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Virtual Reality and Augmented Reality Imagine the Impossible

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Abstract:- Innovation is progressing at an energetic pace the same number of things that were impractical a couple of years prior are conceivable at this point. Virtual Reality (VR) and Augmented Reality (AR) are a part of these progressed and inventive types of advancements that were thought as a part of fiction however at this point, they are an indispensable part of the day by day reality. VR and AR are ideas that are going mainstream.

Both have appeared potential and adaptability over a wide scope of utilization. AR can be utilized as an "overlay" idea to connect certifiable conditions to innovation, for example, through recognizable proof of people, giving GPS information or "attempting on" accessories in internet shopping scenarios. Conceivable utilizations for VR include education and training, designing a product, architecture, language interpretation, and obviously movies and gaming.

The greatest confusion on the planet is the contrast between VR and AR. AR is a manufactured, computer simulated/re-enacted reality or recreation of endless scenario wherever a client will act with the replicated real environments, whereas VR is totally immersive. It submerges the client by creating them a feel that they're encountering the real condition not the mimicked one by strategies for audile, visual, and real recreations (actual simulations). VR immerses the client in an environment while AR improves their environment. Although VR has primarily been utilized for gaming so far, it has additionally been utilized for training, similarly as with Virtual Ship, a reproduction/simulation software used to prepare U.S. Naval force, Army and Coast Guard transport chiefs. The popular Pokémon Go is a case of AR.

VR and AR Optical Head-Mounted Displays (OHMDs) are on the brink of turning into artifact hardware accessible to the users and is simple to use as a tool for 3D activities. Some OHMDs embody front-facing cameras, facultative VR and AR functionality. with the exception of avoiding a clash with the environment, interaction with virtual objects may additionally be plagued by seeing the real environment.

For practically all tasks it isn't known whether AR has any favorable position over VR. Both have huge potential in training, entertainment, education, marketing, and even rehabilitation after an injury. Either could be utilized to prepare specialists to do a medical procedure, offer exhibition goers and museum-goers a more profound experience, improve amusement parks, or even upgrade marketing.

Getting started in VR and AR doesn't require a ton of specific learning or knowledge. Fundamental programming abilities (basic programming skills) and a forward-thinking mindset can be enough. VR and AR technologies will be helpful for employee coaching, education, engineering, and alternative fields. However, the high value of entry has led to an absence of applications, that successively has kept prices high.

At present, AR has made further advancements than VR, for example, Google Glass and Oculus Rift, which give augmented reality highlights. While VR may not move toward becoming as across the board at this time, within a couple of years it will turn out to be progressively ordinary.

Keywords:- *Augmented Reality (AR); Mixed Reality (MR); Virtual Reality (VR); System Architecture; How does it Works?; Advantages; Disadvantages; Applications.*

I. VIRTUAL REALITY

A. What is Virtual Reality (VR)?

➢ *Definition:*

Virtual Reality (VR) is a man-made atmosphere created by software system and bestowed to the user to experience the virtual world occurring within a simulated scenario. It consolidates basically sound-related and visual criticism, however, might likewise allow differing types of sensory input. This may be like similar real-world reality or it alright could also be fantastical.

Fig 1:- Introduction to Virtual Reality. [1]

Fig 2:- Virtual Reality technology being used by a user. [2]

Virtual reality may be a counterfeit scenario that's created with a software system and displayed to the user so that the user beliefs and acknowledges it as a genuine real world. Virtual Reality falsely make tactile encounters, for example, locate(sight), contact(touch), hearing, and smell.

Established researchers are operating within the field of computer-generated reality (VR) for quite a long time, having recognized it as a ground-breaking human-computer interface. Innumerous publications, TV shows, and conferences have represented computer-generated simulation in several and conflicting ways. This has prompted uncertainty, even in specialized writing.

In addition, the manufactured world is not static however reacts to the user's data (signal, verbal order, and so on.). This characterizes a key component of virtual reality, that is constant interactivity. Here constant interactivity implies that the pc will determine a user's data and modify the virtual world instantly or perhaps at the same time. people prefer to see things modification on the screen consequently to their directions and become excited by the simulation. Anyone who doubts the hypnotizing addictive intensity of simulated illustrations has simply to require a goose at youngsters enjoying pc games. it absolutely was accounted that 2 youths within the United Kingdom kept on enjoying Nintendo even if their home was ablaze!

Interactivity and its charming power contribute to the sentiment of submersion, of being a locality of the activity on the screen, that the user encounters and experiences.

In any case, virtual reality pushes this considerably further by utilizing all human sensory channels. beyond any doubt, users not simply observe and control illustrations and virtual objects on the screen, however, they likewise contact and feel them. Specialists are furthermore discussing the faculties of smell and taste, despite the fact that these sensory modalities are less utilized as of currently. Current VR innovation most typically utilizes virtual reality headsets or multi-anticipated environments, occasionally in mix with the physical atmosphere, to form realistic pictures, sounds and completely different vibes that simulate a user's physical distance in a very virtual atmosphere. a personal utilizing virtual reality hardware will "glance around" the counterfeit world, move around in it, and collaborate with virtual objects. The impact is typically created by VR headsets comprising of a head-mounted presentation with a screen before the eyes, however, will likewise be created through unambiguously structured rooms with numerous intensive larger screens.

VR frameworks or systems that incorporate transmission of vibrations and completely different sensations to the user through a controller or different gadgets are referred to as haptic frameworks. This material knowledge is often referred to as force feedback in medicinal, video recreation, and military trainer simulated applications.

the general population can normally associate's virtual reality recreations with head-mounted displays (occasionally known as "goggles") and sensing(detecting) gloves, simply since these were the most gadgets utilized in simulations. The virtual reality nowadays is finished typically without head-mounted shows, by utilizing huge projection screens or personal computers.

B. System Architecture of Virtual Reality (VR)

The virtual reality architecture has five classic elements of a VR system as shown in Figure 3. The elements are as follows:

1. Input and/or Output Devices
2. VR Engine
3. User
4. Software and Databases
5. Tasks

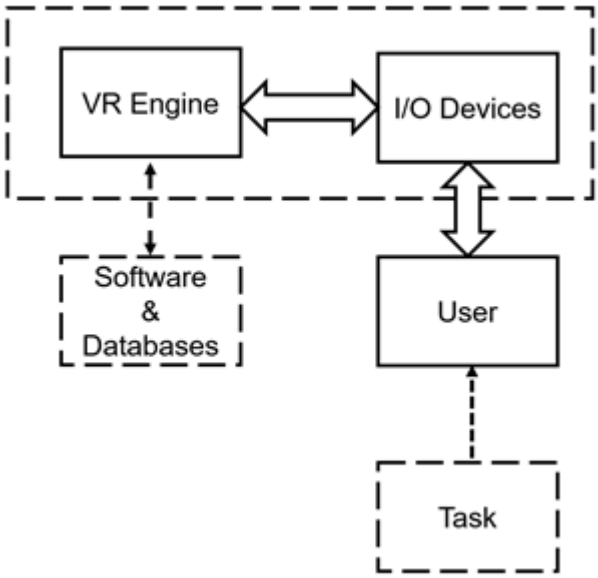

Fig 3:- The five classic elements of a VR system. [3]

➢ *Input Devices:*

One of the elements characterizing virtual reality represents interactivity. To allow human-computer association, it's vital to utilize special interfaces meant to incorporate a user's directions into the pc commands and to grant feedback/response from the simulation to the user. the current VR interfaces are modified in utility and reason, as they address a number of human sensory channels.

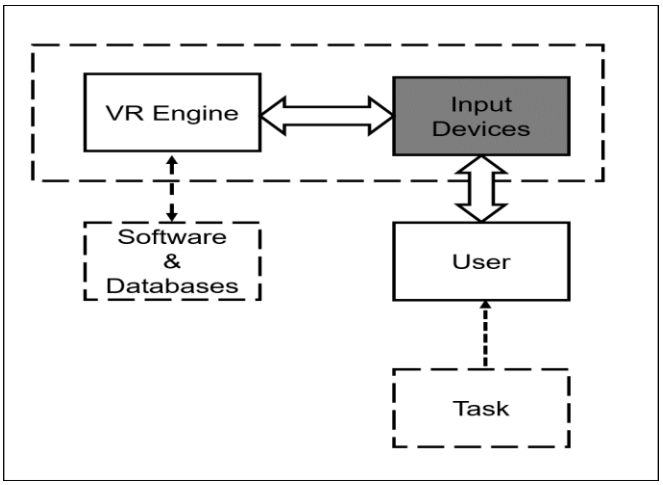

Fig 4:- Input Devices in Virtual Reality architecture. [3]

For instance, body movement is calculable with 3D position trackers or utilizing sleuthing (sensing) suits, hand motions are digitized by sleuthing (sensing) gloves, visual input is distributed to stereo HMDs and large volume displays, a virtual sound is processed by 3D sound generators, and so on. some of this data Input/output gadgets are financially obtainable and accessible some are still modelling (prototyping) associate exceedingly in a field that has was an exceptionally dynamic analysis space. The aim of specialists is to allow fast and quicker regular strategies for communication with the pc and on these lines to defeat the correspondence bottleneck exhibited by the console, Keyboard and therefore the mouse. This half depicts the VR interfaces used in trailing, VR route(navigation), what is a lot of, gesture information input. Virtual gadgets for visual, sound-related, and tactile feedback and response to the user is that the center of attention.

➢ *Output Devices:*

The input gadgets represented 3D trackers, trackballs, and sensing gloves, that are gadgets accustomed mediate the user's input into the VR simulation. Presently we tend to see at special instrumentality supposed to grant feedback and response from the simulation attributable to this input. The sensory channels sustained back by these interfaces are sight/locate (through styles and graphics displays), sound (through 3D sound displays), and touch/contact (through tactile displays). For reasons of simplicity, we tend to treat every sensory feedbacks and responses methodology independently.

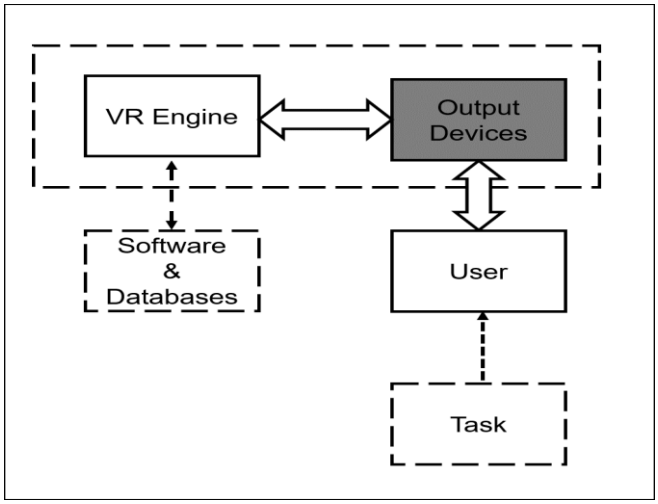

Fig 5:- Output Devices in Virtual Reality architecture. [3]

A further simplification here is that the decoupling of sensory feedback from the user's input. Current VR frameworks are, withstanding, multimodal, feedback interfaces typically consolidate instrumentality to allow user input (such as trackers, pushbuttons, so forth.). Combining a number of varieties of sensory input in an exceedingly simulation builds the user's immersion into VR. Moreover, joining a number of sensory modalities improves the simulation credibility and consequently the convenience of VR applications.

➢ *VR Engine:*

Presently we glance at the reckoning instrumentality supporting such period cooperation, that we tend to decision the "VR Engine". This term may be a deliberation, that relates to completely different physical instrumentality configurations, from one pc to several organized PCs in an exceedingly network supporting a given simulation.

➢ *Definition:*

"The VR engine may be a key part of any VR system, that reads its input devices, access task-dependent databases, perform the specified period computations to update the state of the virtual world, and feeds them leads to the output displays". [3]

Amid a VR simulation, it's tough to anticipate all of the user's activities and store all examination designed world states in memory. thence the virtual world is computed (and erased) in real time. Human studies proposing a rate of interest at that the photographs (or frames) are to be flaunted to the user. For swish simulations, one thing like twenty-four (the frame rate of films) or, better, thirty frames/sec ought to be shown. on these lines, the VR engine must recompute the virtual world every thirty-three msec! This procedure alone outcomes in an exceedingly substantial machine burden that ought to be taken care of in parallel with completely different tasks (for example, I/O communication and storage capacity).

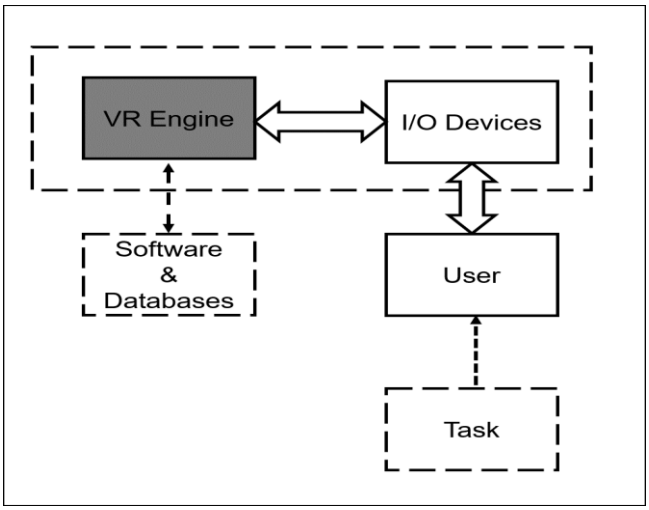

Fig 6:- VR Engine in Virtual Reality architecture. [3]

Similarly, the concept of total simulation latency is also important in VR engines. This is the time between the user input and the corresponding output. Total system latency is the overall impact of sensor latency, transmission delay (to and from VR machines), in addition to the time needed to recalculate and indicate the state of the new world (through design, sound, and haptic input). For visual channels, for example, if the total latency is more than 100 msec, at that time the simulation quality is inherently lowered. Extensive latency can even lead to dizziness in users and simulated diseases.

Low latency and fast graphics, haptics, and sound refresh speeds require a VR engine that has an amazing computer architecture. This architecture is structured around a rendering pipe. Simultaneously, detailed VR machines based on computers and workstations, with more pressure on the graphics. Finally, we see VR architecture. This is a simulation framework that is intended for single users or a framework that makes multi-user interactions in a single VR simulation.

➢ *Software's and Databases:*

The I / O devices and VR machines discussed earlier can be seen as empowering hardware for VR simulations. Another important point of view is cyberspace modeling. This first implies mapping I / O devices with simulation scenes. For example, sensing gloves can control virtual hands, or HMD trackers can adjust the simulation display. VR interface mapping expects alignment with user characteristics such as I / O communication coding. This assignment is usually completed by a business tool box.

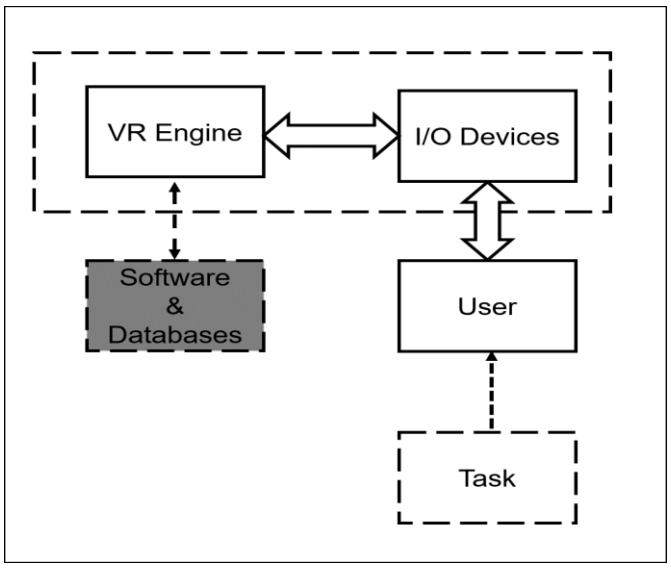

Fig 7:- Software's and Databases in virtual Reality architecture. [3]

Mapping the I/O tailing gadget the next stage is increasing the object database to fill the virtual world. This implies modeling object shapes, appearance, kinematic imperatives, intelligent behavior, and physical characteristics (weight, latency, violence, etc.).

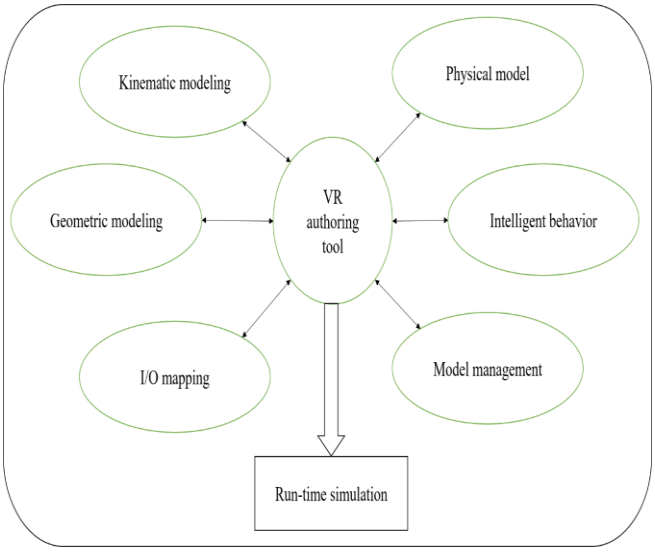

Fig 8:- Various aspects of VR modelling. [3]

Finally, to maintain real-time connections with simulations, the model must be upgraded and optimized in the middle of the model administration and management steps.

➢ *User / Trainee:*

It is currently time to measure the user's performance while interacting with the simulation. It is likewise essential to measure the user's response to the technology to iteratively improve the VR framework or the specific application design. Moreover, it is important to comprehend why some user responses lead to simulation sickness, what are its causes, and what should be possible to limit its effects. Finally, at a more elevated level, it is savvy to consider the advantages and negative impacts that VR can have with respect to society.

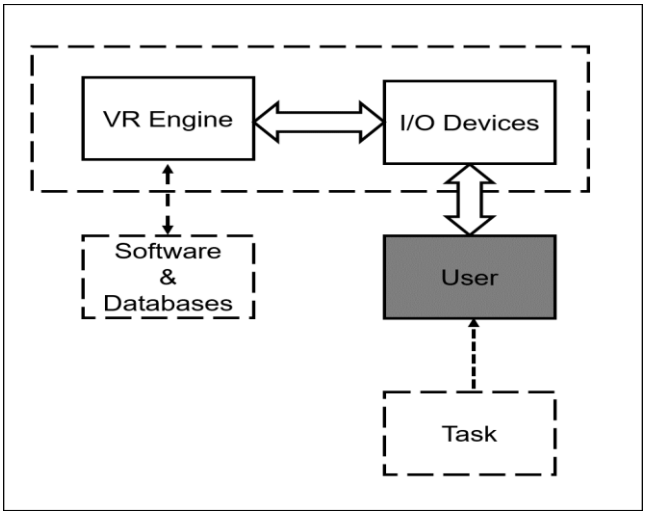

Fig 9:- User / Trainee in Virtual Reality architecture. [3]

These issues fall into the region of human factors research. This comprises of orderly examinations by multidisciplinary groups of engineers and connected analysts to check which tasks are increasingly reasonable for users, which user attributes impact the VR simulation performance, how VR technology ought to be improved to even more likely address user issues, what sort of designs upgrades user performance, the negative societal effect from the users' abuse of the technology, etc. These interrelated human factors research directions are illustrated in Figure 10.

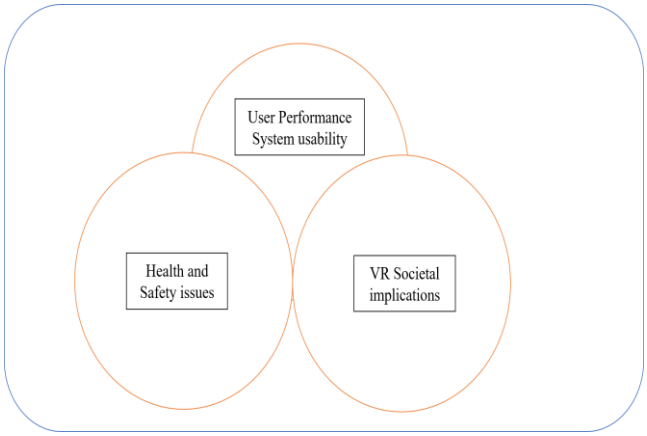

Fig 10:- Areas of human factors research in VR. [3]

No comprehensive model of human behaviors exists attributable to its multidimensionality just as vast individual inconstancy. The legitimacy or integrity of a simulation is qualitative, best case scenario and can't be effectively measured scientifically. It is in this manner justifiable that it is significantly progressively hard to investigate human-machine interaction. The more human parameters are included, the more troublesome it is to have a legitimate comprehension of such an interaction. Therefore, deciding the performance of a VR simulation is to some-what subjective.

➢ *Tasks:*

A piece (bit) of work to be done or embraced. Tasks can be assigned by others or can be voluntarily undertaken.

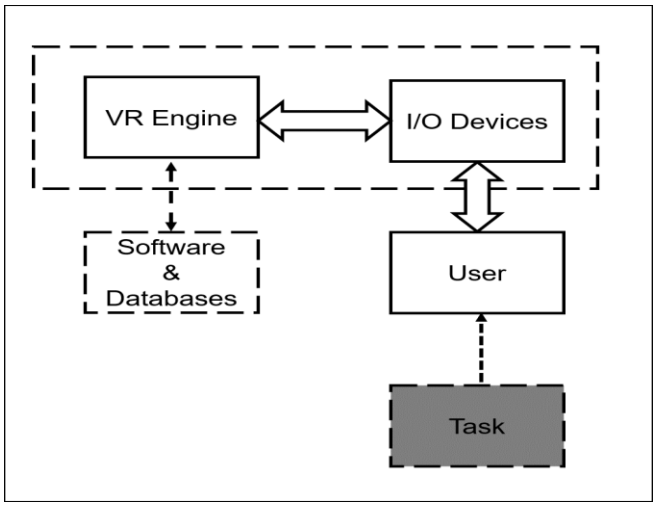

Fig 11:- Task in Virtual Reality architecture. [3]

C. How Does Virtual Reality (VR) Works?

The important goal of virtual reality is to simulate vision. Each headset plans to perfect their way of dealing with creating a deep 3D environment. Each VR headset arranges the screen (or two - one for each eye) before the

eyes, eliminating interactions with the real world. Two autofocus focus points are generally placed between the screen and the eyes that change depending on the movement and position of each eye. Visuals on the screen are displayed either by using a cellular telephone or HDMI cable that is connected to a PC or console.

Fig 12:- How does Virtual Reality works. [4]

To make virtual reality truly immersive there are several prerequisites - a minimum frame rate of 60fps, a refresh rate that is equally skilled and a field of view of at least 100 degrees (but 180 degrees perfect). The frame rate is the rate at which the GPU can process images every second, the screen refresh rate is the display speed for making images, and the FOV is the extent to which presentations can support eye and head movements.

If both do not function in accordance with the guidelines and standards, the client can experience total latency. For example, the excess delay between the interaction and the output of the screen. We need a reaction under 20 milliseconds to trap the brain achieved by consolidating all of the above components in the right proportion. Another problem that must be maintained is to prevent cyber-sickness due to inconsistencies between frame rate and refresh rate. If the GPU fps is more than the screen refresh rate, at that moment, the image can end up distorted. To solve this problem, we limit the frame-rate to the screen refresh rate achieved by utilizing a technology called Vertical Sync (VSync).

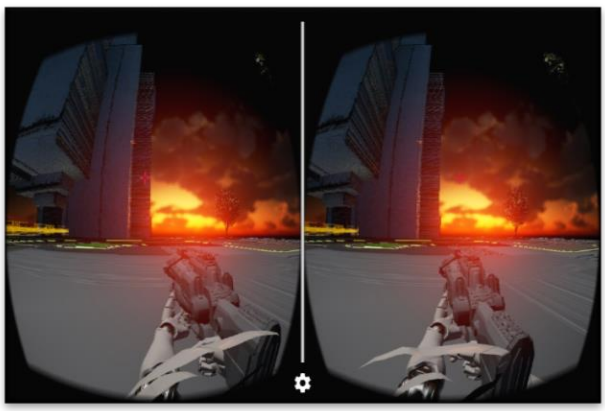

Fig 13:- An example of what a stereoscopic display looks like. [5]

Virtual reality traps your mind to believe that you are in the 3D world. The main way VR does this is with a stereoscopic display. This works by displaying two rather unique angles from view to each eye, simulating depth. This is in addition to different approaches to mimicking depth such as parallax (farther items for you seem to move slower), shade, techniques, and procedures create almost the same experience. Examples of stereoscopic displays can be found in Figure 13.

As observed, the angle of the weapon is slightly unique on each side, the same as the crosshair, but when you put on the headset and play the game, everything marches perfectly. The stereoscopic screen mode changes the platform to platform because each headset is very different in how to display content, the image above (Figure 13) comes from a game created for Google Cardboard using the Unreal Engine.

The diverse VR platform also has special specifications on the headset itself. HTC Vive and Oculus Rift both have a 90Hz display, while the PlayStation VR has a 60Hz display. This is a standard guideline that you need your frame every second to coordinate your screen's refresh speed, so it is recommended that Vive and Rift both remain 90 FPS while the PSVR stays 60 FPS. Portable smartphones are alternative stories, because various cellphones have varying resolutions, but keeping something like 60 FPS is the goal.

Extending more about how FPS works and refresh rates, FPS and screen refresh rates are two things that are separate from each other. Frames per second is how fast your GPU can display images, every second. 60 FPS implies that the GPU produces an output of 60 images every second. Screen refresh speed is how fast the screen can display images every second, estimated in hertz (Hz). This implies if you are playing a game and FPS is 120 but your screen's refresh rate is 60 Hz, you might almost certainly display 60 FPS. You basically lose half of your frame, which is not something to be grateful for because a "tearing" can happen.

Tearing is a phenomenon of objects in game-separating into several parts and displayed in two different locations along the X-axis giving a torn effect. This is where Vertical Sync (VSync) enters. This limits the frame-rate to your screen's refresh rate. Along this line, no frame is lost and thus, no tears are experienced. This is the reason for the best VR experience, the same number for frame rate and refresh rate must be achieved.

❖ *For user interaction there are a few alternatives:*

➢ *Head tracking*

The head tracking frame in the VR headset chases the movement of your head to the sides and corners. It sets X, Y, Z pivot in direction and movement, and includes instruments such as accelerometers, rotating, an LED

hover (around the headset to empower the external camera).

Fig 14:- Image showing the Head Tracking. [6]

Head tracking requires low latency, for example, 50 milliseconds or less, in general, users will see a gap between head movement and simulation.

➢ *Eye tracking*

Some headsets contain infrared controllers that track the direction of your eyes in virtual situations. The significant advantage of this innovative technology is to get an increasingly realistic and deeper field of view.

Fig 15:- Image showing Eye Tracking. [7]

➢ *Motion tracking*

Motion tracking will increase VR to a new dimension. The problem is, that without tracking your movements you will be restricted in VR - it is not feasible to look around and move.

Fig 16:- Image showing Motion Tracking. [8]

Through the idea of 6DoF (six degrees of opportunity) and 3D space, the option to help track movement is divided into two groups, optical and non-optical tracking. Optical tracking is usually a camera on the headset to pursue movement, while non-optical methods utilize various sensors on the gadget or body. Most of the gadgets actually combine two choices.

D. Examples of Virtual Reality (VR)

➢ *Tilt Brush by Google*

Fig 17:- Tilt Brush by Google. [9]

Tilt Brush gives you the opportunity to paint in 3D space with virtual reality. Unleash your creativity with three-dimensional brush strokes, stars, light and even flames. Your room is your canvas. Your palette is your imagination. The possibilities are endless.

➢ *Volvo Reality*

As a leading vehicle brand, Volvo took an innovative method to utilize Google Cardboard. For their Volvo XC 90 Luxury SUV, Volvo runs a giant #volvoreality crusade where they allow clients to immerse themselves in amazing mountain trips by applying Virtual Reality.

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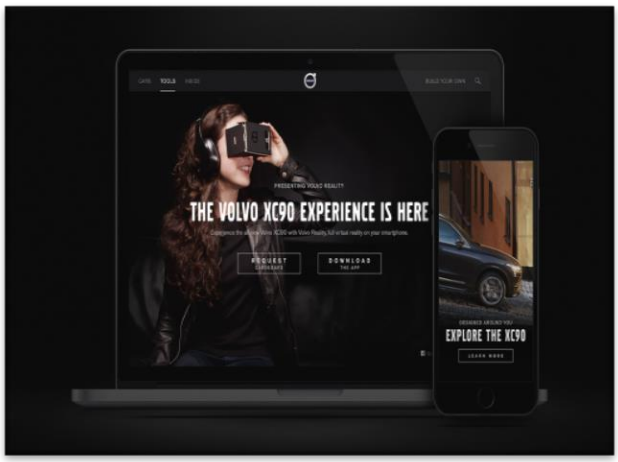

Fig 18:- Volvo reality. [10]

Volvo cleverly plans various dimensions of distribution. This experience is all enhanced for Google Cardboard but on the other hand, it can be accessed on a gadget with only video experience. The Virtual Reality initiative taken by Volvo helped them reach a million impressions.

➢ *Matterport 3D Spaces*

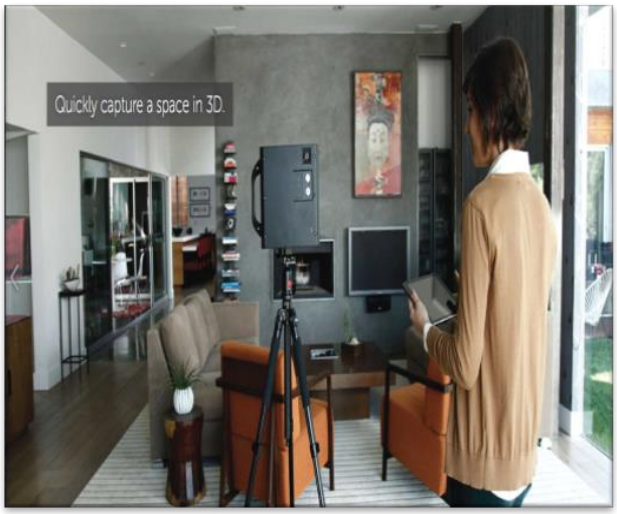

Fig 19:- Matterport 3D Spaces. [11]

Offering an incredible 3D experience in the real estate section, Matterport uses Virtual Reality and 3D in the most ideal way available. This is a truly new type of media that welcomes clients to make virtual visits and explore the place as if they were really there. Because printed images are very outdated and virtual reality sessions in 360 degrees are also a discussion of the past, Matterport provides a reality catch frame board with land visits in 4K objectives. In addition, 3D perception can be accessed on the web or for VR headsets such as Oculus Rift or HTC Vive.

E. Advantages of Virtual Reality (VR)

➢ *Feels like reality*

Visuals seen in virtual reality are clearly better than reality in some situations. Virtual reality technology is used in computer games and clients get the feeling that they are in a different universe. In computer games by VR game controllers, transmission of vibrations and different sensations has been completed. The use of sound and design in videos has been consolidated into VR. In addition, this provides a decent game background for clients. Likewise, clients can also get a real encounter in playing games, for example, clients fight zombies.

➢ *Utilized in various fields*

Because of its extensive features, virtual reality has been used in various fields, for example, in military services, education and medicine. This includes more dimensions in various fields. Virtual reality is used in aviation and architecture to survey end products.

➢ *Users have extraordinary encounters*

The client has a colossal encounter in utilizing virtual reality. VR technology makes clients feel that they experience real areas and hear real sounds and see real things. Many people have a tendency to use virtual reality technology that is increasing. This is very used by people who have special abilities. Because they utilize virtual reality, they can investigate the real world. The film sent to VR gives approval to the audience group to see the entire environment in each scene. In this way, make understanding smart reviews for many people.

➢ *Give a detailed view*

Virtual reality provides a complete and detailed place perspective. For example, virtual reality makes tourist destinations more attractive and simpler. This provides a detailed perspective on the place where you need to visit. So, viewers can plan their trip by observing the real location of the place. In addition, users can see important tourist attractions as well as important places where they are interested in going.

➢ *Connects with individuals*

Virtual reality provides an opportunity to talk to people you don't know in your real life. It helps in forming new connections in a way that is increasingly proficient as a contrast to real life. Users begin to think of various types of individuals and relate to them.

➢ *Strong communication*

One of the aces of Virtual reality is successful communication. Users can talk to each other and therefore appreciate the discussion between them. This gives the experience of talking to the general public.

➢ *Helping with Impressive Visualization*

This helps in investigating and exploring various facts and can even change the level of involvement and experience. If you are wearing a VR headset, you can find the best quality artificial world.

➢ *Enables Students to Get Engaged*

These days it has turned out to be troublesome for the lecturers to conduct classroom cooperation and interactive sessions. With the use of Virtual Reality, cooperation with the students has turned out to be so easy. The students take help of virtual reality to talk about their own encounters and experiences.

➢ *Creating Interest*

Virtual Reality has made observing and watching more pleasant than reading. VR is amazingly interesting and engaging. VR innovation makes pleasant encounters. This innovation rouses them students to learn and know better throughout everyday life.

➢ *Improves Educational Value*

The specialists exploit the VR innovation to think about the new characteristics of medicines. VR innovation additionally works best in the fields of editing and writing. It helps in finding mistakes.

➢ *Helps to Overcome Language Barriers*

Language boundary is a noteworthy issue in the field of training and education. If you are not concentrating in the place where you grew up, you must embrace the vernacular of where you are thinking about. With the execution of Virtual Reality, the conceivable language can be aptly actualized by utilizing suitable programming software.

❖ *Some of the other benefits of Virtual Reality are:*

1) Virtual reality makes a realistic world
2) It empowers the users to investigate and explore places.
3) Through Virtual Reality, the user can try various things with a virtual environment.
4) Virtual Reality makes training easier, more comfortable, effective and calm.

- Little / no risk
- Safe and controlled area
- Realistic scenarios
- Can be done remotely saving time and money
- Improves retention and recall
- Simplifies complex problems/situations
- Suitable for various learning styles
- Innovative and enjoyable

F. Disadvantages of Virtual Reality (VR)

➢ *Expensive*

One of the main principles of virtual games is that it is not realistic for everyone to pay the cost. It is too expensive and individuals who cannot afford this fee will be forgotten from the use of innovative technology.

➢ *Communication may not be replaced for a group of individuals*

Another con of virtual reality is that communication using innovative technology cannot be exchanged with groups of individuals. Also, there will be a helpless nature to cheat.

➢ *Feeling useless*

Users generally get usability sentiments. They feel that they are getting away from reality and sometimes this tendency eventually becomes risky for them.

➢ *Users get addicted to virtual world*

Users are addicted to the virtual world and explore non-virtual conditions. This habit can cause various medical problems for them.

➢ *Innovation and technology are still being experimented*

Although virtual reality experiences are used in various fields because they are still exploratory. It is not recognized or made fully. VR has many cons because it is not satisfying and can be fully accepted.

➢ *Training in VR condition isn't genuine*

Another con of virtual reality is that an individual who has been trained and prepared in a VR simulation can do well in that condition, but he cannot work well in reality. Furthermore, it will not give the same results.

➢ *Lacks Flexibility*

In the classroom you can act with flexibility. You can give recommendations and make inquiries. This is absurd with virtual reality. With the augmented experience headset, you can utilize a similar program in every one of the sessions. There is no degree in positive cooperation.

➢ *Getting Addicted*

Addiction to Virtual Reality is normal. Students can be addicted to the virtual world. The population segment is increasingly addicted to computer games and the rest. In the realm of Virtual Reality, a person can even depend on dangerous drugs or even drugs.

➢ *Break of security*

While using the virtual reality technology a stranger might break into one's privacy and breach your personal security.

➢ *No influence over personal details*

With the use of VR in browsing the web and browsing in real-time, in the future it will be possible to get any individual details like Facebook profile details or more just by pointing your camera at that individual. So, imagine how dangerous it is!

➢ *Low resolution content, extensive file size.*

New, extinguished glasses or headsets offer the best high-resolution display that can be accessed. The experience of playing games goes forward with low resolution, leaving you with a low-resolution experience.

➢ *File Size*

The VR stage currently requires some kind of download to get started. Regularly the size of documents is more than 1 GB and is very slow.

➢ *Video quality*

The following problems are only video quality. Most VR in stereo and equipment are not ready to fully support it. The video comes through rough and pressed preferring it to be taken like that and obviously it's definitely not. Improved resolution is an improvement.

G. Applications of Virtual Reality (VR)

➢ *Entertainment*

The entertainment business is now increasingly interactive and technology is strange because no one has enough energy to invest time in entertainment while VR technology serves entertainment through VR headsets where users can appreciate and enjoy content in an entertaining way without a physical presence in a particular place.

Fig 20:- Entertainment in Virtual Reality. [12]

When human life is now increasingly limited to TV, cellphones, headphones, and so on to entertainment, virtual reality sees existence without investing extra time and money. The deep substance of illustration quality, virtual simulation, commitment, and more fun with dynamic participation in the virtual world makes it more comfortable and adaptable.

➢ *Education*

If we talk about the education system, at that time it was only tiring books with curiosity that appeared little in the brain, yet some developed countries experienced progress towards making the education system wider and more interesting with various tricks and techniques.

Fig 21:- Education in virtual reality. [12]

Virtual Reality regulates the education system to a certain extent in terms of commitment while interacting with virtual items that make more premium and curiosity among students while interacting with virtual situations while studying.

➢ *Virtual Tours*

Virtually visiting certain places with more information and great designs and graphics makes your visit more comfortable and comfortable without having to spend a lot of time on physical tourism.

Fig 22:- Virtual Tours in Virtual Reality. [12]

The virtual tour is also entertaining and interesting through Virtual reality where users can visualize a more successful and productive place when interacting in the virtual world. Virtual Reality offers travelers who make them more excited when interacting to a place virtually because of better immersion.

➢ *Training*

If you are limited to limited training resources, equipment that is unusual or rich, a lot of labor must be prepared at one time. If a portion of this confinement applies to you at that time by utilizing virtual reality can be a perfect alternative to your needs.

Fig 23:- Training in Virtual Reality. [13]

Virtual reality has a fundamental impact in the training industry by providing accurate and error-free training where there is no room for error while offering training in any field such as aviation, defense, modern and others. Deep learning through VR reduces trivial training.

➢ *Retail*

Consumers are dependent on the age of the internet, where they put trust in data, detailed descriptions, video reviews, and social proactivist that previously determined their buying choices. Top e-retailers are currently implementing and executing experience that is rich in substances for their clients and they have developed fundamentally as a result.

Fi24:- Retail in Virtual Reality. [12]

Actualizing virtual reality experiences to client's benefits retailers in different ways such as fewer promoting costs, reducing returns, increasing investigations, etc., which adds a favorable position to retail businesses while preparing to show methodology.

➢ *Medicine and HealthCare*

The way humans fall into various infections, diseases, and so on. Health care organizations need increasingly talented work to overcome this problem. Where we have seen the insurance, industry move towards Virtual reality that consolidates the re-enactment of medical operations, fear care, robotic medical procedures, and skills training.

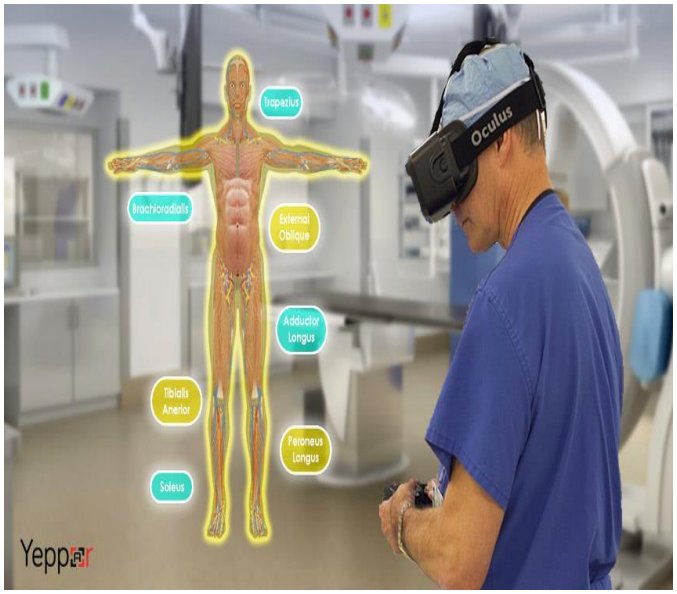

Fig 25:- HealthCare in Virtual Reality. [12]

Fig 26:- Medicine in Virtual reality. [14]

Virtual reality supports the health care industry by allowing experts to learn new skills, refresh training in a safe environment. In addition, it allows experts to treat patients without danger or danger. The best case of this technology is the human system that empowers specialists and drug experts to connect with others in a deep simulation environment.

II. AUGMENTED REALITY

A. What is Augmented Reality (AR)?

➢ *Definition:*

An enhanced version of reality in which direct or indirect views directly from the physical real-world environment are augmented by computer-generated images superimposed on the user's view of the real world, thus enhancing one's current reality perception. [15]

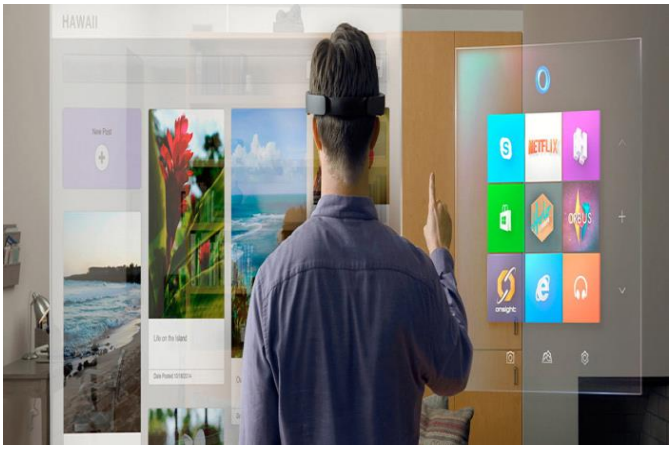

Fig 27:- Augmented Reality. [16]

Augmented Reality (AR) may not be as attractive as the crazy journey of virtual reality, but this technology proves itself to be a very valuable tool in our daily lives.

From web-based life filters to surgical procedures, AR is rapidly developing in popularity because it brings the components of the virtual world, to our real world, along this line enhancing the things we see, hear and feel. At the point when contrasted with other reality technologies, augmented reality lies between a range of mixed realities that are between the real world and the virtual world.

The origin or beginning of the augmented word is augment, which intends to insert (add) or increase something. Because Augmented Reality (also called AR), graphics, sound, and touch feedback are added to our natural world to make a better user experience.

Unlike virtual reality, which expects you to occupy a truly virtual environment, augmented reality utilizes your existing habitat and only covers virtual data and information on it. Because the virtual world and the real world coincide together, augmented reality users experience a new and better natural world in which virtual data and information are used as tools to provide assistance with training and regular activities.

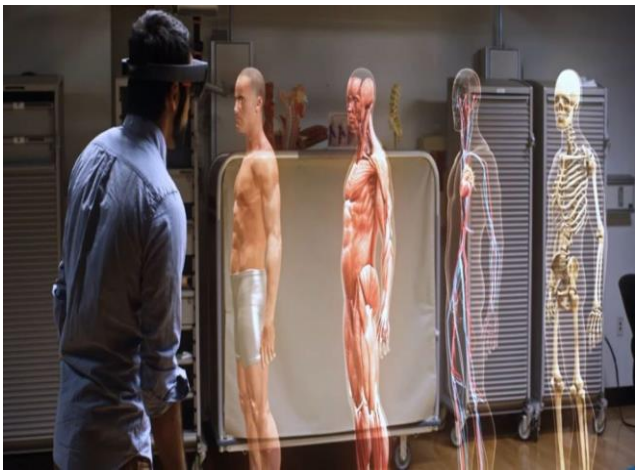

Fig 28:- Augmented Reality Explained. [15]

The augmented reality application can be as basic as notification of content or as complex as guidelines about the best way to play the methodology of a surgical procedure. They can highlight important features, improve understanding, and provide available and timely data and information. Smartphone applications and business applications by organizations that use augmented reality some of the many applications that drive augmented reality applications towards improvement and development. The key point is that the data and information provided is extraordinarily topical, important and relevant to what you need to do.

B. System Architecture of Augmented Reality (AR)

The Components of Augmented Reality architecture are as follows:

1. User
2. Physical World
3. Sensors
4. Context Analyzer
5. MAR Execution Engine (Mixed and Augmented Reality)
6. User Interface (Display)
7. External Factors (Media Assets and External Services)

We are going to analyze all the components usually present in an AR system.

Fig 29:- Augmented Reality System architecture overview. [17]

Remember Figure 29, the user is perceiving his environment as a combination of the direct perception and the computer-mediated one. Let us further know and investigate what lies within the computer-mediated perception. The blue box in the image below is responsible for computer-mediated perception. We already know that it is connected to the physical world and the user.

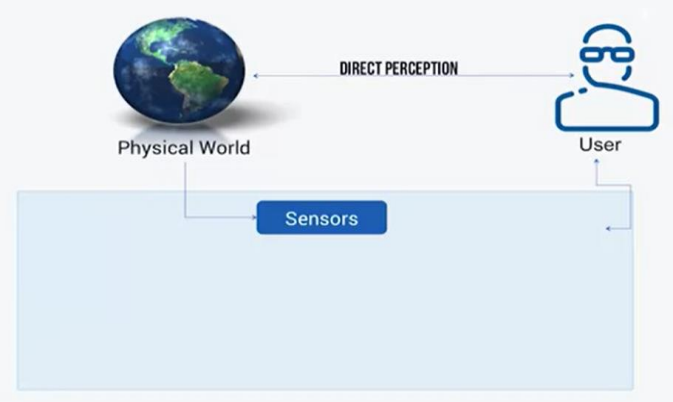

Fig 30:- Sensors in AR system architecture. [17]

The connection with the physical world is done by a set of sensors of various types like cameras, microphones, accelerometers, compass and so on.

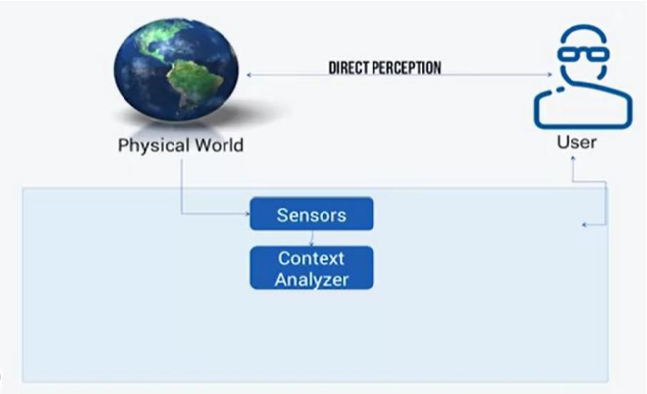

Fig 31:- Context Analyzer in AR system architecture. [17]

The data produced by the sensor is continuously analyzed by what is called a Context Analyzer. some results of the analyzer and some data produced by the sensors are transferred to the brain of the system called "MAR Execution Engine".

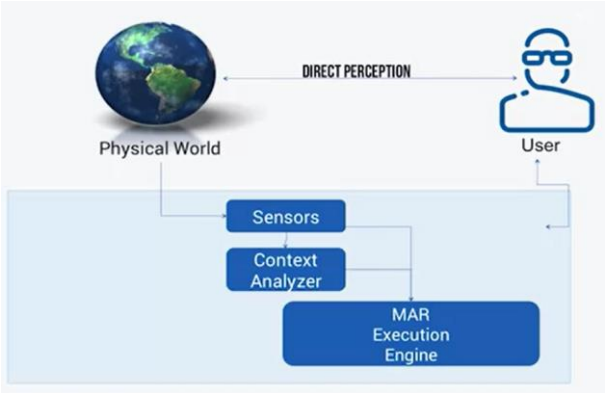

Fig 32:- MAR Execution Engine in AR system architecture. [17]

The main job of the engine is to verify if the conditions established by the AR designer and the expressed in the MAR Scene are met.

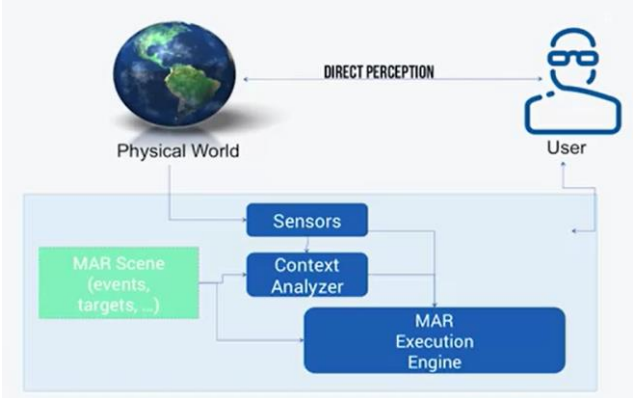

Fig 33:- MAR Scene in AR system architecture. [17]

Some of the examples of the MAR Scene can be GPS location set by the end user within a range, a face detected by the camera, a specific sound captured by the microphone and so on.

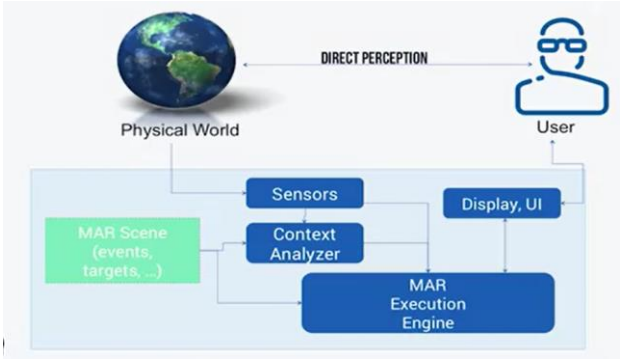

Fig 34:- Display and User Interfaces (UI's) in AR system architecture. [17]

Some results produced by MAR Execution Engine are presented to the end user by using specific displays such as screens, loudspeakers, vibration devices and so on. The user can interact with the system by using User Interfaces (UI's) components.

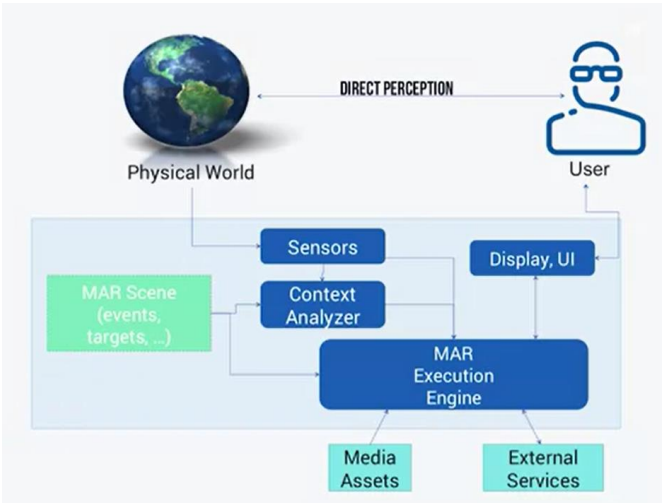

Fig 35:- Media Assets and External Services in AR system architecture. Also, shows the level 1 of the AR system architecture. [17]

Finally, computer-mediated perception can connect to other servers. Some of them are specialized in distributing Media Assets. For example, the simulated objects used to augment the scene captured by the camera. Some others may be specialized in processing data captured by sensors or in aggregating data from various resources. This is the level one architecture of the AR system.

The main functionality of the architecture is to capture the real world, analyzing it, comparing with some conditions specified by the designer and presenting the results to the end user.

Let's look at the components closely. First, the sensors can be classified into two types.

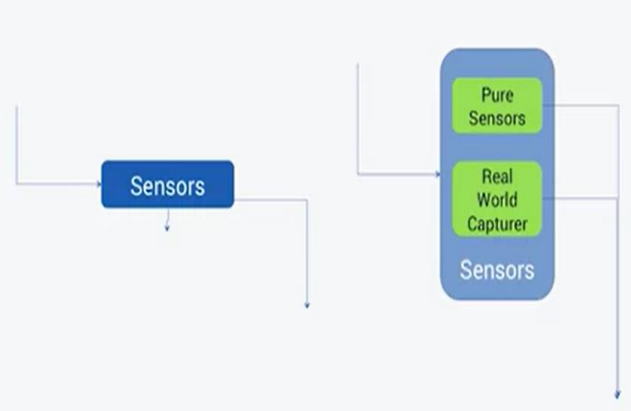

Fig 36:- Classification of sensors in AR system architecture. [17]

The ones that are measuring the physical property of the environment that is not directly applicable to the human sense are called “Pure Sensors”. The best example here is the location of the end user. It can be computed using the GPS system but never sensed by our natural senses (human senses). By convention, we will call these sensors as “Pure sensors”. The second category is the sensors capturing the physical property that are directly detectable by the human sensing capabilities. Here we can mention video cameras and microphones. We distinguish both types of sensors by calling the second category “Real World Capturer” and by considering the data produced by these captures can be presented to the user as it is. For example, the video captured by a camera can also be displayed by the phone without any alterations.

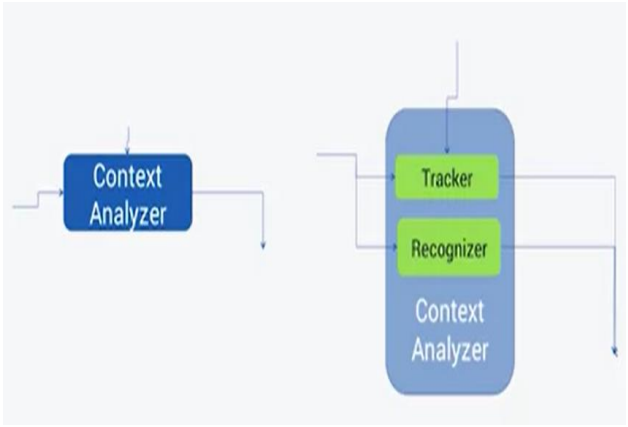

Fig 37:- Classification of Context Analyzer in AR system architecture. [17]

Secondly, we focus on the Content Analyzer. This component has two functionalities.
1. To recognize if the condition is met or,
2. To recognize and track the condition.

An example of the first functionality is a camera of the end user is pointed to a particular logo. Then on action displaying the name of the company having that logo would be triggered.

For the second functionality, it is not enough to detect the logo but also to compute the position of the logo in space with respect to the end user.

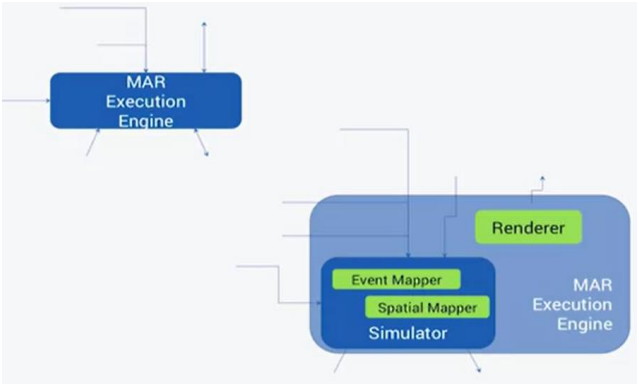

Fig 38:- Classification of MAR Execution Engine in AR system architecture. [17]

Finally, as you may imagine the brain of the AR system can relatively be complex. It has an orchestration of all receiving all the messages from an external source, external services, end users. Simulating the actions specified by the AR designer and rendering it to the end user in the right modality the results of the end users. The execution engine in the majority of cases is using a scripting or even advanced programming language.

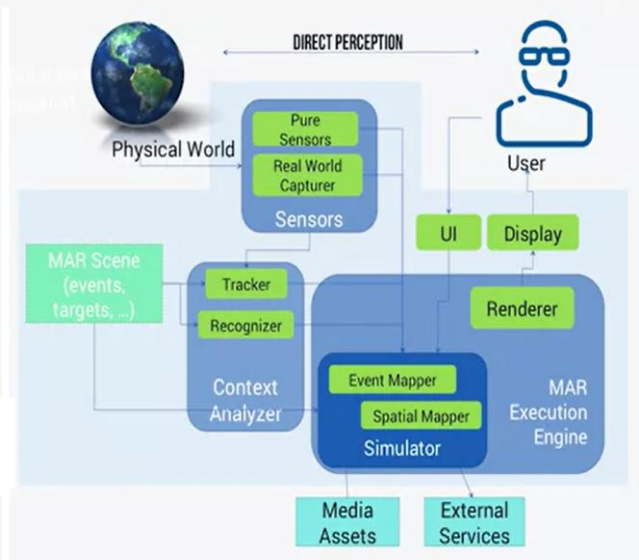

Fig 39:- Level 2 AR system architecture. [17]

Figure 39 shows the level 2 architecture of the system which is updated.

C. How Does Augmented Reality (AR) Technology Works?

To see how the augmented reality technology functions, one must initially understand its purpose: to bring computer-generated objects to the real world, which can only be seen by users.

In most augmented reality applications, users will see engineered and regular light. This is done by coating the anticipated image through some transparent glasses or glasses, allowing interactive images and virtual objects to coat the user's view of the real world. Augmented Reality devices are regularly independent, implying that not at all like the Oculus Rift headset or HTC Vive VR, they are completely detached and do not have to bother with the HDMI cable, console or computer functioning.

There are several classifications of augmented reality technology, each with contrasting differences in their goals and application use cases. Underneath, we investigate the various types of technology that make up augmented reality.

➢ *Augmented Marker Based Reality*

Augmented Marker-based Reality (also called Image Recognition) uses cameras and visual markers, for example, QR / 2D codes, to make results right when the marker is detected by the reader. Marker-based applications use cameras on gadgets or devices to recognize markers from several other real-world objects. In particular, however, simple archetypes (for example, QR codes) are used as markers because they can be identified effectively and do not require much processing capacity to scan. Position and orientation are also determined additionally, where several types of data and / or information are then overlaid with markers.

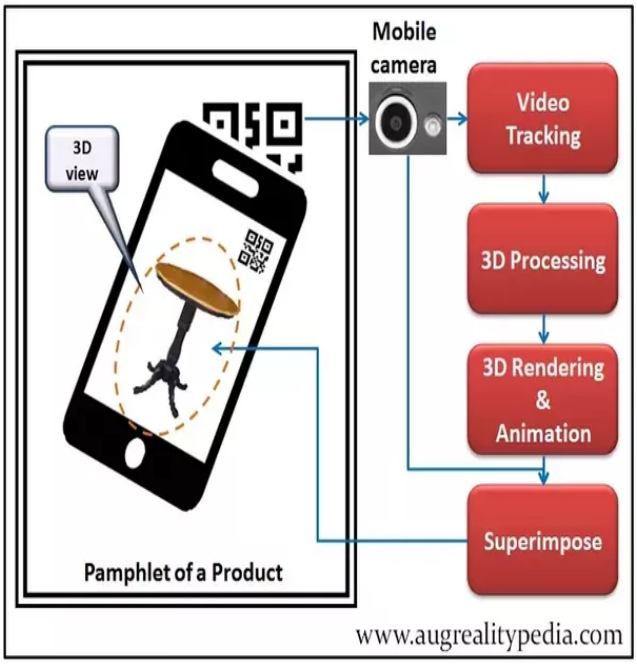

Fig 40:- Augmented Marker Based Reality. [18]

➢ *Marker-Less Augmented Reality*

Marker-Less Augmented Reality markers are one of the most common augmented reality applications, marker-less (also called location-based augmented reality, position-based, or GPS), using GPS, a sophisticated digital compass, speedometer, or an accelerometer installed on a device or gadget to provide data and / or information based on your location. A very powerful advantage behind augmented reality

Fig 41:- Marker-Less Augmented Reality. [19]

technology is the broad accessibility of mobile phones and the location discovery features they provide. Most are used to map directions, find nearby organizations, and other location-based portable mobile applications.

➢ *Projection-Based Augmented Reality*

Augmented Reality Based Projections work by anticipating artificial light to surface the real world. An augmented reality-based application considers human interaction by sending light to the surface of the real world

and after that it detects human interactions (such as touch) from the anticipated light.

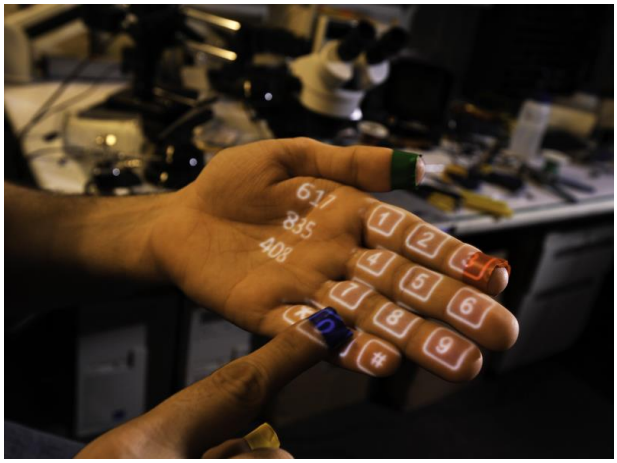

Fig 42:- Projection-Based Augmented Reality. [20]

Differentiating user interactions is completed by separating between normal (or known) projections and modified projections (carried by user interactions). Another interesting use of projection-based augmented reality uses plasma laser technology to expand interactive (3D) three-dimensional images into the air.

➢ *Superimposition Based Augmented Reality*

Superimposition based on Augmented Reality is either incomplete or completely replaces the original appearance of an object with a newly added display of equivalent objects. In augmented reality based on augmented reality, object recognition assumes that work is important because the application cannot replace the original display augmented if it cannot know what the object is.

Fig 43:- Super Imposition Based Augmented Reality. [21]

A consumer who faces augmented reality augmentation cases can be found in IKEA's augmented reality furniture catalog. By downloading the application and checking selected pages in printed or sophisticated digital inventory, users can place virtual IKEA furniture in their own homes with the help of augmented reality.

➢ *How Do Augmented Reality Devices Work (Inside)?*

Enlarged reality can be displayed on various displays, from screens and monitors to handheld devices or glasses. Google Glass and other head-up displays (HUD) put augmented reality directly into your face, more often in the form of glasses. The handheld device uses a small screen that fits in the user's hand, including cellphones and tablets. Because reality technology continues to progress, augmented reality devices will continue to need less hardware and start connecting to things like contact lenses and virtual retinal displays.

❖ *Key Components to Augmented Reality Devices*

➢ *Sensors and Cameras*

HoloLens Sensors and Headsets Augmented Reality Sensors are usually outside the augmented reality gadget and compose real-world user interactions and communicate them to be prepared, processed, and interpreted. The camera is also located outside the gadget, and visually scans to gather information about the surrounding zone.

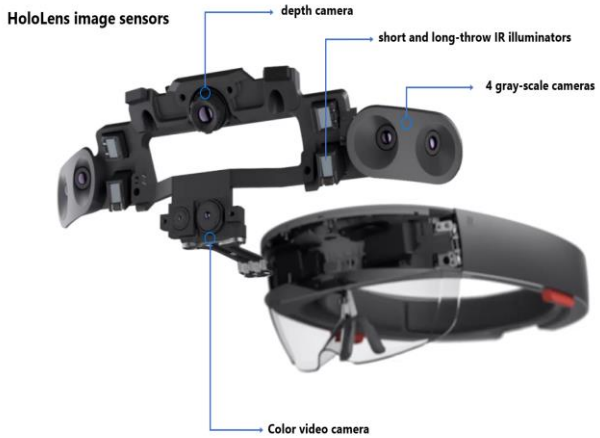

Fig 44:- Sensors and Cameras in AR Devices. [15]

The device retrieves this information, which regularly finds out where the physical objects around it are found, and then determines a computerized model to decide the right output. Because of Microsoft HoloLens, cameras explicitly carry out explicit obligations, for example, deep sensing. The Sensing Depth Camera works with two "environmental sensing cameras" on each side of the gadget. Other types of normal cameras are standard megapixel cameras (such as those used on cellphones) to record images, record videos, and sometimes data and / or information to help augment.

➢ *Projection*

Although "Projection-Based Augmented Reality" is the classification itself, we explicitly refer to minimized projectors that are often found in front-facing and outward positions on usable augmented reality headsets. The projector can basically change any surface into an interactive domain.

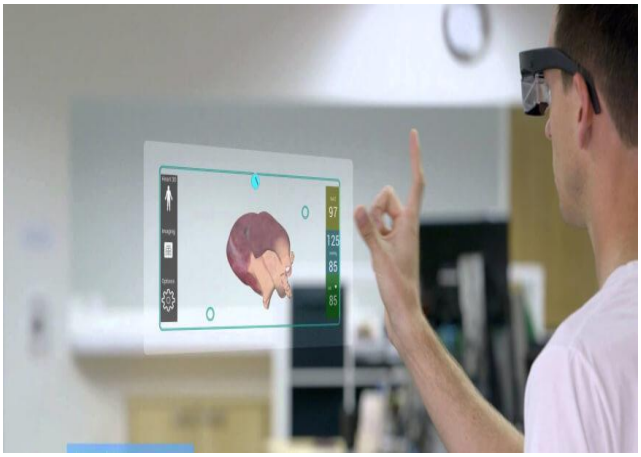

Fig 45:- Projection in AR Devices. [22]

As referred to above, information taken by the camera used to see the world around it is handled and after that it is anticipated to surface in front of the user; which can be wrists, walls, or other people. The use of projections in augmented reality devices implies that screen real estate will definitely turn out to be a less critical segment. Then, you might not need an iPad to play chess on the internet because you will most likely play it on the table right in front of you.

➢ *Processing*

Headset HoloLens Augmented Reality Processing Unit, augmented reality devices are fundamentally reduced by supercomputers that are pressed into wearable devices. This device requires very large computer processing power and uses many of the same segments that our cellphones do.

Fig 46:- Processing in AR Devices. [15]

These segments combine the CPU, GPU, flash memory, RAM, Bluetooth / Wi-Fi microchips, GPS microchips, and so on. Developing augmented reality devices, for example, Microsoft HoloLens uses an accelerometer (to measure the speed of movement of your head), a gyroscope (to measure the slope and orientation of your head), and a magnetometer (functions as a compass) and which direction your head makes sense) to accommodate truly immersive experiences.

➢ *Reflection*

Fig 47:- Reflection in AR Devices. [15]

HoloLens Augmented Reality Optical Lens Headset, Mirror is used in augmented reality devices to help the way your eyes look at virtual images. Some augmented reality devices may have "a variety of small curved mirrors" (as well as augmented reality Magic Leap gadgets) and others may have a direct two-sided mirror with one reflecting surface that approaches the side-mounted camera and the other. the reflecting surface of the display that is mounted next to the user's eyes. At Microsoft HoloLens, the use of "mirrors" includes transparent holographic lenses (Microsoft offends them as waveguides) that utilize an optical projection frame for your multi-dimensional image shaft. A light machine is called releasing light to two separate lenses (one for each eye), which consists of three layers of glass of three different essential colors (blue, green, red). Light touches the layers and after that enters the eye at certain points, intensities, and colors, creating the last comprehensive holistic image of the retina of the eye. Regardless of the strategy, these ways of reflection have the same goal, which is to help align images with the user's eyes.

➢ *How Augmented Reality is Controlled?*

Augmented reality devices are regularly controlled either by touch pads or voice commands. Touch pads are often somewhere in a gadget that can be reached effectively. They work by detecting pressure changes that occur when a user taps or swipes a place. Voice commands also function in everything as done on our cellphones.

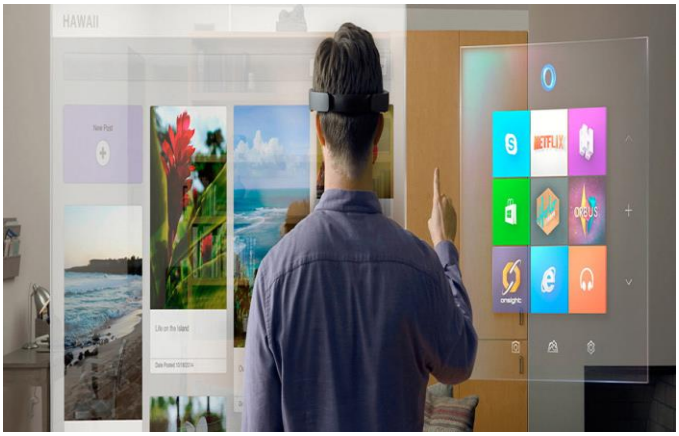

Fig 48:- How AR is Controlled. [23]

A small amplifier or microphone on the gadget will get your voice and after that, a chip will translate the command. Voice commands, for example, in the Google Glass augmented reality gadget, are pre-arranged from a list of commands that you can use. On Google Glass, almost every one of them starts with "alright, Glass," which reminds your glasses that an order will be executed soon. For example, "alright, Glass, snap a photo" will send the command to the chip to take whatever photo you look at.

D. Examples of Augmented Reality (AR)

➢ *IKEA Mobile Application*

In addition to the amusingly named furniture that you have to collect yourself, IKEA is also considered in the world of technology as one of the leading organizations to use augmented reality.


Fig 49:- IKEA Mobile Application. [24]

The retailer began exploring different augmented reality tracks in 2012, when customers could use the app to see the look of tables and shelves at different locations around their homes. IKEA brings new enhancements to its IKEA Place app, which allows you to choose any item from the store's catalog and see how it expects to grow anywhere in your home.

This is a surprisingly easy-to-use tool for people who wonder if a specific household item will fit in a small space or if the shadow of their eventual purchase will coordinate the theme of the room.

➢ *Nintendo's Pokémon Go Application*

You cannot really discuss augmented reality without referring to Nintendo's Pokémon Go app for augmented reality.

Fig 50:- Pokémon Go Application. [25]

The resounding success of Pokémon Go 2016 allowed users to get their most beloved Pokémon by browsing their smartphones in the real world, but with superimposed images.

The game was a staggering success, with 65 million customers at the top of its popularity. This is probably also why you have seen several teenagers and teens wander around your neighborhood looking at their smartphone all the time.

➢ *Pepsi MAX*

Recently, PepsiCo drove Londoners with an AR-enabled bus stop display.


Fig 51:- Pepsi Max Bus Stop Campaign. [26]

Explorers and travelers have been shown to be a threatening tiger, a meteoric destroyer and a foreign arm that is tearing people off the road.

E. Advantages of Augmented Reality (AR)

➢ *Augmented Reality applications development is helpful in Modern day surgeries and procedures*

The idea of augmented reality is huge in modern surgeries. The relevant application development offers patient records a way that can rearrange the tasks and tasks of physicians and enable them to effectively understand

patients' illness. Advanced radiography was based on computerized tomography (CT) or real images from an ultrasound, analyzing the situation of a tumor seen in an endoscope video, and so on thanks to the development of the application.

➢ *Helps children and youngsters to be increasingly expressive and interactive*

An ongoing review at the University of Washington revealed that augmented reality play could fundamentally help students "in danger". These students could create their own world of virtual reality in which they will face simulation situations. In addition, they could also portray themselves as champions in this way, which would give them a sense of satisfaction and ownership in the making of the play.

➢ *Shared gaming experience enhances socialization*

The idea of AR (augmented reality) application development capabilities to socially unite people. For example, Pokémon Go is a great case of AR in games. The game really helped the audience a lot by transmitting the players together. The diversion asks you to leave your home and starts communicating with different players they may or may not ignore. We realize that the factor has helped players suffering from grief, worry or mental imbalance, etc.

➢ *Simplifies Shopping hassles*

The development of an augmented reality application for the iOS and Android platforms allows you to discover the new offline and online shopping experience. It is currently possible for virtual fitting rooms to help customers get the right size, reducing the total number of benefits. Something very similar applies well in the shadow of a new car or new furniture in your home. Merchants can now create exceptional augmented reality applications that are fundamentally customized for their brands to separate the enhanced experiences offered to their customers. Nevertheless, it should not be overlooked that RA technology could also be used for advertising efforts simply by merging ARs as a support medium.

➢ *Facilitates Object Visualization in the Unique way*

One of the applications of AR application development is the methodology in which it is useful to put advanced resources. Embedding virtual objects in the real world allows engineers to interact with computer components (such as 3D objects) that they create as if they look like real objects. To get it, for example, car designers have to chip out many parts to give the car a chance to be configured efficiently. By using immersive AR application development technology as well as computer graphics, they could extend advanced designs from the inside of the car primarily to a comprehensive estimate demonstrating identification with the car's dashboard. We realize that viewing virtual objects using this application development technology provides a complete overview of what a completed element, identified by a delimited level element image, looks like. screen.

➢ *Experience the World from Your Living Room*

Take a trip to the Eiffel Tower in Paris, scuba dive in Belize or experience the wildest entertainment stops in the world ... all in your living room! Virtual reality allows us to "see" the world, without actually investing energy in a flight or staying online behind many tourists. You will not need to buy the manual! With virtual reality, you can follow your own pace or master something as you please, while never leaving your home.

➢ *Real-Time Feedback*

AR and VR facilitate preparation and training to deliver instant and detailed results. This will ultimately improve performance and allow learners to make finer entries as part of explicit races, which will result in increased productivity and attention or more remarkable decisions of their abilities.

❖ *Some of the other advantages of Augmented Reality are as follows:*

- The AR is inherently interactive and works simultaneously with the environment in real time.
- This diminishes the boundary between the real world and the virtual world.
- It improves perceptions and associations with the real world.
- Due to its use in the medical industry, patients' lives have proven to be safer. It helps to effectively analyze diseases and locate them at an early stage.
- It can be used by anyone depending on the applications.
- It is possible to reduce costs by testing critical situations to assert their prosperity without actually implementing them in real time. When it is demonstrated, it can very well be updated in the real world.
- It can be used by military personnel without putting their lives at risk by applying the war zone simulation method before the actual war. It will also help them in a real war to make critical decisions.
- This may be related to some of the program preparation because it makes things memorable and appealing.

F. Disadvantages of Augmented Reality

➢ *Addictive gaming features would create numerous health issues*

This immersive technology is remarkably charming because it keeps its players captivated on the game constantly for a few hours. This can end up having a detrimental effect on the player's health. In addition, negligible physical movements may be subject to problems such as obesity, concentration and concentration problems in student education, eye problems, etc.

➢ *Chances of deadly injuries or accidents*

The use of the enhancement of the AR application is not supervised. We discover that this increases the chances that players will get hurt or suffer real injuries. People who are looking for heart problems can be really affected to play horror recreations created by this advancement of application.

➢ *The increase of ethical dilemma and aggressive traits among aspiring users*

The war and some other brutal game reenactments have lots of coercive features that can adjust players' state of mind. This is particularly valid for the contemporary period, because they are actually influenced by it. Later, they feel that it is also normal to define this type of fierce driving in an open space. In addition, they produce a negative message and evade the necessity of having a social obligation in the same way as moral conduct.

➢ *Disassociation of Reality*

In general, users of advanced augmented reality applications invest a lot of energy to be seduced and neglect to recognize the virtual and authentic world. We realize that this could be a real concern, because one of the reasons why the improvement of the application is the supreme submersion (immersion).

➢ *Prone to cybercrimes*

The major disadvantage of this breakthrough in applications is that augmented reality actually duplicates the ability of cyber threats, or in other words, cyber-initiated threats, far more than usual applications. In addition, potential results are significantly higher than virtual reality applications. It is discovered that the devices used to create RA are pirated and that this is predominant in tablets and cell phones, even in wearables and cameras.

➢ *Graffiti, Misinformation, and Abuse*

Anyone who has used the Internet for a long period of time thinks in a relevant way from an angle that they could not possibly escape: people who simply want to challenge, quarrel, offend and create chaos. Every negative part of human cooperation on the Web would really mean the world of augmented reality. It is very easy to understand that when you can post messages anywhere, nothing will stop some people from becoming abusive or insensitive. Chances of censorship and individual aggression would increase exponentially. Common graffiti laws probably cannot contain such richly enriched instances, or would not be before significant delay until a standard has been established. All things considered, it would also be extreme, if not unachievable, to control without tackling the intrusion and invasion of privacy.

➢ *Issues About Privacy*

One of the drawbacks or weaknesses of augmented reality is that it depends on the accumulation, search and redistribution of different kinds of data, particularly through the use of Big Data, which raises concerns about confidentiality and security. For example, some devices record the earth continuously. Registration can create potential legal problems.

Similarly, some AR frameworks collect and examine data about their users, for example biometric data and a history of use of gadgets and / or peripherals, among others. With increasingly stringent data assurance laws, such as the European Union's RPGD, designers of these frameworks are required to look for gauges for the use of data.

➢ *Perils and/or Dangers of Reality Modification*

AR obscures the line of demarcation between this present reality and the advanced digital world. Now another disadvantage or bad service of augmented reality is focusing on the imaginable risks of changing reality. For example, the presentation of the game Pokémon Go has given rise to debates because of incidents and even overruns. Overlaying computer components in the natural habitat hides certifiable hazards and makes users less cautious.

The perils of changing reality require the formation of landmarks. Engineers and developers should not overload their AR infrastructures with advanced components. In addition, it is necessary to ask users to let them know that they should not rely too much on the RA to indicate that they become passive from this reality.

➢ *Implementation and Execution Requirements*

Although professional associations, learning foundations, and associations can benefit from the use of augmented reality because of its various enabling circumstances or useful applications, creating and updating a framework RA are both expensive and innovative. Everyone cannot do it as such. In this way, with respect to businesses, small businesses may be confused because of their lack of assets.

Note that AR also requires new technologies and new models. Cell phones require manipulative skills to easily run AR applications. Improvements in AR are also based on advances in human-made consciousness technology, particularly explicit AI structures, such as AI, language preparation, and PC vision, among others.

➢ *Invades and/or Attacks Privacy*

Like other modern technologies available, AR and virtual reality can also be conducive to data piracy - and that's a terrifying thing, given the amount of data associated with virtual environments. In addition, many people fear that authorities use individual data to track or control people.

➢ *Hampers Interaction with Real-World*

At random that we can see and experience the world of home, okay, do we really have to go out? AR and VR can give individuals better approaches to communicate, but they could also remove an essential part of our public activity that includes human association and interaction.

❖ *Some of the other disadvantages of Augmented reality are as follows:*

- It is expensive to build enterprises (projects) based on AR technology and maintain them. In addition, creating AR-based devices is expensive.
- Lack of privacy is a concern in AR-based applications.
- In AR, people are going through important moments.

- The low performance level is a concern that must be taken into account in the testing process.
- It requires that it is essential to discover how to use AR-compatible devices in a viable way.

❖ *Applications of Augmented Reality*

➢ *Gaming*

Pokémon Go is not the same sensation that used to be two or three years ago, but made other famous games. It utilizes the intensity of augmented reality to join our original world with an increasingly fantastic world - where we can roam with friends and capture fantastic imaginary creatures.

Fig 52:- Gaming using Augmented Reality. [27]

Since then, there have been more ideas. There is one dependency on the Jurassic Park building that gives you the opportunity to find dinosaurs, and the creator of Pokémon Go Niantic also deals with one depending on Harry Potter.

➢ *Medical Training*

From MRI equipment that functions to complex operations, AR technology has the potential to help the depth and effectiveness of medical training in various regions.

Fig 53:- Medical Training using Augmented Reality. [28]

Students at the Cleveland Clinic at Case Western Reserve University, for example, will now study the structure of life using an AR headset that allows them to dig into the human body in an interactive 3D format.

➢ *Retail*

In the current physical retail environment, buyers use their smartphones such as never analyzing costs or investigating additional information about the products they research.

Fig 54:- Retail using Augmented Reality. [29]

The world-famous Harley Davidson bicycle brand is one of the extraordinary events of a brand that utilizes this pattern, by building AR applications that can be used by buyers. Clients can see the bikes they might like to buy in the showroom, and modify them using the app to see the colors and highlights they like.

➢ *Repair and Maintenance*

One example of the largest industrial use of AR is to repair and maintain complex equipment.

Fig 55:- Repair and Maintenance using Augmented Reality. [30]

Regardless of whether it's a vehicle engine or an MRI engine, repair and maintenance staff start using AR headsets and goggles while they do their business to give them valuable information on the spot, propose potential improvements, and call attention to areas of potential inconvenience. This utilization case will only continue to be grounded when IoT machine-to-machine technology

develops and can legitimately fertilize information to AR headsets.

➢ *Design and Modelling*

From interior design to architecture and construction, AR helps professionals visualize their latest products amid creative procedures. The use of headsets empowers architects, engineers and design professionals to step legitimately into their structure and space to understand how their designs are seen, and even make virtual changes in place.

Fig 56:- Design and Modelling using Augmented Reality. [31]

City planners can even model how the entire city design looks using AR headset visualization. Any design or display of work that includes a spatial connection is an ideal use case for AR technology.

➢ *Business Logistics*

AR presents a variety of opportunities to build effectiveness and cost reserve funds that intersect in various business logistics zones. This includes transportation, warehousing and route optimization.

Fig 57:- Business Logistics using Augmented Reality. [32]

DHL shipping organizations have effectively actualized sharp AR glasses in some of their storage space, where focal points show workers the shortest (shortest) routes in the distribution center to find and select certain things to send. Giving workers an increasingly productive approach to their activities stands out among the best cases of ROI use in today's business environment.

➢ *Tourism Industry*

Technology has gone a long way forward to encourage the tourism business, from audit purposes such as TripAdvisor to informative websites like Lonely Planet. Even so, AR presents a giant opportunity for travel brands and specialists to give potential tourists a much deeper experience before they travel.

Fig 58:- Tourism Industry using Augmented Reality. [33]

Imagine taking a virtual Australian "Walkabout" before using AR glasses before ordering a ticket to Sydney, or taking a leisurely stroll around Paris to see which historic centers or bistros you might get from the opportunity to visit. Guaranteed AR to make travel sales, trips and visits (vacations) much simpler in the future.

➢ *Classroom Education*

While technologies such as tablets are apparently not limited to many schools and study rooms, instructors and teachers now improve student learning experiences with AR.

Fig 59:- Classroom Education using Augmented Reality. [34]

The Aurasma application, for example, is currently being used in a study room with the aim that students can see their classes using a cellphone or tablet for an

increasingly rich learning environment. Students who find out about space science can see a complete guide to nearby planetary systems, or those in a music class may almost certainly observe a continuous melodic tone when they are looking for ways to play instruments.

➢ *Field Service*

Regardless of whether it is as simple as a climate control system, or as large as a wind turbine, field administration technicians are routinely sent to repair a few essential equipment that require preparation to act as quickly as possible.

Fig 60:- Field Service using Augmented Reality. [35]

At present, these technicians can land nearby with AR glasses or headsets and see whatever they are fixing to more quickly diagnose and correct the problem. And as opposed to browsing repair manuals, technicians can go ahead with free hands to enter and exit faster than other times.

➢ *Entertainment Properties*

In media outlets, it is related to a solid relationship structure with your branded character and gathering of people. Property like Harry Potter is very effective because books and film watchers move to feel they know their character and really like additives.

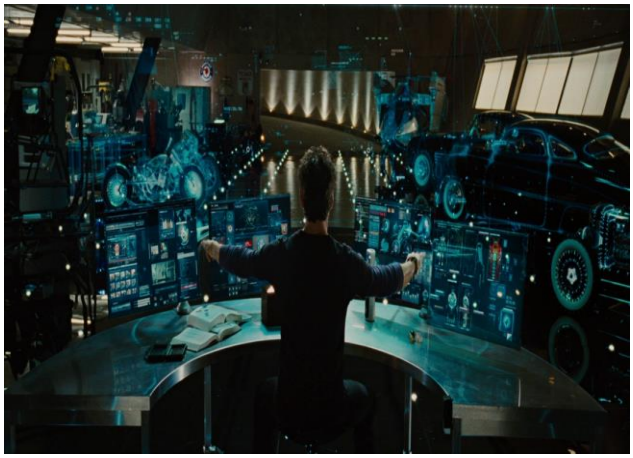

Fig 61:- Entertainment using Augmented Reality. [36]

Enthusiastic brands now consider AR to be a great advertising opportunity to make further ties between their characters and gather people. Indeed, the producers of the AR sensation Pokémon Go have no intention of releasing Harry Potter-themed AR games that fans can associate throughout the day.

➢ *Public Safety*

In the case of today's crisis, people will quickly search for their cellphones to find out what happened, where to go, and whether their friends and family are protected. Also, people who are touched based on seismic flames or earthquakes try to understand who needs help, and the most ideal approach to make them safe.

Fig 62:- Public Safety using Augmented Reality. [37]

AR appears in revealing two bits of an open welfare puzzle. People who wear AR glasses can be warned to threaten the area and show progressively individuals who need help when empowering to now know about their environment. For those who need it, geolocation empowered by AR can show their post, and the best route to, safe zone and area with firefighters or surgeons.

III. SIMILARITIES AND DIFFERENCES BETWEEN VIRTUAL REALITY AND AUGMENTED REALITY

A. Similarities in Virtual Reality (VR) and Augmented Reality (AR)

➢ *Technology*

At the heart of VR and AR is basically the same technology. They also have the same purpose and reason, namely to serve users with enhanced or enriched experiences. As far as technology, augmented reality and virtual are almost equivalent. Both have the goal of serving clients and / or users with a truly immersive and enhanced experience.

➢ *Entertainment*

Apart from the way that many people regard this technology as a figment of science fiction imagination, this technology is a reality today. Both VR and AR have many applications, although it is possible, they are generally sought for entertainment purposes. Both of these technologies are in the development stage and until now empower the experience sought in the entertainment business. The new artificial world was built and began to live with many games extending their assistance, implementing and executing VR and AR technology.

➢ *Medicine and Science*

Although until now, the focus has been on entertainment and social networking, there are many bunches around the world who are trying to embrace these two technologies into the medical field. Both technologies have tremendous potential in the health care business industry. VR and AR can completely change the therapeutic field by making things like remote surgery possible. Until now it was distinguished that this technology could be used to reduce the suffering experienced by patients and to cure mental conditions, for example, Post Traumatic Stress Disorder (PTSD).

B. Differences in Virtual Reality and Augmented Reality

➢ *Augmented versus Virtual Reality regarding Technology*

VR and AR are both increasing innovations in this scenario. And, both can provide a carefully enhanced experience. In AR, virtual substances or computers are superimposed or mixed into real and real-time environments. While in VR, the real environment was first digitized and then the virtual component was entered into the virtual world that was previously digitized.

In the end, Augmented Reality technology makes your real-world untouched and simply enter virtual information into it (remember the case of inserting a virtual bend in live broadcasts of real matches) even though Virtual Reality technology breaks the world and your real place. in a truly immersive virtual environment (remember the case of seeing 360-degree videos on your VR headset).

➢ *Distinction between Augmented reality versus Virtual Reality as far as their Applications*

VR and AR both have various applications in various fields. And, each can give you a life-changing experience. However, due to its total immersive behavior, VR makes the most sense for playing and entertainment reasons (eg PlayStation VR).

In fact, because of its interactive characteristics in real time, AR is mostly suitable for training, medical, marketing, notification, and real-domain applications. In addition, many Augmented Reality Applications can also be accessed to handle various practical problems in a very interactive way.

By determining that today the organization is testing a ton with VR and AR. As a consequence, Augmented reality also gets a part in the field of play (eg Pokémon Go) too. And meanwhile, Virtual reality extends its wings to medical, retail and skills training applications.

➢ *Augmented Reality versus Virtual Reality regarding Hardware necessity*

Hardware requirements assume an important job to separate VR and AR. You can experience AR with Android or iPhone. In this way, every smartphone or tablet with a camera and RAM is adequate to appreciate the important work of AR. And, there is no requirement for extraordinary hardware for AR.

Meanwhile, to appreciate Virtual Reality, Head Mounted Display (HMD) is also needed for options to cellphones. The VR headset is one of the most difficult types of HMD business. Even though various VR headsets are immediately available on the market, you can start with important VR headsets, Google Cardboard.

➢ *Purpose*

VR produces its own artificial agent. In contrast to VR, AR enhances the client's experience by expanding virtual parts such as illustrations, computerized images and several types of innovative sensations to create new layers of interaction.

➢ *Delivery Method*

VR will be delivered to the final client via a handheld controller or mounted on the head. Using this equipment, individuals are connected with VR and they can explore and control their activities in artificially created scenarios.

Nevertheless, AR is more widely used in tablets, smartphones, work stations, and various types of cellphones to change the visual way, advanced symbolism, and cross the real world and are interrelated.

➢ *Devices Used in Virtual reality and Augmented Reality*

Virtual reality is usually obtained through a headset. In line with this, the real world can be completely closed and replaced by the environment produced. Because the client does not have to interact with anything "real", there is no requirement to expand the device such as a telephone. The information provided by the VR gadget can combine visual appearance and sound, touch, smell, and taste in a sophisticated setting. While most retail devices today cannot be modified to make aromas or tastes, this spotlight can be experienced in real life in places like 4D theater.

➢ *Augmented reality devices are progressively diverse in design*

Some AR devices are like usable headsets, similar to Google Glass glasses. AR usually uses cellphones to display layers to the surrounding environment on the screen. For this situation, the phone or tablet application is just the original AR interface, not just the telephone. The camera can in the same way place the layer into the world

when the client glances at the lens. The more established AR framework often uses computers as the interface between the real world and enlarged reality, but today computers in general will be used for VR. Like VR devices, AR devices and applications try to talk to the majority of client faculties to make the experience acceptable, but sound and vision are the easiest information to convey at this time.

- *Level of Immersion in Virtual and Augmented Reality*

Immersion level in Virtual Reality and Virtual Augmented Reality is designed to be a truly in-depth framework. The VR gadget completely closes the client's physical environment and creates a virtual display. Therefore, VR is very useful for media such as computer games or additional films, where clients must really focus on the substances they see. Nonetheless, VR is not unobtrusively integrated into the world such as AR and destroys client fixation.

As the name suggests, augmented reality is not a completely separate environment. On the contrary, it is a layer above the client's physical environment, and, for the most part, depends on important things from the real world to express its substance legally. AR telephone applications may require clients to stand near famous landmarks or certain restaurants to see new information or artwork on their phones, for example. AR is not expected to be immersive like VR.

- *Type of Media Displayed in Virtual and Augmented Reality*

Because virtual reality is an immersive framework that typically uses computers or other extraordinary machines to create its environment, virtual reality media, in general, is unpredictable. Computer games and films are the most widely recognized types of media adapted to virtual reality. This procedure requires a PC or convenience to display and can be seen as a result of their own waste.

- *Augmented reality media is usually much less process-intensive than virtual reality*

A phone or headset that is released can create an AR item layer. Because AR is intended as a modest extension to the physical world, AR media regularly appears as a marketing or artistic effort. This kind of crusade can undoubtedly provide a new layer of information to the client environment without the need for preparatory power or end client convergence from virtual reality devices.

- *How the Reality is Generated in Virtual and Augmented Reality*

Virtual reality can be produced in a variety of ways depending on the media displayed. Regular computer games in a split second are given as client play, if an entertainment motorbike is available, or they can be made beforehand, in this case they are static and like pictures or moving images. Some people also believe recording 360 degrees as virtual reality; this is really pre-production.

Augmented reality is regularly coded for telephone applications and makes it responsive depending on the client area. It can be very well modified similar to virtual reality, but generally does not require a motorbike to be made to make.

- *Occurring Live or Pre-Programmed in Virtual and Augmented Reality*

Although virtual reality can respond to client contributions amidst media such as computer games, it does not by definition respond to the physical environment. The VR world and the real world are separate and not reactive, and VR media has been adjusted beforehand.

Augmented reality may be able to accept the physical world rather than VR. Because AR is integrated into the client's physical environment, every development that occurs directly will also jump out on the augmented reality layer. Augmented reality can respond to the real world especially by noting the direction of the client and changing the appearance as needed; there is potential for more responses to be modified into AR as a technology driver.

Features	Virtual Reality	Augmented Reality
Headsets	Yes	Yes
Applications	Yes	Yes
Totally Immersive	Yes	No
Pre-programmed	Yes	Yes
Moment Rendering	Yes	Yes
Responds Live to Real World	No	Yes
Real World conscious	No	Yes

Table 1: *Differences among virtual and augmented reality.*

As previously referred to, augmented reality is about expanding the virtual segment as a new layer of interaction in reality.

In contrast, virtual reality makes its own environment truly produced by PCs and does not have to be close to reality until the client really appreciates it. You fly over the Pacific like winged creatures, for example.

Another important difference is the prominence of this technology delivered to the final client. VR can be experienced using head-mounted and hand-held controllers. Many different ornaments connect individuals with virtual reality that allows them to expressly control and explore their activities.

Augmented reality is now being used in cellular phones, for example, PCs, smartphones, and tablets. However, there may also be many head mounted controllers such as Google Glass and HoloLens made by technology organizations.

However, these advances cannot be regarded as banter with each other. They can be combined to get a deeper and deeper experience. The best case of this as we have seen is that the use of haptic criticism (eg vibration)

including interaction is an indispensable part of AR. However, it is used in VR to make immersion more precise.

Virtual Reality and Augmented Reality are extraordinary advances that present elements of interaction that are completely different from the computerized world. Both of these advancements bring other opportunity arrangements into various businesses and make our lives much simpler.

IV. MIXED REALITY

A. What is Mixed Reality (MR)?

➢ *Definition*:

Mixed Reality or Mixed Reality (MR) experience, which consolidates AR and VR components, the original world and connected virtual objects. MR technology has just begun to take off with Microsoft HoloLens and HoloLens 2, which is one of the most famous early mixed reality assemblies.

Fig 63:- Mixed Reality. [38]

Mixed reality, either as an independent idea or used to refer to the whole range of circumstances between genuine reality (for example real world) and computer-generated reality (Virtual Reality), endeavors to join the best of both augmented and virtual reality experiences. At the point when both genuine and virtual universes are combined, new situations and perceptions become conceivable where physical and virtual objects can coincide and associate continuously in real-time. The contrast between the three can be effectively clarified utilizing the underneath table (Table 2).

Characteristics	Virtual Reality (VR)	Augmented Reality (AR)
Is user aware about the real world?	No	Yes
Can user interact with the real and virtual world in the real-time?	No	Yes
Can real and virtual contents interact with each other in the real-time?	No	No

Table 2:- Comparison of virtual reality, augmented reality and mixed reality. [40]

Because of VR, you are totally secluded and isolated from this real world. So, you can't cooperate and interact with the real world. Be that as it may, because of AR and MR, you are totally mindful and aware of your genuine physical world. Here, you can connect with both, virtual and the real world in the ongoing real-time. All in all, are AR and MR same? Numerous individuals utilize the term AR and MR conversely. Be that as it may, these two terms (AR and MR) are unique. Because of AR, the collaboration between virtual substance and this present reality is beyond the realm of imagination. However, because of MR, content from the virtual and this present reality can communicate with one another in real time. In progressively explicit words, because of Mixed reality (MR), the virtual item is responsive in nature and a basic part of your genuine world.

How about we accept a virtual puppy is covering up and hiding under your study table. You need to bend down to interact and cooperate with it. When you bowed down and call the virtual puppy, it likewise reacts to you in a responsive manner. Therefore, this is a Mixed reality (MR) as both are responding and reacting to one another. Though because of Augmented reality (AR), the virtual puppy is obviously visible to you in the real-time but however not responsive and receptive to you.

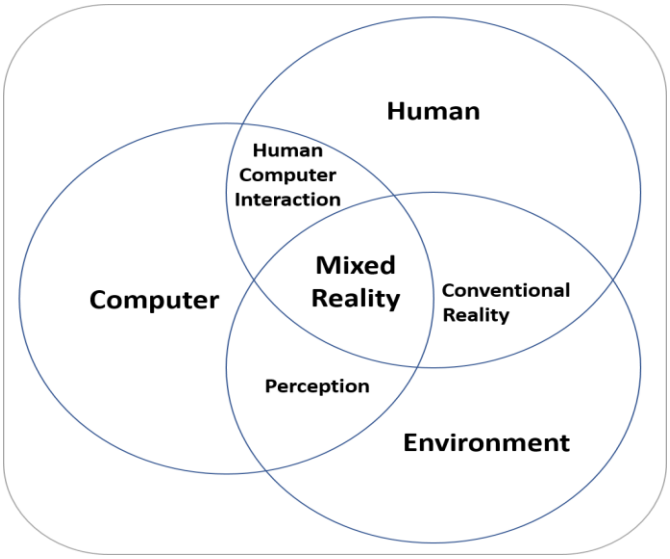

Fig 64:- Environmental Input and Perception. [39]

Over the past few decades, connections between human input and computer input have been investigated and explored. It even has a generally contemplated order known as human-computer interaction or HCI. Human input occurs through various methods including keyboard, console, mouse, touch, ink, sound, and even tracking the Kinect framework.


Fig 65:- HoloLens and HoloLens2 are examples of Mixed Reality. [41]

Progressions in sensors and handling are offering to ascend to another territory of computer contributions and inputs from situations and environments. The collaboration and interaction among computers, environments, and situations is adequately ecological comprehension or observation and perception. Consequently, the API names in Windows that uncover ecological data are known as the perception APIs. Ecological information catches things like an individual's situation on the planet (for example head tracking), surfaces and limits or boundaries (for example spatial mapping and spatial comprehension), surrounding ambient lighting, environmental natural sound, object acknowledgment and recognition, and area(location).

Presently, the combination of each of the three – computer processing, human information and input, and natural information (for example environmental input) – set the chance to make genuine mixed reality encounters and experiences. Movement through the physical world can mean movement in the advanced digital or virtual world. Limits in the physical world can impact application encounters and experiences, for example, interactivity in gameplay, in the advanced digital world. Without ecological input, encounters can't mix between the physical and computerized realities.

B. Use cases for Mixed reality (MR)

- *Construction*

Bosses can utilize MR to sign laborers about what work should be finished. For instance, an administrator may drop a virtual stick to flag that a bit of hardware isn't working effectively. Laborers will be alarmed and think carefully to see schematic graphs and analyze what should be fixed.

- *Manufacturing*

Controllers can utilize MR headsets amid plant visits and view continuous information for explicit mechanical segments. Data about the segment's execution and vitality utilization can be transmitted with Near Field Communication (NFC) innovation and will refresh when the overseer's look moves in the direction of an alternate part.

- *Design*

Planners can utilize MR to associate with new items before they are manufactured. For instance, MR could permit rocket specialists to see and collaborate with full-scale computerized models of another Mars meandered to recognize potential plan issues, diminishing the general improvement time and cost.

- *B2B Communication*

Universal companies can utilize MR to furnish reproduced up close and personal gatherings with geologically scattered item groups. Members can see a real existence measure, a 3-D form of the item being talked about, while interpretation administrations can be coordinated, wiping out language boundaries.

- *Healthcare*

Specialists can utilize MR to work on embeddings a very little medicinal embed into a patient's body. It's normal that sooner rather than later, medicinal understudies will likewise be utilizing MR imaging, rather than dead bodies, in life structures classes.

- *Supply chain management*

A store network director can see a bed through his cell phone's camera or brilliant glasses, verbally make an

inquiry about the bed's sending history and view a prompt answer on the showcase.

V. CONCLUSION

Augmented Reality and Virtual Reality are not new ideas. They were depicted in movies for a long time a decade ago. Both virtual reality and augmented reality are comparable in the objective of submerging the client, however, the two frameworks technologies do this in various ways.

What was just creative energy and sci-fi 10 years back is a reality today. Both advances are gaining a ton of media consideration and are promising colossal development. It's essential to comprehend their likenesses and contrasts, to apply them to both organizations and end consumers.

VR and AR can reshape and upset existing markets and plans of actions and models. Be that as it may, there are a few limitations of embracing VR/AR: UX, advancement of substance and applications, and high-value focus. They must be managed to convey the innovation to a more extensive gathering of people.

VR and AR are not constantly utilized freely. Despite what might be expected, they must be utilized together to make a significantly progressively vivid reality. Both AR and VR open ways to an entrancing existence where any individual can move toward becoming do anything they need. Alone or mixed together, these advances are without a doubt a standout amongst the most creative innovations of mankind.

What couldn't be accomplished by VR and AR autonomously are conceivable today by utilizing mixed reality which merges both AR and VR technologies.

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