AUGMENTEDREALITY
ABSTRACT:

Technology is goose bumping into future with an enormous speed. Everyday new approaches to technology are being developed and the technology is now focusing on making everything digital. From watches to laptops everything is digital and now the researchers are focusing on a more highly complicated technology of converting everything to digital and this has been achieved by Augmented reality a future technology in which 3-D virtual objects are integrated into a 3-D real environment in real time. For example if we consider a digital camera we should have a laptop or computer to access and see the images, but the augmented reality has opened the doors of new way where we can access the images by projecting them on wall and even can send the images through mail. In this paper we will be focusing on the hardware components of Augmented reality like Displaying, tracking and where this technology can be used and what makes it the sixth sense technology.

INTRODUCTION:

The world environment around us provides a wealth of information that is difficult to duplicate in a computer. This is evidenced by the worlds used in virtual environments. Either these worlds are very simplistic such as the environments created for immersive entertainment and games, or the system that can create a more realistic environment has a million dollar price tag such as flight simulators. So, Computer graphics have become much more sophisticated, and game graphics are pushing the barriers of photorealism. Now, researchers and engineers are pulling graphics out of the television screen or computer display and integrating them into real-world environments. This new technology, called AUGMENTED REALITY, blurs the line between what's real and what's computer-generated by enhancing what we see, hear, feel and smell and
hence we call it as the SIXTH SENSE TECHNOLOGY. On the spectrum between virtual reality, which creates immersive, computer-generated environments, and the real world, augmented reality is closer to the real world. Everyone from tourists, to soldiers, to someone looking for the closest subway stop can now benefit from the ability to place computer-generated graphics in their field of vision.

Augmented reality is changing the way we view the world -- or at least the way its users see the world. With augmented-reality displays, which will eventually look much like a normal pair of glasses, informative graphics will appear in our field of view, and audio will coincide with whatever we see. These enhancements will be refreshed continually to reflect the movements of your head. Similar devices and applications already exist, particularly on smartphones like the iPhone.

WHAT IS AUGMENTED REALITY:

The basic idea of augmented reality is to superimpose graphics, audio and other sensory enhancements over a real-world environment in real time. The term augmented reality is believed to have been coined in 1990 by Thomas Caudell, an employee of Boeing at the time. **Augmented reality** (AR) is a term for a live direct or indirect view of a physical real-world environment whose elements are merged with (or augmented by) virtual computer-generated imagery - creating a mixed reality. The augmentation is conventionally in real-time and in semantic context with environmental elements, such as sports scores on TV during a match. With the help of advanced AR technology (e.g. adding computer vision and object recognition) the information about the surrounding real world of the user becomes interactive and digitally usable. Artificial information about the environment and the objects in it can be stored and retrieved as an information layer on top of the real world view. The ultimate goal is to create a system such that the user can not tell the difference between the real world and the virtual augmentation of it

Augmented Reality vs. Virtual Reality:

Virtual reality is a technology that encompasses a broad spectrum of ideas. The term was defined as "*a computer generated, interactive, three-dimensional environment in which a person is immersed.*"

There are three key points in this definition.

1. This virtual environment is a computer generated three-dimensional scene which requires high performance computer graphics to provide an adequate level of realism.
2. Virtual world is interactive. A user requires real-time response from the system to be able to interact with it in an effective manner.
3. The user is immersed in this virtual environment.

This gives a very visible difference between these two types of systems is the immersiveness of the system. Virtual reality strives for a totally immersive environment. The visual, and in some systems aural and proprioceptive, senses are under control of the system. In contrast, an augmented reality system is augmenting the real world scene necessitating that the user maintains a sense of presence in that world. The virtual images are merged with the real view to create the augmented display. There must be a mechanism to combine the real and virtual that is not present in other virtual reality work. Developing the technology for merging the real and virtual image streams is an active research topic.

MILGRAMS REALITY- VIRTUALITY CONTINUUM:

Milgram describes a taxonomy that identifies how augmented reality and virtual reality work are related. He defines the Reality-Virtuality continuum shown as

The real world and a totally virtual environment are at the two ends of this continuum with the middle region called Mixed Reality. Augmented reality lies near the real world end of the line with the predominant perception being the real world augmented by computer generated data. Augmented virtuality is a term created by Milgram to identify systems which are mostly synthetic with some real world imagery added such as texture mapping video onto virtual objects. This is a
distinction that will fade as the technology improves and the virtual elements in the scene become less distinguishable from the real ones.

Milgram further defines a taxonomy for the Mixed Reality displays. The three axes he suggests for categorizing these systems are: Reproduction Fidelity, Extent of Presence Metaphor and Extent of World Knowledge. Reproduction Fidelity relates to the quality of the computer generated imagery ranging from simple wireframe approximations to complete photorealistic renderings. The real-time constraint on augmented reality systems forces them to be toward the low end on the Reproduction Fidelity spectrum. The current graphics hardware capabilities cannot produce real-time photorealistic renderings of the virtual scene. Milgram also places augmented reality systems on the low end of the Extent of Presence Metaphor. This axis measures the level of immersion of the user within the displayed scene. This categorization is closely related to the display technology used by the system. There are several classes of displays used in augmented reality systems that are discussed here. Each of these gives a different sense of immersion in the display. In an augmented reality system, this can be misleading because with some display technologies part of the "display" is the user's direct view of the real world. Immersion in that display comes from simply having your eyes open. It is contrasted to systems where the merged view is presented to the user on a separate monitor for what is sometimes called a "Window on the World" view.

The third, and final, dimension that Milgram uses to categorize Mixed Reality displays is Extent of World Knowledge. Augmented reality does not simply mean the superimposition of a graphic object over a real world scene. This is technically an easy task. One difficulty in augmenting reality, as defined here, is the need to maintain accurate registration of the virtual objects with the real world image. As will be described in this often requires detailed knowledge of the relationship between the frames of reference for the real world, the camera viewing it and the user. In some domains these relationships are well known which makes the task of augmenting reality easier or might lead the system designer to use a completely virtual environment. The contribution of this thesis will be to minimize the calibration and world knowledge necessary to create an augmented view of the real environment.

TECHNOLOGY:

HARDWARE:

The main hardware components for augmented reality are: display, tracking, input devices, and computer. Combination of powerful CPU, camera, accelerometers, GPS and solid state compass are often present in modern smartphones, which make them prospective platforms for augmented reality.

DISPLAY TECHNOLOGIES IN AUGMENTED REALITY:

Figure2-Monitor based Augmented Reality

The combination of real and virtual images into a single image presents new technical challenges for designers of augmented reality systems. The monitor-based augmented reality is the simplest technology of augmented reality.

This is the use of graphics on TV and computers to bring more elements to a user's experience to enhance what they see. Sports programs have been doing this for decades. For example, if a football game is on TV and that yellow first down line appears, that is augmented reality. The real elements are the football field and players, but the virtual component is the yellow line. Similarly, rugby fields and cricket pitches are branded by their sponsors using Augmented Reality; giant logos are inserted onto the fields when viewed on television.

The user has little feeling of being immersed in the environment created by the display. To increase the sense of presence other display technologies are needed.
II. Handheld Displays
III. Spatial Displays.

HEAD MOUNTED DISPLAYS:

A Head Mounted Display (HMD) places images of both the physical world and registered virtual graphical objects over the user’s view of the world. The HMD's are either optical see-through or video see-through in nature. The "see-through" designation comes from the need for the user to be able to see the real world view that is immediately in front of him even when wearing the HMD. Major HMD applications include military, governmental (fire, police, etc.) and civilian/commercial (medicine, video gaming, sports, etc.).

VIDEO SEE THROUGH HMD:

The standard HMD used in virtual reality work gives the user complete visual isolation from the surrounding environment. Since the display is visually isolating the system must use video cameras that are aligned with the display to obtain the view of the real world. This can be seen to actually be the same architecture as the monitor based display described above except that now the user has a heightened sense of immersion in the display.

OPTICAL SEE-THROUGH HMD:

The optical see-through HMD eliminates the video channel that is looking at the real scene. The merging of real world and virtual augmentation is done optically in front of the user. This technology is similar to heads up displays (HUD) that commonly appear in military airplane cockpits and recently some experimental automobiles. In this case, the optical merging of the two images is done on the head mounted display, rather than the cockpit window or auto windshield, prompting the nickname of HUD on a head.

The researchers began to explore the use of wearable computers for mobile AR applications. The MARS (Mobile Augmented Reality Systems) project from Columbia University was the first mobile augmented reality systems which allowed the user to freely walk around while carrying all the necessary hardware. However, these systems had the common disadvantages that they were too bulky could be used for only short periods of time due to limited battery life and often had novel user
interfaces that were difficult to learn. The original Columbia University weighed over 40 pounds and was built on a custom wearable PC, GPS hardware, inertial head tracking system and see-through head mounted display.

This reliance on bulky Hardware decreased in 2003 when Wagner ported the popular AR tracking library AR toolkit to the pocket PC platform and created the first self contained PDA AR applications. To achieve this they created custom computer vision libraries that allowed developers to see- video through AR applications that run on mobile phone. Therefore since 2004 it has been possible to develop AR applications that run on consumer level mobile phones.

HANDHELD DISPLAYS:

Handheld Augment Reality employs a small computing device with a display that fits in a user's hand. All handheld AR solutions to date have employed video see-through techniques to overlay the graphical information to the physical world. Initially handheld AR employed sensors such as digital compasses and GPS units for its six degree of freedom tracking sensors. This moved onto the use of fiducial marker systems such as the ARToolKit for tracking. Today vision systems such as SLAM or PTAM are being employed for tracking. Handheld display AR promises to be the first commercial success for AR technologies. The two main advantages of handheld AR is the portable nature of handheld devices and ubiquitous nature of camera phones.

SPATIAL DISPLAY:

Instead of the user wearing or carrying the display such as with head mounted displays or handheld devices; Spatial Augmented Reality (SAR) makes use of Camera, Small projector, Smartphone, Mirror. These components are strung together in a lanyard like apparatus that the user wears around his neck. The user also wears four colored caps on the fingers, and these caps are used to manipulate the images that the projector emits. The key difference in SAR is that the display is separated from the users of the system. The tangible nature of SAR makes this an ideal technology to support design, as SAR supports both a graphical visualisation and passive haptic sensation for the end users. People are able to touch physical objects, and it is this process that provides the passive haptic sensation.

TRACKING:

Tracking is the basic enabling technology for Augmented reality. Modern mobile augmented reality systems use one or more of the following tracking technologies: digital cameras and/or other optical sensors, accelerometers, GPS, gyroscopes, solid state compasses, RFID, wireless sensors. Each of these technologies have different levels of accuracy and precision. Most important is the tracking of the pose and position of the user's head for the augmentation of the user's view. The user's hand(s) can tracked or a handheld input device could be tracked to provide a interaction technique. These tracking techniques are replaced by much...
higher tracking technologies using markers called ARtoolkit, which was originally developed by Hirokazu Kato in 1999. ARToolKit is a computer vision tracking library that allows for the creation of augmented reality applications that overlay virtual imagery on the real world. It is level 1 Augmented reality which depends on markers. To do this, it uses video tracking capabilities in order to calculate the real camera position and orientation relative to square physical markers in real time. Once the real camera position is known a virtual camera can be positioned at the same point and 3D computer graphics models drawn exactly overlaid on the real marker. So ARToolKit solves two of the key problems in Augmented Reality; viewpoint tracking and virtual object interaction.

ARToolKit Tracking:

The ARToolKit is a software library that performs the tasks of video capture, image registration, and image overlay for video see-through AR applications. The basic ARToolKit recognises special black and white markers in the camera frames and can calculate their positions and orientations. With this information, 3D graphics can be drawn so that they appear connected to the markers. We will see the basic outline of ARtoolkit application:

![ARToolKit Tracking](image)

**STEP1:** Image capture and display

**STEP2:** Marker Detection.

**STEP3:** Marker Identification.

**STEP4:** Getting 3D Information

**STEP5:** Object Interactions.

**STEP6:** Display Virtual Objects.

**Tracking Limitations:**

The ARToolKit of Computer vision based tracking libraries have found to be having some limitations such as:

1. Camera pose found only when marker is visible.
2. Shadows/lighting can affect tracking.
3. Tracking range varies with marker size.
4. Tracking accuracy varies with marker angle.
5. Tracking speed decreases with number of visible markers

So to overcome this markerless AR have been developed which is still in its developing stage. Augmented Reality without markers is powerful. Pull out the mobile phone and experience an augmented reality. It can be that simple. Only G1 (the Android - Google phone from T-mobile) owners had the opportunity to experience this with Wikitude from Mobilizy and later ING Wegwijzer. Its based on GPS data and the compass. Because the phone knows where it is (the GPS) and in what direction you are looking (the compass) it can augment reality on the screen correctly.

Level 2 - Markerless AR is halfway the technology trigger and will be nearing the peak of inflated expectations in a year when more phones have the combination of GPS and compass. The Nokia N97 which will be out in the summer will have a compass and will trigger the first non Android Markerless AR applications.

**Augmented Reality Application Domains:**

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Augmented reality can be applied in medicine as the surgeon can view a volumetric rendered image of the surgery he performs and many more applications of it can be seen in military training, entertainment, engineering, manufacturing, robotics and telerobotics. It is the technology that promises for future applications also.

CONCLUSION:

Thus Augmented reality is the growing virtual technology that can make our world fully digital and we can interact with the real objects digitally, the technology has halfway reached its goals and in no time it can make this real world fully digital with more powerful displays and tracking techniques and we can experience this technology with ease.

REFERENCES:

www.se.rit.edu/~jrv/research/ar/introduction.html
worldtravelererin.blogspot.com/
www.howstuffworks.com
www.wikipedia.org/wiki/Augmented_reality

Mixed reality in Architecture, Design and Construction by Xiangyu Wang, Marc Aurel Schnabel - Computers