

Opportunities of Adopting AI-Powered Robotics to Tackle COVID-19

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Abstract—The coronavirus disease (COVID-19) pandemic has made a dire requirement for traditional and disruptive technologies to react to the flare-up across health and wellbeing areas, and technologies such as AI and robotics have been recognized as promising ways to tackle the current challenges. The COVID-19 pandemic has exhibited the solid capability of different advanced technologies that have been tried during the emergency. However, acceptability and adoptability of the latest technologies may face serious challenges due to potential conflicts with users' cultural, moral, and religious backgrounds. This paper discusses the current opportunities and challenges with respect to artificial intelligence (AI) powered robots to battle COVID-19. To diminish the danger of contamination and infection, the opportunities must be utilized during this pandemic for a better future. More deliberate measures ought to be executed to guarantee that future robotic health initiatives will have a greater impact on the pandemic and meet the most key needs to facilitate the life of individuals who are at the forefront of the crisis.

Index Terms—Healthcare; robotics; artificial intelligence; telemedicine; telehealth; internet of things; coronavirus; COVID.

I. INTRODUCTION

Nations around the globe have been affected by the COVID-19 pandemic since December 2019 [1], and the medical care facilities in these nations are quickly adjusting to the exponential challenges and demands. The World Health Organization (WHO) has called for latest technologies to help the reaction to the flare-up across health and wellbeing areas, and AI-powered robotics have been distinguished as one of the most encouraging ways to tackle COVID [2].

The COVID-19 pandemic is solitary from multiple points of view. To start with, as far as number of individuals infected, contagiousness, and range of clinical seriousness, it has had a greater impact to date than previous epidemics such as pandemic influenza, Middle East respiratory syndrome (MERS), severe acute respiratory syndrome (SARS), or Ebola virus [3]. Now, COVID-19 pandemic is happening in a period of monstrous innovative progression. AI-powered Robotics can effectively support healthcare and well-being areas during pandemic by tracking health conditions in real time, creating virtual visits for day-to-day operations, and providing telemedicine visits for patients.

However, these kinds of latest technologies may face challenges associated with barriers to access, acceptability, and ethical issues. The COVID-19 pandemic is setting a stage to

examine how AI-powered robotics can and ought to be utilized to address this pandemic. This paper offers an outline of the current opportunities and challenges with respect to artificial intelligence (AI) powered robots to battle COVID-19.

II. OPPORTUNITIES

We identified ten opportunities of adopting AI-Powered robotics to tackle COVID-19. They are as follows:

1. The general surge of 3D printing during the COVID-19

The global unforeseeable caused by COVID-19 pandemic has pushed the globe into a tangled situation which is yet to entangle. The quick product development of 3D printing accredits a prompt movement of the technology and therefore a swift response to the exigencies. 3D printing has made it possible to manufacture critical parts on demand by leveraging designs shared via online platforms in spite of facing heavy discrepancies in the supply chain. This manifested to be really helpful in this pandemic where all the protocols of social distancing were very well managed and at the same time the work of producing essential equipment was never put on halt. Furthermore, customization of complex designs can be availed easily due to 3D printers. The enormous demand of 3D-printing applications in tackling COVID-19 includes personal protective equipment (PPE), visualization aids, public accessories and essentials, medical and testing devices etc. Introduction of 3D printing in intricate care has been fruitful. 3D printers fabricate low-cost prosthetics where people need them (for example, lungs can be 3D printed as shown in Fig 1). People who are not capable of affording a prosthetic can go for the prosthetics created by 3D printers as these are cost efficient. 3D printing makes it easier to print the necessary equipment in those villages where regular transportation is a subject of concern. Fitz Frames, a company which manufactures custom glasses using the latest 3D printing machines. The company has also manufactured a lot of other safety aids [4].

2. Testing done by autonomous robots in a bid to protect frontline warriors

During these hardship times, self-governing systems which require minimal manual operations can be of great help.

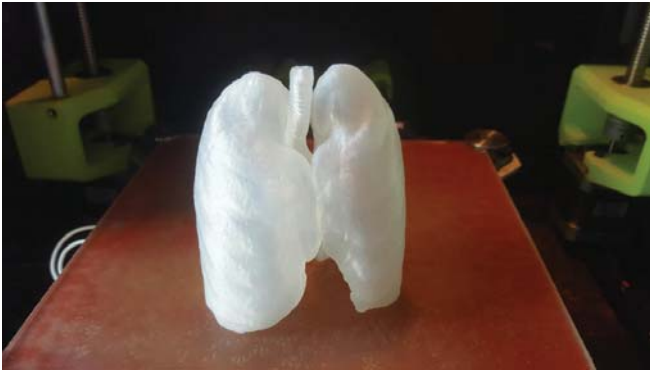


Fig. 1. 3D Print of lungs from a CT scan.

Such systems can be fostered in medical centers and research labs for aiding and shielding the people working there in numerous ways and in similar fashion this can be beneficial for the general public. For example, robots can be used to help prevent the spread of COVID19. The wheeled machine which is fully remote controlled, is well versed in performing tests such as swab, ultrasound scans and recording the information by listening to organs with a robot stethoscope. By introducing Smart telecare systems, we can turn down the risk of frontline workers getting infected by the transmission of deadly viruses by ensuring they monitor, test and diagnose the diseased patients from a safe distance. Diagnostic tests such as swab tests or checking a patient's temperature can be done by wheeled robots carrying manipulators to conduct such tests and this can potentially safeguard the medical staff from directly coming in contact with the diseased. Telecare systems can reduce the use of PPE during examining a patient as it's a tough nut to crack by wearing the PPE suit and doing the treatment. Nearly 14 robots were arranged by a Beijing-based robotics company CloudMinds to Wuhan for providing necessary help. The CloudMinds humanoid service robot, Ginger, helped with hospital services [5].

3. Digital communication during pandemic

It is very crucial to keep up the communication strong between the government officials and the medical authorities as well as the research team. Since the outbreak of COVID-19 there has been a lot of miscommunication and disbelief via social media, texts, SMS etc. about the inception and transmission of the disease. Lots of misleading facts are present in the internet and in government disclosures regarding the same. The society and its people may get hampered by the wide spread of false speculations in the public domain. WHO is all set to provide people the correct information in a timely fashion, via an active authentic information campaign. With the betterment of communication strategies, the courage in people reinforces and thereby helps manage their fear factors and keep the risk of other health conditions such as blood pressure, heart rate etc under control resultantly decreasing

the risk of weak immune systems. The communication must not only be comprehensible and based on true facts but also must be fast enough to reach the target community such as health workers, hospitals and the public for them to take up immediate action wisely when necessary. Such as guidelines such as maintain social distancing were misjudged and misunderstood as it wasn't well elucidated. Rather messages such as "stay home, stay safe", should have been emphasised more to avoid the spike in the number of people affected by COVID-19 daily. The WHO web page projects the usage of the phrase "physical distance" in association with "social distance". So, here comes the importance of digital interaction, this helps to avoid physical contact or physical interactions and enables people to maintain social distancing in person as per the WHO guidelines. During the initial months of the pandemic, industry reports showed that there is a visible hike in the usage of digital media as people stayed home due to lockdown [6].

4. Robotic guidance and assistance for a much better life

Robotics is not only limited to navigating racks and tools and assisting in pathological labs, in the healthcare field. With the introduction of remote-controlled medical robots, such as the ones invented by Anybots, caretakers keep a track of the health conditions of patients, make necessary arrangements for regular check-ups and even book appointments as per the requirement. This practice can be of great help in saving time and increasing efficiency by ruling out the doctors visit to residents for treating patients. A company Luvozo created Sam, the robotic concierge and this was tested first in Washington D.C [7]. It is a human sized robot, it is the conglomeration of cutting edge mechanization and human touch for assisting the medical staffs in providing frequent check-ups and nursing patients personally at their residents if required, and most interestingly, it has been mechanized with a machinery smiling face which resembles a human smile to make the patients feel lively from within. This not only reduces the overhead but at the same time pulls up the graph of the satisfactory level of the patients high. One added advantage is that, as it is a machine it can work continuously with better accuracy and reliability. These features make it more reliable.

5. Robots in medical supply chain

Robots are known for their impeccable accuracy with a very high speed, their work has a wide range from moving boxes to chemical testing. We even have robots designed for testing protection clothing for US military [8]. Robots are always prioritised in emergency situations as they are more reliable and it is always better than risking a human life in a hazardous situations. Robotics medical dispenser systems, PharmASSIST Robots, which has got tremendous data mining capabilities, and this practice is going to be of great help in the near future where the medical experts

can save a lot of time and incentives, and can invest these resources in considering the social aspect of society such as : educating people about the preventive measures, providing practical demonstrations and therefore making healthcare truly caring and way too effective.

6. Robots in delivering goods during this pandemic

There is no rocket science to figure out that robots can be the best replacements for thousands of manual jobs. By this year, robots were presumed to be working in malls, doing commercial works and helping to deliver goods at our place (example, Fig 2 . During this pandemic situation, in order to reduce the risk of infection among people, these robots will come handy. Two Skype co-founders initiated a six wheeled robot of Starship Technologies in 2014. This special robot needed no human assistance to helm around [9].



Fig. 3. Social Robots that can interact with people to guide them with COVID situations.

In order to avoid the overcrowding of emergency rooms during COVID-19, Telemedicine plays a pivotal role by allowing patients to stay and receive care at home whenever required. Telemedicine allows regular basic medical care and electronics prescriptions besides secured bracing of COVID-19 patients (as shown in Fig 4). It is also beneficial to professionals as they can screen and scan symptoms and provide helpful medical advice to the patients at home. This keeps patients away from overloaded hospitals. A potential study regarding COVID-19 severity was taken in Luxembourg (Predi-COVID). The data was being extracted from the national telesurveillance system which had utilized all patients that had tested positive for COVID-19. The collected information is integrated with the patient's reported results and biological illustratives. There are ingenious data collections such as the voice recording based on smartphones which is used to recognize respiratory syndromes due to vocal biomarkers.

Fig. 2. Demand For These Autonomous Delivery Robots Is Skyrocketing During This Pandemic [9].

7. Social robots for epidemic and pandemic

Health care medical devices are an important part of the system which balances the insanity stability and comfort during quarantine so that they are socially engaging with people (as shown in Fig 3). It will be an inspiration and captivate those quarantined to build up their heaps/calibre among their groups while under isolation. Main purpose of such devices' innovation is meant for senior citizens plus kids having severe illnesses. Majorly, these people have been pompus due to the pandemic because of no visitors in the health care. Undergoing such situations, these devices can be extensively used in reducing their mental sickness, regardless being in any age group. These medican robotic devices are developed in different types. That is, starting with pets resembling miniature till hominoids [10]. In order for making social robots more effective, various kinds of sensing elements as well as actuating elements are feasibly introduced in them.

8. Telemedicine and remote patient monitoring systems



Fig. 4. Healthcare robots are used as telemedicine assistance

9. Robotic surgeries in the new normal

Surgery using robots can be carried out in a less inhibitory manner with the surgeon handling the robot at a distance. Hence, treatment of the patients can be done with the minimal number of nurses or caretakers which in turn reduces the expense. This also benefits the quality of healthcare for the

patient. In addition, doctors might become unfocused due to weariness or fatigue. Therefore, it becomes stressful for surgeons to operate at long stretches of time which could lead to huge blunders. On the other hand, Surgery using robots could change all of this and would beat all these odds. Robotic surgery will allow much greater and better precision during neurological or orthopaedic surgeries. Stryker was the second-dominant competitor in the market of robotic surgery, after the possession of MAKO Surgical Corp in 2013 for \$1.65 billion.

10. Triage and risk management

There is an alarming situation in the world which has created uncertainty among all of us. In order to assure the allocation of resources, video conferences can be very helpful in comforting patients and also at the time of trials. At first, patients are designated as possibly COVID-19 infected or uninfected prior to their arrival at hospitals. On top of it, telemedicine ensures keen monitoring of patients at home who are less severely infected by constant communication. The next phase usually occurred at hospitals where severely infected COVID patients are televised by lively evaluation of immunological characteristics and testing. These patients are isolated in emergency rooms, where they are provided with android (or apple) devices to talk to professionals; these electronic gadgets are sanitised regularly. A robot enters this place to observe the vital and cardiac signs. These robots come in handy to reduce the contamination among healthcare providers. They also act as an interface between patients and health care professionals. Their activities are controlled by nurses somewhere out of this room. Symptoms check, consultations and prescription can be taken place online. Basically, low-risk people can be kept track from their homes regularly. And severely infected patients can be evaluated with the help of these robots. In order to measure temperature, breathing rate, pulse, oxygen saturation and to make them mobile, researchers have decided to utilise prevailing computer vision technologies.

III. DISCUSSION

1. Use of 3D Printed Robots: 3D printing has played a pivotal role during the rampant and has proved to be one of the most aiding techniques. As the pandemic has brought an unexpected barrier upon various industries, 3D printing has been a pillar. It has not only enhanced the working ability but also has made the material cost-effective. From healthcare to Food and Drug Administration industries, 3D printing has been of great significance. The FDA is effectively connected beyond this range and creating approaches to help and assist individuals who are hoping to help their networks in this manner. Infirmary got 3D printers to help in creation of defensive clinical hardware, colleges advanced their added substance capacities to emboss segments for neighborhood medical care suppliers. All of this has geared 3D printing producers who grew into specialist co-ops in short-term.

Example: This is an extraordinary illustration of how the

Research of Oxford University, School of Engineering came up with such a wonderful respirator with low cost and high efficiency during the COVID-19 outbreak. Though this type of respirator designs take years to develop, this team has made it possible with 3D printing. With the excellent efforts and skills of the team, they were able to make a respirator using 3D printing in a short span of time.

2. Use of Automated Robots: Commencing work during the pandemic has put forefront laborers beneath monstrous and remarkable constraint. With the outbreak of COVID-19, it's become much harder for the frontline workers to cope up with their work as many of the norms set up has brought them to a strenuous condition. Hence, this has been very stressful. This is where autonomous robots come into play. This has been a support for the frontline workers in many ways. With growing digitization of data, this has been one of a change.

Example: When a patient has been tested positive for COVID-19, a form has to be filled out by hand numerous times. This is replaced by the AI-powered robot, which can read the handwriting and pick up data and helps in precise identification and prepares reports for the patient.

3. Use of Digi Robots: Effective communication in this time of pandemic must incorporate ideas and strategy so that people are unharmed. Communication must not only be clear and unambiguous but must also reach the target population quickly. The society and the people may get obstructed by the wide spread of false speculations. Official communication plans should promote easily accessible and diverse channels of digital communication at all stages and for different purposes (global, regional, and community-based communication). The use of apps or instant messaging services must be enabled so that ministries or health agencies can contact health workers remotely and to inform government officials about the number of cases, symptoms, and prevention measures.

Example: An example of a communication strategy that was developed very quickly and effectively to fight fear and rumors among a population is the sending of messages by the government of Singapore through WhatsApp. Robots are used in reminding staff to provide treatment or medicine to patients. In some cases, the robot can even take the medicine to patients.

4. Use of Guided Robots: Automated robotic systems used as thermal check publicly and docks of entry presenting an empirical usage of improvised technologies. Such automated systems could also be used for in-/outpatients in all the departments of the hospitals with data connected to the hospital IT department. By the presence of network secure controls with facial identification operating systems, it enables the reiteration of connections of affected people to alarm the rest of them. Robots can efficiently address cognitive decline issues by reminding care-receivers when to eat, or drink or take medication, do exercise or attend an appointment. Such

tasks can be performed by nursing-care robots with a high level of accuracy. Newer versions of automated systems, from macro- to microscale, should be created to direct hazardous areas and continuously function to decontaminate personal touch areas.

Example: The usage of service robots has been recently growing in nursing or care homes in most advanced countries with Japan currently leading the world in advanced robotics. Across the country, there are about 5,000 nursing-care homes testing robots for use in nursing care due to the declining number of human nurses to care for aged people (above 65 years of age) who are more than a quarter of the population.

5. Use of Self-governing Robots: Self-governing robots are used in classifying and identifying various healthcare gadgets inclusive of airborne robots which could also be customized to carry out function with almost no human arbitration. Believe it or not, robots are close to being a human, as it has been of great help to humans during the pandemic. The healthcare industry has seen a tremendous change in its sector. Surgical robots and other bots have been deployed in this sector and has seen an expanse of revamping which has made the tedious tasks much simpler and time efficient.

Example: Robots such as auxiliary ones, assist in restocking items, bringing from warehouses, cleaning them on and so forth, helps the nurse to interact and take care of the patients. Also robots could perform accurate surgeries at all times whenever the doctor feels more stressful from a prolonged work schedule.

6. Use of Delivering Robots: The compartments in these robots are locked such that no one can steal the items that are to be delivered. Today's robots are quite dunderheaded, but tomorrow things may certainly change due to the rapid development of AI. Pandemic is the time, when there must be less human interactions to control the spread of infection. Replacing humans by robots has its own pros and cons. These can reduce the level of infection but can increase the unemployment rate. Once the outbreak is controlled, the world will not go back to normal, instead there will be a new normal. The new normal will have delivery robots on our streets.

Example: Savioke, the autonomous robot comes with the feature having the most secure sovereign indoor delivering system. It is fast and very efficient for the dynamic atmosphere. It can be of great help in situations where the world is taken aback by the pandemic and help us to resolve the problems faced due to manual deliveries.

7. Use of Social Robots: Few say that this could be a great companion for the introverts. But, No matter how well they are developed, they still cannot replace humans in understanding the feelings of their fellow beings. They can just interact with humans by abiding a set of rules and social behaviour.

Example: Sophia, Nao, Atlas, Pepper. Sophia tends to be the

smartest robot in the entire world. And got diffused by its own inventor. In the future, they will become the new reality. The Emerging AI technology will pave the way for these robots to enter into almost all human domains.

8. Use of Tele Robots: Robots entering into healthcare would be highly beneficial. During a pandemic like this, healthcare workers are in more danger and tend to fall prey for the contagious diseases. At this perilous period, Health care robots will come in handy. Nurses can handle them remotely. These robots can transport delicate and dangerous materials too. This trend is gradually accelerating across the world.

Example: Endoscopy bots are used to take biopsies from the tissue to test for diseases and conditions, such as anemia, bleeding, inflammation, diarrhea or cancers of the digestive system. These capsule like bots have inbuilt camera in them to get a view of the digestive tract. Disinfectant bots are highly helpful in disinfecting the hospitals where contamination is at high rate. These disinfectant bots use UV C rays that alter the DNA structure of the bacteria and curbs it from producing the offsprings.

9. Use of Surgical Robots: The journey of robotics assisted surgeries is still in its inception. In conventional surgeries, usually the incisions made by the doctors are prodigious which eventually leads to a prolonged recovery period. Due to the extension in the time of recovery the patient has to stay in the hospital occupying a ward for a longer period of time. This leads to shortage of rooms in situations like pandemic. The recent scenario where people are striving to book a ward to get the necessary treatment for COVID or any other normal treatment. There is a paucity of beds for patients and most importantly they don't get the privilege of being treated on time properly and in the worst case this proves to be fatal, at times. The need of the hour is vacancy of rooms in healthcare centers and hospitals which can only be done when the recovery rate is faster. This will be very helpful for people of every class. I see a future where robotic assisted surgeries are high on demand and people get the best of both worlds.

Example: In the year 2000, the da Vinci Surgery System became the first robot to perform a surgery and got its approval from FDA for general laparoscopic surgery. Before this, ROBODOC was also invented in the mid 1980s. These robots not only made it easier for the surgeons but also for the patient as the size of incision was comparatively less than that of traditional method of performing a surgery and involved no major surgeries.

10. Use of Triage-based Robots: Outbreak of the deadly pandemic like COVID has created havoc not only in the lives of normal people but it has not even spared the lives of doctors. This happened due to lack of safety measures in proper monitoring of patient's health conditions before allowing them to enter into the hospitals and thus, this infected the medical staff as well as doctors on duty in spite of following the

safety protocols. We can visualize a future having robotic monitoring systems which not only sanitizes but also detects the infection and notifies the medical authorities about the health condition of the patient visiting the premises. The robot should be capable of sanitizing itself before and after verifying a patient's condition. This can be lucrative to mankind and at the same time can hugely contribute towards the growth of digitalization.

Example: MIT in collaboration with Boston Dynamics, and other medical institutes has developed a touch free and contactless monitoring system to verify if the patient is infected by COVID.

IV. CONCLUSION

At a global level, where the COVID-19 pandemic is growing at an exponential pace, the health, hygiene and wellbeing innovations has quickly and liberally added to the management of the emergencies. Various telehealth, telemedicine, teleconsultation and telemonitoring solutions using robotics have been deployed in healthcenters and social care homes. However, the efficacy and effectiveness have always been a question that needs to be addressed by considering acceptability and adoptability of the latest technologies due to potential conflicts with users' cultural, moral, and religious backgrounds. This paper discussed the current opportunities and challenges with respect to artificial intelligence (AI) powered robots to battle COVID-19. To diminish the danger of contamination and infection, the opportunities must be utilized during this pandemic for a better future. More deliberate measures ought to be executed to guarantee that future robotic health initiatives will have a greater impact on the pandemic and meet the most key needs to facilitate the life of individuals who are at the forefront of the crisis.

Time is critical to battle COVID-19, and AI-powered robotic solutions provide the opportunity to buy time and human resources. As the COVID-19 pandemic is a worldwide health emergency, we have observed and will observe a plethora of robotic solutions. This makes a pressing requirement for strategic decision makes, policy makers, specialists, researchers, scientists and healthcare experts to effectively implement AI-powered robotic solutions into practice without further dividing the current scenes of care. We currently call for more coordinated measures to optimally have an impact on the epidemic and to address the most vital needs to facilitate the life of individuals who are at the front line of the COVID-19 emergency. We will also consider various robotic applications for physiotherapy healthcare [11], [12], [13], [14], and build various other application related to prevention of diseases [15], [16], [17].

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