Artificial Intelligence and Coronavirus
COVID-19: Applications, Impact and Future Implications

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Abstract. Artificial Intelligence (AI) acts as the potentially powerful tool in fighting against the spread of COVID-19. Since the outbreak of the pandemic, the use of AI in the healthcare sector has been largely evident. This chapter provides a detailed analysis regarding the use of AI technology in the healthcare sector and identifies its contributions in the fighting against the deadly pandemic, i.e. COVID-19. Discussion regarding the challenges in the AI technology is further provided. Following the analysis, it has been revealed that AI is effective and contributes under six areas; including the production of early warnings and alerts, tracking and prediction, data bash boards, diagnosis and prognosis, information related to treatment and cures resulting in controlling the widespread of the disease. In broader terms, AI is effective and can be used to identify and analyze patterns in complex and large data sets in a more precise time and high speed which was never done before. It is further useful in providing a thorough search related to the literary studies conducted previously regarding the development of different drugs. Furthermore, manufacturing of drugs is held through robots designed by the infusion of the AI technology for fast and quick delivery of services. Contributions of AI when used in the healthcare industry is further important to search out patients that are suitable for the clinical studies. AI due to its fast-tracking systems is further effective in reducing the workload of radiologists, since it is capable of reading the radiological reports through deep learning and machine learning systems. These scans can be stored for some time and are available when required in order to train the AI systems. AI through its fast-tracking quality, allows cost and time effective functions by quickly analyzing a number of scans resulting in providing better treatment to patients.

In the healthcare sector, AI has shown promising results by detecting conditions such as; pneumonia, skin cancer, eye diseases etc. Also, most hospitals used AI technologies to analyze echocardiography scans, ultra sound system, neurological conditions, speech patterns or to predict the psychotic episodes. Many surgical robotics are being designed to assist clinical experts in surgical processes. In the prevailing diseases like pandemic, AI technology-based robots are used by various countries for medication and routine checkup purposes in order to reduce the chances of doctors being affected by the disease contact. However, in the existing crisis the role of AI has been limited since only limited countries were able to install the AI technology which has limited its impact in controlling the virus. Besides, the lack of data in providing the accurate predictions regarding the spread of disease was another major gap in reducing the overall impact of the disease.
Overcoming these barriers and limitations are effective in developing the right balance between public health and data privacy leading towards the development of human based AI interactions. These gaps will likely to address the issues faced in the time of the present pandemic situation, as by gathering extensive data related to the infected population countries will be able to save thousands of lives, through prior preparations.

**Keywords:** Artificial intelligence · COVID-19 · Literature review · Bahrain

1 An Introduction to Artificial Intelligence

The advent of artificial intelligence and its development has attracted hype of discussion in the past few years due to its rapidly increasing contributions under various domains. The concept of AI can be explained under the light of Ramon Llull’s theory of reasoning machine, and Aristotle’s syllogisms which were developed in 1300 CE and 300 BC respectively (Warwick 2013). By the passage of time i.e. in 1950s, a very clear and practical definition regarding the AI technology was proposed (Kok et al. 2009). In the existing time, the role and efficiency of AI has undergone through a dramatic revival due to the extensive contribution of research and development in the field of AI programs. Developing countries like China, have prioritized the use of AI technology through huge investments in the AI industry (Curansok 2018). Similarly, other major global corporations have made huge investments into the AI programming and the creation of innovative AI applications and programming (Diprose and Buist 2016; Chen et al. 2009).

Several tools have been employed by AI to automate the problem-based tasks. Such tools are being developed following the AI principles, and are used to create different AI based applications that are important in resolving issues across different disciplines and industries. Search in this type of system reflects the real-life problem-based solutions by the application of the computing power to resolve these issues (Chandel and Sood 2016). These search issues are generally classified based on the amount of information presented to the search process. Such an information is associated either to the overall problem area or to any specific part of the program. AI, following an independent search planning process tend to analyze variety of options while identifying the most suitable and prominent solution. This type of search and optimization is based on different conventional techniques (Chandel and Sood 2016; Badar et al. 2014).

It is important to pinpoint the effectiveness of the search process which makes it novel and different from other major technologies currently operating in similar domain. The conventional technique adopted by the AI includes past search results, which AI learns and uses to refine its search process in comparison to the prior searches and thus plans forward while clarifying the major queries similar to the human intelligence. The role of Evolutionary Computation is one such example, and is referred as the umbrella term for algorithms following the national evolutionary processes which incorporates the mechanism of automated selection, while providing survival to the fittest principal (Gambhir et al. 2016; Ramesh et al. 2004).
2 Role of AI in HealthCare Sector

Considering the effectiveness of the AI implications in almost every sector, a significant attention has been granted towards the its application in the healthcare sector. Different AI based solutions are being used to improve the effectiveness in the delivery of health care while addressing useful solutions and information regarding the previously interactable problems (Gambhir et al. 2016). Following this, several AI based applications and other smart solutions have been introduced to the healthcare market, which serves as the testimonial to this increased attention. Different commentators and healthcare experts have discussed how the use of AI technology in the healthcare sector will further contribute in the near future (Diprose and Buist 2016).

A significant increase in the implementation of AI technology has been noticed in various clinical settings (Diprose and Buist 2016, Kim 2015; Mishra et al. 2017), since the modern medicine is facing various challenges in extracting, analyzing and applying both structured as well as unstructured data in order to ensure disease management through its unique data mining as well as pattern recognition ability. In the light of this, medical AI is generally associated to the development of technology-based programs that are effective and efficient in predicting, diagnosing and managing chronic as well as mild diseases. Development of the medical AI is different to that of the non-medical AI applications which are based on pure statistical and probabilistic approaches, as it follows symbolic models of diseases while analyzing the relationship between patients’ symptoms and signs (Wimmer et al. 2016; Scott 1993). For instance, medical diagnostic related AI applications are useful in gathering and synthesizing information while providing the predefined categories of diseases that contributes in providing diagnosis and treatments. These technologies are important as they not only help in providing treatment and diagnosis, rather they contribute towards the development of treatment protocol and patient’s monitoring (Ramesh et al. 2004; Razzaque and Hamdan 2021; Zainal and Hamdan 2020; Bader and Ganguli 2019; Aqleh et al. 2019).

Artificial Neural Networks (ANNs) is one of the most prominent examples regarding the role of AI in medical (Ramesh et al. 2004; Priddy and Keller 2005), as most of the AI researchers, following their inspiration developed ANNs, which is an attempt to simulate the nerve cell networks of the brain. This type of approach involves the replication of the biological neural networks for an independent functioning is different from the conventional computing which requires support through human brain computation. This wide acceptance of AI, specifically in the field of healthcare is associated to the complexities of the modern healthcare industry along with the development of diseases which requires a detailed an in-depth information for diagnosis. The technology is unique in meeting clinical limitations to address different needs, by the development of medical applications that are based on computing abilities resulting in the use of techniques which are useful in assisting clinicians in medical care. AI through its highly efficient results is now serving for all the three classical medical tasks which includes, disease diagnosis, its prognosis and therapy (Farrugia et al. 2013; Awwad and Zidan 2021).

In general, the medical diagnostic process involves six phases. Beginning from the first phase of the cycle where patient is observed, leading towards the examination of disease where important data is being collected.

When comparing the medical diagnostic cycle with the concept of an intelligent agent system, the physician acts as the intelligent agent, where patient data is the input...
while diagnosis serve as the output. Several methods have been proposed to replicate the diagnostic cycle to assist clinicians with medical diagnosis. One such example is the use of expert system, which is developed based on rules which explicitly outline the steps involved in progression from inputs to outputs (Reddy 2018).

3 AI Technology and Fight Against COVID-19

The spread of the global pandemic COVID-19, which was first identified in December 2019 in China has been identified as the most life-threatening disease caused by the SARS-CoV-2 virus. Role of AI is critical and serves as most potentially powerful tool in the fight against the spread of the growing pandemic (Bullock et al. 2020). AI, in this regard, can be referred as the Natural Language Processing (NLP), Machine Learning (ML), and Computer Vision applications, which use big-data based models for pattern recognition, its explanation along with the prediction. These functions can be of greater interest in recognizing, predicting and developing a treatment plan for the COVID-19 infection, while managing its socio-economic impact.

However, for the effective management of the global pandemic, many doctors and medical experts have incorporated the use of AI along with other data tools to fight against the prevailing impact of the disease. Following this, six areas have been identified where AI may contribute in effective management of the pandemic. This includes; early warnings and timely alerts, predicting and tracking the prevalence of the disease, formation of data dashboards, diagnosis and prognosis, treatment and cure, resulting in the social control. AI is further useful in tracking, forecasting and predicting the spread of COVID-19 disease by the passage of time.

Consider an example of the last pandemic which was spread in 2015 and is known as the Zikra virus. The spread of this virus was tracked through the development of the dynamic neural network. Such models can play a huge role in dealing with the pandemic situation, like that happening in the present world due to the spread of COVID-19.

Hao (2020) explained that at the Carnegie Mellon University, researchers are now working to train algorithms to forecast and predict the spread of seasonal flu. Besides, several initiatives are now under process in collecting the training data regarding the current spread of the pandemic. The usefulness of AI in healthcare can be understood by the fact that several measures have been undertaken for accurate and timely diagnosis of the COVI-19, which can save numeral lives, while limiting the spread of the deadly disease. It further generates data which is helpful in providing training to the AI models. Contributions of AI can be meaningful in this regard as it provides information regarding the proper diagnosis, based on the chest radiography. Bullock et al. (2020) in his recent review related to the role of AI in fighting against the spread of COVID-19 stated that the usability of AI can be as accurate as humans and is helpful in saving time of the radiologists, while providing a faster and cheaper diagnosis of the disease in comparison to the present standard tests held for COVID-19.

Diagnosis of the disease can also be held by incorporating the use of Computed Tomography (CT) and X-rays. In the light of this, Rosebraock (2020) provided a tutorial which explains the usability of Deep Learning to diagnose COVID-19 by utilizing the X-ray images. He added that though there is a short supply of kits for undertaking
COVID-19 diagnostic tests, X-ray machines present in each hospital can be favorable in this regard. Another similar contribution of AI is mentioned by Maghdid et al. (2020), who proposed a unique technique through mobile phones to scan the CT images.

4 Successful Usability of AI Features in the Global Pandemic Situation

AI and Deep Learning Algorithms
Deep learning algorithms are important and are specifically good in finding small details of the visual data that are often unnoticed by the human eye. In this regard, COVID-Net has been effectively trained on COVIDx, which serves as the public database and consists of 16,756 chest X-rays across 13,645 patients’ cases not only from COVID-19 but also of other types of lung infections. This type of data is helpful in enabling the deep learning model to separate the characteristics, which individually defines each type of illness while detecting the new X-ray images. According to Wong, through the model is not ready for production, still preliminary results are of significant value in identifying the distinction between COVID-19 and other similar infections. However, the improvisations in the model will be held by the availability of additional data (Deckson 2020).

Wong added that inclusion of the large sample size would make a huge difference in improving COVID-Net which is used to develop new learning models in order to detect COVID-19 infections. It is further suggested that chest X-rays and other CT scans are still considerable as complementary tools, and can be used in regions experiencing the short supply of the testing kits. Besides, there are certain situations which require CT scans and multiple chest X-rays for the positive diagnosis of the viral tests in order to identify the intensity of spread of disease for further treatment and care planning. Wong emphasized on the efficiency of deep learning technology in reducing the burden of radiologists by enabling different front-line health workers with minimum expertise for better diagnosis (Deckson 2020).

Contributions of AI Through Machine Learning
Mostly, computer algorithms used for AI specifically rely on Machine Learning (ML) techniques which, in a broader sense includes computer vision and natural language (Kaplan and Haenlein 2019). Wiens and Shenoy (2018) conducted a recent review on the usability of ML in healthcare epidemiology and defined it as the study of methods and tools to identify patterns in data. ML techniques are developed by utilizing a set of algorithms for instance; decision trees, logistic regression, or deep learning which can be categorized into unsupervised, supervised, and reinforcement learning techniques. Contributions of each category is unique, as unsupervised learning at one end provides methods for data clustering, whereas supervised learning is centered towards disease classification. Roth et al. (2018) provided a detailed analysis regarding the usefulness of ML in healthcare sector, where patients medical records have been widely stored as electronic healthcare records (HERs) at different global healthcare institutions. For instance; hospitals in most of the developed countries employs EHRs with basic functionalities
including the patient’s diagnosis, demographics, nursing assessments, patients’ notes and medication lists, along with patients’ problem lists, radiology reports, diagnostic test results, discharge summaries and order entries for medication (Adler-Milstein et al. 2017). EHRs are sometimes characterized as weak systems, since they are noisy and inconsistent, along with many missing values and unstructured text fields. However, the electronic availability of data in large volumes provides the potential for the application of ML in the field of infection management. Contributions of ML in healthcare industry are effective as chronic conditions like sepsis requires an immediate diagnosis along with the therapeutic actions, specifically at a time when causative pathogens remain unidentified (Rhodes et al. 2017).

However, an early identification of the septic patients by the infusion of ML derived predicted models are helpful in facilitating and improving the patient care, specifically under situations where time is life. In a recent review, current applications of ML were listed for clinical decision support during the spread of an infectious disease, which include aims such as; the diagnostic support, predicting the severity of disease, and making the final choice of appropriate diagnostic antimicrobial treatments (Peiffer-Smadja et al. 2019). The study further provided different characteristics and objectives of the ML system, while providing specific focus on the selection of variables used for the ML approaches (Luz et al. 2020).

Pandey et al. (2020) conducted a study to outline the methodological approaches and requirements for the optimal use of ML in future infection management. A lifelong learning application was developed in this study, to deliver the accurate information regarding the disease. Important functions are performed through the matching sources of authentic and verified information extracted from the reports such as those proposed by World Health Organization (WHO) through natural language processing and machine learning. The application is useful as it utilizes the state of art text to develop different speech engines. The approach was further useful in providing useful information regarding, sanitation, hygiene and water which is critical to the current development of the growing pandemic.

**Contributions of AI and Evolution of Blue Dot**

Blue Dot operates through machine learning and by processing the natural language. It uses huge data to find patterns that may serve as a cautious hint against the spread of the pandemic. These results are of significant value to different data scientists, doctors, epidemiologists, and veterinarians, which are viewed to decide the point which needs further investigations. This final report, after being analyzed is sent to the Blue Dot’s customers including governments and businesses (Deckson 2020).

Other than hotspots, AI may also predict the spread of the contagious diseases by using and studying flight data along with its movement patterns. Blue Dot technology was used by various nations, in order to predict the first spread of virus in different cities, right after its outbreak in Wuhan. Under normal conditions, Blue Dot serves as the commercial application, however, in present conditions it is being used by the government in order to track the spread of COVID-19. Considering this, the usability of Blue Dot and AI technology may serve as an early warning generating system to facilitate governments in preparing for the spread of deadly diseases such as; COVID-19.
According to Dr. Kamran Khan (the CEO of Blue Dot and an infectious disease physician) “Blue Dot is grateful for the provided opportunity regarding the combination of physician’s expertise in the control of infectious disease and big data analytics along with the use of digital technologies as held by the Canadian government in order to mitigate the impact of COVID-19 in Canada and globally.” (Deckson 2020).

Contributions of AI Through Robotics

AI and its competent features when deployed in healthcare domain calls for highly diverse applications, along with the development of different teams with long term partnerships. Robotics is another such domain where AI technology when employed helps in fighting against COVID-19. These robots are used for cleaning, disinfecting, and logistics purposes that requires human involvement (Bullock et al. 2020). Mullane and Bischofberger (2020) in their recent article in science robotics outlined that robots can be an effective resource in combating the fight against the pandemic, as their services can be utilized for medicine and food delivery, disinfecting, along with collecting information regarding the most vital signs. The practical implementation of the robotics is held in the northern Italy which was the epicenter of COVID-19 outbreak. Besides, clinicians residing in the town of Varese which is close to Italy’s border with Switzerland where robotics were installed for the treatment of COVID-19 patients. These robots were equipped with a camera which allows medical staff to keep a check on their patients and to acquire readings on monitor screens.

The robotics have a friendly face, specifically designed to keep patients at ease. To protect doctors and nurses, these robotics helps in reducing the need of face masks and protective gowns specifically at the time of their short supply in these hospitals. These robots further enable patients to communicate with the medical sensors, as they are developed by utilizing over 60 sensors providing them the capacity to make meaningful voice interactions, voice localization, face recognition, and video chat, by avoiding obstacles through auto charging feature. In the cases where most of the manufacturers have restricted themselves into their homes to avoid contact with virus, many manufacturers have focused in converting their production lines to the overall automation. The use of robotics is not limited to the healthcare industry only, as most of the farmers employ robotic as a helping assistant in their fields, specifically those which requires a team work.

Though contributions of robotic in the field of healthcare are undeniable, however the developing trend of the robotics is already creating a huge impact over low incoming jobs specifically in the developing countries. Besides, automatic payment encounters are already installed in most shops along with railway stations. Similarly, different shopping warehouses, cleaning industry and fast food-restaurants rely heavily on the robotic (Mullane and Bischofberger 2020). In the time of COVID-19, robots are increasingly expected to complete tasks which are dull and dangerous for human contact.

Once of such example includes, Chinese huge e-commerce JD.com deployed different self-driving robots for the proper delivery of medical goods to Wuhan. Different robots were sent by the startup Shanghai TMI Rob to disinfect wards such as the intensive care units and operating rooms of the city hospitals. Similarly, a robot was also used in one of the hospitals of the US in order to take vitals of patients infected with the COVID-19 virus. This was specifically done to minimize the risk of exposure with
the virus. Communication and other diagnostic processes were held through screen on
the robot, and were further used to monitor recovering patients. These robots were also
sent to Thailand to measure patients’ fever, while allowing physicians to communicate
with patients through them. The solution was also adopted in four different hospitals of
Bangkok, where robots were even called with names such as; ninja robots. In regions
where people were banned to assist and visit the older ones, robots are used to break the
transmission chain while keeping them in contact with their close ones remotely.

Contribution of AI Based Gadgets
According to the Medical College of Georgia, smartphone applications along with
machine and artificial intelligence contributes in increasing individual access to homes
based COVID-19 risk assessments, to provide medical experts with real-time informa-
tion regarding target infected patients. The report provided in the Infection Control &
Hospital Epidemiology indicated that the application is helpful in directing health experts
towards patients who are more vulnerable towards COVID-19. This prior management
helps in enhancing prevention as well as treatment related initiatives.

Role of artificial intelligence is critical in rapidly assessing the individual’s infor-
mation, while providing them the risk assessment report to alert medical representatives
of the nearest medical center with the testing ability. However, in cases where patient
is unable to travel, a mobile check will be arranged. According to Mc Grail (n.d.), the
collective information of different individuals helps in rapid aiding and the accurate iden-
tification of regions, cities, areas and villages where virus is in rapid spread along with
the predicted health risks in that region. This enables healthcare providers in exhibiting
better preparedness level when needed.

On-Line Learning and Distance Learning
In the growing circumstances of the pandemic situation, most of the students are unable to
carry on with their education systems and are offered subtle approaches to continue their
learning processes. Academics are now provided with different ways where they may
easily access the learning materials. Students, through flexible timings may experience
their class room based learning, by approaching towards web-based online materials
by the use of different technologies such as, Artificial Intelligence (AI) or Augmented
Reality (AR). Similarly, employer-based learning has emerged as the new method which
enable students to study in combination with their ongoing work processes. This serves
as the innovative learning opportunity for employers to develop useful means of learning.
However, in most of the regions, education institutions are encouraging learners to use
AI based mobile applications to gain access to various learning materials. These online
activities involve imitating the reading process, group discussions, automatic grading
and online classes through social network-based applications.

    AI technology has overcome the barriers held in students learning processes, since
most of the lectures are now delivered online by the instructors which enable learning
in live virtual classrooms (Huang et al. 2020). This is similar to the distance education
system, which is based on artificial intelligence technology and are designed following
the analytical processing of big data and data digging. It further utilizes machine and deep
learning strategies of artificial intelligence along with cloud storage technology which
provides a proper classification of the large amount data extracted from the internet.
The overall process is held through feature generation and pattern matching, resulting in providing the personalized learning opportunities for global students. Distance learning system is further effective as it can collect and measures learners’ learning environment data, while analyzing data generated in the two-way teaching process through strategical and statistical analysis, predictive recommendation and other techniques which are useful in better optimization of the learning process. Distance learning enabled through AI systems, allows tracking learners’ time to provide constructive feedback, while enabling the learner oriented educational approach (Xiaogang 2018).

In the ongoing spread of global pandemic, educational institutions have directed their teaching and learning processes through AI technologies, where mobile based applications such as; Zoom are widely used by educationalists to overcome the barriers held in online teaching and learning process.

**Social, Ethical and Political Considerations in AI**

The implementation of AI technology involves certain boundaries, which are largely based on social, ethical and political considerations. Physicians that are truly aware of the functioning of AI technology are generally familiar with the drawbacks posed by this technology in the form of incorrect patients’ diagnosis. This will lead to a more complicated situation, as the wrong diagnosis results in providing an inappropriate treatment making it even more difficult to ensure accountability of the target person. Also, there is a greater likeliness for incidents in which patients may receive medical information from these AI systems, while preferring to receive healthcare through a more empathetic clinician.

Another important consideration required when working through the AI systems falls in the ethical category, where AI systems may provide biased results based on either gender or race which is opposite to the reality (Davenport and Dreyer 2018). A similar perspective regarding the influence of algorithms was discussed by Professor Margaret Boden working as a Research Professor of the Cognitive Science at University of Sussex. According to Prof. Borden, algorithms are based on the measurable data which includes patients’ health records, radiographical images, and blood test results that are largely based on the quantitative information. However, most of the healthcare experts rely on quantitative data as well as the information received through nonverbal communication between people. Considering this, healthcare experts who solely rely on the quantitative information may miss some important diagnostic information, which ultimately create a significant impact on patients’ treatment methods.

In addition, the implementation of the AI system in the healthcare sector also has some ethical implications. Since the decisions undertaken in the past were mostly developed exclusively by human participants, in comparison to those developed through machines which lack permission, privacy and transparency. Moreover, radiographical images or diagnostic reports that are interpreted through deep learning algorithms are usually difficult for providing reference guide to patients (Davenport and Kalakota 2019). Most of the medical practices are based on patient’s consent, such as cases which requires the use of patients’ diagnostic information or tissue in research process. Since AI algorithms are based on large data sets, it is impossible to obtain the consent of each and every patient whose data is being used in specific data set.
The relative benefits of big data are generally common in influencing geographical standing in conventional as well as corporate realms, as most of the powerful economies struggle in attaining increasing control over big data due to the growing competition between the powerful economies. Most of the economies offer opportunities to increase internet speed which is ultimately connected to the opportunities of handling big data. While, developed economies such as; Europe and US are against this initiative, as for them this is an inappropriate way of using useful information. This pinpoints that the issue of big data control is of significant values for a nation’s wellbeing, while benefitting the territories to which they are being registered. Thus, it can be assumed that the distribution of large data is usually held with the corporations that are largely located to the most powerful, politically and economically stable economies (Allam 2019; Allam 2020).

In the light of this, both developed and developing economies will continue their struggles to gain predominant control over big data to facilitate its healthcare and other important sectors with the critical information that is required to save large economies through massive economic recession (Allam and Jones 2020).

5 Conclusion

The delivery of quality healthcare services has been significantly challenging and complex. Major part of these complexities is due to the voluminous data that is being generated for the timely process of the quality healthcare delivery. For quick processing, this data needs to be interpreted through intelligent means. Role of AI is critical here, as it can address this need through its problem-solving approach. Besides, its intelligent architecture with its ability to incorporate reasoning and the intelligent ability to act anonymously without being directed through human attention.

Therefore, it can be assumed that medical field has provided significant opportunities for the AI researchers to test and explore different techniques which may successfully contribute to the field of study. For instance, AI applications through their successful contributions have solved different problems associated to the field of health and sciences. Since the delivery of healthcare services are costly, stakeholders, through continuous research and development look for developmental means which may provide cost effective measures for patient healthcare through AI based solutions. As cold technology may not entirely replace the human base elements involved in patient care, a model may be incorporated by involving both human care and the technological innovations through detailed and timely investigations.

Future Trends for the Application of AI in Healthcare

By the growth in the AI based researches, AI systems are now being more intelligent and well-trained and are foreseeable to replace human elements of clinical care to a certain level (Diprose and Buist 2016). AI systems are efficient as they cover most of the routine-based tasks which includes daily diagnosis and other related treatment processes, while leaving decision making related tasks to humans. The intention behind the intervention of AI technology in human clinicians is not to reduce human clinicians, rather it helps in delivering an extremely high-quality healthcare delivery process. Among all the AI based domains, its contributions in the field of healthcare are significant due to the
development of multiple AI based technology. AI through its deep learning and machine learning features help in predicting the spread of any such disease while opening ways for appropriate measures through timely diagnosis and development of treatment methods. Besides, mobile applications that are developed on the basis of AI features are effective in guiding and transmitting information important for the safety of people. Similarly, robotics that are driven by the AI plays an important role in the medical automation processes.

With the advancement of AI and robotics, the employment opportunities for robotics in healthcare industry is bound to grow. Moreover, the conventional thinking is that robotics serves as the vessel specifically for a silicon-based brain, while most of the scientific experts are now planning to use the biological brains in robots. By the advancement in the scientific developments, future allows the culture of biological neurons and the utilization of the biological brain in a robotic frame to sense the ongoing situations. This cyborg thus represents the true elimination of the boundaries specifically between the artificial and human intelligence with the imaginable development of the hybrid human artificial intelligence health workers for quality healthcare delivery.

**Challenges in AI Technology**

Though the application of AI in the healthcare delivery shows very promising results, still there lies a greater probability of both technical as well as ethical challenges. Researches based on the AI technology are largely driven through computer scientists without including significant medical training, which has led to a very problem focused yet technology-based approach in the application of the AI technology in the healthcare sector (Coiera 1996). Moreover, the contemporary healthcare models are largely dependent on human reasoning, communication between clinician and patients while establishing the professional relationships with patients to ensure maximum compliance. These aspects are sometimes difficult to replace through AI technology. In addition, the use of robotic assistants in the healthcare sector is further problematic due to the development of issues related to the healthcare mechanism specifically in vulnerable situations where interaction and intervention is more required. Also, many clinicians are reluctant to adopt AI technology as this will eventually replace human role.

However, the use of technologies which speed up and automate laboratory diagnostic processes are still preferable. This had led to the suggestions such as developing a model of co-habitation (Diprose and Buist 2016), which utilizes both human and AI elements in delivering the healthcare services. It further anticipates the unavoidable atomization of the significant components related to the medical processes, while preserving the human related characteristics of clinical care such as; procedures, communication and decision making.

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