ARTIFICIAL INTELLIGENCE (AI) AND AUGMENTED REALITY (AR): DISAMBIGUATED IN THE TELEMEDICINE / TELEHEALTH SPHERE

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ABSTRACT

The world is navigating through unfamiliar and incomprehensible times – COVID-19, international economic crisis, and crumbling healthcare systems. The United States (US) healthcare industry is grappling with an increased workload and advancing digitization technological concerns. The failure of organizations to offer suitable cybersecurity controls within the critical infrastructure leads to advanced persistent threat (APT) that could have incapacitating effects on organizations. A keen understanding of cybersecurity is vital for leaders and the need is referenced in US policy that advances a national unity of effort to strengthen and maintain secure, functioning, and resilient critical infrastructure. Akin to the Presidential Policy Directive (PPD) 21 Critical Infrastructure Security and Resilience, leaders' goals should be to reduce vulnerabilities, identify and disrupt threats, minimize consequences and hasten response and recovery efforts related to critical infrastructure. To address the concern, it is necessary to review how AI and AR serve as co-technologies to support security of patient care and monitoring, examine impacts on individuals' and overall healthcare organizations, address how enhanced comprehension of AI and AR could guide medical professional leaders' decisions and boost the overall patient experience. Therefore, this literature review examines AI and AR connections to cybersecurity for the healthcare environment.

KEYWORDS:

Artificial intelligence, augmented reality, cybersecurity, continuous improvement, telemedicine/telehealth

1. Introduction

Technological digitization evolution persists to change the manner people work, live, and survive in future decades (Masood & Egger, 2020). AI and AR are often assumed to be alike (Pranav et al. 2020). These applications are considerably different

technical digitization improvements (Pranav, 2020; Prilla et al., 2019; Vijai & Wisetsri, 2021) used to support healthcare strategies to include remote, rural, and underserved populations (Bhattacharyya & Nair, 2019). On the other hand, organizations are struggling to prevent progressively complex

cybersecurity attacks (Hoffman, 2018; Muller, 2020; Olsen, 2020). The data shows that there are failures to provide suitable cybersecurity controls within the critical infrastructure sectors and these concerns leave the United States vulnerable to an attack that could have a devastating and incapacitating effect on security (Dawson et al., 2021). Information technology teams must determine a new method and new powerful tools to shield data and other high-value assets (Dawson et al., 2021; Olsen, 2020).

Ideally, AI could be used to resolve challenging concerns to include cybersecurity issues to address or resolve current and emerging cybersecurity issues (Hoffman, 2018; Olsen, 2020). The larger perspective of this article is to offer sound understanding of AI and AR and how these digitization technologies function and co-exist to live within security and process improvement approaches in healthcare. By incorporating vital data AI and AR into decisions and conclusions, leaders can incorporate these developing and budding technologies to surge operations plus enhance and expand healthcare in this strict economy, accompanied by stabilization, or minimally growing overall profit margins (Bhattacharyya & Nair, 2019). AI is alleged the future of cybersecurity, and incorporating AI can systematically stop cyber threats (Columbus, 2019). AR strategy is touted as a need by all organizations and that AR is expected to become the novel crossing point between humans and machines (Porter & Heppelmann, 2017). Next-generation AR devices will incorporate the use of senses – touching, hearing, and seeing (Albright, 2019; Dudkin, 2020).

Technology interdependence remains significant to the degree that diverse sections of organizations have to exchange data and materials with the purpose of accomplishing required activities. As given by the (American Medical Association [AMA], 2018), every state in the United

States permits physicians to ascertain a relationship with new patients via telemedicine; however, states' laws vary. The AMA specified, "a few states" have some stipulations and broad rule such as curbing the location wherein patients must be positioned with the intention of establishing the patient-physician relationship or the method applied to establish the relationships. Devices used for established relationships include telephones contrasted with two-way audio and video technologies (AMA, 2018). The AMA maintains a chart showing defined establishment of the patient-physician relationship through telemedicine and telehealth.

Telemedicine and Telehealth technologies are growing in usage to improve access to healthcare in remote, rural, and underserved locations, therefore extending specialty care to these types of regions (Brown-Jackson, 2017; Ponce et al., 2016; Taylor and Burton, 2018). For example, the 8-member research team of Ponce et al. (2016) offered how telemedicine is a model that digitally brings patients and providers together, permitting synchronous dealings athwart geographic locations. Due to the current COVID-19 pandemic, the telemedicine and telehealth technologies are increasing and are hastening in usage by healthcare professionals and patients (Tuckson et al., 2017). The COVID-19 pandemic continues to effectuate greater connectivity in the healthcare arena (Simon, 2019). AI rapidly compiles, sorts, and analyzes trillions of data bits and can find trends and patterns that an individual might miss, predict individuals' future habits, understand individuals' personalities, and the function on their behalf (Burton, 2019; Dawson & Szakonyi, 2021). Preliminary data from the Centers for Medicare and Medicaid Services (2020a), and Jercich (2020) suggested a "2,632 %" increase in telehealth services delivered March through June 2020 as compared to March through June 2019.

Telemedicine and telehealth technology offer a variety of benefits (Chivaroli & Associates Inc., 2021; Jacobson, 2020). The COVID-19 pandemic revealed the crossroads of cybersecurity and telehealth as a perfect storm for new views on cybersecurity leadership in healthcare (Lee et al., 2014). Over a few months, organizations had to quickly shift their IT budgets, schedules, and scopes, to leverage their existing technologies and get providers and patients acclimated to the new health delivery services and increase adoption in this short timeframe (Centers for Medicare and Medicaid Services, 2020a). While telehealth is an integral part of maintaining social distancing and providing patient care, it has also increased healthcare providers' digital footprint and attack surface, which we see with the increase of findings per telehealth domain, and in factors like endpoint security (Jacobson, 2020). The results of this literature review will offer insight for leaders to comprehend the difference between AI and AR, as well as the values both offer telemedicine and telehealth.

2. Literature review

This literature review about cybersecurity, specifically AI, and AR connections to telemedicine and telehealth will evaluate the literature, and synthesize the information from the literature into a summary. This researcher accomplished a manual search of the reference list of articles. The main coordinates of the methodology are ascertained from numerous databases. Academic fee-based databases, and the Internet are used to retrieve information. Academic fee-based databases utilized are ABI Inform Complete (ProQuest), MEDLINE, Academic Search Premier (EBSCO), Business Source Premier (EBSCO), ProQuest Dissertation Database, PubMed, Science Citation Index, Chronicle of Higher Education, Ebook Collection

(EBSCO), Education Research Complete (EBSCO), ERIC (EBSCO), and First Research. Association fee-based databases used include American Telemedicine Association (ATA). The Internet searches applied are Telehealth Resource Centers.org, Department of Health and Human Services (telehealth, rural health), Agency for HealthCare Research and Quality (AHRQ), Healthcare.gov, Google Scholar, and recent peer reviewed literature. Other literature data searches include the US National Library of Medicine, and the National Institutes of Health (NIH). Utilizing the noted databases and scheme supported this researcher's reassurance in the sources of data examined plus in the exactitude and authority of the information. The usage of the given subscription-based and scrutinized databases supported recognition that the examination and data underwent rigid, meticulous, scrupulous, and controlled evaluation systems, that define scholarly work (Saldaña, 2018).

Next the literature review will critically scrutinize the data collected by detecting gaps in current knowledge, and reviewing areas of controversy. Additionally, this literature review will offer the literature in an organized manner. Modern society is transforming from technology mingling physical, digital, and biological worlds, a fourth industrial revolution (Daemmrich, 2017) to the fifth industrial revolution embracing cybersecurity's augmented reality and artificial intelligence. In the midst of the transformation erupted a pandemic, COVID-19. On January 30, 2020, the World Health Organization (WHO) announced the COVID-19 outbreak to be a Public Health Emergency of International Concern (PHEIC; Ohannessian & Yaghobian, 2020). March 7, 2020, the data showed more than 100,000 confirmed cases of COVID-19 in 88 countries (Ohannessian & Yaghobian, 2020). Stay-at-home orders in 2020, across the United States, rapidly escalated

telehealth from a promising innovation to an essential priority (Zielinski & Marino, 2020). Healthcare has been overwhelmed by an influx of patients, limited resources, rationing, and other challenges due to the COVID-19 pandemic (Jacobson, 2020; Zielinski & Marino, 2020).

2.1. Interpreting AI for telemedicine/telehealth

Artificial intelligence is a capable resource that can be used by organizations to be more data-driven. According to the AMA Journal of Ethics (2019), improvements and developments in the power of computing, storage capacity, sensors, and large data sets, advancement in machine, and deep learning, along with multidisciplinary research have prepared the ground swell for amplified creation and usage of AI methods in medicine and healthcare. The transformations are due to progressions in technology such as 5G, artificial intelligence, edge computing, and robotics (Dawson & Szakonyi, 2021). The two key expanses connected with AI in medicine and healthcare comprise virtual components and physical AI, specifically medical devices and robots intended for delivering care (Londhe, 2018). As posited by (Keenan, 2020), AI can ascertain patterns in surgical procedures to expand best practices and to enhance a surgical robots' control accuracy to submillimeter precision. Technological advancements such as 5G and artificial intelligence will transform the augmented and virtual experiences in the future (Burton, 2019).

Five-G is allowing improved mobile broadband along with advanced capacity more uniform experience with steadily high data rates (Elham & Ammar, 2020), and lower latency which will improve the screen and equipment quality of AR and VR devices (Dawson et al., 2021). Some significant impacts of 5G across sectors could be

enabling virtually crafted workplaces and fully interactive and emulating in-office work environments (Sethi, 2021).

2.2. Critiques of Artificial Intelligence

The application of AI is not without critiques. Even with the wide-ranging application of AI, the knowledge regarding managing AI initiatives is limited (Lichtenthaler, 2020a).

AI can be challenging for organizations when this digitization technology cannot offer data as to how it reached a deduction (Keenan, 2021). Concern raised in Canada when reporters from the Ottawa Citizen detected they could acquire the court-protected name of a sexual assault victim by observing related searches on Google.²⁴ (Duffy, 2017; Keenan, 2021). According to Duffy, Google officials replied that they did not intentionally defy the courts publication ban; still, it was possible that the Google.²⁴ algorithms, united with the pattern of user queries, enabled visibility of the protected names.

According to Hoffman (2018), even though AI is permitting improved threat intelligence from users, this digitization technology could also help bad actors looking to do their jobs better and more efficiently, such as cause cyberattacks. For example, the Petya malware utilized AI to scan ports faster and detect vulnerabilities where their program attacks (Rothwell et al., 2017). Posited by Solon and Hern (2017), Peyta ransom ware attacked organizations in Europe and the United States, to include the Heritage Valley Health system that runs hospitals and care facilities in Pittsburgh, PA. A significant concern is that AI could be used to allow bad actors like RobbinHood and WannaCry the needed technology to avoid cyber defenses, tunnel into computer networks and wreak pandemonium (Warner, 2019).

2.3. *Interpreting Augmented Reality (AR) for telemedicine / telehealth*

Converse to AI, AR overlays a computer-generated content (impressions, sounds, and texts) on individual users' visions of the actuality (Joda et al., 2020). According to (Skorenkyy et al., 2021), the usage of augmented reality-enabled scenarios in cybersecurity teachings is proposed as a reply to new requirements for the rapid acceptance of new technologies and deep knowledge of cybersecurity issues by professionals. Skorenkyy et al., (2021) touts that this change is expected to enhance competence forming.

As given by Garon and Lalonde (2017), for vigorous AR applications to work, a real-time tracker is needed. This real-time tracker is more robust to occlusions (two or more objects too close together and appear to merge or combine together causing an image processing system with object tracking to frequently incorrectly track the obstructed objects), and which will not generate these situations not capable of being recovered or rectified (Garon & Lalonde, 2017). To register individual AR applications in respect to the real world they need a tracking technique to track the users' or devices' positions. Since cybersecurity is critical for their operation, networked objects that interrelate with the physical world (cyber-physical systems) are pertinent to inform ethical models for AR (Radziwill, 2019). The use of a tracking algorithm in AR application remains significant for the purpose to yield a high performance AR application (Tan et al., 2019). Pre-COVID-19, the bidirectional web cameras, considered telemedicine and telehealth devices, generally produce images and voice in two opposite directions, bidirectional flow (Logitech, 2021). More sophisticated web camera systems have extra features like camera control, telestration, and digital image processing (Photonics Marketplace, 2021). Advanced digital interaction techniques such as mobile

device platforms (e.g., physical examination and image review) are evolving (Freeman et al., 2017; Gartner, 2021). AR telehealth platforms are transforming the manner in which doctors and patients interrelate, providing healthcare physicians with exact information in real-time to ascertain the best manner to treat patients (Pennic, 2020). Also, per Pennic, the practicality of each system is influenced by the patient care circumstance being serviced.

AR technology offers an improved avenue for students to learn in an interactive environment (Gudoniene & Rutkauskiene, 2019). Technological virtual interactive presence permits surgeons and patients to join up in an augmented reality space, to aid verbal, visual, and manual communication (Ponce et al., 2017). The advent of augmented reality technology provides a training method for surgeons to practice surgical procedures that are considered quicker, dependable, and less costly (Gudoniene & Rutkauskiene, 2019). Significant for leaders to understand is that in a clinical study medical professionals introduce a mobile virtual interactive presence iOS application into routine post-operative orthopedic and neurosurgical care. The study's results revealed that the virtual interactive presence iOS application interaction delivered essential virtual follow-up in occurrences wherein person follow-up may be curbed (Ponce et al., 2017).

2.4. *Critiques of Augmented Reality*

The precipitous growth in ICTs and increasing demands to adopt technology in education are growing (Galati et al., 2019). Even with advantages discussed in past studies, critiques exist. According to Gudoniene and Rutkauskiene, (2019), the augmented reality data reveals concerns on whether augmented reality can and should change an educational process. Another concern is that AR has stumbling blocks to overcome, for example, too much information at one time, opposition from

teachers about the technology, and usability of the technology by students and teachers (Akçayır & Akçayır, 2017). Posited by Tuglar (2019), augmented reality's disadvantage includes usability and practicality, technical problems, lack of users' training, as well as the risk of isolation by users.

3. Artificial Intelligence and Augmented Reality concerns

The transitioning of AI and AR into clinically validated and applicably regulated systems to benefit the masses remains a challenge (Gudoniene & Rutkauskienė, 2019; Keenan, 2021). Clinical evaluation has to be vigorous and apply metrics that are instinctual and natural to diverse clinicians (Centers for Medicare & Medicaid Services, 2020b). Also, such evaluations should, in an ideal

world, be effective past measures of technical accuracy to add in quality of care and patient outcomes, is essential (Centers for Medicare & Medicaid Services, 2020b). Additional research and work is obligatory to ascertain and identify bias of algorithms and unfairness, and determine how to alleviate the concerns (Keenan, 2021). Before application, algorithms must be able to generalize or adapt to conditions outside of narrow sets of assumptions. Also, there has to be techniques for quality interpretability of machine learning predictions. If these goals can be achieved, the benefits for patients are likely to be transformational. In addition to benefit for patients, cybersecurity leaders can benefit from better comprehending AI and AR as it related to telemedicine and telehealth. Review Table no. 1 for an overview.

Table no. 1
AI and AR in telemedicine and telehealth Overviews

Categories	Artificial Intelligence	Augmented Reality
Likenesses	<ul style="list-style-type: none"> • Produce more engaging user experiences • Create enhanced learning 	<ul style="list-style-type: none"> • Produce more engaging user experiences • Create enhanced learning
Differences	<ul style="list-style-type: none"> • Utilizes algorithms and statistical models to accomplish tasks without explicit/obvious instructions • Joins machine and deep learning, which determine patterns and correlations 	<ul style="list-style-type: none"> • Combines real/physical and digital environments • Create immersive experiences • Computer-generated objects harmonize and interact with the real world
Examples of the Technology	<ul style="list-style-type: none"> • <i>AI Enabled tools</i> - Identify meaningful relationships in raw data drug development, patient treatment decisions, and patient care. • <i>Clinical Trials and Studies</i> Apply algorithms and statistical models to determine patterns and similarities to support researchers to establish vigorous patient cohorts • <i>Medical Records</i> – Apply algorithms and statistical models to offer applicable patient histories • <i>Clinical Decision Support</i> – Discover and monitor diabetes neuropathy, nephropathy and wounds, and other comorbidities 	<ul style="list-style-type: none"> • <i>Smart Glasses</i> - Wearable computer-capable glasses that insert additional information, idyllically 3D images and data for instance animations and videos, to users' real-life scenes by superimposing the computer-generated/digital information on users' real-life • <i>Vein Detection Devices</i> – AR technology – handheld scanner used to determine the exact location of veins in patients' bodies • <i>Virtual Sneakers</i> – Allow users to see themselves in medical footwear before the actual purchase • <i>On-the-Job Training</i> – Wearables are utilized to offer staff members richer and more cost-effective learning options

4. Conclusion

The data shows that some organizations continue to ignore AI, others are engaging in strategic AI programs; however, the management of these AI programs, many times are systems to

observe the inputs and outputs, but not the internal workings (Garbuio & Lin, 2019). Also, other than initial insight, knowledge about directing AI application remains deficient (Lichtenthaler, 2020b; Shrestha, Ben-Menahem, & Krogh, 2019). Because

AI has five maturity levels – activating, arranging, accomplishing, advancing, and amalgamating, these diverse levels give insight into organizations’ challenges in managing AI programs and in profiting from such initiatives by fortifying their individual competitive positions (Overgoor et al., 2019). Even though the capability exists to identify the limitations of organization, a number of these organizations are considered to effectively manage AI (Metcalf et al., 2019). Such organizations are often in the contradictory situation of believing they leverage AI, alternatively comprehensive analyses uncovered too many dormant opportunities that could be actualized with a combined intelligence architecture (Wilbert, et al., 2018).

Augmented reality and AI continue to deliver virtual information. Also, AR and AI technologies are being researched to support the U.S. military to be able to perceive environments in real-time (Keller, 2021). The results of the research, per

Keller, is for specialists’ roles such as mechanics, and medics, through AR and AI, to be able to accomplish tasks inside and beyond their skillsets, offer just-in-time feedback, and provide directives and teachings for physical tasks. Akin to telemedicine and telehealth, AI and AR are disruptive technologies (Ullah, 2018). Also, two leading drivers for change continue to emerge – high volume demand, and high criticality applications, both requiring specialized skillsets at precise moments of clinical demand (Ullah, 2018). Focusing on telemedicine and telehealth, Information and Communication Technology (ICT) tools can be utilized to tackle concerns such as misdistribution of the demand versus supply of healthcare services (Madhavaram, 2017). Artificial intelligence could assist the supply of healthcare services and appropriation concerns through the development of algorithms to match the availability of required healthcare providers to the need for such skillsets in the remote, rural, and underserved populations.

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