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Virtual Reality: An Overview of its Features and What the Future Holds

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Abstract: This journal aims to make the readers understand how VR(virtual reality) works and the various features in it. It also focuses on how VR can be used in various sectors like gaming to healthcare. Moreover it aims to show the recent trends in VR development and literature review, ultimately showing what the future holds.
Keywords: VR, Image Processing, gaming

I. INTRODUCTION

If we go by the textbook definition, Virtual reality (VR), the use of computer modeling and simulation that enables a person to interact with an artificial three-dimensional (3-D) visual or other sensory environment. VR applications immerse the user in a computer-generated environment that simulates reality through the use of interactive devices, which send and receive information and are worn as goggles, headsets, gloves, or body suits. In a typical VR format, a user wearing a helmet with a stereoscopic screen views animated images of a simulated environment. The illusion of "being there" (telepresence) is effected by motion sensors that pick up the user's movements and adjust the view on the screen accordingly, usually in real time (the instant the user's movement takes place). Thus, a user can tour a simulated suite of rooms, experiencing changing viewpoints and perspectives that are convincingly related to his own head turnings and steps. Wearing data gloves equipped with force-feedback devices that provide the sensation of touch, the user can even pick up and manipulate objects that he sees in the virtual environment.[1]
The term virtual reality was popularized by American scientist Jaron Lanier during the late 1980s.

II. TYPES

Depending on the type, VR can be of 3 types-

1) *Non-immersive:* This technology provides a computer-generated environment, but allows the user to stay aware of and keep control of their physical environment. Non-immersive virtual reality systems rely on a computer or video game console, display, and input devices like keyboards, mice, and controller. A video game is a great example of a non-immersive VR experience.
2) *Semi-immersive:* Semi-immersive virtual experiences provide users with a partially virtual environment. It will still give users the perception of being in a different reality when they focus on the digital image, but also allows users to remain connected to their physical surroundings. Semi-immersive technology provides realism through through 3D graphics, a term known as vertical reality depth. More detailed graphics result in a more immersive feeling. This category of VR is used often for educational or training purposes and relies on high-resolution displays, powerful computers, projectors or hard simulators that partially replicate design and functionality of functional real-world mechanisms.
3) *Fully Immersive:* Fully-immersive simulations give users the most realistic simulation experience, complete with sight and sound. To experience and interact with fully-immersive virtual reality, the user needs the proper VR glasses or a head mount display (HMD). VR headsets provide high-resolution content with a wide field of view. The display typically splits between the user's eyes, creating a stereoscopic 3D effect, and combines with input tracking to establish an immersive, believable experience. This type of VR has been commonly adapted for gaming and other entertainment purposes, but usage in other sectors, namely education, is increasing now as well.

III. LITERATURE REVIEW

In the last 5 years, virtual reality (VR) have attracted the interest of investors and the general public, especially after Mark Zuckerberg bought Oculus for two billion dollars (Luckerson, 2014; Castelvecchi, 2016). Currently, many other companies, such as Sony, Samsung, HTC, and Google are making huge investments in VR and AR (Korolov, 2014; Ebert, 2015; Castelvecchi, 2016). However, if VR has been used in research for more than 25 years, and now there are 1000s of papers and many researchers in the field, comprising a strong, interdisciplinary community, The study of VR was initiated in the computer graphics field and has been extended to several disciplines (Sutherland, 1965, 1968; Mazuryk and Gervautz, 1996; Choi et al., 2015).

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Currently, videogames supported by VR tools are more popular than the past, and they represent valuables, work-related tools for neuroscientists, psychologists, biologists, and other researchers as well. Indeed, for example, one of the main research purposes lies from navigation studies that include complex experiments that could be done in a laboratory by using VR, whereas, without VR, the researchers would have to go directly into the field, possibly with limited use of intervention. The importance of navigation studies for the functional understanding of human memory in dementia has been a topic of significant interest for a long time, and, in 2014, the Nobel Prize in "Physiology or Medicine" was awarded to John M. O'Keefe, May-Britt Moser, and Edvard I. Moser for their discoveries of nerve cells in the brain that enable a sense of place and navigation. Journals and magazines have extended this knowledge by writing about "the brain GPS," which gives a clear idea of the mechanism. A huge number of studies have been conducted in clinical settings by using VR (Bohil et al., 2011; Serino et al., 2014), and Nobel Prize winner, Edvard I. Moser commented about the use of VR (Minderer et al., 2016), highlighting its importance for research and clinical practice. Moreover, the availability of free tools for VR experimental and computational use has made it easy to access any field (Riva et al., 2011; Cipresso, 2015; Brown and Green, 2016; Cipresso et al., 2016).[2]

IV. FEATURES OF VR

Virtual reality (VR) is one of the highest levels of multimedia application to this day due to its fidelity and real-time interactivity provide powerful support for system simulation technology. It is a combination of different types of technology which includes:

Computer graphics
Computer technology
Computer vision
Human-machine interface technology
Human T smart technology
Microelectronics technology
Network technology
Sensing and measurement technology
Simulation technology
Speech recognition
Stereo display technology
Synthesis technology
Visual psychology
Visual physiology
Other high-tech integration

There is a spectrum of VR technology from low-end to high-end technology. Low-end VR technology uses smartphones to experience interactive VR and 360° using smartphone headsets or cardboard goggles and it is able to scale; high-end VR technology uses a powerful laptop that connects with a built-in VR headset and sensors that install into a room.

We will divide the features of VR into three main sub topics namely, immersion ,interaction and imagination.

1) Immersion is also known as presence, refers to the degree of reality that the viewer exists in the virtual environment as the protagonist. Viewers can put themselves in a virtual environment and become a part of the virtual environment by wearing interactive devices such as helmet-mounted displays and data gloves. The interaction between the viewer and various objects in the virtual environment makes the viewer feel like they are just like in the real world. The viewers' brain tricks themselves with what they are seeing and hearing from the VR head-mounted displays or a VR headset giving them an immersion feeling and thinking that what they are experiencing feels real.

2) Interaction refers to the user's degree of manoeuvrability of objects in the simulated environment and the natural degree of feedback from the real environment. The human-computer interaction in VR technology is natural-like interaction. There are two types of interactions which are the three-degree-freedom (3DoF) interaction and the six-degree-freedom (6DoF) interaction. Normally, 3DoF is where a viewer can view a 360° image or video using a VR headset and move their head side to side to explore around; whilst the 6DoF requires a powerful gaming laptop or computer to process information to play and interact with using extra accessories such as sensors, data gloves and other sensing devices. The device adjusts the image and audio presented by the system according to the movement of the viewer's head, hands, eyes, language and body. Viewers can inspect or manipulate objects in the virtual environment through natural skills such as their own language, body movements or actions.

3) Imagination Since the VR system is equipped with sensing and responsive devices for sight, hearing, touch, and kinesthetics, viewers can obtain various perceptions such as vision, hearing, touch, and kinaesthesia through human-computer interaction in the virtual environment to achieve an immersive experience. The research and development of VR are to expand human cognition and perception capabilities and establish a harmonious human-machine environment. VR technology is a perfect combination of humans and technology that is a product of computer graphics and human-computer interaction technology. Humans occupy a very important position in the entire system. Using the means of VR technology, we can get an "immersive" experience of the research object and environment, thereby enhancing the breadth and depth of human cognition, and broadening the "cognition space" and "method space" for humans to understand the objective world. Ultimately achieve a more essential reflection of the essence of the objective world.

Fig: VR Oculus

V. APPLICATIONS OF VR

A. *Automotive Industry*

VR allows engineers and designers to experiment easily with the look and build of a vehicle before commissioning expensive prototypes. Companies such as Honda, BMW and Jaguar Land Rover (JLR) been using VR for years to hold design and engineering reviews, prompted by the pandemic to find new alternatives to traditional clay models.

VR is saving the automotive industry millions in man hours and material, by reducing the number of prototypes built per vehicle line and opening up the design process to a global workforce.

B. *Healthcare*

VR is making a significant impact in healthcare. In November 2021, the FDA approved prescription-use EaseVRx for the treatment of pain reduction in adults. The system uses cognitive behavioral therapy and other behavioral principles such as deep relaxation, attention-shifting, interoceptive awareness, and others, to aid in the reduction of chronic pain. VR has even been used as pain relief for burn injuries.

Healthcare professionals can use VR to better prepare themselves for being in the operating theater – whether as a junior doctor explaining diagnoses and treatment plans, or an orthopedic surgeon performing surgery. Companies like Osso VR enable surgeons to interact with medical devices in VR and practice surgery on virtual bodies, helping to increase familiarity with new devices and proficiency in implanting them. Moreover, companies like Altoida are trying to leverage XR and machine learning to develop digital biomarkers for neurological diseases, such as Alzheimer's. This technology platform offers earlier diagnosis, facilitates clinical trial participation, and enables precise monitoring of disease progression and treatment responses.

VR can also be used as a treatment for mental health issues, with Virtual Reality Exposure Therapy thought to be particularly effective in the treatment of PTSD and anxiety. There are many other ways spending time in VR can have therapeutic benefits.

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C. Retail

The way we shop online is set to drastically change with 'the metaverse'. With VR retail experiences and body-scanning technology, we will be able to try on clothes in the virtual world to see what they'd look like in person. Not only is this a time-effective experience for shoppers, but it's also more sustainable because customers will know before they order whether the item fits their shape and size, reducing the environmental cost of production and shipping fast fashion.

Various companies are attempting to bring us the VR shopping experience, including the European retailer ASOS, who invested in software development company Trillenium. Fashion houses like Tommy Hilfiger and DKNY were also amongst the brands that took part in the second annual Metaverse Fashion Week in March 2023.

Brands like Ralph Lauren and Gucci have also worked with VR Studio Emperia to make bespoke, virtual store environments for high end customers to browse their collection.

D. Tourism

The global pandemic and lockdowns accelerated a lot of developments in virtual travel, with many missing the freedom to travel to different countries, visit world-famous landmarks, and experience a glimpse into another culture.

Imagine being able to experience a guided tour of Barcelona or Budapest from your home in California or Singapore. With VR, you can do just that. You can even take a Harry Potter tour of Edinburgh from anywhere in the world!

In the post-Covid era, the developments in VR for tourism enable you to try a holiday before you buy it. Thomas Cook launched their 'Try Before You Fly' VR experience all the way back in 2015, where potential holidaymakers could visit stores in various countries to experience the holiday in VR before booking it. As a result, there was a 190% uplift in New York excursions bookings after people tried the 5-minute version of the holiday in VR.

VR Expeditions 2.0 is another way tourism can become more accessible, with hundreds of virtual field trips available. From Rome's Colosseum to coral reefs, and the surface of Mars, users can travel the world from the comfort of their own home.

E. Real Estate

If you'd prefer to stay closer to home, you can look around properties from the comfort of your [existing] home – no estate agent appointments or sacrificing your weekend needed.

Companies like Matterport are leading the way for people to explore houses online and get a 'feel' for the space, saving time looking rounds places that might be smaller, darked, or otherwise not what you expected. This way, you can focus your time viewing only the properties you're most likely to love in person.

Besides, some companies like Stucco are using VR for home staging. This doesn't only save costs but also allows real state agents to use different interior design styles depending on the client's preferences.

F. Architecture

VR is gradually changing the way that architects design and experiment with their work. VR makes it possible to see not just what a building or space will look like but how it will feel.

For example, if someone was looking to add an extension to their property, they can experience the space and what it will look like before it's physically built and then make real-time changes. This saves the customer and architect time and money, as well as increasing satisfaction on completion of the project.

Architects have been using 3D models for years but using immersive tools allows them to understand and explore the space at the deepest level possible. The BBC even have a TV show in the UK, Your Home Made Perfect, built on two rival architects showcasing designs to homeowners in VR, before they're built in reality.

G. Interior Design

It's not just the structure of your home that's getting a makeover in VR. You can now use immersive experiences to mimic the interior design too. Companies like Flipspaces are capitalizing on this, providing users with 3D visualizations of the interior of their home or workspace – from lighting to ventilation, color schemes, and products themselves.

Platforms like this don't just help designers and homeowners visualize the look and feel of a property- they also have the potential to drive direct sales for furniture companies like Ikea.

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H. Gambling

Fancy yourself as a poker pro? You can play multiplayer poker in VR with Vegas Infinite, formerly Pokerstars VR. It's just like being in a real casino where you can talk to other players and read their body language. You can plan poker, blackjack, roulette, and slots against real opponents and be in with the chance of winning money prizes.

I. Learning and development

The training industry has started to embrace the opportunities VR learning brings, with companies like Bank of America sourcing 10,000 headsets, and Walmart offering VR training to its 1mn employees.

With VR, people can learn through experience in a risk-free space; it's consistent, affordable, and scales. VirtualSpeech, for example, provides VR training for soft skills such as public speaking, active listening, and sales. They blend e-learning with practice in VR and online simulations, enabling learners to build their confidence and skills in VR environments, from meeting rooms to auditoriums.

With the experiential learning VR brings, VR training significantly increases learning retention levels PwC infamously did a study on the effectiveness of VR learning for soft skills, and found people learnt up to 4 times faster in VR.

J. Recruitment

Lloyds Banking Group became the first organization in the UK to introduce VR exercises to assess graduates for its 2017 intake. In the future, VR could be used to assess key skills required for a job such as decision making, for job interviews, and could even replace assessment days altogether by bringing candidates together in the metaverse.

This would save both the employer and potential employee time and cost in the interview process, and even attract higher quality candidates, as Deutsche Bahn has found.

K. Entertainment

VR is being used in the entertainment industry to heighten experiences with 360 films (Examples on YouTube) and increase emotional connection with the characters or film itself. Disney Movies VR, for example, takes the user to red carpet events and to an interview with 'The Jungle Book' cast.

VR could also revolutionize the way that media content is made, as companies like Flipside XR have shown. Flipside provides real-time animation and motion capture, enabling creators to built interactive animated shows or live stream animated performances via VR or more traditional channels YouTube, Twitch or Facebook live.

L. Education

VR is revolutionizing education by enabling students to learn in an immersive, experiential way, from anywhere in the world. VR provides the opportunity to democratize education by opening up opportunities to students of all backgrounds, which may not have been possible before. For example, Victory XR has partnered with Engage to provide digital twin campuses to enable students to learn in live, interactive classes from the brightest minds in the world. Another example of VR in Education is the RTC Antwerpen project, the largest XR education initiative to date, which will equip 150K students across 690 schools with immersive learning opportunities.

Other companies like Tech Row enable students to go on a space mission to Pluto, explore Antarctica, and experience the wonders of Machu Picchu. Field trips to the Colosseum and Ancient Rome can be completed from the classroom, and you can even be taken on a journey of the human body as a white blood cell!

M. Sports

The way that we watch sports is already changing, with several VR companies specializing in watching live sports events. You can now watch the NBA, NFL, and other events in VR. BT Sport broadcasted the UEFA Champions League final in 360 degree VR via YouTube and the BT VR app, all for free. You could watch the game from several viewpoints in the stadium, as if you were actually there. Companies such as Big Screen VR enable people to watch the Superbowl together in VR, and NBC announced it will live stream the opening and closing ceremonies of the Beijing Olympics in VR, as well as provide highlights for some of the events in VR. You can even host a 'virtual Olympics watch party' if that's your kind of thing.

This is a great way of opening up live sports events to people who can't travel to the venue or can't afford tickets to watch the sports in person. Instead, they can get a sense of atmosphere and presence from VR.

N. Art and Design

With VR, you don't just create life-size artwork – you can be in it. You can actually step into your image and come out the other side. The most well-known application for creating art in VR is Tiltbrush and it's amazing what some people have managed to paint in it. You can also draw, sculpt, create and animate virtual 3D models and sculptures with Masterpiece Studio..

O. Events, Conferences and Meetings

Since VR enables individuals to meet in places virtually, it's no surprise that the pandemic brought a rise in VR events, conferences, and meetings. Platforms such as Remio VR, Rec Room, and Horizon Workrooms can be used to hold collaborative, interactive meetings with colleagues from anywhere in the world.

You can put on your headset in London, and meet virtually with your colleagues in New York and Madrid, and connect and work with them as if you were all in the same room. With collaboration tools such as whiteboards and freehand 3D drawings, they help remote or hybrid meetings become as good as face-to-face meetings, without the time and cost needed to travel.

Some people are using VR for networking and events. Educators in VR regularly host events in VR on topics including cyberbullying, storytelling, and language learning, which are available to attend in VR or desktop. By bringing people together in VR, attendees can immerse themselves in the topic and virtual space, and build stronger connections with each other compared to events via traditional video conferencing tools.

P. Fitness

When we first wrote this article in 2017, VR fitness wasn't a thing – we originally had 21 industries using VR and fitness wasn't one of them. Now, VR fitness apps are some of the most downloaded and used VR apps available, allowing you to upgrade and socialize your home workout.

Two of the most popular VR fitness apps are Supernatural and Fit XR. With FitXR, for example, you join an immersive fitness club with new classes added each day, including boxing, dance, and HIIT. You can even take part in the classes live with your friends to make your workout even more fun, and mimic the social interaction of traditional gym classes. Another use case of VR in fitness is wearing the headset while being on a static bike. Apps like Vzfit and Holofit allow you to bike through real locations or virtual worlds from the comfort of your own home.

Q. Wellbeing

With the rise in popularity for wellness and meditation, it's not surprising that, yes you guessed it, you can now meditate in VR too. TRIPP are paving the way for calmer minds in VR with over 40 meditations, breath visualization, and visual landscapes.

Available for VR, and coming soon for AR as well, they claim to be a 'fitness solution for your inner self', and what's more calming then escaping reality and immersing yourself into a calmer physical space?

R. Social

VR enables people to meet in the same virtual space from anywhere in the world. Once in VR, or 'the metaverse', people can visit virtual cinemas, restaurants, beaches, concerts, and more together.

There are several big players already building social communities in the VR space, including Meta's Horizon Worlds and AltspaceVR. Horizon Worlds not only enables people to explore virtual worlds together, but they can create immersive content too, including VR spaces specifically for their friends and colleagues.

S. Charity

One of the best things about the rise of VR is its ability to evoke empathy. This makes it extremely valuable to charities as it can be used to increase understanding of an issue by experiencing it either in the first person or as a bystander to specific situations.

People are more likely to be moved to action when they are immersed in a situation, they would otherwise not be able to relate to, or come close to experiencing.

For example, in 2015, Unicef used the video 'Clouds Over Sidra' to double their donations towards their work with the Syrian Refugee Crisis. Another example of this is the "A walk through dementia" VR experience. Created by Alzheimer Research UK, this experience walks users through the heartbreaking reality of what having Alzheimer's is like.

T. Marketing

Marketing is becoming more and more about how companies make customers feel so utilizing the immersion of VR seems like a natural extension. From Topshop providing fashionistas with a front row at London Fashion Week with a VR headset, to Tom's shoes taking customers on a trip through Peru to show where each pair of shoes they donate goes to, the heightened sense of connection through VR is sure to make you remember and connect with these brands.

VR marketing is also becoming popular for universities to create virtual campus tours of universities. Princeton, Yale, and Columbia have all tried this out as a way for more students to be able to see their campus.

U. Recreation

Many real-life hobbies are now available in VR, and the immersive, social experience makes them all the more enjoyable and accessible. If you're a fan of cultural activities, you can visit museums such as the Natural History Museum in London or if you're into sports, you can play golf or football in VR.

If you're more of a thrill-seeker, you can head to Guizhou in China to VR Star Theme Park, where there are over 40 VR rides.

V. Law Enforcement

As with the military, police forces are using AR and VR tools from companies like VirTra to train personnel in simulated scenarios complete with visual, auditory, and physical stimuli (ranging from barking dogs and street noise to the recoil of discharging a weapon).

The technologies even enable police forces to escalate or de-escalate trainees' simulated interactions with individuals inside the virtual training environments, helping learners practice making judgment calls and critical decisions under stress.

A group of University of Alabama researchers had collaborated with law enforcement officials to measure brain waves during VR police training. One of the lead researchers said the work may "improve training of officers and positively affect the hiring process."

W. News and Journalism

You can now watch news stories and documentaries in VR. The New York Times has already entered this space, and it's only a matter of time before other media outlets join them. In the NYT VR app, you can experience stories rather than just listen to them, as if you were standing opposite the journalist where the story is happening.[3]

VI. DEVELOPMENT

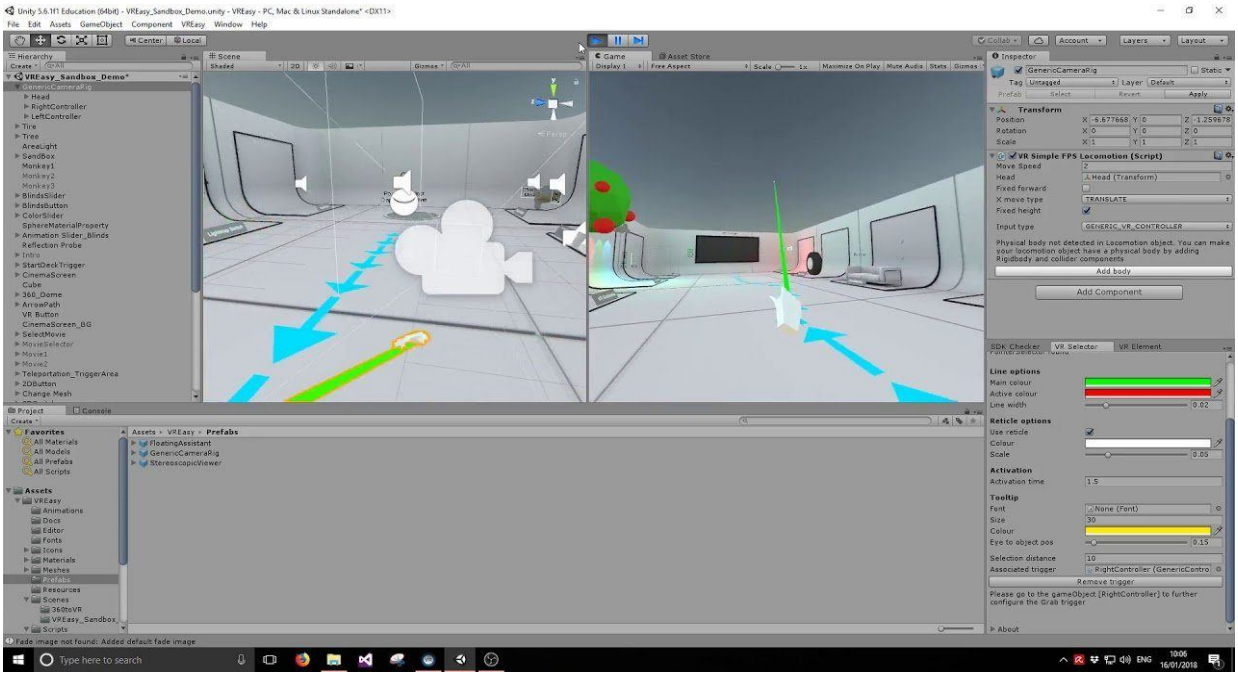

Fig: Unity interface

We will design our prototype model in Unity. Additionally, it is designed to be easily integrated with other development tools, such as Adobe Photoshop and Autodesk Maya. Unity offers powerful features such as 3D modeling, animation, physics simulations, shader creation, and much more..

Cross-platform engines such as Unity and Unreal, we can tap into any market, but any development requires us to pick the starter SDK to shape our experience around. SDK is a plug-in that we add to our chosen engine. It includes engine- and platform-specific assets, content, and techniques that shape the overall native experience for each device. Among many community-provided APIs and tools, we probably should start with each brand's official SDK.

Let's review SDKs from five VR providers.

1) Viveport SDK. Devices from the HTC Vive line appeared from the collaboration of a hardware company HTC and Valve, a creator of the largest software distribution platform Steam. According to Steam, over 12 percent of their users experience VR via an HTC devices. The apps are distributed via – you guessed it – the Steam VR platform and available on PC.

2) Oculus SDK. As Vive's biggest competitor in VR experiences for PC, Oculus started the global VR adoption with its Kickstarter campaign in 2014. Apart from the Steam platform, you can distribute applications in the Oculus store. Today, the company sells one headset – Oculus Quest 2 – yet its previous devices are still in use. Namely, on Steam alone, almost 40 percent of VR is viewed via their main headset with its no-longer-produced model as Oculus Rift S remains in third place with around 15 percent.

3) OpenVR SDK. Not an SDK for any specific type of platform, OpenVR is an API for accessing any attached headset, be it Oculus, Vive, Index, or Mixed Reality. Provided by Valve, it basically communicates with SteamVR and any device supported there. While this may be a handy option, since you don't have to rely on any specific SDK, it doesn't have detailed documentation, so it might be not the simplest solution. But if you're planning to reach Valve Index's vast audience of almost 16 percent VR users on Steam, this is your only option.

4) Windows SDK. There's no separate SDK for Windows Mixed Reality development, so you would be using Visual Studio with Windows SDK. WMR headsets include devices both for AR and VR, and its VR products are Samsung HMD Odyssey+, HP Reverb, Acer OJO, and more. Overall, they comprise 5.69 percent of SteamVR userbase.

5) PSVR Dev kit. The most elusive of all, a development kit for PlayStation VR,which is provided per formal request.[4]

A. VR Interface

A virtual reality (VR) interface allows users to provide input to a virtual environment and experiment as a result. VR interfaces should have the following characteristics:

1) No lag time: Users should be able to perceive the interaction as real time

2) Seamless digitalization: The interface should be seamless

3) Behavioral interface: The interface should use sensorial and motor skills

4) Immersion: The interface should be as effective as possible

Fig: VR gaming interface

VR UI design should also consider the target audience's needs, preferences, and expectations. VR users may have different levels of familiarity, comfort, and tolerance with VR technology, as well as different preferences for interaction styles.

Here are some steps for designing a VR interface:

a) Set up "360 View"
b) Set up Artboard
c) Design the Interface on the "UI View" canvas
d) Merge Artboards and Export
e) Test It in VR

VR gaming systems simulate user's physical presence in a computer-generated environment. The goal is to let users believe they inhabit a virtual world and move around the virtual world, interacting with virtual features and items. VR technology provides an immersive experience by simulating a realistic 3D environment. Users can interact with the virtual world as if they were physically present, creating a highly engaging and immersive experience.

Here are some options for VR gaming interfaces:

- Standalone headsets: Oculus Quest 2
- PC-connected headsets: HTC Vive, Oculus Rift, or Valve Index
- Smartphone-powered headsets: Samsung Gear VR or Google Cardboard

VII. FUTURE OF VR

The future of virtual reality is increasingly leaning towards multisensory experiences. It's not just about what users can see; it's about what they can touch, smell, and even taste. The more realistic the virtual world, the more immersive and captivating the experience for the user.

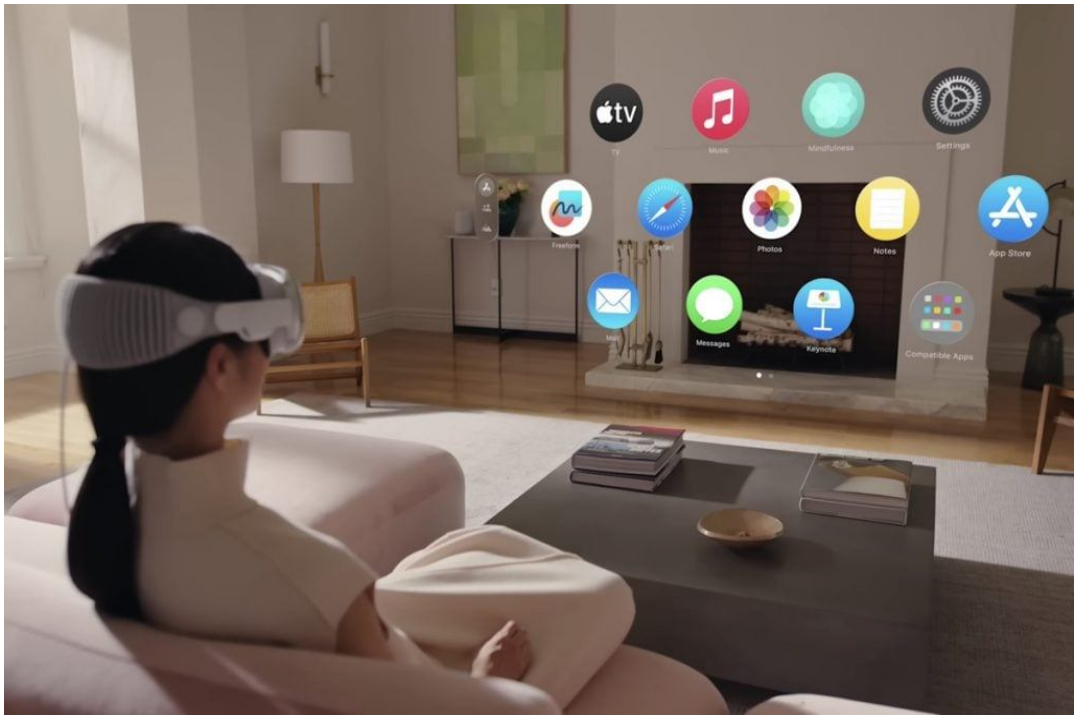

Fig: Apple Vision Pro interface

With the recent launch of Apple's Vision Pro, the competition of VR technology has boosted. Be it Meta Quest 3 or Samsung Gear VR, the future seems to be more interesting than ever. Be it for entertainment or for medical healthcare, there are limitless possibilities on what these technology can bring.

Fig: Apple Vision Pro

In July 2021, CEO of Facebook Mark Zuckerberg announced the creation of the metaverse, following suit to rename his company to Meta. In the months that followed, dozens of major brands (like Microsoft, Disney, Tencent) also announced their entry into this metaverse. The metaverse is a remarkable digital universe accessed via virtual reality, allowing you to mirror many activities from your daily life into a virtual domain. Unlike traditional VR applications, which operate as independent entities, the metaverse weaves all applications and services together, providing a seamless, uninterrupted experience. This fascinating phenomenon is shaping up to be one of the defining VR trends of our time.

While we have a solid understanding of the short-term trajectory and future of virtual reality, based on recent advancements and industry trends, the long-term future of virtual reality remains a captivating mystery filled with immense potential. If we project 10-15 years into the future, we can formulate some predictions about the evolution and application of VR technology.

A. A Seamless blend of real and Virtual Worlds

The trends in virtual reality suggest a future where the boundary between the real and virtual worlds will be almost indistinguishable. The advent of hyper-realistic VR experiences we are witnessing today will likely mature into a standard feature, leading to a wholly immersive and interactive virtual reality future. Virtual environments will not only simulate our physical reality visually but also engage all our senses, creating a more profound and authentic experience.

B. Ubiquitous use in Various Industries

As VR continues to evolve, its application will likely extend to virtually all sectors. We can expect to see an expansion in the use of VR beyond gaming and entertainment into areas like education, healthcare, retail, real estate, and more. The future of VR in these industries will likely involve more immersive training programs, virtual tours, product demonstrations, and therapeutic treatments, among other applications.

C. Enhanced Social Interactions

The social aspects of VR platforms are likely to become more prominent in the future. Virtual reality trends suggest that we'll see more interactive social VR platforms, enabling users to engage in collaborative projects, participate in shared experiences, and build communities within the virtual world. It's not unrealistic to predict that significant life events might be celebrated in these virtual spaces, further blurring the lines between physical and virtual interactions.

D. Greater integration of AI and VR

Artificial Intelligence (AI) is poised to play a more integral role in shaping the future of VR. AI algorithms can tailor virtual experiences to individual users, creating a personalized and intuitive VR environment. The combination of AI and VR could usher in a new era of dynamic, responsive, and adaptive virtual realities.

E. Evolution of the Metaverse

Looking into the far future of virtual reality, the evolution of the Metaverse stands out. This interconnected virtual world will likely become more sophisticated, hosting a myriad of applications and services in one seamless and uninterrupted experience. The Metaverse could become a central hub for work, play, and social interaction in the virtual realm, significantly impacting how we live, learn, and connect.

F. Full-body Motion Tracking

For now, virtual reality apps mostly track the movements of our heads and possibly hands (if controllers or gloves are used). In the future, we could see full-body tracking with users wearing a special suit or just attaching some sensors to their clothes. This should be very handy in safety training (e.g. working with heavy equipment) since VR simulators will not only analyze users' knowledge, but also the precision of their movements.

G. Immersive Movies

In the distant future, we could see virtual reality headsets and glasses replace or substitute TV sets and movie theaters. People will be able to get the entertainment they want right in front of their eyes without the need to go anywhere or invest in a giant screen for their home.

The entertainment industry could contribute to this trend by making movies more immersive. They might let people see events unfold from more than one angle, and perhaps influence character choices. Netflix already experimented with this format (although not in VR) with their Bandersnatch movie.

H. Smart Personal Assistants

Virtual assistants are already helping us in our phones (e.g. Siri, "Ok Google"), but VR could really evolve them. These assistants will take on a human-ish form and act much more. If people wear VR glasses, these helpers could accompany them through their daily tasks and activities. The implications of this are huge for all industries: if the AI is sufficiently advanced, these programs could provide knowledge, perform customer service, and even help monitor the quality of work.

I. Playpens for Physical Activity

One of the current limiting factors of virtual reality is that apps must be designed for very careful and limited user movement (you don't want the user to move too much due to unseen hazards). However, 10 years from now, everyone could have a playpen where they use VR and also physically move around – run, crouch, jump, etc. without any risk to their health. This would be huge for the gaming and fitness industry, which will jump at the chance to provide a much more engaging experience to their clients.[5]

As hardware becomes increasingly powerful and affordable, more people will have access to high-quality VR experiences. This could lead to more specialized devices designed specifically for different types of immersive content, such as gaming, educational applications, or even medical training simulations. Haptic feedback, eye-tracking, and mixed reality are just a few of the exciting advancements on the horizon.

Haptic feedback technology utilizes devices that vibrate or provide electronic stimulation to give users physical sensations in response to their interactions with virtual objects. This can range from subtle vibrations that mimic the feeling of touching an object to more powerful sensations meant to simulate the effects of extreme temperatures or force. With haptic feedback, VR experiences become even more realistic, allowing users to "feel" their environment instead of merely seeing it visually.

Eye-tracking is also set to revolutionize VR design by allowing developers to track where players focus their gaze throughout the experience. By understanding what players are looking at, developers can create more dynamic content tailored to individual participants' interests and preferences.

Eye-tracking also opens up new possibilities regarding how developers can measure user engagement within an experience, allowing them to optimize the overall quality further. Mixed reality is another critical area of development set to shape the future of VR. In mixed reality (MR) applications, virtual objects appear as if they're present in one's physical environment and can be interacted with accordingly.

This means users will be able to view and explore 3D environments from multiple angles and interact with them naturally as if they were present. With this new level of immersion, here come countless opportunities for exciting gameplay mechanics and engaging educational applications, making MR a significant factor in the evolution of VR design.[6]

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VIII. CONCLUSION

Virtual Reality development has made significant strides in recent years, driven by technological advancements and diverse applications across industries. While facing challenges such as cost and content quality, VR holds immense potential for transforming entertainment, education, healthcare, and beyond. With continued innovation and investment, VR is poised to redefine human experiences in the digital age.

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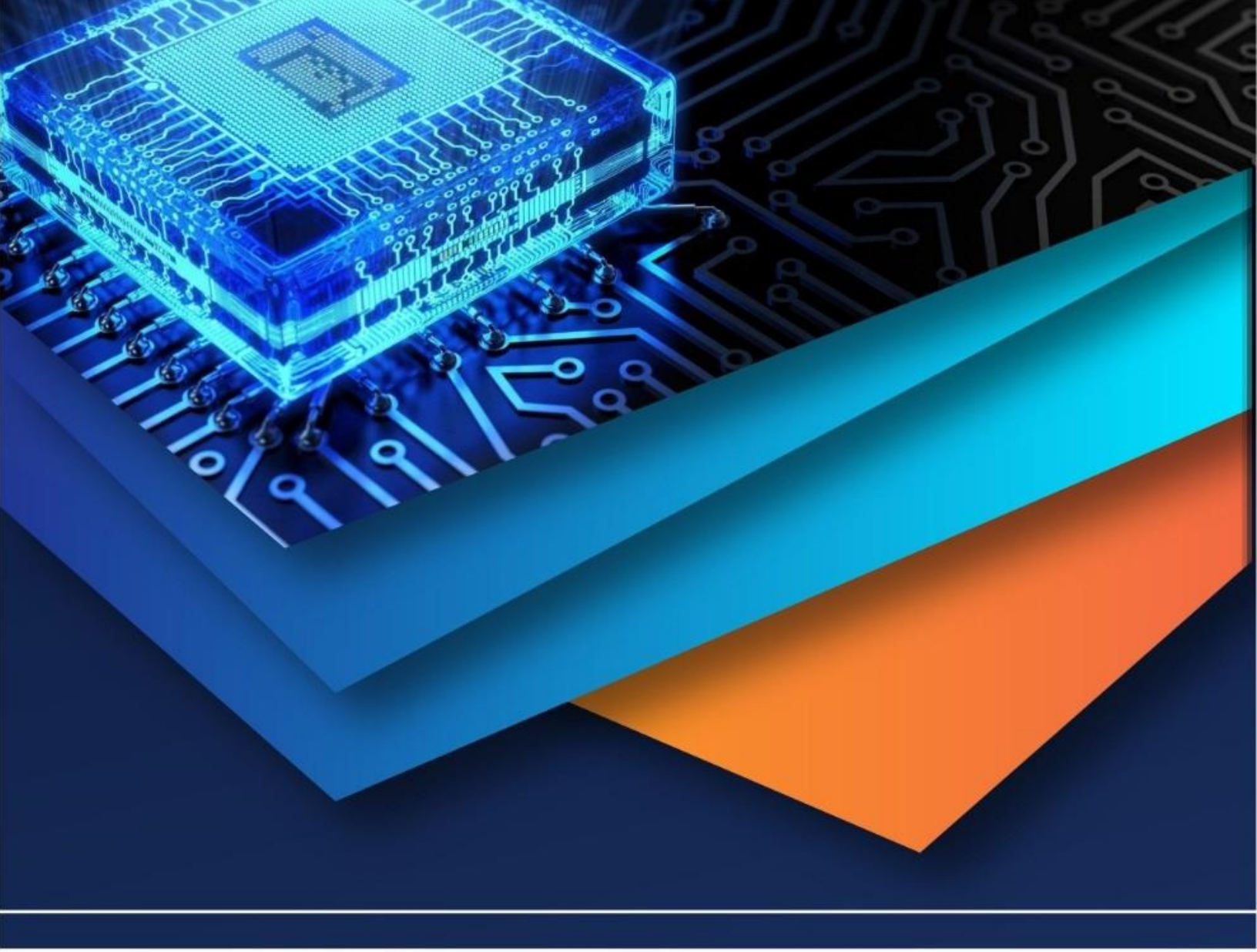

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