# Role of Augmented Reality with Edge Computing and 5G Network to Help CORONA Warriors during COVID-19

Vivekananda Journal of Research
July - December 2021, Vol. 11, Issue 2, 204-219
ISSN 2319-8702(Print)
ISSN 2456-7574(Online)
Peer Reviewed Refereed Journal
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http://www.vips.edu/vjr.php

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**Abstract**

*Augmented Reality (AR) with edge computing plays a vital role in this COVID-19 pandemic time and feasibly will provide a significant solution related to this disaster. From the epidemic of this pandemic, new emerging technologies with 5G networks and with data analytics tools are used. Augmented Reality (AR) commences vast opportunities in diverse industries in terms of time and accuracy. Still, current devices required high graphical and computational performance due to the speed of the network, and it becomes an obstacle for the comprehensive deployment of AR. Hence an Edge Computing with 5G network explores in this paper. This paper also explores the prospect of accosting the ongoing COVID-19 epidemic by proposing these advanced technology' usage against the war in the health domain.*

**Keywords:** *COVID-19, Coronavirus, Augmented Reality (AR), Edge Computing, 5G Network*

## INTRODUCTION

The COVID-19 virus was initiated from Wuhan, China, and spread speedily across the world (R. Singh & Adhikari, 2020). The World Health Organization (WHO) declared this

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disease as a pandemic in the world where coronavirus is present (Montemurro, 2020). All the countries of the world are affected by COVID-19 and its impact is also visible in the health domain. Due to this pandemic, the condition of hospitals has become more terrible and has also taken a massive toll on all the frontline workers. In the existing conditions, patients and doctors are canceling or postponing normal surgeries because doctors and health workers are working 24 hours without any rest to treat COVID-19 patients. There is a requirement to introduce several advanced technologies to tackle this pandemic time. With the support of the 5G network, VR and AR would play a far-reaching role in this domain. VR provides a broad edge to defend the present pandemic of COVID-19 by enhancing the skills, confidence, performance, and overall attitude of healthcare-related persons. This technology also helps to improve ongoing learning and strategies to handle cases. It acts as the complementary health edify tool which helps to enhance the execution of medical activities(R. P. Singh et al., 2020). In the digital era, "the Matrix" develops into non-fictitious because developers are trying to improve AR by creating the line between real and virtual life. AR will be implemented in all sectors of human being's life. Augmented reality with cloud computing works for a revolution in advanced IT to help a human being in different areas to satisfy the requirements in lesser time.

To enhance automation, AR technology makes available wireless connectivity. During surgical actions in ultrasound and optical imaging, the usage of non-ionizing real-time images requires a new visualization and display technology that allows the physicians to understand the data. At that time AR has introduced new technology in the medical field to increase visualization (Sielhorst et al., 2008). AR and Mixed Reality-based applications act as the complement tool over the traditional method in the medical sector and also accomplish the transformation in healthcare education(Gerup et al., 2020)mixed reality (MR.

AR is an emerging technology in the medical field that can help patients, health care professionals, and medical practitioners. MeSH (Medical Subject Headings) shows that Computer-Assisted Surgery. AR technology is easily integrated with already used technologies(Eckert et al., 2019).

## LITERATURE REVIEW

In the health care system, many technologies played a very important and significant role. This literature review gives a summary of the number of technologies that are used in the medical domain.

**Table 1: Literature Review**

| S.No | Reference | Year | Study |
|---|---|---|---|
| 1 | (Sipior, 2020) | 2020 | Recommend the use of AI technologies in the offices and organizations to maintain the social distancing, contact tracing, and diagnoses during the COVID-19. |
| 2. | (Vaishya et al., 2020) | 2020 | Industry 4.0 would be medicine 4.0 proposed in this paper by explaining various smart technology. |
| 3. | (Greco et al., 2020) | 2020 | IoT technology in healthcare is used to collect visual data by wearable sensors and transmit it towards a smart system which helps to make decisions. AI and ML techniques play a significant role to analyse the data but the implementation of these technologies requires the capacity to handle a huge amount of data provided by cloud services. |
| 4. | (Rahman et al., 2020) | 2020 | Proposed the new smart systems with IoT technology which would be helpful to control the spread of COVID-19. |
| 5. | (Favale et al., 2020) | 2020 | COVID-19 forced them to modify the way habits and also pushed them to use virtual services like online learning, smart working with work from home through a digital platform. |
| 6. | (Park et al., 2020) | 2020 | Discussing the social and ethical implications of Artificial Technology and recommended focusing on privacy security and confidentiality etc. |
| 7. | (Ghosal et al., 2020) | 2020 | Linear Regression Analysis methodology is used to forecast the number of deaths in India due to COVID-19 until 6 weeks. |
| 8. | (Javaid et al., 2020) | 2020 | According to this study in the COVID-19 pandemic, Industry 4.0 would be helpful and can fight against this pandemic using different kinds of sensors. |
| 9. | (Iyengar et al., 2020) | 2020 | Smartphones are widely used worldwide but recently its usage has increased with the number of applications during the COVID-19 pandemic. With the usage of smartphones, face-to-face contact for communication can be avoided and help to retain the social distancing between people and thus avoid virus transmission. |

| | | | |
|---|---|---|---|
| 10. | (Swayamsiddha & Mohanty, 2020) | 2020 | CognitiveInternet of Medical Things (CIoMT) is proposed with the novel application of cognitive radio (CR) and the Internet of Things (IoT) to handle the challenges during the pandemic of COVID-19. With this, the workload of the health workers is minimized by real-time tracking of patients and monitoring the health status remotely. This technology helps to prevent and control the infection of this virus. |
| 11. | (Qiu et al., 2020) | 2020 | The role of big data played a very important role in recognizing the characteristics of new infectious diseases COVID-19. Big data technology uses the Baidu Search Engine to represent real-time statistics. |
| 12. | (Ke et al., 2020) | 2020 | AI technology is used to identify the marketed drugs which are useful in the treatment of COVID-19 and also identified old drugs with activities against the proliferation of feline infectious peritonitis (FIP) virus in Fcwf-4 cells. |
| 13. | (Imran et al., 2020) | 2020 | Develop an AI4COVID-19 named smartphone app as a diagnosis tool for coronavirus by using cough sound through an app. The 3 second sound of cough is recorded and sent to the AI engine on the cloud and after analysis, it provides the result within 2 minutes. |
| 14. | (Bai et al., 2020) | 2020 | Introduce nCapp assisted COVID-19 diagnosis and treatment system based on IoT. It implements real-time online communication with the cloud. By using the previous record of patients and questionnaires filled by them is used to identify the patient is confirmed, suspected, or suspicious of COVID-19. |
| 15. | (Shaw et al., 2020) | 2020 | Promotes the use of innovative technologies like AI, Big Data, 5G Network with other emerging technologies like drones, automated vehicles, and robotics to identify affected people in different countries. |
| 16. | (Haleem et al., 2020) | | Economics, as well as the life of human beings of the world, are affected due to COVID-19. There are various areas of research needed regarding COVID-19. The main area of research is to develop the various antibodies which provide immunity for COVID-19. |

AR has been expected disruptive technology. This technology potentially uses education and training to medical students, surgical planning, and guides to doctors and

health workers in the health care system (Chen et al., 2017). Till now mostly AR is used in rehabilitation & recovery, laparoscopic surgery, and phobia treatment, along with other medical training. Every study conducted in AR showed healthcare benefits. Few of them are based on the prototype. The digitalization of the system has bought the healthcare system into a new era(Kamphuis et al., 2014)costs, or didactics, alternative ways are needed to achieve clinical excellence. Educational technology and more specifically augmented reality (AR.

In recent years, AR is quickly evolved with the latest features and they are very effective and successfully implemented in wide areas. In healthcare education, ongoing integration of experience, responsibility, skills, and knowledge responsibility with the process of teaching, learning, and training qualifies an individual to practice medicine(Wojtczak, 2002). As the era changes, healthcare workers have quick to adapt to new technologies (Smith & Foley, 2016). In current times mostly studies are dependent on display technologies. From 2014, onward maximum surgical studies used display technology. With the display technology, many physicians have taken up actions and surgical treatment inventiveness by the operation as the use of hands to give the desired movement in part of the body. Application-based on AR is typically created for highly trained medical practitioners. They are nature specialists and have good knowledge of advanced technologies because AR provides an instinctive interface to medical equipment as the implementation of virtual information in the real world.

Along with AR, many other technologies are performing well. Dozee is a contactless tracker of health that monitors and analyzes the user health data and app to give users daily, weekly, and monthly health patterns. It is a convenient device that provides continuous respiration data of users exclusive of wires or technical expertise. The thin sensor sheet is attached with it which is set below the mattress and basically underneath the user's chest area. Dozee gives 98% accurate data. By this device, the health status of the quarantined user at home is recorded. Several devices are introduced in the health domain to minimize the burden of healthcare workers. Asimov Robotics named robots is used in Kochi of Kerala to distribute sanitizers, masks, and medicine to the employees. Karmi-bots named robots are employed in the isolation ward of COVID-19 patients to provide food. Another example, quarantine monitoring services have tied up the state police with the offer given by Chennai-based Pixxon AI Solutions. Police provide the link to the quarantined person for COVID-19 and the person installed this app on their mobile phones. This app helps police to track the patients and send the patient location to the command center after every minute (Samreen, 2020).

In the medical field, sophisticated equipment is being pulled from time to time to meet

the present desires. For example, Sequoia-backed healthcare startup Qureai has significantly modified the AI solutions developed to assist to identify the diseases like tuberculosis from X-rays. Like all above-mentioned achievements in the COVID-19 pandemic period, this paper recommended to use AR for the same with Edge computing and 5G Network (Jessica Kim Cohen, 2019) so that is present as well as in future if such kind of pandemic will occur, our medical system would we able to fight with such situation in a better and strong way which will be helpful for corona warriors against such kind of war.

AR technology is different from VR technology as VR create a 3D world and AR is unique in two ways:

1. It provides the touch of reality to the user
2. It attracts the eyes as quickly as possible.

With these extraordinary features, AR becomes the future of medicine.

**Table 2: History of AR**

| YEAR | Description |
|---|---|
| **1960s** | A first head-mounted display- primitive computer graphics. |
| **1970s** | Videoplace– an artificial reality laboratory where users in a separate room in the lab were able to cooperate with this technology by using the projectors, video onscreen silhouettes. |
| **1980s** | First portable computer- EyeTap and a heads-up display (HUD) |
| **1990s** | Origin of the "augmented reality" term.- "Virtual Fixtures" and Navigation Software. |
| **2000** | an open-source SDK-ARToolKit, Trimble Navigation, and Wikitude |
| **In the current scenario -Augmented Reality** | Google beta-tested Google Glass(2013).<br>Windows Holographic and HoloLens (AR goggles with lots of sensors to display HD holograms)(2015).<br>The Pokemon Go game for mobile devices(2016).<br>Dignity Health(It uses Augmedix software and Glass to streamline the interaction between physicians and patients)(2020). |

**Use of AR in healthcare and it will be revolutionary in the upcoming year**(Futurist, 2019)**:**

**Table 3: Existing AR-based application**

| S. No | Name | Usage |
|---|---|---|
| 1 | Locating Nearby Automated External Defibrillators (AEDs) | Automatically detect serious cardiac conditions |
| 2 | Accuvein | Verify veins avoiding puncturing incorrectly |
| 3 | SmARtsKin | During radiotherapy, find out the patient position and monitoring |
| 4 | MindMotion Pro | Provide a 3D virtual environment to simulate the movement of the hand on a display |
| 5 | EyeDecide | Simulate in what way certain conditions affect the vision of the eyes. |
| 6 | Oxsight | It helps the patient in partial vision loss |
| 7 | Google Glass(The Philips IntelliVue) | It helps doctors during a surgical procedure to monitor patients' vital signs, without taking their eyes off of the patient. |
| 8 | Hololens | Help in medical education and study of anatomy |

All the above are AR-based powered devices that aid patients and assist doctors and health workers in alignment and disorder in the same field. AR is an emerging technology set to dominate the healthcare empire by given its dynamic and valuable usage.

In the war of COVID-19, such smart technologies are very helpful. Phlebotomy is a process in which a needle is used to take blood from a vein usually from the arm. It is also called a blood draw or venipuncture. After extract, the bold sample is dispatched to the science laboratory for testing and an important tool for diagnosis of the medical condition of the patient. Sometimes, health workers face difficulties in spotting veins. At that time AR technology play a vital role with the help of the Accuvein device. This device uses projection-based AR. It is a portable, handheld device, health workers can easily view a virtual real-time image of the underlying vasculature on the surface of the skin. This device contains a laser-based scanner, a processing system, and a digital laser projection. The usage of this technology in this COVID-19 pandemic time is very useful for health workers.

**According to the WHO**(WHO, 2020)**:**

Medical devices used on a priority basis and help in diagnosis and treatment of COVID-19 mentioned here

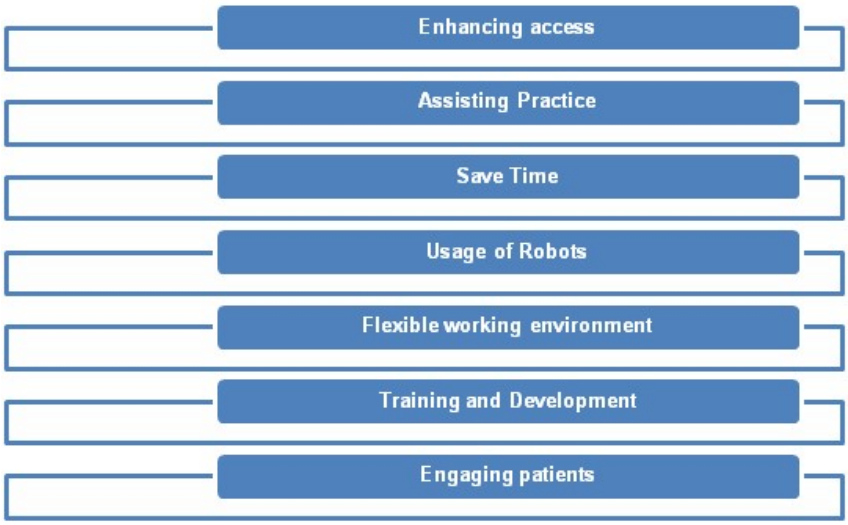
1. Personal protective equipment
2. In-vitro diagnostics
3. Medical equipment and consumables to manage the patient
4. For innovative technologies for COVID
5. Global collaboration for medical devices for COVID

**Significant benefits of Augmented Reality for COVID- 19** (CGS, 2020)

The application of AR technology is a new opportunity in the healthcare sector. Innovations in AR enhance the ability of doctors and health workers to diagnose, treat, and also perform surgery on patients with more accuracy by providing g real-time data and patient information to them. These Technologies provide a better digital solution for the daily task easily and safely during this pandemic period. AR has many significant benefits like:

**Enhancing access:** In traditionally, physical presence is necessary for both patient and doctor for consultation, and face-to-face communication needs. The Telemedicine concept of AR helps to access information over the phone, internet, and smart devices also. With AR tools, patients can get a consultation with specialized surgeons over different geographical locations in real-time.

**Figure 1: Significant benefits of Augmented Reality for COVID- 19**




1. **Training and Development:** The skilled medical staff acts as an asset for the healthcare industry. AR acts as a learning tool and helps the health workers get

immersive educational experience and also easily grasp complex concepts.

2. **Assisting Practice:** In the medical domain, AR technology is playing an essential role in fulfilling the daily needs of tasks by implementing the diagnosis process to assist training accurately and efficiently. For this purpose number of AR, applications are available for example, project anatomical cross-sections onto a patient, 3D visualization of internal organs of the human body which help the surgeon to get the real view of the body and then plan accordingly to them.

3. **Engaging patients:** With the usage of AR tools, the involvement of patients is increased. These tools enable the patients to believe an increasingly proactive role in the supervision of their health and welfare. And also enhance the perspective power of humans.

4. **Save Time:** with the usage of AR in the medical field, all the information of patients, doctors, and health workers is stored on the server means in one place. At that time access to data can become easy and fast. So it saves the time of doctors, surgeons, and trainers on searching.

5. **Usage of Robots:** Robots play an imperative role in this COVID-19 pandemic time. They are used to provide sanitizer, foods, and medicines to coronavirus patients in isolation word. By this usage, physical contact with coronavirus patients is reduced.

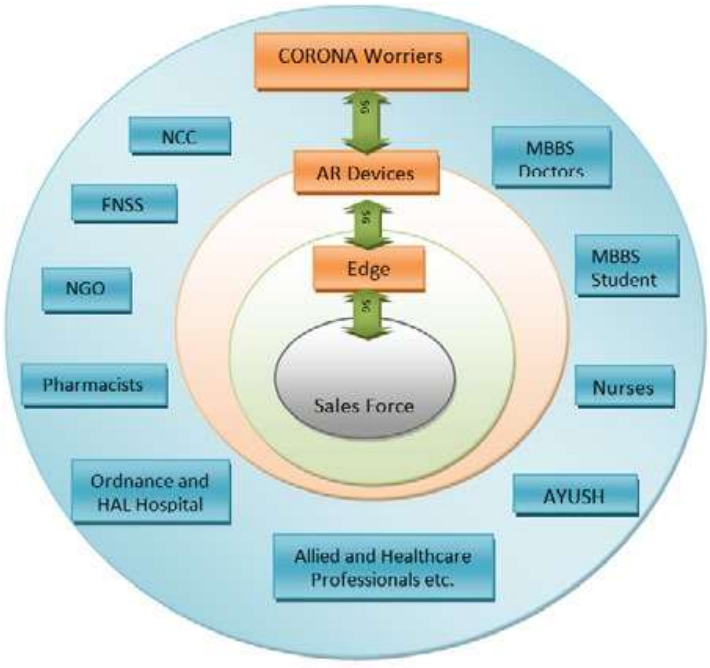
6. **Flexible working environment:** AR promotes a flexible working environment for the user. With the help of these digital technologies, the user can perform their daily life work during the lockdown. Patients not needed to go to hospitals for consultation. With AR technology, doctors, health workers, and patients easily communicate in the virtual environment without any movement.

**Role of Edge computing and 5G Network in COVID-19**(Satyanarayanan, 2017)(Kumavat & Kumar, 2019)**they have decided to concern the latest technology in particular areas to increases the Quality of their life. One of the important section of research that has seen an agreement of the latest technology is the healthcare. the people who need healthcare services they have to suffer for long process, to reduce the problem As a result, basically this complete technology would try to resole the healthcare issues. The main goal of the project is to develop a remote healthcare system. It have three main parts. The first and most important section in this process is to detecting the patient current health status**

**using this sensors. second important thing is sending data to cloud storage and the last section is to get the detected data for remote viewing. Remote viewing of the data provided to the doctor will able to monitor a patients health progress aboard from hospital places. The Edge-Cognitive-Computing-based (ECC-based**

COVID-19 is a pandemic disease and it would be rectified with the usage of advanced digital technologies which help to make available proper preventive and also help to control this situation. By the use of AR technology, an anomaly in the patients is easily identified. The main technology which is easily adopted at this time is a remote health monitoring system. In this system, many sensors are present which are used to intellect physiological data and also give useful information to doctors as well as to patients. Advanced digital technologies are implemented for better exposure and innovative resolution in this pandemic time and COVID-19 patients. Edge computing plays a very important role here because all data stored and used by various devices in AR would be stored in Cloud hence refined data should be deployed on the cloud as well as accessed from the cloud.

**Figure 2: Role of Edge computing and 5G Network in COVID-19**




A combination of 5G with edge computing creates tremendous opportunities in various industries like healthcare, education, automobile, service sector, etc. This combination helps industries to develop their positions by providing new offers and online services to get connected with their consumers. The role of edge computing is to provide stored resources

through distributed computing to the location where data is needed and generated also support specific application use cases for targeting new business opportunities. It enhanced better data control, minimize the cost, faster insights, and action when required.

AR would engage in recreation during this COVID-19 period and the rate of innovation going forward with the application system. Several players are involved in designing end solutions and Communication Service Providers must carefully consider which industries can expand their offerings beyond connectivity. Distance education, online meeting with doctors, learning from remote areas in COVID 19 epidemic are enhanced with these technologies.

Edge computing could soon enable the healthcare sector to reach remote areas of the country. The main function of this technology which is appreciable is to execute many key functions without interference or connection with remote data centers. The processing feature at the local area of this technology receives data from more healthcare-related IoT devices and after processing, information is delivered to the needed place or receiver. Recommended technologies would help corona warriors in finding a solution for this pandemic disease. With the usage of this technology, information is share for guidance and also documentation based on requirements during the lockdown period when movement is a ban. As AR is an emerging trend but still it has some limitation such as:

1. The visual device is needed for presenting the binary data into meaningful graphics and scaling.
2. The major drawback of AR is less privacy.
3. The cost of implementation and maintenance of AR technology is very expensive.
4. Limited processing power with small storage.

All data captured by AR devices are sent to the cloud and because if edge computing is used here such limitations will be rectified. Many times connectivity issues come which will affect the movement of data from capturing to the storage process.

The workload of doctors, nurses, health workers, and hospital management can be reduced by using cloud technology. This help to supervise the activities of coronavirus affected patient and also provide this information to medical team with a better solution. AR technology helps to understand the functioning of COVID-19 and also helps to tackle this pandemic time in a better way.

After the study has analyzed and suggested that AR-based applications can be put into practice in various industries which help to handle this epidemic period of COVID-19. The combination of Edge computing and 5G network would be very supportive of the COVID-19 warriors like doctors, nurses, health workers, and hospital management.

## CHALLENGES OF TECHNOLOGIES PROPOSED HERE FOR USE AGAINST COVID-19

- Sustainability of AR-based model for a long time, because although there are broad adoption and huge acceptance but still not doing well business-wise.
- There are no application design standards. Standards are defined in terms of a universal language for software development.
- Security and privacy issues.
- A lack of expertise in this field
- Investment cost and maintenance are high in these technologies

Besides all aforementioned challenges, there is nothing to worry about these advanced technologies. They have proven their capabilities of expanding user experiences and make them more convenient. The solutions to these challenges are dependent on time, and these technologies will certainly find their footing and establish themselves on their terms very soon.

## FUTURE SCOPE

In the future, AR technology with edge computing and 5G network will be used to accumulate sensitive data of patents and other users which can be utilized in the future for a similar kind or another pandemic time like COVID-19. Hospital staff that works on the front line at this pandemic time can adopt this revolution and implement it in their daily work. With the usage of cloud computing, all medical tools, devices, and treatment processes are centralized. In upcoming years, the health sector will become smarter by adopting digital technology. With this transformation, the effect of the COVID-19 virus can be minimized and the spread of the virus can be controlled.

## CONCLUSION

AR with edge computing using the 5G network becomes a powerful and instinctive solution for all industries, including manufacturing, Healthcare, Education, Weather forecasting, etc ., which consists of different digital information revolutionary technologies to collect, transfer, store, examine and properly monitor information systems. Though AR applications are costly and need suitable training and guidance as comparative other technologies, cloud computing helps in reducing such costs to some extent. Digital technologies are provided innovative methods for the COVID-19 infected patients, remotely treatment process and care, and also help in the manufacture of COVID-19 drug. With the help of applications based on these technologies, people are allowed to work at home with the well sound lines "work from home" by using the application designed by advanced technologies. As by facing the current pandemic situation, people are opting for a new office culture based on virtualization like virtual meetings, etc. with extensive written communications. These smart technologies have the capabilities for remote operations and integrate digital information into the real-world environment of users. Augmented Reality helps to treat patients very effectively. This paper proposed that use of these smart technologies, helpful for the COVID-19 upsurge.

## REFERENCES

Bai, L., Yang, D., Wang, X., Tong, L., Zhu, X., Zhong, N., Bai, C., Powell, C. A., Chen, R., Zhou, J., Song, Y., Zhou, X., Zhu, H., Han, B., Li, Q., Shi, G., Li, S., Wang, C., Qiu, Z., … Tan, F. (2020). Chinese experts' consensus on the Internet of Things-aided diagnosis and treatment of coronavirus disease 2019 (COVID-19). *Clinical EHealth*, *3*, 7–15. https://doi.org/10.1016/j.ceh.2020.03.001

CGS. (2020). *Adapting to COVID-19 with Augmented Reality Solutions | CGS*. Article.

Chen, L., Day, T. W., Tang, W., & John, N. W. (2017). Recent developments and future challenges in medical mixed reality. *Proceedings of the 2017 IEEE International Symposium on Mixed and Augmented Reality, ISMAR 2017*, 123–135. https://doi.org/10.1109/ISMAR.2017.29

Eckert, M., Volmerg, J. S., & Friedrich, C. M. (2019). Augmented reality in medicine: Systematic and bibliographic review. *Journal of Medical Internet Research*, *21*(4), 1–17. https://doi.org/10.2196/10967

Favale, T., Soro, F., Trevisan, M., Drago, I., & Mellia, M. (2020). Campus traffic and e-Learning during COVID-19 pandemic. *Computer Networks*, *176*(May). https://doi.org/10.1016/j.comnet.2020.107290

Futurist. (2019, November). *Augmented Reality In Healthcare Will Be Revolutionary: 9 Examples - The Medical Futurist*.

Gerup, J., Soerensen, C. B., & Dieckmann, P. (2020). Augmented reality and mixed reality for healthcare education beyond surgery: an integrative review. *International Journal of Medical Education*, *11*, 1–18. https://doi.org/10.5116/ijme.5e01.eb1a

Ghosal, S., Sengupta, S., Majumder, M., & Sinha, B. (2020). Prediction of the number of deaths in India due to SARS-CoV-2 at 5–6 weeks. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, *14*(4), 311–315. https://doi.org/10.1016/j.dsx.2020.03.017

Greco, L., Percannella, G., Ritrovato, P., Tortorella, F., & Vento, M. (2020). Trends in IoT based solutions for health care: Moving AI to the edge. *Pattern Recognition Letters*, *135*, 346–353. https://doi.org/10.1016/j.patrec.2020.05.016

Haleem, A., Javaid, M., Vaishya, R., & Deshmukh, S. G. (2020). Areas of academic research with the impact of COVID-19. *American Journal of Emergency Medicine*. https://doi.org/10.1016/j.ajem.2020.04.022

Imran, A., Posokhova, I., Qureshi, H. N., Masood, U., Riaz, S., Ali, K., John, C. N., Hussain, I., & Nabeel, M. (2020). AI4COVID-19: AI enabled preliminary diagnosis for COVID-19 from cough samples via an app. *Informatics in Medicine Unlocked*, 100378. https://doi.org/10.1016/j.imu.2020.100378

Iyengar, K., Upadhyaya, G. K., Vaishya, R., & Jain, V. (2020). COVID-19 and applications of smartphone technology in the current pandemic. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, *14*(5), 733–737. https://doi.org/10.1016/j.dsx.2020.05.033

Javaid, M., Haleem, A., Vaishya, R., Bahl, S., Suman, R., & Vaish, A. (2020). Industry 4.0 technologies and their applications in fighting COVID-19 pandemic. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, *14*(4), 419–422. https://doi.org/10.1016/j.dsx.2020.04.032

Jessica Kim Cohen. (2019, May). *Why 5G matters for healthcare*.

Kamphuis, C., Barsom, E., Schijven, M., & Christoph, N. (2014). Augmented reality

in medical education? *Perspectives on Medical Education*, *3*(4), 300–311. https://doi.org/10.1007/s40037-013-0107-7

Ke, Y. Y., Peng, T. T., Yeh, T. K., Huang, W. Z., Chang, S. E., Wu, S. H., Hung, H. C., Hsu, T. A., Lee, S. J., Song, J. S., Lin, W. H., Chiang, T. J., Lin, J. H., Sytwu, H. K., & Chen, C. T. (2020). Artificial intelligence approach fighting COVID-19 with repurposing drugs. *Biomedical Journal*, *xxxx*, 1–8. https://doi.org/10.1016/j.bj.2020.05.001

Kumavat, G. D., & Kumar, S. (2019). Health monitoring using edge cognitive computing based smart health care. *International Journal of Innovative Technology and Exploring Engineering*, *9*(1), 5356–5361. https://doi.org/10.35940/ijitee.L2719.119119

Montemurro, N. (2020). The emotional impact of COVID-19: From medical staff to common people. *Brain, Behavior, and Immunity*, *1591*(March), 1–2. https://doi.org/10.1016/j.bbi.2020.03.032

Park, Y., Casey, D., Joshi, I., Zhu, J., & Cheng, F. (2020). Emergence of New Disease: How Can Artificial Intelligence Help? *Trends in Molecular Medicine*, *26*(7), 627–629. https://doi.org/10.1016/j.molmed.2020.04.007

Qiu, H.-J., Yuan, L.-X., Wu, Q.-W., Zhou, Y.-Q., Zheng, R., Huang, X.-K., & Yang, Q.-T. (2020). Using the internet search data to investigate symptom characteristics of COVID-19: A big data study. *World Journal of Otorhinolaryngology - Head and Neck Surgery*, *xxxx*, 1–9. https://doi.org/10.1016/j.wjorl.2020.05.003

Rahman, M. S., Peeri, N. C., Shrestha, N., Zaki, R., Haque, U., & Hamid, S. H. A. (2020). Defending against the Novel Coronavirus (COVID-19) outbreak: How can the Internet of Things (IoT) help to save the world? *Health Policy and Technology*, *9*(2), 136–138. https://doi.org/10.1016/j.hlpt.2020.04.005

Samreen, A. (2020). *New-age warriors against coronavirus: Robots, drones, chatbots, apps | Business Standard News*. Article.

Satyanarayanan, M. (2017). Edge Computing. *Computer*, *50*(10), 36–38. https://doi.org/10.1109/MC.2017.3641639

Shaw, R., Kim, Y., & Hua, J. (2020). Governance, technology and citizen behavior in pandemic: Lessons from COVID-19 in East Asia. *Progress in Disaster Science*, *6*, 100090. https://doi.org/10.1016/j.pdisas.2020.100090

Sielhorst, T., Feuerstein, M., & Navab, N. (2008). Advanced medical displays: A literature review of augmented reality. *IEEE/OSA Journal of Display Technology*, *4*(4), 451–467. https://doi.org/10.1109/JDT.2008.2001575

Singh, R., & Adhikari, R. (2020). *Age-structured impact of social distancing on the COVID-19 epidemic in India*. 1–9.

Singh, R. P., Javaid, M., Kataria, R., Tyagi, M., Haleem, A., & Suman, R. (2020). Significant applications of virtual reality for COVID-19 pandemic. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, *14*(4), 661–664. https://doi.org/10.1016/j.dsx.2020.05.011

Sipior, J. C. (2020). Considerations for development and use of AI in response to COVID-19. *International Journal of Information Management*, *June*, 102170. https://doi.org/10.1016/j.ijinfomgt.2020.102170

Smith, M. L., & Foley, M. R. (2016). Transforming clinical education in obstetrics and gynecology. *Obstetrics and Gynecology*, *127*(4), 763–767. https://doi.org/10.1097/AOG.0000000000001356

Swayamsiddha, S., & Mohanty, C. (2020). Application of cognitive Internet of Medical Things for COVID-19 pandemic. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, *14*(5), 911–915. https://doi.org/10.1016/j.dsx.2020.06.014

Vaishya, R., Haleem, A., Vaish, A., & Javaid, M. (2020). Emerging Technologies to Combat the COVID-19 Pandemic. *Journal of Clinical and Experimental Hepatology*, *xxx*(xxx), 2–4. https://doi.org/10.1016/j.jceh.2020.04.019

WHO. (2020). *WHO | Priority medical devices for COVID prevention, diagnostic and management*. Article.

Wojtczak, A. (2002). Glossary of medical education terms: Part 4. *Medical Teacher*, *24*(5), 567–568. https://doi.org/10.1080/0142159021000012667