RESEARCH ARTICLE OPEN ACCESS

# Augmented Reality and Virtual Reality

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**ABSTRACT**
Mediated reality also known as augmented reality plays various vital role from providing safety to in directing the personal to what to do next in the industries. It has been becoming a part of every individual person for the past few years due to advancement in technology. The principle behind this technology is merging visual perception of the real world environments and objects with virtual, computer –generated content. The virtual reality is generated by rendering the generated imagery in more proportion over the real environment, so there exist a common method to generate a virtual world but the amount of virtuality created says the type of environment created. It is achieved by using various systems such as computers, displays, specialized devices for geospatial and graphic alignment, wired and wireless networks and software. In this paper we will see the various applications of AR in various fields like medicine, aircraft, Industries, automotive, military, Welding, Maps, Education, Personal use and their working in general, as the technology advances the usage of technology along with other technology increases.

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Date of Submission: 14-06-2018 Date of acceptance: 29-06-2018

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## I. INTRODUCTION

Ever since 1968, scientist Ivan Sutherland at MIT introduced the concept Augmented reality, since then the drastic development in this field has led in comforting to in providing support in technology. Augmented reality is the technology that merges computer generated image with the real world environment and objects. The three characteristics of Augmented reality are:

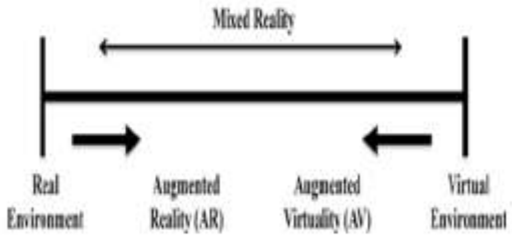
1) Making of virtual image
2) Combining with the real world using specific coordinates
3) Displaying of the augmented world.

This technology uses various systems like computers, displays, specialized devices for geospatial and graphic alignment, wired and wireless networks and software.

Research in augmented reality draws on development from a number of other fields including virtual reality, wearable and ubiquitous computing and human computer interaction. Augmented reality is related to virtual reality and virtual worlds in its use of virtual content however it does not fully immerse the user in virtual environment. Whereas virtual reality and virtual worlds immerse the subject in a computer-simulated environment, augmented reality augments and annotates the natural environment with virtual components. It brings virtual reality into the real world and in the process, enhances what we can do in real-world scenarios. There are various challenges to widespread, everyday acceptance and use of augmented reality applications. Alignment of reality content with real-world environments is a complex and vexing challenges. Wireless networks for mobile augmented reality applications are inconsistent and often lack sufficient bandwidth for sophisticated applications. Head mounted displays, although improving constantly with advances in miniaturization of optical and display technology, can be uncomfortable and socially awkward.

## II. CONCEPT OF MEDIATED REALITY

- **Milgram's reality–virtuality continuum.**

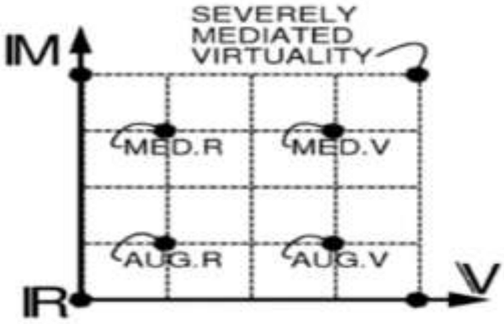



This Reality-Virtuality continuum is a scale showing the range with which a mediated reality is combined. A mediated reality is something in general representing the virtual reality and the augmented reality. So the level of virtual reality over the real world depends on the level to which the real world is mixed with the virtually created images by the computer.

Here, from the figure we can see that to both the extreme of the range, there is a existence of a single environment, that is the real environment and on the other end it's the virtual environment. In between where the real environment is mixed with the virtual environment is created and that depends on the type of reality the medium or the environment exist.

As in virtual reality the environment exists as 70% of virtual environment over the 30% real world environment.

Example: Imagine yourself in a room, assume you don't have any objects or things in the room, where in virtual reality condition the whole room can be customized virtually like by virtually providing TV, Curtains, Chair, Tables all over the room this kind of environment creation where you see a virtual world infront of you overlayed on the real world is virtual reality but on the other hand in augmented reality consider the same room but with some things like table, chair, TV in this the virtual environment is overlayed over the real world in small proportion like providing a virtual screen over a real TV or Placing virtual food over the table.As in whole the mediated reality depends on the amount of virtual reality created over the real world.




M- Mediality
R- Unmodified reality
V- Virtuality

In the above graph, as we know the mediated reality depends on the level of virtuality created over the real world. The horizontal axis represents the amount of virtuality, the origin R represent the unmodified reality and the vertical axis represent the mediality. Here along the horizontal axis, as the virtuality is increased the augmented reality and the augmented virtuality is created and when the mediality is increased the level of virtuality in the augmented reality and augmented virtuality is found, so when the virtuality is increased to an extent the real world is submerged under the virtual world and the user interfere with the virtual world over the real world.

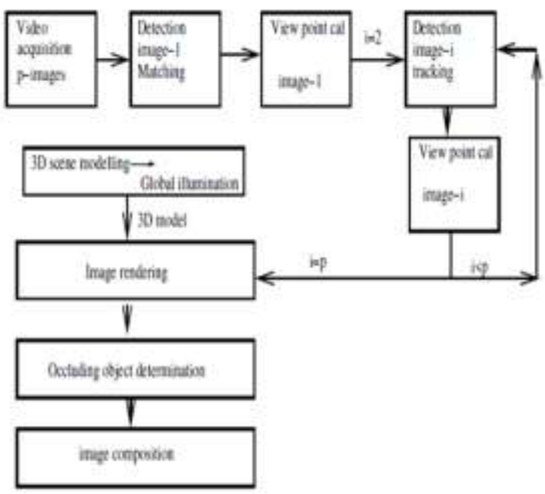
## III. WORKING OF MEDIATED REALITY

The first step in the working of mediated reality is alignment of the generated imagery with the real world, this is achieved by two basic methods:

1) Registration
2) Tracking

Registration

The following flow chart shows the flow of augmented reality system to get the final display.



Augmented reality applications should be able to consistently identify location and depth cues within the user's view for accurate placement of virtual content. Registration requires the computer to have accurate knowledge of the structure of the physical world and the spatial relationships between the world, the display and

the viewer. The two distinct approaches to register are:

- Fiducials
- Image based

There has been various research in registration process of this technology, various methods where proposed such as:

- Simon, Berger et al have presented different vision based registration methods.
- Simon, Zisserman et.al have presented real time registration method using planar structure in the scene.
- Kanade et.al presented Z-keying method of merging images in real time. Registration Methods for Augmented Reality
- Kanade et.al presented probabilistic registration of 3D medical images.

**Fiducial Registration**

Fiducials are markers placed in the real world scene to facilitate alignment between computer generated content and the world. These markers employ an easily recognizable symbol or shape, preferably one that can be computationally recognized in a maximum of different conditions and from any angle or alignment. The augmented reality software deduces not only the lateral alignment but also depth and distance information from the fiducials.

**Image Based Registration**

Image based registration relies on a number of environmental cues for alignment of computer generated content with real world. We use an edge based method which uses computer vision algorithm to detect object boundaries, we also use texture based method that isolate and uniquely identify points on a surface and then correlate the points in real time to incorporate motions while maintaining registration.

**Tracking**

This application's plays a vital role as the user's point of view shifts the tracking has to be made sure the rendering is done properly and the shifting does not affect the location of the augmented image over the real world. Likewise, virtual object should not tilt if the user tilts his head. The main role is to align the virtual image at the correct position irrespective of the view of the user.

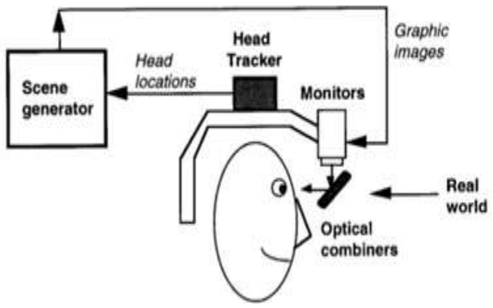
Tracking can be achieved with a variety of different technologies that are based on different physical principles. Mechanical, magnetic, acoustic and optical tracking approaches are commonly used.

**Displays**

A wide variety of display methods are used such as:

- Optical display
- Video display
- Hand-held display
- Projected display
- Retinal display
- Screen based display

**Optical Display**

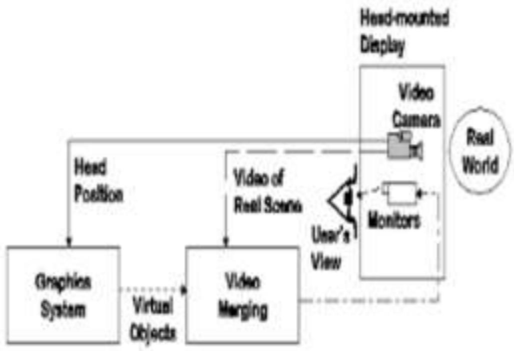



In the display method we use scene generator, Head tracker, Monitor, Optical combiners to get the final display. The scene generator generates the virtual image and sends to the monitor, where the optical combiner combines the generated image with the image from the real world to get the final display.

**Hand Held Display**

In this we use a device such as mobile, PDA's and tablet PC's to get the final display. We use various equipments like processor, memory, camera and interactive components. Imagery from the devices's camera is combined with the generated imagery to produce the final display.

**Video Display**

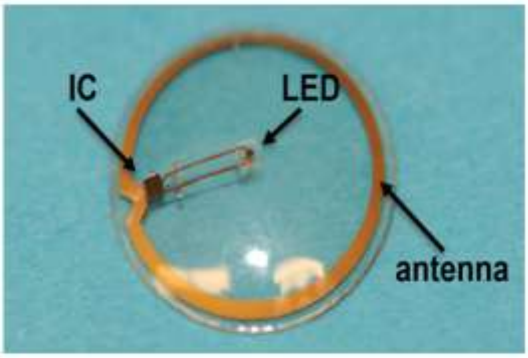



In this display system, we use a video camera to record the real time surrounding and then its combined by using a video merging application with the computer generated imagery and send to the monitor and is displayed for the user's.

**Projected Display**

This is a type of display were the augmented view is projected on the real environment which can be viewed by using a head mounted device. This method employes various steps like registering, then tracking, and finally displaying it for the user's.

**Retina Display**




This is going to be future of augmented reality, where the final environment is rendered using a lense which consist of an IC circuit, LED and antenna for signals. The light is obtained by combining the light passed throught the retina to the nerve cells of the eyes for visibility so a display component is eliminated and is less complex in its design.

**Location Tracking Devices**

Location tracking devices, such as GPS receivers and digital compasses, are also key components of wearable computing for augmented reality applications. The GPS location is not that accurate so some enhanced method has to be employed to improve it, thusit is true mainly in mobile phone-based applications, where designers can use cell tower location tracking to supplement the GPS data. However, there is no reason why this technology cannot be incorporated into wearable computers and used for augmented reality applications that use head-mounted displays and other wearable computing equipment.

**Pointing Devices**

Pointing devices are a design challenge for wearable computing. Joysticks and trackballs are the preferred pointing devices, and twiddler or chording keyboards (keyboards with alternate layouts from the QWERTY standard) are employed when full text entry is required by the application. Frequently, augmented reality applications with wearable computers use innovations that are unique to the augmented realm: icons and symbols appear as virtual objects projected over the real world scene, and can be activated by hand gestures, wearable pointing devices or even eye movements. Another methodology, particularly suited for hands-free application requirements, is voice-activated command. When voice commands are employed, the wearable computing system must include headphones or earbuds as well as a head-mounted microphone. Voice command sub-systems can also supplement other interaction technologies.

**SOME APPLICATIONS OF MEDIATED REALITYMILITARY APPLICATIONS**

**Figure:**The window screen has an augmented reality display which guides the plan during landing**.**

The US military, in conjunction with major defense contractors and aerospace companies, has been researching and experimenting with augmented reality systems for the better part of two decades. Their stated goal is to improve situational awareness for pilots and soldiers and to facilitate enhanced communication with their peers and the chain of command. Heads-up displays (transparent displays of data mounted in the pilot's line of sight) have long been a reality for fighter jet pilots, and recent developments make use of advanced eye-tracking to allow pilots to acquire targets and fire upon them simply by looking at them.

**LAND WARRIOR**

Land Warrior is a US Army wearable computing and augmented reality application that is part of the Future Combat Systems initiative. It combines commercial, off-the-shelf technology and standard military equipment, integrating weapon systems (M16 rifle or M4 carbine) with video, thermal and laser sighting in a head-mounted display that overlays situational awareness data with real world views in real time.

The head-mounted display shows digital maps, intelligence information and troop locations together with imagery from the weapon sighting systems. Thermal imaging enables the soldier to see through obstacles as well as offering greatly enhanced night vision. A GPS receiver provides location information and an integrated radio facilitates communication among troops. Integration with Stryker class military vehicles provides enhanced voice and data communication between soldiers and vehicles across the battlefield.

The Land Warrior system was used by the 2nd Infantry Division's 4th Battalion, 9th Infantry Regiment in Iraq in 2007 during the much publicized surge .

F**igure**:Land Warrior Individual Soldier Combat System

**Battle Field Augmented Reality System**

The Naval Research Laboratory is developing a prototype augmented reality system called the Battlefield Augmented Reality System (BARS). Consisting of an optical head-mounted display, computer and tracking system, it will network multiple outdoor mobile users together with a command center.

The system contains detailed 3D models of real-world objects in the environment which are used to generate the registered graphic overlays. The models are stored in a shared database which also stores metadata such as descriptions, threat classifications and object relevance (to each other and to the mission). Intelligent filters display or hide information based on physical location and contextual information gleaned from the shared database.

User interaction with the system is facilitated by a handheld wireless mouse which superimposes a cursor on the scene. Speech and gesture-based interaction is also being developed.

The prototype BARS consists of:

- GPS receiver
- Orientation tracker
- Sony Glasstron optical display
- Laser retinal scanning head-mounted display
- Dell Inspiron 7000 Notebook computer
- Wireless hand-held gyroscope-equipped mouse

**Industrial And Manufacturing Application**

Many modern manufacturing systems have largely abandoned the "one size fits all" approach in favor of methodologies that allow highly customized, one-off versions of a product line as customer demands become increasing specialized. Workers must consult multiple versions of assembly guides, templates, parts lists and other related documents in order to fulfill customer orders.

Augmented reality can provide hands-free visual overlays of dynamic manufacturing information targeted to specific, highly controllable automated and semi-automated assembly environments. Problems of registration and tracking within busy, noisy factory environments remain however these stumbling blocks are sure to be overcome in the pursuit of the competitive advantages afforded by augmented reality and related technologies.

**Figure**:Augmented glass used in factory

**Boeings Wire Bundle Assembly Project**

The first application of augmented reality technology to manufacturing was Boeing's wire bundle assembly project, started in 1990. The term "augmented reality" was coined by Tom Caudell, a researcher on the project. Boeing's Everett, Washington engineering and manufacturing facility, the world's largest factory building, was a logical choice of sites to introduce this ground-breaking technology.

At Boeing, wiring bundles are assembled prior to installation in aircraft. The traditional method is to prefabricate one or more 3' by 8' easel-like boards called formboards. Plotter paper glued to the surface of the boards contains full-scale schematic diagrams of the wire bundles to be assembled. Workers refer to the diagrams and also to stacks of printed material in assembling the bundles on pegs mounted to the boards.

Boeing researchers developed an augmented reality system using a stereo optical head-mounted display. Registration and tracking were limited to the highly controllable environment of the formboard. When a worked looked through the headset at the formboard, the 3D path of the next wire to mount in the bundle was indicated by a colored line superimposed on the view. The wire gauge and type were indicated in a graphic shown to the side. As the worker changed his or her perspective on the formboard, the graphical indicators appeared to stay in the same location, as if painted on the board. With this new approach, workers were able to better concentrate on the accuracy of the bundle assembly without having to look away from the work to consult documents or changed formboards for every different assembly required.

**Figure:**Augmented reality used in Boeing maintenance

**Truck Wiring Harness Design.**

Purchasers of DaimlerChrysler trucks have a high degree of freedom in configuring their vehicles. Because of this, wiring must be individually planned for virtually every truck produced. DaimlerChrysler developed an augmented reality system for designing customized wiring configurations for truck assembly.

The system uses head-mounted displays to project a virtual geometric line known as a spline curve representing the wiring within the structure of the truck chassis. The workers can interact with the system, changing the path of the line using a 3D pointing device. Once they have configured the optimum wiring path, the design is exported in the form of manufacturing orders for subcontractors or for their own factories.

**Visualisation OF DATA IN AIRPLANE CABIN.**

DaimlerChrysler developed an application for interpreting computational fluid dynamics data within an airline cabin. The user wears an optical head-mounted display and data such as air temperature, velocity and pressure are overlaid in colored-coded volumetric graphics, like transparent smoke or vapor clouds. After an initial calibration step, the application can be run in any airplane cabin.

**Motor Maintanence**

Site-specific repair of car engines was the target of an augmented reality initiative by DaimlerChrysler. Rather than having to look away from the work area to reference a paper manual or CD-ROM, the workers wear head-mounted displays connected to an augmented reality service and maintenance system that overlays repair information on real-world car engines. The information is conveyed as both static text overlays and as video and 3D animated graphics. DaimlerChrysler also developed a user-friendly authoring system to build the sequence-based instructions called Power Space, using the slide metaphor of Microsoft's popular PowerPoint software.

**Bmw's Intelligent Welding Gun**

Constructing prototypes of experimental vehicles presents a challenge to automobile manufacturers. Since only a few cars of an experimental design are ever built, the process is largely based on manual work. Automated factories cannot be customized quickly enough to accommodate prototype construction. BMW turned to augmented reality technology in order to streamline the prototype construction process.

Stud welding is a time-consuming process for prototype construction. Typically, it is a two-person process: the first person reads the coordinates of a stud from a computer printout and positions the locater arm; the second person marks the position of the stud with an etching device. Typically, around 300 studs need to be welded to every car frame. Once all of the stud positions have been marked, the welders place the studs at the specific locations using a welding gun.

BMW's augmented reality application skips the two-person stud marking process. The system guides welders directly to the exact stud locations using visual overlays on a video screen attached to the welding gun. They found this to be a safer solution than the usual head-mounted display which would restrict the welder's field of view and compromise safety. This approach added a layer of complexity to the tracking and registration of the system: it not only had to track the position of the welder's head and viewpoint, but also the position of the welding gun.

In testing the intelligent welding gun, BMW found that workers using this technology were able to quadruple their speed without any loss of precision compared to unaided workers.

**Figure:**Augmented glass used in BMW workshop


**The Touring Machine**

Researchers at Columbia University have developed a mobile augmented reality application called The Touring Machine. The system uses both hand-held and head-mounted displays. Interaction with the display is accomplished with a trackball or touch pad worn by the user. GPS receivers track the user's location and orientation tracking sensors monitor the user's point of view.

The Touring Machine displays virtual flags which appear to be planted in various locations across the Columbia University campus. The flags represent locations that have stories associated with them. If the user selects a flag, the application displays a series of still photos and video snippets with a narrator's voice-over playing over headphones.

One story recounts the student anti-war protests at Columbia in 1968. Another story describes the Bloomingdale Asylum, which previously occupied the current site of the Columbia campus. The asylum's buildings, rendered in 3D models, are overlaid at their original locations on the optical head-mounted display. Meanwhile, the hand-held display presents an interactive annotated timeline of the asylum's history. The user can choose different dates on the timeline and the application synchronizes the overlay of relevant buildings on the head-mounted display.

## IV. CONCLUSION

Despite the challenges and difficulties of bringing this sophisticated technology to society in a form that is user friendly, inexpensive, and vitally useful, advances in augmented reality are occurring every day. From mobile applications for cell phones to breakthroughs in computerized contact lenses, the pace of innovation has quickened noticeably in recent years. What was once the province of university laboratories and science fiction is rapidly becoming accessible for everyday use. Those with the imagination and determination to create breakthrough augmented reality applications will stand to benefit and lead this wave of innovation, and in the process, expand the scope of human communications and capabilities immeasurably.

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Aananthan M "Augmented Reality and Virtual Reality "International Journal of Engineering Research and Applications (IJERA) , vol. 8, no.6, 2018, pp.38-45