ABSTRACT

Virtual Reality (VR) is a computer-generated environment with realistic-looking images and objects that gives the viewer the feeling of being completely immersed in their surroundings. This world is viewed through the use of a Virtual Reality headset. We used to think of Virtual Reality as something that was near but remained science fiction until lately. Virtual Reality is already being integrated into a variety of sectors of our life, ranging from video games to various industrial applications, and, of course, it is beginning to be employed in medical. Despite the fact that Virtual Reality is a decades-old technology, many people are still unfamiliar with it. The terms Virtual Reality and Augmented Reality are frequently confused. The fundamental difference between the two is that VR creates a virtual environment in which we may immerse ourselves using a headset. Everything we see is part of an artificially built world created through pictures, sounds, and other means. In augmented reality (AR), on the other hand, our own environment becomes the framework inside which objects, pictures, and other media are inserted.

This presentation focuses on the medical applications of virtual reality, including a general overview of its operation and benefits in the medical profession. Robotic surgery, phobia therapy, surgical simulation, and skills training are just a few of the applications of virtual reality in healthcare. Many healthcare institutions across the world have begun to use virtual reality into their operations and have seen its benefits. The introduction of the Oculus Rift and HTC Vive has increased the use of virtual reality in a variety of businesses. Medical Education, as a training tool for physicians and students, is one of the most important applications of virtual reality in medicine. Virtual reality is being utilised as an effective diagnostic tool to assist doctors and physicians in making correct diagnosis. It is also employed in the treatment of mental diseases since it is a low-cost, flexible, and low-risk option. VR also aids in the treatment of anxiety and panic attacks by giving new techniques to keep the body relaxed and peaceful. Therapy, Physical Fitness, and Pain Management Virtual Reality in Surgery, Autism Treatment with VR, VR for the Disabled, and more incredible uses of the technology.

Above are some of the ways virtual reality is fast revolutionising the healthcare field and will undoubtedly play a significant part in our lives in the next years, changing the way we live entirely. Virtual reality is a technology that has the potential to revolutionise every sector, including healthcare, space, construction, and tourism. This technology will become exceedingly strong very soon as the metaverse develops. Medical virtual reality has many intriguing prospects. Clinical researchers and real-life medical professionals are equally enthusiastic about this technology as gamers. Every day, healthcare practitioners discover new methods to make

people's lives better. It's interesting to see how a technology like this may be so beneficial in the medical area. We must continue to create innovative technology to benefit society.

1. INTRODUCTION

In 1957, a cinematographer named Morton Heiling created the Sensorama as a multimedia device. It was a multimedia device that allowed viewers to interact with it in a theatre cabinet. The consumers' senses were stimulated by a display screen for sight, oscillating fans for touch, fragrance-generating devices, and audio speakers for sound. Following this, various gadgets based on this technology were developed in the 1960s and 1970s, leading to Jaron Lanier, a computer scientist, researcher, and artist, coining the term "virtual reality," which has since become society's marvel. He co-founded the Visual Programming Lab (VPL) with Tom Zimmerman and co-developed the Dataglove and the EyePhone HMD, making VPL the first company to offer VR eyewear.

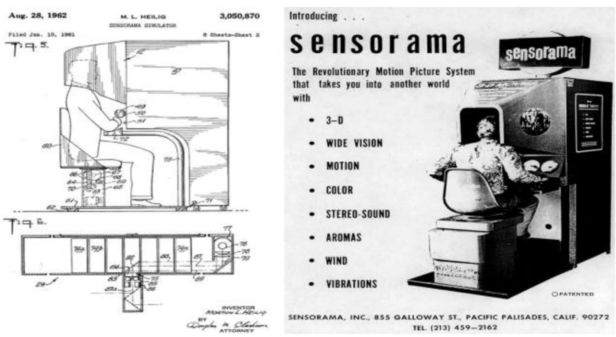

Fig 1: The Sensorama

Virtual reality headsets were first developed in the 1960s. Ivann Sutherland produced the first VR headgear for military uses almost 30 years after the concept was initially conceived. The first VR headsets were created for use in training exercises using specific military software and a motion control platform. These virtual reality training tools have now become the military's standard for training for flying exercises, combat situations, and other scenarios. To challenge military soldiers and prepare them in a safe training setting before they join the field, an immersive experience is essential. Virtual Reality is being incorporated into a variety of sectors of our lives, ranging from video games to various industrial applications, and, of course, it is beginning to be employed in medicine. Robert Mann established the first virtual system in medicine in 1965 to provide a new teaching environment for orthopaedics. The head-mounted display (HMD) was first presented as a wearable device for VR visualisations in medicine in the late 1980s. Over a decade later, some of the earliest pioneering apps in medical education were based on hands-on procedures. Many negative impacts of VR usage were identified in the 1990s.

Nausea, dizziness, briefly decreased eyesight, and a lack of sensation of presence were all reported after only 20 minutes of usage. Technical flaws such as lag time and the human eye's incapacity to concentrate in-depth to "artificially distant" 3D objects were blamed for the negative impacts.

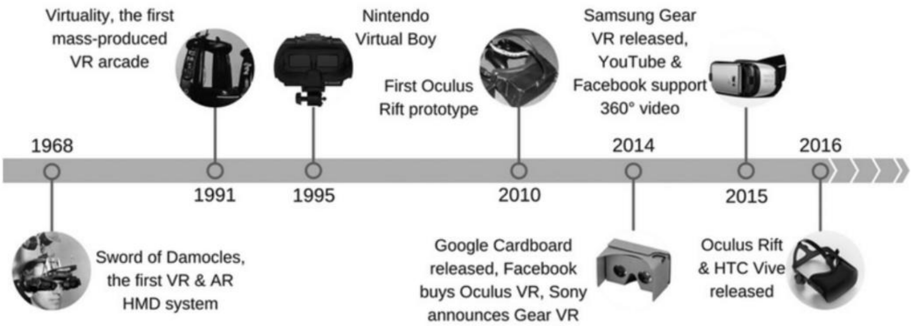

Fig 2: History of VR

Thanks to helmet mounted display (HMD) technologies in development like the Oculus Rift, HTC Vive, Gear VR, and Google Cardboard, there has been an extraordinary boom of interest and buzz around mass market virtual reality (VR) since 2012. Since the Sensorama Simulator in 1962, virtual simulation technology has advanced significantly.

Virtual reality and simulation technology have been used in healthcare training and education for several decades. Surgery simulators have shown to be quite useful for physician training, and hospitals have spent a lot of money on them. In terms of breakthrough therapy paradigms and general clinical adoption and application, virtual reality in healthcare is still in its early stages. Clinical effectiveness evidence from well conducted and controlled human studies will be reviewed more closely by innovators in this sector. With the seamless integration and intersection of technologies like VR with artificial intelligence, deep learning, big data analytics, sensors, bio-feedback, and increasing computer power in the (not-too-distant) future, things will become very interesting. Virtual simulations that learn as a patient interacts with them will revolutionise decentralised patient-centered care and drastically alter how healthcare is delivered.

2. WORKING

Virtual reality is a technology that replicates vision to create a three-dimensional environment in which a user appears to be immersed while surfing or experiencing it. The user controls the entire 3D environment as he or she is experiencing it. On the one hand, the user creates 3D VR environments, and on the other, they experience or explore them using appropriate devices such as VR headsets. Some gadgets, such as controllers, allow the user to control and examine material. Making the content begins with a working knowledge of computer vision, the technique that enables phones and computers to process images and videos in the same way that a person's sensory system does. Virtual Reality is a very immersive experience that may be enjoyed safely while simulating something real. You can enter customised simulations by using a Virtual Reality headset or an appropriate programme. These simulations are intended to be very immersive experiences with which the user can interact and explore. The viewer has complete control over the environment, including the ability to look about and interact with the objects in the scene. Virtual Reality is most commonly used in computer-generated simulations in which a whole 3-D environment is reproduced in the most realistic way possible. A user can then engage with the scene and manage the surroundings using a range of electronic equipment.

However, a headset is crucial for a really immersive VR experience. A virtual reality headset (VR headset) is a head-mounted display (HMD) that shuts out the outside world and shows the user a 3-D world or interwoven images to create a simulation. VR headsets block us off from the world and give the user a whole different perspective. The screen is often set to concentrate such that it fills our complete peripheral vision and blocks out the outer world. You should feel as if you are in the scene and interacting with it when you put on a premium series VR headset.

Figure 3: VR headset

Putting on this headset is the first step towards initiating a VR simulation. On a PC or console, users normally run the application or have someone start it for them. After plugging in the VR headset, the user can switch their vision to the headset to fully immerse oneself in the experience. After the headset has been fitted to the user's head and adjusted to fill their peripheral vision, they can use the motion controls or their own body movement to move about the scene. Motion controls in the headset control the scene as it pans across the screen when the user looks around. Immersion continues to develop with VR technology. New virtual reality headgear, such as the Oculus Rift and Samsung Gear VR, are now available for usage in practically any home. The Oculus Rift is regarded as one of the most advanced home VR systems, while the Samsung Gear VR works with the latest Samsung Galaxy smart phones to transform any smartphone screen into a virtual reality experience. It will be interesting to see how the industry evolves and what types of products are offered to users in the near future as more rivals produce products.

The main features of VR systems include immersion and interaction. Any VR system aims to immerse the user entirely in a new simulation environment. This entails employing the visor to fill their peripheral vision, introducing sound cancelling headphones that immerse them in the environment, and allowing them to control the scene with their head movements. Introducing these three levels of control can at the very least provide an immersive experience. Adding additional interaction features can make a difference. App developers are attempting to create more immersive experiences in various films and games. In the new Playstation VR, for example, using a specialist controller can enable users interact with the scene and control aspects. Picking up objects in the setting or even interacting with actors can further enhance immersion and increase the value of VR simulations.

2.1 Virtual Reality Headset

The primary goal of virtual reality headsets is to create life-size, 3D virtual environments that are free of the limitations that come with computer and television screens. Video is delivered from the computer or console to the headset via HDMI cable in the case of the Oculus Rift and HTC's Vive, while videos are already on the smartphone mounted on the headsets in the case of Google Cardboard and Samsung's Gear VR. A single or two feeds may be delivered directly to one or two LCD screens, one for each eye, in VR headsets. The gadgets are commonly referred to as goggles because they have a set of lenses that sit between the user's eyes and the pixels. The lenses can be calibrated in some situations to fit the path length between the eyes, which varies from one user to the next. The lenses will focus and reshape each eye's picture before generating a stereoscopic 3D image by placing the 2D images to depict how each of the two eyes sees the world. Increased field of view, or simply how broad a picture seems, is one method virtual reality headsets boost immersion. A 360-degree display may not be practical, thus most high-end VR headsets employ a 100- or 110-degree field of vision, which is usually enough to get the desired effects. To avoid shuttering or making users nauseous, VR headsets demand baseline frame rates of 60fps for the final images to be completely realistic.

2.2 Basic Components of VR Headset

a) <u>An array of sensors:</u>

Virtual reality, unlike 2D video, is not a passive experience. Users interact with virtual worlds that adapt to their constant inputs. VR headsets are equipped with a variety of sensors to accomplish this, and some even feature a six degrees of freedom (6DoF) head tracking system. A 6DoF system tracks head motions and repositions the display using gyroscopes, accelerometers, and other sensors. Some headsets additionally have eye-tracking sensors that detect when the user's gaze is drawn to a virtual object or location.

b) <u>Lenses and screens:</u>

The majority of the VR headset's hardware is made up of lenses and screens. Between the screen and your eyes are stereoscopic lenses that distort the image to make it appear three-dimensional. Two images, one for each eye, are transmitted through the lens, simulating how human eyes perceive and interpret visuals in the actual world. In addition, visuals in VR headsets appear to move side to side to simulate a 360-degree experience, which is accomplished by subtly shifting the visual content in accordance to head tracking data.

Fig 4: VR lenses

c) <u>Immersive audio:</u>

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d) Controllers:

Finally, virtual reality headset controllers serve as a link between the physical and virtual worlds. Aside from the standard set of two portable controllers that come with most headsets, there are a number of controllers you may utilise. For example, Samsung's Gear VR package includes a single-handed motion controller, while HTC VIVE provides single-handed joystick-like controllers that come with a docking station. Meta is said to be working on a set of haptic-based controls that would allow for pressure-sensitive touch and navigation. Valve Index also features a unique controller design that utilises fist gripping.

Fig 5: VR controller

The headset's correct operation is dependent on all of these components, as well as advanced VR software. Users are greeted by a lifelike virtual world that works as a lobby and is similar to a computer's homepage once the headset is turned on. Users may utilise this environment to download programmes, chat with other virtual individuals, change settings, upgrade devices, and access other functions. In current headsets, pictures are streamed from a video source such as a smartphone, PC, or, more often, the cloud. The lens divides the video picture into two halves and calibrates them into a stereoscopic 3D image, which you see on the screen. The environment alters gently when you glance around, move your gaze, or raise your hands, thanks to built-in sensors. VR headsets are quite powerful aside from this fundamental capability. For example, there are productivity applications that allow you to develop products in virtual reality and export them as 3D files to the cloud. A fast screen refresh rate is used in advanced VR headsets to generate and update content instantly.

Key features that characterize a good VR headset are as follows:

- Light Form Factor: The screen and sensors might add weight to the headset, making anything more than 500-600 grammes impractical to wear on a daily basis. This is why the 150-gram weight of Apple's impending mixed reality (MR) headset is so significant.
- Easy To use controllers: The controllers will very certainly include multiple buttons, wheels, and sticks to aid navigation in virtual reality. They must be well-designed and offer a consistent user experience.
- Onboard storage: While most VR headsets rely on the Internet and the cloud, having at least 32GB of onboard storage allows you to install apps, keep your system up to date, and save a few files without slowing it down.

3. TYPES OF VR HEADSETS

Virtual reality headsets of various varieties are available to explore the variety of virtual reality experiences accessible. Some require a tethered connection to a PC, while others are completely self-contained and have built-in processing capacity, while yet others rely on a smartphone. Each type has advantages and disadvantages, and it is up to the user to strike the correct balance between budget, use case, and quality of experience.

1) Tethered VR Headsets:

   This kind of headset is the one that is physically attached to a computer by HDMI and/or USB cords. Due to the high-quality experience they can provide, tethered virtual reality headsets are now significantly more immersive than other forms of VR. These high-end VR headsets need some setup space as well as a continual wire connection to a powerful computer (generally a very expensive acquisition). A few companies are beginning to develop PC VR headsets that demand less processing power. However, this usually means sacrificing graphical quality and tracking precision.

Fig 6: From left to right: Oculus Rift, HTC VIVE Pro, Lenovo Explorer, Samsung Odyssey

   Advantages of desktop VR include high-quality virtual experiences and access to high-quality virtual reality. Cons of desktop VR include restriction of movement, room space and an advanced cable management system are required. Hidden expenses (PC, controllers, sensors, and cameras)

2) Standalone VR Headsets:

   Standalone headphones need the least amount of external engagement; they are plug-and-play without the plug. Apart than charging the battery and sometimes registering an account to access specific VR platforms, users of standalone VR headsets are not required to do anything else. Because standalone VR headsets include built-in computers, sensors, batteries, storage memory, and screens, they don't require a PC or smartphone connection. As a result, they're also known as all-in-one VR headsets. Users are not restricted to their living rooms since they are wifi. All-in-one virtual reality headsets are, on average, far less powerful than PC headsets. They have poorer graphics quality and refresh rates. However, major tech companies such as Google, Facebook, and HTC appear to be putting increasing emphasis on virtual reality.

Fig 7: From left to right: Lenovo Mirage Solo, HTC VIVE Focus, Pico Neo, Oculus Go

Standalone VR has the advantage of being wireless and having no hidden fees. Cons of standalone VR include being less powerful than tethered headsets and having a short battery life.

3) <u>Smartphone VR:</u>

Smartphone VR headsets employ smartphones to create a virtual reality experience, as the name implies. Users just insert their cellphones into the headgear, and the screen appears immediately in front of their eyes, with a pair of optics that create a sensation of depth (like other types of headsets). Handheld VR headsets, such as the original Google Cardboard, require a smartphone as well, but are often composed of low-cost materials. Due to the lack of strapping, users must hold these VR headsets up to their faces to experience VR.

Fig 8: From left to right: Samsung Gear VR, Google Daydream View 2, Xiaomi Mi VR Play 2, Google Cardboard.

The advantages of mobile VR include its ease of use, the fact that many people already own a smartphone, and the fact that it offers a cost-effective introduction to VR.

Mobile VR offers reduced immersion compared to PC and standalone VR due to the smartphone's battery draining rapidly.

4. APPLICATIONS

4.1 Virtual Reality for medical training

According to research involving 16 surgical residents, those who were trained using Virtual Reality techniques performed procedures 29 percent faster than those who were trained using traditional approaches, demonstrating yet another evidence of Virtual Reality's potential in this profession. The user can "conduct" a surgical or medical treatment on a digital patient that appears very lifelike by wearing goggles and a headset connected to a computer programme while holding a controller in each hand. While the student is making real-time movements (and key decisions), the procedure is only taking place in virtual reality. Other students can wear goggles and join in to watch their colleague's development, extending the learning opportunity to the entire class.

As an example, consider the following. Special cameras, such as the Samsung Gear 360, can record the entire world around the camera since it has two fisheye lenses. These photographs and videos cannot be utilized until the dissection and operating room have been recorded. A sewing procedure must be completed first. The two images that we acquire when we snap a picture with a 360 camera are stitched together in the stitching process to create a 360 image. There will also be a recorded video of real lung surgery so that the user can see the procedure as if he were there.

Fig 9: Samsung 360 camera

Two different scenes or modules separate this software. The initial scenario will have a 360-

degree view of an operating room with virtual items placed near the various machines found in an operating room. These virtual items react to the user's gaze, so when the user stares at one of these machines, an interactive panel with information about that machine or tool appears. The user will be placed in the middle of an operating room during a scoliosis surgery in the second scene. A Unity3D video game engine is utilised to construct this system (as well as the simulator).

4.2 Virtual Reality in surgery

In orthopedic procedures, the human knee joint is the most frequently treated anatomic location. Some knee procedures, such as osteotomy, need extreme precision and are hence difficult to perform. To have a better knowledge of the technique, virtual reality can be used to replicate it. A 3D knee surface model is reconstructed utilising a model-based reconstruction technique to achieve a realistic effect in a VR environment. An artificial plastic knee model is first scanned in 3D space to create a reference knee surface model. The reference model is then distorted to match a series of patient-provided knee MRI images. The patient's motion data is collected using a 3D motion capture technology. The device records the changing 3D coordinates of several markers placed on the walking patient's leg. These coordinates can be used to compute the flexion, extension, and rotation angles of the femur and tibia. The 3D knee model and a virtual cutting device are displayed in the virtual environment during the operation simulation. The cutting instrument may be navigated by the user to cut through the 3D knee model. The knee model will be split along the intersected curve when the algorithm calculates the intersection. During the cutting process, the user can rotate the knee model to see the incision path. This method, which may or may not be possible in real surgery, will assist the surgeon in determining the ideal incision, gaining experience, and improving their skills.

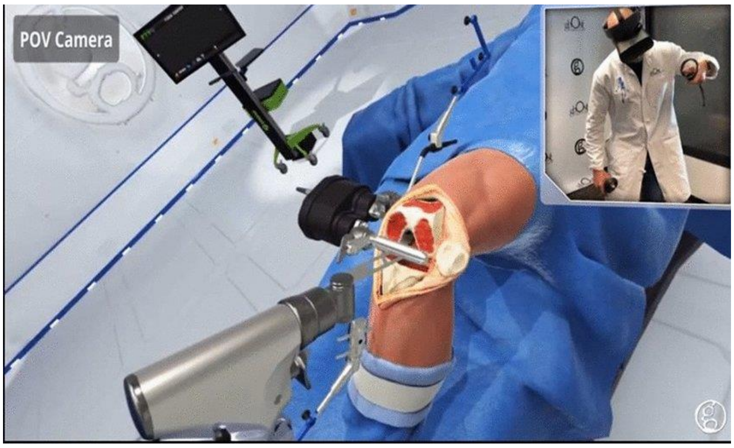

Fig 10: Knee surgery using VR

In a typical training approach, learners must go through a lengthy learning curve and significant preparation in order to complete laparoscopic training safely and quickly. While doing a real MIS procedure, they are directed by visual input from a visual fibre camera on a video monitor. Surgical tool manuals are used to make the assessment. Visual and tactile assessment are frequently used in endoscopic procedures. Surgical trainees, on the other hand, cannot practise routine medical surgery and laparoscopic surgery in hospitals without putting real patients in danger. Virtual reality has been used to replicate minimally invasive surgery (MIS), such as laparoscopy and arthroscopy, by matching the user interface of the simulation to the actual interface of medical devices. Trainee surgeons can learn core skills and MIS operations such as camera searching, tool handling, artefacts, cutting, and clipping in a virtual reality environment. Their training is carried out as if it were a routine practise.

4.3 Phobia Treatment

The use of virtual reality to treat anxiety problems in adults is becoming more widespread, and multiple outcome studies back up its effectiveness. Children's research is also falling behind. Only certain phobias are currently addressed in outcome studies on the use of virtual reality to treat anxiety disorders in children, and this article reviews all of the known trials. Despite the small number of trials, the outcomes for the treatment of school and spider phobias are quite promising. Treatment for phobias and other anxiety disorders often includes some form of exposure to the dreaded stimuli. The traditional method is called in vivo exposure. Virtual reality exposure, also known as vivo exposure, gives you more control over the situation. For instance, in the therapy of a fear of flying, the therapist can manage the frequency and severity of turbulence as well as the flight duration.

Controlling phobias like thunderstorms, wind, or dogs is challenging. VR may also be safer, particularly in the case of exposure to heights, where parents may be concerned that their child would fall during the therapy session. In vivo exposure can sometimes generate confidentiality issues, such as when exposing a youngster in front of classmates (for example, to address public-speaking phobia), whereas in virtuo exposure does not. A primary objective of the therapist throughout every exposure session is to control and reduce reluctance as much as feasible.

In virtuo exposure also allows the youngster to repeat the same experience multiple times or to go far beyond what they might try in in vivo sessions. The necessity to care for pets is also reduced for therapists who treat animal or insect phobias. For some instances, such as a fear of flying, it is also less expensive than purchasing plane tickets.

Fig 11: VR phobia treatment environment

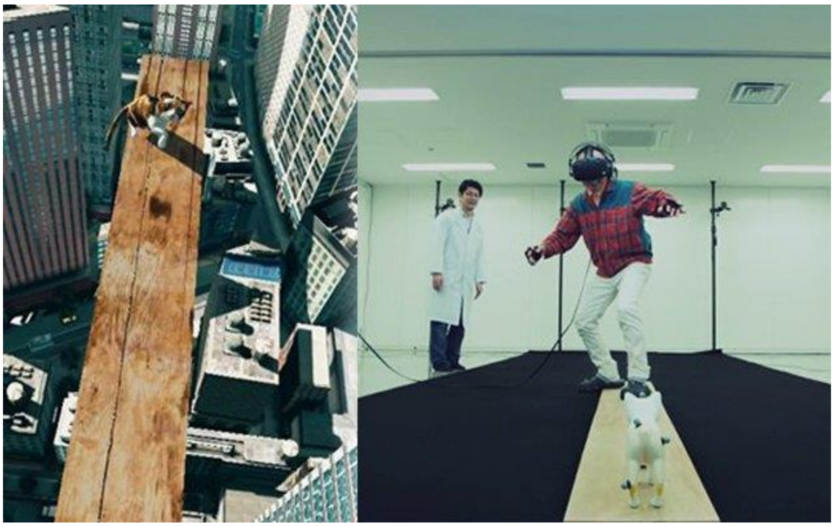

Fig 12: Using VR to treat fear of heights

Virtual environments can be created and used with a variety of technologies, the most common of which are head-mounted displays (HMDs) and immersive rooms. Traditional computer monitors could be used to simulate synthetic worlds and interact with them. Large monitors offer a more immersive experience and are the least expensive virtual reality option. That technology could be used to learn, study, and even change behaviours and cognitions. Other technologies, on the other hand, can create a considerably more strong sense of being immersed in a virtual

environment. A motion tracker is an additional and necessary gadget that transmits information about the position and movements of the head to a computer. A person engaged in a 3D computer-generated environment with this equipment has the sense of being in a virtual world that alters according to his or her head motions. Additional devices can help the user walk around and explore virtual environments, experience force feedback or engage with the sense of touch (haptic devices), get stronger 3D impressions (by using stereoscopic visuals), or enjoy 3D sounds and even scents.

With nine children suffering from spider phobia, the first study used a single-case multiple-baseline across participants approach. Children were asked to explore various rooms where spiders of diverse sizes and behaviour were discovered. The spider webs on the walls progressed to a room with a little spider that remained static and larger moving spiders. Children expressed enthusiasm for their therapy and the utilisation of virtual reality. After starting a four-session virtuo exposure-only treatment, daily self-reports of spider phobia decreased. These children, who were on average 11.3 years old, also reported a significant decrease in arachnophobia (fear of spiders) and anxiety in general.

Fig 13: Using VR to treat fear of spiders

Virtual reality has also been utilised with children who have 'school phobia,' which is a type of school refusal caused by a dread of events that occur in the classroom. Gutiérrez-Maldonado and colleagues randomly assigned 36 school-aged children (ages 10–15 years) to a waiting list control condition or five cognitive–behavioral therapy sessions. Relaxation training, imaginal exposure to a hierarchy of school-related concerns, and virtual exposure were all part of the treatment. The virtual environment enabled the child to enter a school, find his or her classroom, deal with progressively more people in the corridors, take a seat in a classroom, answer questions from a professor, present in front of the classroom, and solve difficult problems while being judged by classmates. Instead of a full immersion using an HMD, the exposure was done through a computer monitor. The findings were extremely encouraging, revealing a considerable improvement in specific school anxieties from pre- to post-treatment.

The use of cognitive–behavior therapy with in virtuo exposure with adolescents showed excellent effects in a pilot study with five 15–17-year-old adolescents suffering from social phobia. The virtual environments employed in this study were created to help adults overcome their fear of public speaking. The therapist's stimuli were confined to presenting speeches in front of a small or big group of adults whose reactions were under his or her control. Although

the virtual people did not represent other adolescents, a visual examination of the weekly anxiety ratings shows that three participants improved significantly, one improved somewhat, and one did not improve at all.

The side effects of virtual reality are an essential consideration. Immersion in a virtual environment has the potential to cause cybersickness. Cybersickness, or more accurately the adverse effects generated by virtual reality immersion, could be linked to the equipment or to sensory information conflict. Given the rapid speed of technology advancements, the equipment issue (e.g., a heavy HMD causing neck pain in toddlers or staring intently at LCD monitors for long periods of time causing eye strain) becomes less and less of a problem. HMDs with a crisp 920,000-pixel resolution and a 1024 768 video graphics array, for example, can presently weigh less than 3.3 ounces. In virtual reality, sensory information conflicts still exist. Consider the case of a person with a fear of heights who is immersed in VR using an HMD. He or she can observe the scenery by turning her head around. He can observe the depth of the cliff by looking down, and he can go forward to the cliff's edges by pushing a mouse button with a finger. When that person 'walks' in the virtual environment, the visual system indicates movement based on what is seen in the HMD, whereas the vestibular and proprioceptive systems do not perceive forward motion. The vestibular system senses motion instantaneously when the user rotates his or her head around, but there may be a slight lag as the computer analyses the information from the tracker and the matching visual stimuli are displayed in the HMD. These sensory system inconsistencies could result in nausea, vertigo, headaches, and blurred vision. Finally, vertigo may be induced by staring down a virtual cliff. While the first two examples of cybersickness are connected to motion sickness, the third is 'natural' in the sense that it is not created by virtual reality per se, but is a normal reaction in some people when they conduct the same behavior in the real world.

4.4 Teaching Empathy

Doctors that care about their patients are better doctors. But how can you persuade doctors to take notice? Let’s take a step back and consider what makes someone sympathetic. Some of this is developmental, genetic, and influenced by life events that are difficult to reverse or duplicate. Although it's unclear how empathy might be influenced, some preliminary study suggests that perspective taking is a potent precursor to cognitive empathy, which can compensate for a lack of emotional empathy caused by disparities in race, ethnicity, religion, or physiology. This is why "clinical rotations" on the wards are so revolutionary; when young students witness doctoring in action, listen to and touch patients for the first time, they stop seeing themselves as novices and start perceiving themselves as physicians. Not everything they learn is perfect: they may copy their residents' time-saving methods to deal with the time crunch they experience, or they may adopt the curt ways an attending responds to patients who refuse to give their medical history in short bullet points. In short, they become doctors, with all the benefits and drawbacks that come with it.

New technologies, on the other hand, have evolved that may be able to reduce the impact of some of those unintended lessons. Virtual reality is one of them. Through virtual reality (VR) software that allows students to simulate being a patient with age-related diseases and to familiarise medical students with information resources related to the health of older adults, the technology teaches medical and other health professions students to be empathetic with older adults. Embodied laboratories create virtual reality labs for medical students to learn about aging services. It places the learner in the shoes of the patient to teach about the aging process from their point of view. Alfred lab is another institution that educates about macular degeneration, which is an eye illness that occurs when the little center region of your retina, called the macula, goes away, as well as hearing loss from the perspective of an elderly person. Another set of new labs focuses on Alzheimer's disease and end-of-life discussions.

Fig 14: Using VR to teach empathy

Virtual reality (VR) game applications are thought to be useful in teaching because of their immersive interactivity, fully controllable virtual environment, and sense of presence and embodiment, according to studies. One of the studies offers a virtual reality game application to improve medical students' empathy for Parkinson's disease sufferers (PD). The study intends to help medical students gain hands-on experience with the disease by immersing them in a simulated daily life of patients with Parkinson's disease from their perspective. This will aid their knowledge of the symptoms and the patients' experiences. For assessment and analysis, in-game

data as well as pre- and post-measurements are used. The programme embeds highly qualified and credible treatment plans with progressing VR techniques and interactive content to build empathy by integrating the skillset of the human-computer interaction and medical fields. Lacking the essential compassion for their patients is frequently a barrier to offering the best possible care. Parkinson's disease is a movement illness produced by the neurological system, and patients with Parkinson's disease have difficulty doing everyday tasks. It is tough to get perspective if one does not have similar circumstances or knows someone close to them who has. The medical curriculum has recently added empathy training. The intended audience is pre-clinical medical students who will be exposed to Parkinson’s Disease presentation for the first time in the curriculum. As an innovative educational strategy, an application was expected to be introduced into the medical program's autumn curriculum in 2021. In that VR programme, the user takes on the role of a Parkinson’s Disease patient in a first-person perspective and simulates the patient's daily activities. The everyday routines were abstracted into six time-limited task scenarios. Performance data collecting and a scoring system are built into the game.

The current application's main feature is the simulation of hand tremor symptoms in Parkinson's disease sufferers. While hand stability is one of the built-in properties of VR controllers, this application deliberately goes against the grain and ingeniously replicates hand shaking. It is accomplished by rapidly shifting the hands of users between numerous places to simulate hand tremors. Instead of employing random movement, the altering directions and distances are tailored using medical information. You can turn on or off the haptic feedback. The frequency and gliding distance are varied to create three degrees of hand tremors. In addition, for a better game experience and repetitive practise, a free play option with dynamic difficulty modification is included. The first students that are trained with the application will have a set complexity level all through training programme to ensure data gathering uniformity. The visual stimulation overrides the user's understanding that they don't have hand tremors, giving the appearance that their hands are trembling. Other PD symptoms, such as gait and loss of balance, are not adopted because to the increased risk of nausea and other motion sickness-related issues.

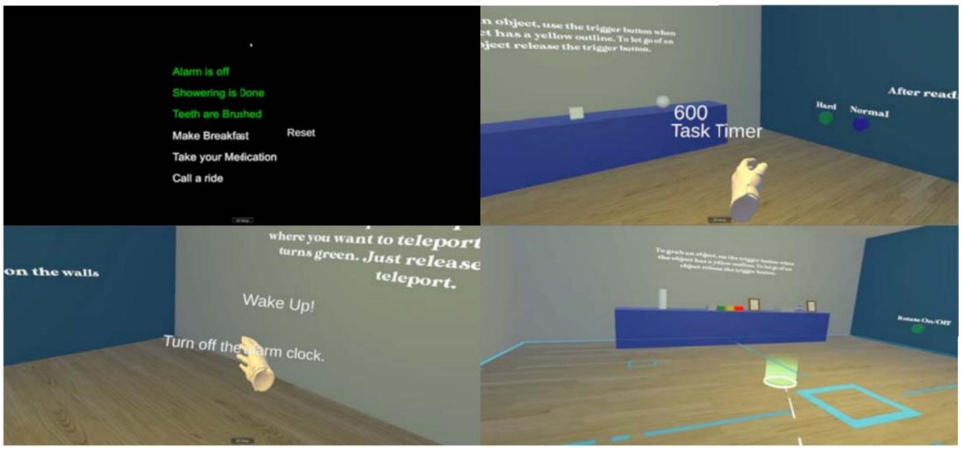

Fig 15: VR application to teach empathy to medical students

The task system works by prompting directions via voiceover and a floating text tip around the virtual hand wrist. The user can turn on or off a menu screen that displays the task completion status. Six daily tasks were identified and put into action. A timer records each job (except the first, which starts the timer) and uses body, head, and hand tracking to verify for user performance. Completing activities within the time limit will result in a score dependent on the amount of time remaining, however running out of time will result in a zero score. After the timer is stopped, either by the task being completed or by the timer reaching zero, each task timer is logged. The user begins in an introduction area where the controls are explained before the tasks begin. Instructions are written on the walls and explained by a voiceover in this tutorial area. There are various objects to practise picking up and learning how to use the teleporting technique, in addition to the instructions. This step has no time limit and no hand tremor, so users can take as much time as they need to become used to moving and picking up objects in virtual reality. The tutorial room is shown in the figure above. The main game timer starts and gives the first prompt, which starts the first task. In this case, the first task is turning off the alarm clock. After the alarm clock has been switched off, the showering procedure begins. The game's task timer does not start until the shower task is performed. After shampooing the user's hair, the shower is finished by turning off the water. To "wash" the hair, the user must bring the bottle of shampoo near to his or her head. After finishing showering, it's time to brush your teeth. The task is divided into two parts: putting toothpaste to the toothbrush and then "brushing" the user's teeth with the toothbrush. Brushing is accomplished by shoving the toothbrush into a thin hitbox on the user's head/mouth. The user is guided through the steps of making a sandwich in the breakfast task. The job is achieved by correctly assembling the sandwich components and then eating the sandwich. The user raises the sandwich to their head, where it collides with a hitbox, in the same way that the teeth brushing assignment is done. The timer for this task is started as the user enters the kitchen, rather than at the end of the previous task, to avoid capturing movement rather than task accomplishment.

Fig 16: Different tasks of the VR application

Picking up and placing the correct pills in the correct order is required for the pills job. Currently, the assignment requires the user to place two of the four tablets in their bag and "bring to the doctor's office." The tablets in the scene are either Parkinson's medications or blood-thinning medications. With the text hint and voiced instruction, the user must select the appropriate drugs for Parkinson’s Disease to take to the doctor. Because both chores are in the kitchen, the timer starts once the user finishes "eating their breakfast." The last job is to arrange for a driver to take you to the doctor. This task necessitates the usage of the bedroom phone. The user must press each button with their finger to dial the phone number. To make it easier to grasp and read, the phone number is displayed twice, once on the user's wrist display and once on a note alongside the phone. The user is transferred to the final score location after completing the final assignment, where the score is displayed and a giant red button that terminates the game is pressed. When you press the red button to end the game, it exports the recorded time data from each timer to a file.

Immersive virtual experiences, on the other hand, could be a tremendous new tool for teaching doctors to be more empathic and understanding. We believe that through improving doctors' empathy training, VR can help them achieve global goals like the United Nations' Sustainable Development Goals, notably goal three, "excellent health and well-being." When used appropriately, virtual reality may transfer aspiring doctors from Harvard's ivy-covered walls to the reality of health in underserved areas.

4.5 Pain Management Therapy

Surgery is often accompanied by pain and worry. Approximately 90% of people experience increased anxiety during pre-operative care, and 66% of people experience moderate to severe pain shortly after surgery. Opioids are currently the most common means of pain management during postoperative treatment, with one out of every 16 surgical patients administered opioids becoming a long-term user. Opioids are a class of medications that are naturally produced in the opium poppy plant and work in the brain to provide a variety of effects, including pain alleviation. Prescription drugs known as painkillers are known as opioids. This, together with the present opioid problem, necessitates the development of alternate pain management techniques.

Virtual Reality (VR) is regarded as one of the most promising supplemental therapeutic approaches. This technique is utilised to harness the mind's power; VR therapy allows the human imagination to have a positive impact. VR is regarded one of the best technologies for distraction employed by psychologists in the field of medical supplemental treatment. VR systems are used to divert patients' attention away from their current situation and immerse them in a virtual world where they can engage in a variety of virtual activities while receiving therapy. It has been discovered that VR systems increase a person's mental state, consequently strengthening their immune system. After each VR session, a "Measure of Assessing Pain" is used to assess pain in patients. This is a worldwide measure of 10 degrees that helps patient care providers estimate pain in various patients. For patient self-assessment, the scale ranges from 0 (no pain) to 10 (pain in the worst instance).

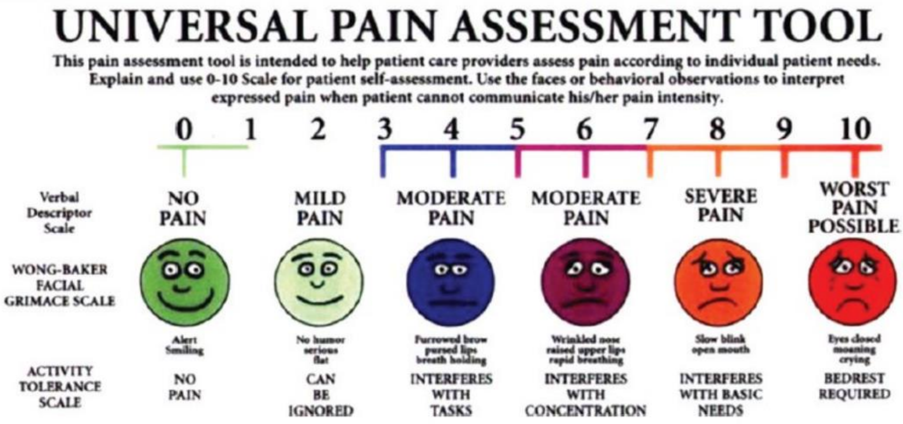

Fig 17: Universal pain assessment tool

Patients with breast cancer spend a lot of time in clinic getting treatment and taking chemotherapy, which causes weariness and sadness. Virtual reality has been found to significantly aid in the reduction of time perception. Many burn patients found wearing a VR HMD on their head to be painful, especially those with serious burns on their head or face. Furthermore, even if patients do not have severe burns on their head or face, the traditional high-tech VR HMD weighs about two pounds. As a result, simply carrying the weight can be painful. Keeping the helmet scraped in throwaway plastic for sterility reasons was also time consuming. This requirement inspired the development and execution of a more comfortable goggle holder for burn sufferers. The goggles are held near the patients' heads by a robot-like arm, so they don't have to wear the VR helmet on their wounded skulls.

Fig 18: Robot-arms holding the VR goggles

Snow World was created by Hunter Hoffman, Ph.D., a member of the University of Washington's Human Interface Technology (HIT) Lab, and doctorate student John Everett, who was working on his dissertation at Harborview Burn Center in Seattle on psychological strategies to alleviate pain in burn victims. They also want to create a burn-pain VR system dubbed SnowCanyon, which will be compatible with the HTC VIVE headset. Both SnowWorld and SnowCanyon employ the same approach: they use virtual reality to divert the brain's attention away from the agonizing pain of burn wound cleansing and skin stretching. When a patient puts on the VR headsets, he or she is transported to a realm of ice and snow that is separate from the physical world and the treatment. Instead of receiving the same information from their visual brain as your pain receptors, they were now competing between what they were seeing in the simulated world and the insights gained in from the pain receptors. According to Hoffman, it was "distraction on steroids." SnowWorld and SnowCanyon are currently being evaluated and utilised on burn patients in a dozen different hospitals.

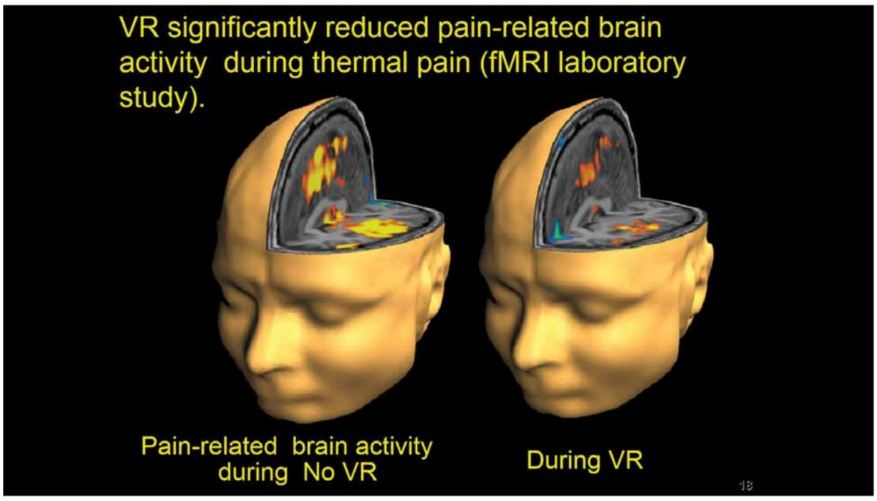

Fig 19: Before and after VR

5. CONCLUSION

Students are typically taught about diseases by reading textbooks and seeing introductory films. Without personal experience or engagement with genuine patients, one can only picture the pain and suffering based on symptom descriptions and video recordings. Medical students can visualize and so have a better grasp of patients’ experiences thanks to the immersion and embodiment of VR apps.

Because all VR systems require constant tracking, the technology is both beneficial and susceptible to mass spying. The rise of virtual reality will improve the possibilities for data collection of personal activities, motions, and responses while lowering the expenses. Eye-tracking sensors, which are expected to become a regular component in virtual reality headsets, may provide information about a user's ethnicity, personality characteristics, fears, emotions, hobbies, talents, and physical and mental health concerns in an indirect manner.

Many apps are still in their early stages. In the future years, virtual reality will be increasingly employed to increase the accuracy and efficacy of present operations, as well as to expand the capacities of humans, both as caregivers and as patients. Simply said, the potential for virtual reality in healthcare is enormous, limited only by the inventiveness and brilliance of those who develop and utilize the technology.

In many ways, virtual reality will enrich and transform our environment. It opens up new ways to comprehend and experience history, cities, and landscapes. There are several unique VR solutions in the field of marketing and public relations that will inspire your consumers. The sales sector and trade acquire modernity and space thanks to virtual reality. As a result, virtual reality not only advances the medical profession but also pleasantly impresses us in every way.