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## CHAPTER 4

# Augmented reality, virtual reality and new age technologies demand escalates amid COVID-19

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## 1 Introduction

Augmented reality technology is a computed image generator that reveals visually real-world images in composite sizes and views. Such technology is used by many surgeons in AR telesurgical centers to view different internal organs, especially bone reconstruction and other internal medical complications. Medical AR has a 2-way audio stream integrated into webcams to highlight with annotations and drawing the structural component of bodies in examination (Greenfield et al., 2018). AR makes it possible for health practitioners to achieve data visualization for diagnosis and treatment, which enhances efficiency, safety, and surgical treatment costs.

Medical Scientists in 1895 carried out the first medical imaging experiment to examine human X-rays, marking the starting and ending points using a well-developed ultrasound (USG) tool. Since then, much progress has been made in medical imaging, developing various imaging modalities, such as computed tomography (CT), MRI, and 2-3D dimensional image tools that show human anatomy, its functional and possible diagnosis. Most physiological therapies make use of either MRI (magnetic resonance imaging), fMRI (functional magnetic resonance imaging), or SPECT/CT (single-photon emission computed tomography). The purpose of this advanced medical imaging technology is to capture real-time data, navigate human anatomy, display microscopes, etc. (Vávra et al., 2017).

In conjunction with modern medical imaging technology, AR/VR has been heavily used in telemedicine, allowing multidisciplinary teams to collaborate and remotely monitor patients to eliminate the shortage of physicians, especially the need to visit nursing homes and hospitals to support the

fight of COVID-19. The use of AR/VR remote procedures minimizes risks of contamination and waste of PPEs. Medically, VR offers virtual illustrations of the world, which can be overlapped with AR real-world virtualization. AR/VR helps physicians to gain insight into patients' well-being and share their discoveries with other experts using mobile devices (Ferrucci et al., 2009). Virtual and Augmented Reality works with a head-mounted device (HMD) that perceives human body systems and identifies human brains. The light from AR/VR can propel real-life appearances of the brain in two visual processing forms known as monocular and binocular processes.

The monocular process captures a single image at a time, while binoculars capture two or more images. A binocular process is publicly accepted due to its strong effects and in-depth data structure used to create stereopsis via dual-image illustration. Binocular also identified human anatomy using 3D immersive sensor tools (IWAR'99, 1999). There are different types of AR/VR projection, but perspective projection specifically displays smaller objects, as the projecting device used can be placed far away from the object. The occlusion AR/VR projection involves the display of an object in front of other blocked objects. AR/VR comes in different sizes, shades, structures and motion parallax (Abdel-Basset, Chang, & Mohamed, 2020).

Before Hollander and Carr (2020) received his first tele-sphere HMD mask patent right, Sutherland (1965) used the traditional half-developed VR to perceive real-world environments. Hence, the Morton HMD mask has a reliable 3D immersed simulator and enabled stereoscopic sound display known as Sensorama. Though, the clinical use of VR commenced in the mid-1990s when experts attempted to use it for surgical training, planning, and therapeutic rehabilitation (Tang, Owen, Biocca, & Mou, 2002). Azuma et al. (2001) describe how AR coordinates real-virtual objects by running a collaborative real-time object using cameras to track and observe the environment. AR visual display component shows a clear definition of the physical world and comes in two types: see-through optical (OST) and see-through video (VST). Most Augmented Reality VST shows virtual images in the real format, while Augmented Reality OST uses the reflection of light that passes through the human retina and lens to offer real-world visualization.

In 1993, Loomis Corporation introduced the first medical AR GPS that senses digital spatial and audio information. Fuchs et al. (1996) used a patient undergoing biopsy to demonstrate the benefit of AR. Some software developers later developed HoloLens SDK and ARToolkit to advance the clinical use of AR. Google recently explored its Google Glass AR software and

Hololens to investigate AR benefits in controlling infections (Wong et al., 2020). The above-mentioned examples represent just a few use cases of AR/VR technology in medicine. In this paper will describe other applications of AR/VR to fight COVID-19 pandemic.

The remainder of this paper is organized as follows: Section 1 introduces the use of AR/VR in COVID-19 pandemic. Section 3 provides technical background of AR/VR technology and a review of the literature. Section 4 explains the demand for AR/VR technology due to COVID-19 pandemic. Finally, conclusions are drawn in Section 5.

The image below illustrates how SARS Cov-2 attacks the body from the lungs to other parts of the body (Fig. 1).

## 2 Updates ways to minimize infections

### 2.1 Vaccination for controlling the spread of Covid-19

World health organization has established cold chain vaccines equipment to achieve safe-injection of the Covid-19 vaccine without compromising drug potency. AR/VR can be used to estimate vaccine or amount of injection equipment needed to serve a specific location or targeted population.

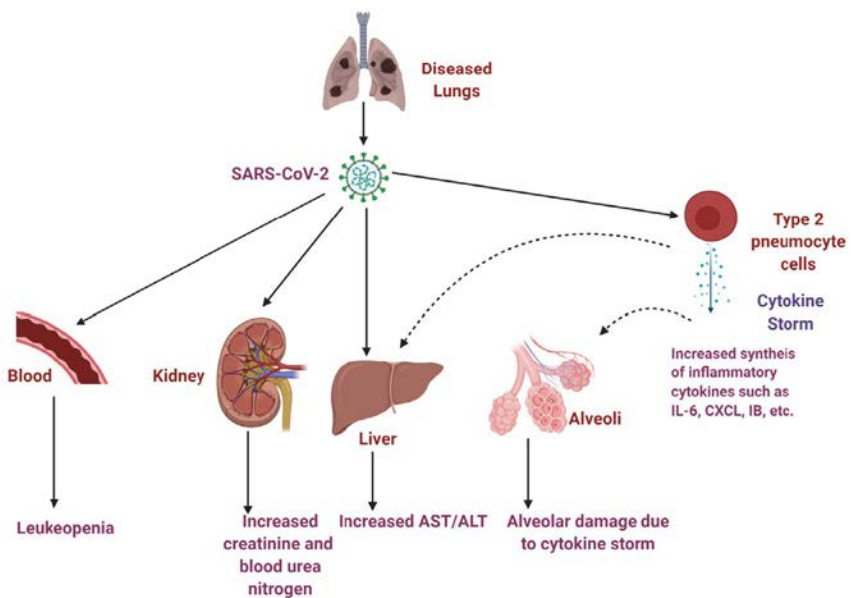


Fig. 1 SARS Cov-2 attacks the body from the lungs to other parts of the body.

AR/VR monitoring tool may eliminate waste multiplication factors (WMF) experienced during previous virus vaccinations.

XR trajectory innovative tool creates a stimulus-response for salvaging the tourist industry from being disadvantaged by the Covid-19 pandemic. Recent research proposes that the “XR trajectory” can be utilized to reshape the collapsing tourist industry (Light & Brown, 2020).

The introduction of vaccines won't stop social distancing and covid-19 monitoring which makes AR/VR usable for maintaining consistent safety measures. VR was found useful for remote medical assistance, drug discoveries and remote training and collaboration during the pandemic. Recently, updated research proves that VR helps to visualize viral proteins to discover how it works and how its inhibited enzymes can suit vaccine development. VR has found its place in Phygital therapies (treatment of psychosomatic surgery) which involves physical therapy, rehabilitation, patient distractive treatment, and correction of health disorders. AR can minimize the spread of covid-19 by offering a consistent review of the spread whereby limiting the spread to a specific location and allows communities, institutions, schools and workplaces to reopen. AR/VR boost dependent on online classes and virtual world whereby limiting human to human contact, contamination, and isolation of infected individuals.

Baidu healthcare in china launched a new app segment that works as an augmented/virtual reality asset for conducting covid-19 vaccination, online vaccine consultation, and appointment scheduling. Hong Kong called Anti-protense introduced AR/VR tool named “WIMI” with multimedia 3D modeling for real-time tracking, registration, intelligent interaction, and sensing. WIMI has computer-generative texts, images, 3D modeled music/videos, and other VR informative tools. It enables people to shop, communicate and socialize visually during the pandemic while minimizing the spread of the infection. WIMI is known as a holographic AR tool for performing visual presentation, 5G communication, Hologram ARSDK payment, etc. (Kwok & Koh, 2020).

## 2.2 Drugs and nutrients for controlling the spread of Covid-19

The Sars-Cov-2 has a profound protease (MPRO) enzyme which science relies upon to discover the correct anti-viral treatment. The replication of protease enzyme known as enzyme inhibitors causes the spread of the virus. Hence, researchers are focusing on identifying molecules causing the replication and stopping its mutation.

AR/VR 3D model structures are used for interactive molecular dynamic simulations to visualize molecules. IMD-VR tool enables the international drug discovery community to predict the leading cause of SARS-Cov-2 and produce relevant vaccines to combat the virus (Ferrucci et al., 2009).

Some nutritional and immune defense dietary component that boosts body system with micronutrients includes A, D, E, C, B6, and B12. It's necessary to adopt the use of Folate and selenium found in fresh meat and plant-based meals while consuming foods rich in Zinc and iron. Good dieting innate immune response controlled by T-cells which recognizes the antigens called cytotoxic. Cytotoxic T-cells are responsible for killing bodily infections and damaging viral cells while repairing T-helper's cells such as Th1 and Th2.

Food plants like onion, garlic, barberry, papaya, bitter orange, turmeric, fig, soybeans, licorice, wolfberry, mango, mulberry, black-cumin and black pepper; act as immunomodulation and anti-viral functional nutrients for subduing the spread of viruses. Some researchers claim that guava, pomegranate, and ginger can provide vitamins, fatty acids/oils, and flavonoid needed to minimize the spread of the virus in the body (Amirghofran, 2010).

### 3 Background and literature review

3D visualization modes elaborate the gap between memorizing, reasoning, and understanding of 3D structure represented as orbital molecules, geometry, and bio-molecular compounds. The future is yet to come, but the possibility that students will wear VR headsets, positioning their gaze while learning through image assimilated stereoscopic depth perception. Digital classrooms using VR/AR can be viable, but the incorporation of interactive learning in medicine to form both a static and spatial-dynamic virtual laboratory is yet to be effective. Meanwhile, App implemented Pixar's Universal Screen description (USDZ) as an object-generated workflow for chemistry students to organize files and implement chemical bonding. Also, Apple attached AR Quick Look app to the Safari browser to offer quick lectures by the enabled AR/VR 3D tool. This quick lecture has a less-distracting blank background known as 3D "USDZ" file that performs command-line activity using USDZ Python Script (Held & Hui, 2011). There are open-source options named Octave, Pymol, Meshlab, and Blender that handle different medic-scientific animated learning approaches.

Over the years, AR/VR has adaptive interfaces for molecular visualization and modeling in science and technology. In technology, AR/VR has

specialized hardware (wearable) and software setup for research and education. AR applications can work on webpages, webcams, and other internet browsers, for examining the display of molecules, electron-microscopic maps, and orbital molecules; exhibited using HTML codes. For the molecule's mechanics to be exhibited in a real-time experimental observation, an interactive JavaScript will be integrated to provide virtual alternatives of the objects. Once the object is displayed in VR Computer Software for augmentation, the modeling kits will help to enhance images for spatial interaction, reactivity, and energetic modeling (Abriata, 2020).

In science, AR/VR has helped chemistry and structural biology disciplines by offering hybrid and computational virtual molecules of real 3D spaces of chemicals for proper calculations (Fjeld & Voegtli, 2002).

Kato and Billinghurst (1999) explained AR/VR for detecting and tracking objects using Ad Hoc hardware with sensors and cameras to track users and control the geographic spread of the virus by examining human hands for traces of dirt causing infections.

Sirakaya and Sirakaya (2018) suggested the use of telemedicine audiovisual technology to care for patients in rural areas while setting up low-resource technology to limit urban visit; while controlling the spread of the virus. Telemedicine can be viewed as a virtual reality that limits physical encounters or in-person visits to the clinic. Telemedicine can promote pre-post-operative consultation.

The American institution for Otolaryngology for neck and head surgery implored virtual reality utilization for post-operative patient checkups. This technique allows virtual visits using oncology surveillance placed on patients to monitor the recovery process. The virtual visit helps physicians to check patients' anatomy and pathology to see how fast they're recovering (Hildrew, 2020).

Medic-AR aids X-ray vision to see through real-world objects, some experts referred to the process as computer vision with pre-intra-post interventions. Medical experts explained oncology tumors, which can be envisioned with AR/VR before administering Oropharyngeal treatment and tumor removal surgery. AR enables tumor assessment using CT or MRI to determine the stage, possible diagnosis, and mapping of the treatment plan. Most doctors performing oral or Cranio-Maxillo-Facial surgery utilize anatomical AR visualization to increase the spatial outlook in a natural 3D form. This 3D reflects the oncology bone resection in an expansive virtual space (Fuchs et al., 1996).

Lu, Wang, Zhou, and Fu (2019) researched chronic Endovascular Pain in the limb of an aging adult. Other research used his research to insinuate the possibility of AR used in detecting the exact painful location. AR/VR tool coordinates with indoor positioning technologies such as radio frequency identification (RFID), Wi-Fi, visible light, Zigbee, and Bluetooth; can obtain Covid-19 records and monitor the control of COVID-19 during quarantine periods.

Ackerman (2020) devised the use of Ava robotics (IRobot) VR that can virtually show emergency cases and minimize threats of virus spread. High Altitude Platform (HAPs) promotes video connectivity to rural areas using Google Loons and Facebook Aquila to offer the possible solution. Covid-19 on the other hand, leads to an extensive use of virtual experience such as Google Hangout, Zoom and Skype as virtual labs, classrooms, and conferences.

Different researchers detailed their discoveries on the benefits of AR/VR in the educational environment, as well as the control of viruses and social distancing. Chang and O'Sullivan (2005) highlights that teaching and learning with AR increases the possibility of achieving higher learning objectives. Carlson et al. (2013) emphasize on how world education can be facilitated and transformed using VR/AR applications. López-Pérez, Pérez-López, Rodríguez-Ariza, and Argente-Linares (2013) stated that 21-Century tools may present great opportunities to achieve permanent transformation. Balsa-Barreiro, Vié, Morales, and Cebrián (2020) researched the increase of academic interest and participation if VR replaces traditional classes. Wong et al. (2020) explained the duty of spatial skill development in medical schools. AnimaRes 3D medical animation and interactive AR/VR focused tools can support the pharmaceutical discovery of COVID-19 vaccine through flow-simulation, spatial explanation, and heart rate reading (Chandola, 2020).

### 3.1 Interrelationship between AR and VR

Abowd and Mynatt (2000) defined AR as a technology that creates a real-based interface which projects real-world objects to be illustrated on a virtual device like a computer. AR can create mixed reality by showing virtual environments and augmented reality. With AR, the real object can be replaced with the visual object which enables the creation of virtual reality (Ahmad & Musilek, 2006).



Benford, Greenhalgh, Reynard, Brown, and Koleva (1998) attempted the classification of AR and considered VR using telepresence to mix real and virtual objects to establish a real alignment and integration with 3D real-time integration. Some AR has head-mounted displays (HMD) that can apply to human senses.

Market Survey revealed why AR technology outpaced VR, in regards to revenue, market penetration, and consumer expectation, because VR typically severs communication, gaming, training, and entertainment while AR has diverse attributes for advancing healthcare and medical training. Based on what survey predicted, AR will overtake VR in regards to sales and market position in a couple of years. However, both represent spatial computable innovations (Perkins, 2020).

The demand for AR outweighs that of VR because AR offers human sensor visibility of sight, sound, and touch which can be felt in all human sense organs. AR has haptic (touch) display attributes, smell (olfactory), and taste (gustatory) display component (Ishii & Ullmer, 1997) discussed AR Haptic audio sound system and addressed its aural display application with limited self-explanatory mono zero-dimensional phase. The aural display has other-dimensional phases that serve stereo-attributes (1-dimensional phase), headphones and loudspeakers (2-dimensional phase), advanced 3D simulator (aids diverse virtual environment Some haptic audios are sold as a consumer device, named Turtle Beach Ear force Headset (Chang & O'Sullivan, 2005).

The image below shows the interrelationship between AR and VR and it helps to track, detect and diagnose Covid-19 (Fig. 2).

### 3.2 Software and hardware components of AR/VR applications

As the world estimates the market growth of \$125.19 billion from 2020 to 2024; NetTech AR company developed 3D photorealistic holograms called Aritize app. This app offers remote video training and live streaming. Microsoft HoloLens established a Six-Degree of Freedom (DOF) augmented reality with HMD attributes. It has unique features like the field of views (FOV), a stereoscopic pixel resolution that demonstrates spatial audio-tech, Wi-Fi, and Bluetooth devices. HoloLens is an augmented glass built as an onboard computable general-purpose processor device with a holographic processing unit (HPU).

HoloLens enable the collaboration of hand, gaze, and voice inputs, allowing an optic wave lens to project images in front of the user's eyes.

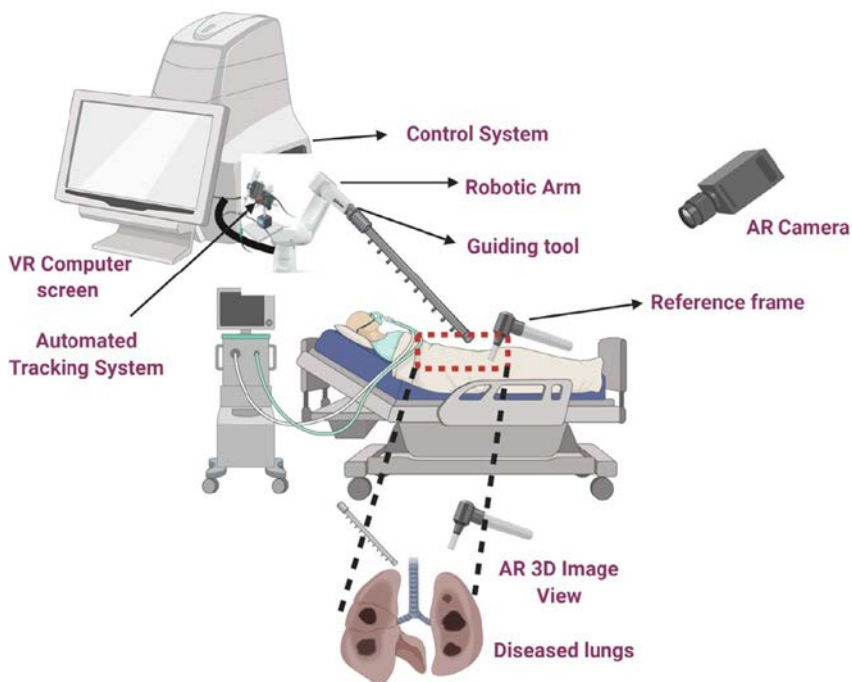


Fig. 2 AR and VR for detecting, and diagnosing Covid-19.

At present, China uses HoloLens to store and track previous locations of people infected with COVID-19 by creating 3D maps using sensors to pinpoint the identified locations. It also comes with an incorporated inertial measurement unit (IMU) and sensors that reflect similar positions, rotate to other positions while allowing the head in the HMD rotation (Microsoft, 2019).

HoloLens clicker enables users to communicate with holograms by selecting, scrolling, moving and resizing applications. AR works with the Raspberry PI component necessary for connecting HoloLens to IoT using its four USB ports, quad-core ARMU8CPC, wireless LAN, Bluetooth, and Low Energy (BLE). AR integrated on IoT devices can be implemented on the Unity 3D Game Engine (Unity Technologies, 2005) to visualize real environments. To integrate AR to work with IoT for a better virtual experience, the HoloLens must work with sensors to either offer biomedical or data leveraging on IoT client-servers through messaging queuing telemetry transport (MQTT) protocols. The collaboration of AR and IoT in HoloLens is known as “Broker” which interacts with MQTT using open source MQTT python client Pahon eclipse application. Common technologies

relevant for performing in-depth sensing of VR/AR include stereo vision, structured-light, and time of flight (TOF).

Stereo and structured-light interface follows triangulated models required to separate multiple capture views, using multiple sensors, light, and camera paths. The stereo vision can sometimes be passive, which helps the depth map to reproduce different pixel positions of the captured images. AR/VR structured path handles baseline image separation. The time of flight (TOF) measures the time offset and phase shift between the emitting and receptive signals. AR/VR applications normally adapt to TOF sensors through the modulated signal, measure phase shift, and depth information (Xu & Hua, 2020).

Popular depth-sensing applications used in AR/VR devices are known to evaluate depth map resolution, depth range accuracy, computation power and size, low/bright high performance, and speed (Xu & Hua, 2020). AR user interface works perfectly in unity framework, C# scripting language, and mixed reality toolkit (MRTK). The mixed reality toolkit is an open-source collection script and its components are compatible with MS HoloLens. The images below show AR/VR devices (Fig. 3).

#### 4 Demand escalation of AR/VR due to COVID-19 pandemic

The global health resistance to viruses has by far been stretched due to the spread of COVID-19. In 2018, the global investment in AR/VR worthed \$641 million and increased to \$3.8 billion in 2020 due to COVID-19.



Fig. 3 AR/VR devices.

Companies manufacturing VR, AR and MR technologies in Asia confirmed a 50% increase in demand. IBM oriented their AR products to offer remote capability using an upgraded network that enables distance learning and collaboration. New emerging applications for video conferencing, webinars, remote access and emails are generally called the “Extended Reality (XR) that allows people to work from home, distance education, home fitness, private entertainment, and social distance interaction (Businesswire, 2020).

Retail stores and malls are presently using high-end AR mirrors for product visualization to prevent consumers from direct contact and virus spread. AR finds its place in cosmetics as Skywell Software used the “Cosma AR makeup app” to provide a detailed virtual outlook of products on customers. VR may influence tourism because tourists may be left with an option to explore locations with parachutes while viewing through VR applications. The real worth of the 3D depictable anatomy tool is evident in its usability to achieve multiplanar and 3D segmented image axial, computed tomography (CT), likewise magnetic-resonance image (MRI) (Gotra et al., 2017). For specialists to achieve complex Angiographic procedures, they need cone-beam rotational angiography that offers 3D segmentation of the images (Chehab, Brinjikji, Copelan, & Venkatesan, 2015).

For COVID-19, 3D and 4D illustration can be attained with an immersive holographic stereoscopic display tool; necessary for detecting virus spread throughout the body anatomy. They can also use it to study the orientation of the virus, pathology, and level of complications in detail. Held and Hui (2011) explained how trainee surgeons and medical apprentices used AR to measure surgical landscape, illustrate bodily anatomy, and understand the pathology.

On the other hand, VR applications such as a head-mounted device can provide gaze tracking, body movement observation, and heart rate examination. For surgical training, students can learn about human anatomy using VR while advancing their experience in laparoscopic and robotic surgical training using the same tool. The exposure of human anatomy during pre-surgical procedures will enhance surgical efficiency, accuracy, safety, improve and reduce operative time and minimize surgical errors.

Different VR simulators are designed to examine different types of body organs (Li & Xia, 2020) identified procedure Virtual Arthroscopy for orthopedic surgery. The insight into Arthro-VR will enable the simulation of shoulders in 3D form. VR simulators are also available for trauma vision examination, neurosurgery, and map mentor observation.

Parkhomenko Egor et al. (2018) discussed urologists' use of VR for pre-operative renal anatomy examination while performing percutaneous nephrolithotomy procedure. VR has been found to alter operative approaches and reduce Fluoroscopy time, blood losses, while offering access to the hidden internal body tracts. VR is presently used by different medical scholars to perform intensive Hemodynamic observation, diseases awareness demonstration, and treatment (Papa et al., 2020).

The DEEP VR Meditative Game developed by Radboud University can serve as a bio-feed mechanism and a control system for patients with COVID-19 stress-related anxiety (Chandler, 2020). Reports recommend physical fitness and proper dieting to help build counter-immunity against COVID-19, especially when immune-compromised individuals are being affected the most. AR/VR has been confirmed to support mobile fitness (Alturki & Gay, 2019).

Pokemon Go mobile app has AR integrated technology meant to support physical fitness. AR can be prevalent in tourism as travelers can make use of AR travel guide apps as an alternative device to substitute travel experience, especially during lockdowns (Adhani, 2012). Rohs and Gfeller (2004) proposed the use of apps built hardware devices configured in a computational platform to aid global tracking of COVID-19 data and control of virus spread.

There are several reasons why AR/VR devices are in high demand in recent times. Kim and Dey (2009) disclosed the use of AR in vehicle windshield displays for elderly people, which support cognitive mapping, and direction to the right destination. Hahn (2012) introduced AR for library service, which can be browsed as physical books that stack optical and facial recognition; implemented for library navigation. Cape Town University in South Africa measured the impact of AR mobile applications on students studying health science. Its impact reveals learning motivation because it grabs attention, offers relevance, boosts confidence and educational satisfaction. The motivational context model of AR learning models, referred to as the ARCS model, aids education attention, relevance, confidence, and satisfaction.

The George Washington Hospital decided to use VR to assess patients with throat and lung damage, enabling them to figure outpatients with COVID-19. The University of California once conducted in-depth research with sensing VR headset and camera, manipulating a three-dimensional model to examine patients with SARS infection. To attain an accurate result, they used R headset, receptor, angiotensin-converting

enzymes (ACE-2), and protein cell surface of different tissue types to discover immune challenges in patients.

Hikers at mountain Everest used an hour recreational VR tool to combat travel anxiety. Thus, the google edition of VR app serves tours to international space stations and national museums in Iraq. The google edition of VR can be accomplished using cardboard VR headsets (PowerUpEdu, 2020). The pandemic impacts economic and social lives, leading to a global recession in some developed countries. Covid-19 has re-directed communication, education, and healthcare services. Balsa-Barreiro et al. (2020) declared the pandemic as a genuine reason to commence de-globalization due to lockdown, border restriction, and limited medical supplies. Progressively, it has caused an uninterrupted boom of virtual revolution and strengthens the significance of AR/VR and telemedicine.

Before the lockdown, different countries allowed their doctors and nurses to practice remote Medicare (telemedicine); whereby using video calls, AR/VR to check vital signs and obtain X-ray scans. A perfect example is a South Korean Radiologist who used AR to conduct X-ray scans on patients. The KCDC developed “Now and Here” app to keep the non-infected region from contracting the virus. They also designed the “COBAEK” app to alert people about COVID-19 spread within 100-m distance by sending an alarm to users, which virtually directs people’s movement.

EduVenture and Museum Scrabble AR teaching and learning recently ranked the top list of well-documented, pattern and framework analyses that functions as an engaging information exchange program that engages team-spirit, personal learning, motivation and gamified learning (Ferdinand, Müller, Ritschel, & Wechselberger, 2005; Yiannoutsou, Papadimitriou, Komis, & Avouris, 2009). Since coronavirus is prevalently a new virus, medical schools need to offer staff and medical students training on how to use VR to predict COVID-19. VR can significantly be used to treat patients, campaigns, and create disease awareness by showing the simulated outcome of the disease to the public. Medical awareness will help patients to understand the ultimate use of VR and why it’s needed for their treatment.

VR can be used to study mental or psychological stress and disturbance in patients with COVID-19. Due to therapeutic procedures, VR creates an atmosphere for motivation and reveals the healing process to patients (Franchi, 2020).

VRs are recorded to be implemented in different contexts of COVID-19 cases, such as physical therapy and pain management. VR application works

for both patients in need of mobile or in-hospital treatment. VR has successfully been used to handle physical rehabilitation and cognitive therapy. Physicians confessed positive results and explained how VR distracts patients while reducing psychological traumas experienced by patients undergoing complex operations (Rajkumar, 2020).

#### 4.1 AR/VR and other new technologies for social distancing and controlling the spread of COVID-19

Researchers agreed during lockdown that VR will support social distancing and promote educational transformation that will enable students to rely on virtual classes while adopting luxurious learning styles from home; joining educational and official conferences.

South Korea stepped ahead with CBS (cellular broadcasting service) to exchange emergency messages and communicate effectively with citizens. CBS messages are sent to mobile devices by the Korean telecom company. They configured “Holding Virtual Video Conferencing” tool to enhance virtual reality experiences and restrict in-person meetings that cause the spread of the virus. The Korean government also encouraged the use of Global Virtual Private Network (GVPN) and G-drive to perfect remote working. G-Drive is a cloud storage application that supports file storage and document handling (Kwok & Koh, 2020).

Some elderly people from age 65 normally develop musculoskeletal diseases in the United States, leading to constant visits to the clinic. During the lockdown, such patients might find it difficult to access health services. Clinical innovations for outpatient settings and telehealth integration with VR experience will help patients to receive medical advice and attention without hospital visits (Saad, 2019).

The South Korean Government made a firm determination to flatten the COVID-19 curve by integrating Drive and Walk-Through Testing AR software with an attached mirror testing screening device. AR GPS Drive/Walk-through navigation has location-based integration, which can be different from VR, utilized for digital world visualization (like Oculus Rift and Samsung Gear VR). The Boston Human performance institute developed “Whoop Strap 3.0” app for research collaboration to consider mechanisms that increase COVID-19 incubation (Yannone, 2020).

Estimote Workplace Contact Tracing Application acts as a Bluetooth location device to help trace workplace activities and stay safe in the workplace (Burns, 2020).

Life signal corporations launched biosensor patches for leveraging cardiovascular detection of COVID-19. It can also help monitor early spreads using single-shower-proof check tools placed on the chest area. The single-show-proof check tool will be essential for detecting ECG, respiratory, and temperature rates (NS Medical Devices, 2020).

Spryhealth Company invested in a new digital technology called “Loop Signal” that limits patient’s clinic visits while offering a remote signal tracking interface for determining heart rates, respiratory and oximetry pulses (Spry Health, 2020).

Shanghai Public health Clinic center deployed the use of Bluetooth gateway called Cassi Network to monitor Covid-19 spread and minimize human contact (Koh, 2020).

Singaporean Government invested in a contact tracing app with Bluetooth AR called Trace together that determines the history of the infected people and subdue further spread of the virus (Chong, 2020).

GPS (2020) ascertained global positioning satellites by navigating with AR tools to monitor real-time locations of positive patients while simulating the outcome to create awareness.

The ministry of health in Israel developed the Hamagen app to monitor positive cases, measure self-isolation, and minimize COVID-19 spread (Cohen, 2020).

Most voice-based COVID-19 diagnostic apps are displayed on real-time AR/VR to discover throat-breaking sound and multiple parameters that show whether a patient is positive (Das, 2020).

AR/VR can effectively work when installed on the 5G plus network because 5G helps to overcome poor network challenges and enable immersive VR/AR performance (Li & Xia, 2020).

Huawei and Deloitte (2020) discussed 5G plus medical imaging with AR/VR authentication that handles picture archive and communication systems (PACS), required to diagnose and treat viruses. They also mentioned the thermal imaging technology initially deployed for anti-aircraft defense, thus adopting 5G plus IR thermal image monitor for real-time temperature checks with an accuracy rate of 89%. AR/VR notably provides critical medical rehabilitation and training using telemedical procedures that handle robotic support for limbs and exercise rehabilitation.

VR offers the expected streamlined opportunity to review vital signs during teleconsultation. Vital signs screening can be calculated from zero-latency of 1 ms radio latency, whereas VR is projected during surgery to demonstrate the stability of patients’ heart rates (Stefano & Kream, 2018).



## 4.2 Use of AR/VR to support remote education and reduce the spread of COVID-19

Virtual reality creates beyond mainstream experience and offers an immersive real 3D dimensional visual feedback that can engage distracted students. Educational VR has been around since the 1990s but didn't go far because experts considered it expensive and non-realistic. The pandemic brought back the forgotten experiment and established new perspectives utilized as Google cardboard, daydream view, Oculus Rift, HTC Vive, etc.; as high definition VR tools for attaining knowledge-driven experience. AR integration can digitally enhance objects to be viewed as real-world videos using smartphones and cameras. Some AR has language translation and QR scan code integration, which enables the viewing of real images in a virtual environment (Cruz-Niera, 2016).

Delialioglu (2012) discovered that traditional methods of teaching could lead to a lack of educational engagement, causing students to develop truant habits, learning confusion, and dissatisfaction. However, VR allows students to experience learning engagement in interactive and hands-on training. Google expeditions permit virtual trips to Mars for students to learn geography and planets. VR enables students to explore with curiosity; specifically, archeological students that won't travel due to COVID-19 may have the privilege to explore VR-specific tools for exploring age and modern caves and archeological sites (Costa & Melotti, 2012). Since VR gives a strong sense of presence that can replace traditional classrooms, VR can encourage reluctant students to learn with excitement (Aylett & Louchart, 2003). According to experts, VR can perform limitless educational tasks and provides constructivist learning, whereby students can solve real educational problems while collaborating with other students. For instance, astronomy courses are manipulated in VR to offer visual concepts of traditional topics. The same principles of VR learning can be accessible in physics, mathematics, machine-building and learning, and problem-solving (Bailenson et al., 2008).

VR holds other significance for students with post-traumatic stress, disabilities, and social anxiety issues which can learn with the tool (Standen & Brown, 2006). VR tools are available for language and public speech learning which enhances speech and help students with speech phobia (VirtualSpeech, 2016).

Scientists unravel the cost and time wasted using traditional methods of training healthcare professionals and suggest VR tools as a capital-intensive application that reduces durations. AR/VR may enhance a multifaceted physiological system of learning and fill-in the gap between theoretical

and practical learning methods, in turn, to provide realistic, complex and dynamic knowledge on how to handle CPRs and other emergency equipment for stabilizing patients with COVID-19 infection (Creutzfeldt, Hedman, & Felländer-Tsai, 2016).

Some VR technologies act as prevention and treatment tools for emergency cases, whereby paramedic trainees are subjected to learn and use AR/VR devices to save lives (Hoge et al., 2004).

Ferriter (2016) tested AR impacts on the textbooks integration approach in Malaysia. Chang and O'Sullivan (2005) reviewed AR mobile learning systems on natural science for fourth-grade students in Taiwan. Akçayır and Akçayır (2017) explored the use of AR interfaces to enhance laboratory science in Turkey, by augmenting 4D anatomy testing for undergraduate students. AR/VR seems quite significant in education and holds the future of education due to its hybrid learning environment, scientific experience, real-world phenomena, and visible chemical reactions.

AR can improve thinking skills, increase understating, and address practical learning difficulties. However, challenges such as complex UI (User-Interface) can affect students' ability to use the tool. Technical and design errors, navigation difficulties and multitasking, inflexibility, and fantasy might influence students' ability to learn.

Surgeons are primarily dependent on AR/VR to train and conduct visual techniques before operations. AR offers a 3D dimensional representation of patients' anatomy while improving outcomes and accuracies of post-operative procedures. Surgeons also depend on AR for vein visualization, specifically when injecting blood or taking blood samples of patients with an invisible vein. The vein augmented process, referred to as "AccuVein," helps physicians to take blood samples of infants and aged adults (Julier & Bishop, 2002). The South Korean Government used the "All-Science" VR portal to tackle the impact of COVID-19 on education. The portal has immersive VR video clips, comics, and quizzes. EDISON (Educational Research Integrated through Simulation Net), has a similar VR portal to provide an international classroom for science and technology students. Most educational broadcasting system (EBS) networks integrate video, text, and data; linked to YouTube and IPTV to provide real-time education globally.

### 4.3 Limitations and health risks of AR/VR

AR/VR can become addictive if users regularly depend on its stereotype HMD and the head tracker graphics can cause brain damage after a long time

of use. Researchers explained that constant use of AR/VR could lead to clusters of confusion because the user may find it difficult to distinguish between virtual events and real events. Another issue mentioned is the ultra-realistic experience that forces emotional instability, tense behavior, and an inability for some users with personality disorders to readjust to real-world experience. People who depend on AR/VR daily may experience social isolation. However, data privacy and identity impersonation are some rising issues of AR/VR in recent times (Slater et al., 2020).

Technical and language barriers are mentioned as limiting factors of using AR/VR in telemedicine. People in rural areas with a poor internet connection and audio quality may face struggles with the tool.

Buvik, Bugge, Knutsen, Småbrekke, and Wilsgaard (2016) recommend post-visits to hospitals if symptoms persist and if dissatisfied, patients can report to compliant cloud-based imaging applications. He also explained common conflicts surrounding the use of AR/VR, such as verging muscle movement conflict, accommodation balance issues, visual discomfort and double vision. However, it is important to control eye sensitivity with an eye-tracker and watch out for issues such as flicker calibration and adjustment issues.

## 5 Conclusion

Studies made numerous representations of computable near-eye displays with AR/VR applications that coordinate simulations, training, visualization, entertainment, games, robotic surgery, education, travel and architectural sightseeing. AR/VR was noted to have penetrated medical schools, especially the recent utilization of it in physiotherapy, psychotherapy, anxiety and stress treatment, and pain management. For the present COVID-19 situation, AR/VR aids X-ray visualization, Marketing campaign to create awareness of the spread and virtual simulation of COVID-19 data. Previously, it worked as a host technology in cloud engineering, conference streaming, near-eye visual acuity, haptic sensor VR camera authentication, and human-computer interface design. Despite the limitations experienced, its implementation enhances multilayered and micro-display of images in 2-3D dimensional formats. This paper discussed different disciplines where AR/VRs are found obtainable. It also discussed its uses in maintaining social distancing, monitoring/controlling COVID-19 virus, and other unique technologies similar to AR/VR that will help mitigate COVID-19 cases.

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