relying on special infrared (IR) illumination invisible to the human eye.

One of Nokia's demo applications is an image navigation system, where a 360° panoramic photo can be panned and zoomed purely according to the gaze direction. Fixated objects are shifted to the center of the display and zoomed in, conversely looking off center zooms out. After a quick learning process, the experience is quite intuitive for most people and something that truly cannot be achieved with any other conventional input methods.

Future versions of the system with see-through displays will make it possible to create augmented reality applications by blending virtual and real objects in real time.

Nokia Point & Find

As a product that recently graduated from the labs at Nokia Research Center, Nokia Point & Find is a new mobile information service that enables people to point their Internet-connected camera phones at real life objects to access relevant digital content and services. For example, pointing at a movie poster will look up information about that movie, and enable the user to watch the trailer, read reviews and check show times based upon their location. Using the phone's camera to scan a barcode provides the latest product information and reviews as well as the lowest prices online.

More information: http://pointandfind.nokia.com
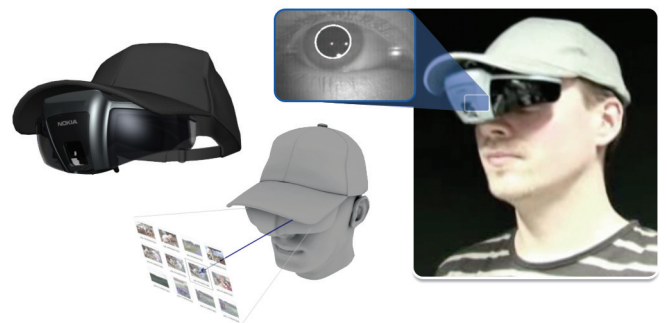
Gaze Tracker

A Near-to-Eye Display (NED) is a way of providing the user with an image that appears to be full-size, despite being physically much smaller. If the NED is integrated with a video-based gaze tracker and a thin see-through screen, it can allow the user to be mobile while still seeing detailed virtual data and images, creating what is essentially a portable heads-up display.

The Future

As our lives become increasingly digital, and information about our environment becomes both more contextual and readily available, we will soon want to interact with the ever-growing amounts of information and expect capabilities provided by mobile technology to be delivered in more intuitive and convenient ways. Rather than having to actively initiate a request for information or a service, we will want it to seamlessly blend into our daily routine, providing immediate feedback to us, as we need it, without disrupting our current activity.

Strengthening Remote Ties

Bringing those who are far away to our sides is a future use case of mixed reality – being able to hold up the mobile's camera so that the video is shared with friends and family online, complete with annotations of interesting places to see, and enabling those friends to immediately help provide feedback on what they are seeing.

Mirror worlds will also continue to advance, with more information about the real world being integrated into our online virtual worlds as well. Meetings that currently take place in cyberspace may be just as accessible by those in the real world, as those online.

Digital and Physical Fusion

Around the world, more and more people are spending more time on the go, outside of our homes, schools or offices. Because of this, it's important to find better ways of interacting with our environment by using our mobiles as a device to help manage life's complexities, connect locally, maintain social ties and make the world around us more transparent and enjoyable.

Through the use of haptic feedback, and other technologies just being invented, our interaction with the digital world and with each other will become more integrated and tangible. Being able to "feel" when a friend is close by through a shirt that hugs you is one example. Tapping a friend on the shoulder from miles away. Having your shoes vibrate if you take a wrong turn, or walk into a bad area of town.

Entering the Final Phase

The realization of the Mobile Mixed Reality vision depends on continued innovation in both software and hardware. The systems being developed depend on advanced algorithms and capabilities not yet common in mobile devices, such as directional data, haptic feedback or heads up displays. But what seems close to science fiction now, is quickly becoming reality.

The results will be incredible advances in the way we all interact with our mobile devices. By using our voices, gestures and other multi-modal input methods combined with new ways of seamlessly viewing information, new user interfaces will be enabled that have the potential to enhance the user experience far beyond what we have today.

For Further Reading

Articles:

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Stephen DiVerdi, Tobias Hollerer, "GroundCam: A Tracking Modality for Mobile Mixed Reality," vr, pp.75-82, 2007 IEEE Virtual Reality Conference, 2007

Eronen, A., Peltonen, V., Tuomi, J., Klapuri, A., Fagerlund, S., Sorsa, T., Lorho, G., Huopaniemi, J. 2006. Audio-based context recognition. IEEE Transactions on Audio, Speech, and Language Processing, vol. 14, no. 1, pp. 321-329.

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http://www.informationdisplay.org/article.cfm?year=2008=10

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http://technologyreview.com/BizTech/17807/

Metaverse Roadmap Overview
http://www.metaverseroadmap.org/MetaverseRoadmapOverview.pdf

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