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Adoption of AR/VR and gamification in Future Healthcare Applications: A Mini Review

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Abstract: ***In the era of rapidly evolving technology, Augmented Reality (AR) and Virtual Reality (VR) has emerged as a transformative force. Nowadays applications of AR and VR technology along with gamification techniques and incentives in the individual health is popular topic of study in academia. However, there is a need and opportunity to study the usage and challenges of AR/VR along with gamification applications in the healthcare system. To explore this, we did a survey in the software-engineer system. Based on the response, we found some of AR/VR app used in healthcare, as well as information regarding the purpose of using their applications and user experience. This survey is beneficial for both software developer as well as researchers in field of CS and medical science. It can give them information about the existing products in the market and potential problems of AR/VR and gamification in the healthcare system.***

Keywords: Augmented Reality; Virtual Reality; Gamification; Healthcare; Unity; Incentives

I. INTRODUCTION

Recent research has started to focus on effect of Augmented Reality and Virtual Reality in our everyday life. Many researches have shown that these digital technologies negatively influence people well-being, such as playing online games can lead risk to people's health. Researchers like Mannikko, Mendes, Barbosa, and Reis concluded that playing online games is linked to risky behavior and overall health problem of an individual. On the bright side some recent technologies and applications in the field of AR/VR that serves as a blend of entertainment, navigation, and health promotion. These applications have been developed to match the efficiency and modernize the healthcare applications by combining gamification graphics and introduction of incent- ties. One example of such project revolve around motivates users to engage in exploration of their surrounding environment and achieve particular destinations by providing them navigation and augmented reality (AR) coupons as a reward, thereby enhancing physical activity and promoting health in an engaging and exciting manner. The Pokémon Go, the location based mobile game developed by Niantic allowed players to use their smartphones camera to capture the virtual object in real world locations. Advance technologies including the introduction of platforms like Unity, Apple's ARKit and Google AR Core are used for making Augmented Reality more accessible for experimentation [2]. PRISMA-P 2015 statement, investigates the impact of Pokémon Go on physical, social and psychological outcomes between July 2016 and April 2021.Thus providing both positive and potentially transient effects of Pokémon Go on physical activity and well beings [3]. This paper presents a user survey with relevant students, profession- als related to software development area with aim to explore the opportunities and challenges with AR/VR and gamification technology applied in healthcare, the next sections in paper describes the relevant background concepts including AR/VR and games. Then describes the related work in the fields of Computer Science and medical and the next section talks about aims and objectives, research method and the research questions. Further section shows the how and in what scenarios AR/VR technology in implemented in real world, perspective of application purpose, advantages and disadvantages. Finally last section gives a summary of the study and highlights information gained and points out the important findings.

II. BACKGROUND

Games are very popular in the world since 1970s, but now they are not used only as a source of entertainment, but are increasingly used in other areas. The challenge and fun in the game are the primary motivations for people to play it. Gamification is using game-design elements and principles in non-game contexts [1], and it aims to bring the benefits of games to non-game contexts. A game comprises a set of rules that govern its operations and lead to various outcomes, the impact of which can be altered by the player's actions. In augmented reality (AR) systems, virtual objects are integrated into the physical environment, enhancing the user's experience [2]. Conversely, virtual reality (VR) systems generate 3D computer-generated objects, simulating an entirely virtual environment and often involving immersive peripherals like VR headsets (Okeil, 2010). Additionally, Wang et al. highlight that by integrating visual and interactive multi-user operation technologies, VR training games could reduce the complexity of task processes, thereby enhancing user interactions (Wang et al., 2018).

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III. RELATED WORK

Gordon Chih-Ming Ku, I-Wei Shang and Meng-Fan Li [1] conducted a study find a meaning of Pokémon Go and users experience using Means-End Chain (MEC) theory. The laddering technique was used to collect the quantitative data, and the collected data was analyzed using content analysis with developing Hierarchical Value Map (HVM).

Ma et al. (2014) identified three emerging trends in the intersection of VR/AR technology and gaming within the healthcare sector: location-based exergaming, mobile applications, and social media gaming aimed at promoting public health. They claimed that our approach of thinking about the healthcare and medical field might be changed by the research and development of mobile devices and applications combined with wearable Devices are anticipated to undergo significant advancements in the forthcoming decade (Ma et al., 2014). The impact of social media on healthcare gaming is expected to increase, driven by the rising popularity of social games and the effectiveness of social interactions, as suggested by Ma et al. (2014) It was seen that AR/VR techniques are very effective to enhance the conventional solutions in healthcare as well as few other sectors. Jorge et al. Jorge et al. (2019) examined various methodologies and obstacles associated with the implementation of VR/AR technology in healthcare and rehabilitation. Their analysis showcased numerous innovative VR/AR systems, including VR applications for radiologists in reading rooms and operating rooms, as well as augmented surgery and laparoscopy.

Perkins Coie LLP and the XR Association interviewed 200 startup founders in 2019, executives with established technology companies, investors and consultants in the AR/VR related area, in their new survey report in 2019 (LLP and the XR Association, 2019), they found out that 90% of the respondents believed immersive technologies including AR/VR would be present everywhere like mobile devices, by 2025. They also said that major concerns are available content offerings and pace of adoption by users. In mass adoption of AR/VR the largest obstacle was lower user experience, glitches in the interface and costly, bulky hardware. Respondents pointed out that slow adoption of AR/VR by user is biggest concern and believed that hardware should be more user-friendly and affordable also comfort should be taken care. One of the respondents said that immersive technologies have potential to connect people in organizations such as doctors, offices or schools along with the individual consumers and they have a strong confidence when it comes to the future of AR/VR technologies.



AR Technique



VR Technique

IV. AR/VR APPLICATIONS IN MEDICINE & PATIENT CARE

Among recent news stories with a happy ending: a pair of conjoined twins in Brazil were successfully separated because of a virtual-reality-enabled surgical procedure. Three-year-olds Bernardo and Arthur Lima were born joined at the head with their brains intertwined, and medical experts had said it would be impossible to separate them. The ground-breaking surgery was conducted simultaneously on both sides of the Atlantic Ocean, taking place in a hospital in Rio de Janeiro and directed live by Dr. Noor ul Owase Jeelani from a hospital in London.

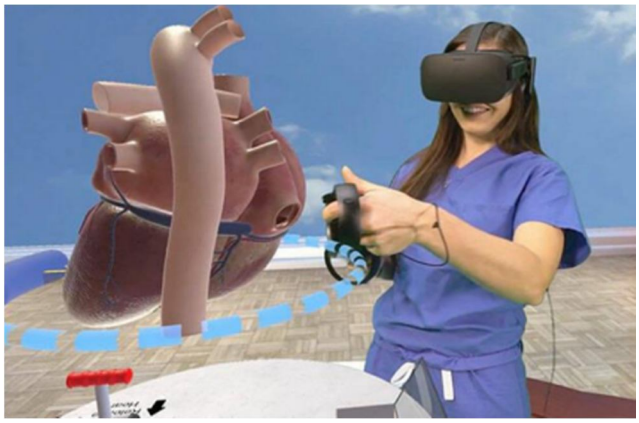
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What made this complicated procedure possible was virtual reality (VR) technology. First, medical teams spent months preparing and practicing the surgery in VR, using 3D models of the boys' brains built from MRI and CT scan data. When they performed the series of seven surgeries required to separate the boys, the UK and Brazil teams wore VR headsets to coordinate their activities, with Dr. Jeelani directing the procedure live. After a span of seven weeks, both boys are showing positive signs of recovery. The idea of using VR in medicine is not new, but now "advances in technology mean the hardware is cheaper, smaller, faster, more reliable, and easier to use." (Delzell E, "Virtual Reality in Medicine"). VR is already established as a valuable tool for medical education and training and it's now being applied in a number of areas.

A. Taking VR to Heart

To aid medical students and patients in comprehending and managing pediatric congenital heart defects, Stanford University, Lighthaus Inc., and Oculus partnered to develop The Stanford Virtual Heart. Launched in 2017, it is currently utilized in pediatric cardiac centers and educational institutions worldwide. Users put on a VR headset to view an interactive, 3D heart, which includes various kinds of defects such as a hole in the septum or improperly attached valve. The user wearing the headset has the ability to "teleport" into the heart, allowing them to observe its chambers, vessels, and blood circulation, gaining insights into the effects of various defects



A clinician explores The Stanford Virtual Heart, an interactive, 3D model that helps demonstrate many common congenital heart defects. (Image © Stanford Medicine)

B. Easing the Pain

The medical community has recognized for at least a decade that attention distraction can be a powerful tool to help manage pain. When individuals feel pain, it occurs as nerve signals from the affected region transmit to our brain. However, the brain's attention capacity is finite. Engaging in tasks or activities that require mental focus and utilize some of our attention capacity can serve as a distraction. This diversion can limit the number of pain signals reaching the brain, offering a degree of relief. VR devices are designed intentionally to capture our focus and provide an immersive experience to let users feel like they are truly inside the images they see. The potential of VR to serve as a distraction holds promise for individuals dealing with pain. Dr. Thomas Caruso, an anesthesiologist and pain management expert explains, "pain is a perception that's coupled to your attention, mood, and emotions. With VR, we can help modulate a patient's mindset to be less focused on pain and anxiety." ("Fool your brain, reduce your pain," Harvard Health Letter, November 1, 2012.) VR treatment may not eliminate pain entirely but when used in combination with medication it can greatly reduce the need for opioids and other potentially addictive painkillers. For instance, VR technology has been employed to assist pediatric burn patients in coping with pain during dressing changes. Acknowledging the effectiveness and advantages of this virtual pain management method, a VR system received Breakthrough Device designation from the U.S. Food and Drug Administration (FDA) in 2020.designed to ease lower back pain and fibromyalgia pain.

C. Revving Up Rehabilitation

Many consumers have used VR applications to get active—from dance workouts, to virtual golf games, to running from zombies, the VR marketplace offers a wealth of options for getting off the couch and getting physical. By introducing gameplay elements, even less-motivated users can find exercise more fun and engaging.

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The same approach is also proving to be very effective at motivating patients to do the physical therapy and rehabilitation exercises needed to help them recover from injuries or illnesses or to address ailments or manage neuro-muscular disorders like cerebral palsy. For patients who have survived a stroke or traumatic brain injury, the sooner they start rehabilitation, the better their chances of regaining lost functioning. Neuro Rehab VR is one company developing VR training exercises using machine learning to tailor the therapeutic regimen to each patient's needs.

D. Giving VR Devices their "Check Up"

When people's health is at stake, patients and clinicians must be able to rely on the performance of VR devices, just as they rely on any other piece of medical equipment. Any visual irregularities in the display of the headset can disrupt the efficacy of the device. In critical situations like a live surgical procedure, even tiny image imperfections could have serious consequences. To help VR headset designers and manufacturers ensure the visual performance of their devices, responsible companies offer a range of solutions. Their lens design simulates the size, position, and field of view of the human eye to accurately capture and evaluate the human visual experience of elements in the headset.



Radian's AR/VR Lens with a Prometric® Y Imaging Photometer (left), TT-ARVR Software showing MTF slant-edge analysis of image taken with our XRE Lens (back), and the XRE Lens shown in periscope configuration with a Prometric® I Imaging Colorimeter (right).

V. DISCUSSION

The primary factors behind the utilization of AR/VR techniques in healthcare were the creation of a secure, regulated, and replicable setting, along with the ability to present from multiple perspectives and simulate real-world scenarios. The AR/VR techniques provided a virtual environment similar to the real world. It is a safe and controllable environment for expensive and high-risk teaching or training. Users can consolidate knowledge and skills in actual operations and avoid the serious consequences of incorrect operations. However, for serious purposes, the proportion of using gamification techniques in this kind of applications is relatively small. But there is still space to combine gamification techniques into medical education and training software applications. Training skills in taking care of babies could look like a" medical education and training" software, but for new parents instead of users with a medical background. In an environment that maintains social distancing and avoids gatherings for safety reasons, software applications have become a better solution instead of face-to-face instruction. The topic of treating psychological and mental health problems is an account for a large proportion of the overall, both in the results of existing software and the requirements designed. Similar to the medical education and training software/applications, the wide application of AR/VR/MR techniques in such software mainly lies in being safe and controllable. Virtual objects provide a safe and controllable treatment environment for doctors. They can influence the mental state of users through the tasks they are designed to provide treatment or relief. Games or gamification techniques could bring fun and motivation in the treatment, promoting usage time and effect, in gamified tasks, they were easier to understand and accept in the software application. This could also apply to users with cognitive impairments. On the other hand, the user experience and content should be the most crucial quality standards to consider. The usefulness of the software as the solution in healthcare and the acceptability of using AR/VR were essential as well. Potential users want a relatively straightforward and simple path to their own virtual application. If the learning curve for using VR applications and preparing them is too steep, they become impractical for use in the healthcare sector. The already demanding workday in healthcare doesn't allow for much additional effort. This applies not only to the software itself but also to the equipment or hardware. Furthermore, the participants' limited technical experience is a factor. Thus, VR application requirements should be user-friendly, with clear language and explanations.

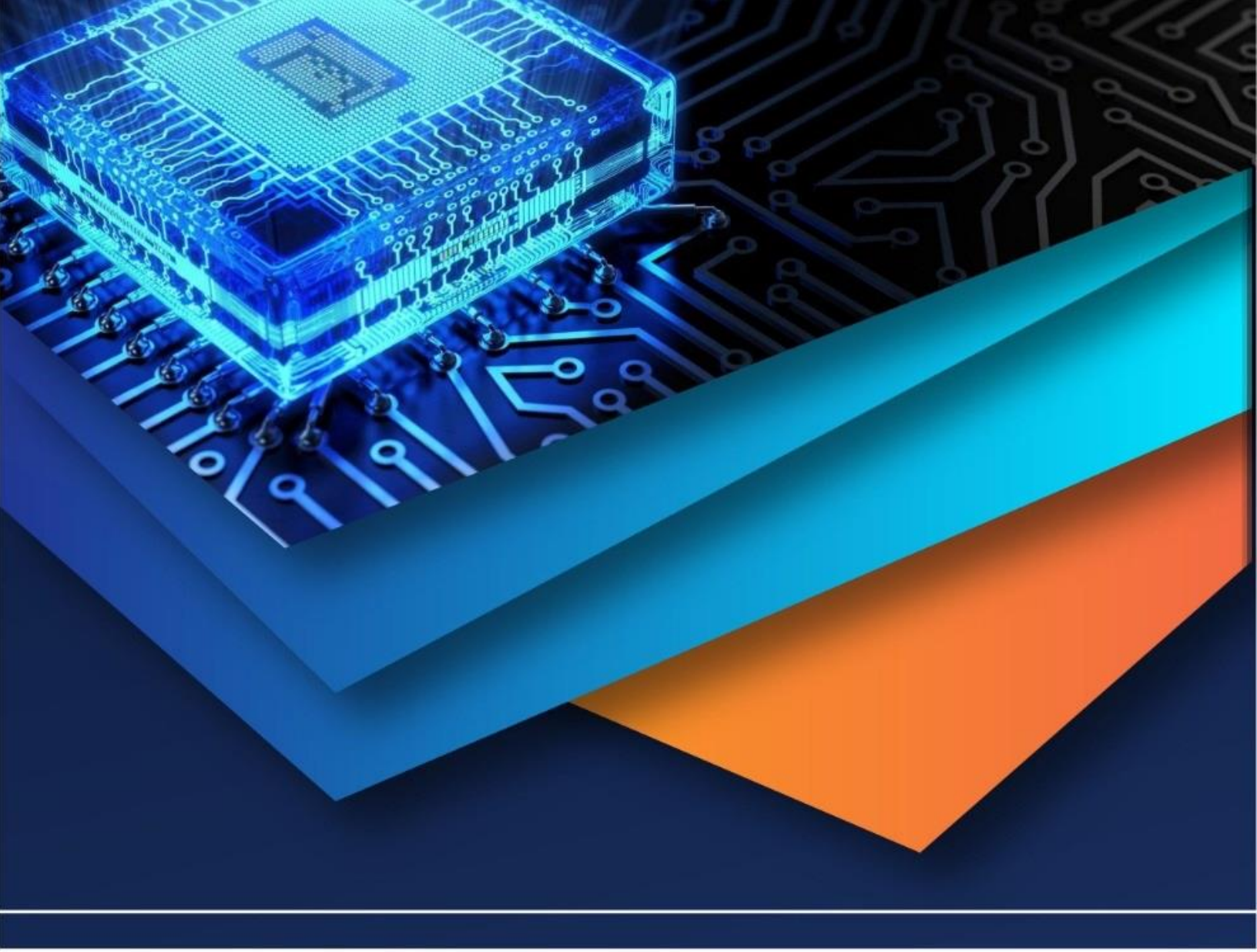
Testing with potential users beforehand can ensure comprehensibility. Documentation on the software platform is necessary, but interactive tutorials could alleviate the learning process. Standard applications within the platform could serve as a basis for tutorials, making them more accessible. Including medical experts and target users in the development and evaluation may help to solve this issue as well as problem of mass adoption.

VI. CONCLUSION

Based on our research and study we came to the conclusion that these techniques were helpful for some health issues due to the acceptance and motivation in game/gamification, as well as the safety, repeatability, and that there is a potential for an improved experience in AR/VR. However, the seen challenges were relating to cost and equipment. Moreover, our research identified that the primary obstacle to the successful integration of VR applications into healthcare workflows is complexity overload. When users face excessive complexity and options, it tends to deter their usage. Given the demanding nature of daily tasks in the healthcare sector, adding significant extra effort is often impractical. So when working on VR healthcare applications, one should not fall into aimless customization and try to enable the users with a myriad of options and settings that allow them to cover every conceivable use case. Instead, applications should prioritize user assistance and automation, analyzing user conditions and offering supervisor monitoring or customizable templates. Emphasis should be on addressing standard use cases efficiently to encourage adoption by healthcare professionals. Requirements for gamification and AR/VR in healthcare software include mental health treatment, elderly care, and caregiver skills training. There are worries related to the techniques and obstacles to mass adoption. Although the study was limited, a conclusion was still obtained, that game/gamification and AR/VR have been accepted and applied in healthcare, as well as highlighting further development space of software and hardware. These insights are useful for both researchers and developers to know the state and development trends of game/gamification and AR/VR/MR in healthcare Conflict of Interest Disclosure: The corresponding author affirms, on behalf of all authors, that there are no conflicts of interest to declare.

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