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AI's Role in the Fight against COVID-19

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Abstract: ***The COVID-19 pandemic has caused complete chaos in our world-forcing us all to go into lockdown. With the impact that Covid-19 has had on our lives, it is of no doubt that every industry has been affected by it- for better or for worse. The shift from reality to the virtual realm is evident as complex algorithms are worked upon and Artificially Intelligent robots take over the roles of humans. Evidently, technology has helped in this pandemic in detection, prevention and reducing the overall spread of the virus. This paper consists of ways the technology department- namely AI- has helped in the fight against this world-wide health crisis.***

Keywords: COVID-19, artificial intelligence, technology, prevention, pandemic, healthcare

1. Introduction

Background of COVID-19

The COVID-19 also called Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) outbreak began in December 2019 in Wuhan, a city in the Hubei province of China. The COVID-19 outbreak was declared a global health emergency on January 30, 2020, and a global pandemic on March 11, 2020, by the WHO. This pandemic has upturned the lives of the entire world, spreading to almost every country. It has caused deaths of over 1.84M people among nearly 84.8M confirmed cases based on statistics of the World Health Organization at the beginning of January 2021.

So, what is the COVID-19? The COVID-19, a novel coronavirus disease, was predicted to have originated in a large animal and seafood market. On further research, it was suggested to have a zoonotic origin- meaning it can spread between animals as well as humans since it was shown to share high sequence identity with bats- and pangolin-derived SARS-like coronavirus.

Some of the symptoms of coronavirus are- mild to moderate respiratory illness which can be treated easily leading to a quick recovery, without requiring special treatment. However, the older generation and those suffering from underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop a serious illness or even suffer death. Due to these reasons, the world had been forced to go on lockdown, creating tremendous chaos around the world. With the significant use of science and technology, especially the use of artificial intelligence, we have been able to get some semblance of our lives back-online school, masks, sanitizers at every stop becoming the new normal.

Artificial Intelligence

Artificial intelligence (AI) refers to the ability of complex software to perform tasks commonly associated with human beings. It aims to mimic human cognitive functions such as the ability to solve problems, learn from past experiences, reason, discover meaning, generalize, or showing some form of human-like creativity. In simpler words, it is the shift of the virtual world to the real world, giving machines the ability to behave like humans.

There have been substantial breakthroughs in AI with the rapid growth in computing power and memory storage, the wealth of data, and the development of advanced algorithms, all leading to its various applications in every aspect of our lives, some of which are computer vision, voice recognition, natural language understanding, and digital pathology data analysis. It has brought a complete change in viewing healthcare with its application in research, detection of disease, management of illnesses, delivery of health services, and drug discovery.

In this worldwide pandemic, new technologies are essential to help the medical community control and overcome the spread of COVID-19. AI is one such technology that can be used to fight in the battle against the deadly COVID-19 outbreak. It can help track the spread of this virus, reduce direct contact, check for early symptoms, identify high-risk patients, and is useful in controlling this infection in real-time. It can also predict mortality risk by efficiently analyzing the previous data of the patients, monitoring positive cases and survivals, providing precautions to be taken for prevention, deploying robots to reduce further level transmission. It has proved to have potentially improved the planning, treatment, and reported outcomes of the COVID-19 pandemic. Thus, his paper provides a complete evaluation of the role of Artificial Intelligence (AI) against COVID-19.

2. Application of AI Intelligence

Early Detection-

AI can quickly analyze irregular symptoms and other 'red flags' with its complex diagnosis and management system for the COVID 19 cases, and thus alarm the patients and the healthcare authorities. It helps to provide faster decision-making, which is cost and time-efficient.

Screening Using AI Framework

Screening of COVID-19 is usually done manually, which is time-consuming as it is impossible to reach and check each and every individual for infection. Additionally, since it is done by other humans themselves, it is highly contagious and has higher chances of being transmitted. Thus, in order to reduce contact as well as time consumption, AI-powered smartphones and other devices are made prevalent. With AI smartphones, which are easy to operate by all, even an ordinary person can self-check for early symptoms. If the symptoms match, then there are high chances of infection

and the patient must take the next required steps for isolation and prevention of further spread.

But, how do our smartphones and other technological applications help in early detection? The mobile devices are used for screening of multiple diseases depending upon their characteristics and symptoms and are added with several sensors including cameras, microphones, color sensors, fingerprint sensors, humidity-sensor, wireless chipsets, and proximity sensors, etc. Each of these is used in collecting and detecting various symptoms. For example- camera sensors are used for analyzing images and neck postures to predict the headache level, microphones are used to detect the type of cough, and fingerprint sensors can be used to detect body temperature. By deploying thermal sensing cameras at public places like airports, railway stations, bus depots, shopping malls, hospitals, etc., AI has detected successfully the level of contamination by surveying data of past medical history and the contacts of the infected humans. Then, these sensor signals are received by The Artificial Intelligence (AI) qualified framework which then helps predict the severity of the disease.

3. Diagnosis of the Infection

Swab Tests

The most common way to run a laboratory test on a patient's specimen is through the process of Reverse Transcriptase Polymerase Chain Reaction (RT-PCR). So, how does it work? To explain briefly and in simple terms, a sample is collected from the patient, usually with a nasopharyngeal (NP)-nose swab or oropharyngeal (OP)-throat swab. Then, through a chemical process, the patient's RNA is collected from this sample, and an enzyme called "reverse transcriptase" enzyme is added to turn the RNA into two-stranded DNA. Nucleotides, an enzyme causing the DNA to multiply, are added to this, and short synthesized DNA fragments called "primers" are formed. These primers, when combined with a fluorescent dye, are able to signal whether the sample contains viral DNA. If the amount of fluorescence exceeds a certain level, then the presence of the virus is confirmed. Thus, swap tests are used to determine the early detection of the virus in a person.

What does the result mean?

Positive test result: – A positive PCR result means that the person is currently infected by the virus.

Negative test result: – A negative PCR result could mean that the person is not currently infected by this virus or the virus is not present at the site the sample was taken from (since the distribution of virus varies in different patients, so the virus may only be detectable in a specific location at one time), or that it is too early, or too late in the infection to detect replicating virus.

Thus, the RT-PCR test is not entirely reliable since it cannot accurately detect if a person has whether a person had the virus in the past as it only detects when an active virus is present. If tested negative, new samples are taken to reduce the chances of incorrectly missing an infected person due to chances of the virus residing in another site. Additionally, if it is not carried out correctly, it can injure the person and cause bleeding.

Clearly, this method has failed to diagnose COVID-19 accurately and caused more and more the increase in the number of cases each day.
This led to finding different and more accurate methods of diagnosis. One of them was collaborating AI with clinical methods such as CT. Chest computed tomography is one of the best ways to diagnose patients of the novel coronavirus. CT alone may not be able to provide accurate results, thus with the help of AI, which correctly analyses data of CT, it has been effectively used for rapid diagnosing across most affected countries like Russia, USA, China, and European countries. Another method of diagnosing is Serological tests.

Antibody Tests

They are also known as Serological Tests. Serology is the study of antibodies in blood serum. They are blood-based tests that help in identifying whether a person has been exposed to a particular pathogen. This is done by taking a blood sample, usually by a finger prick, or by drawing blood from a vein in the arm and analyzing the serum component of the blood which, if exposed to the virus will have created antibodies-which are called antigens- to specific components of the pathogens. The immune system recognizes these antigens as foreign and so targets them. Such tests are often used in viral infections to see if the patient has an immune response to the pathogen of interest and are thus used to diagnose the infection.

The presence of antibodies that work against SARS-CoV-2 – the virus that causes COVID-19 which are usually detectable in the first few weeks after infection- indicates that a person was infected with the COVID-19 virus. The result can be positive irrespective of whether the individual had severe or mild disease, or even an asymptomatic infection- as their body would have regardless created antibodies in an attempt to defend itself. It indicates that you were likely infected with COVID-19 at some time in the past. It is usually done after full recovery from COVID-19 as it takes at least 12 days after exposure to the virus for our bodies to make enough antibodies to show up on a test.

These conclusions may also mean that a recovered coronavirus patient can have some levels of immunity to further prevent infection. But, since there's a lack of evidence on the same and whether having antibodies protects you from reinfection, it cannot be confirmed. Ongoing studies will eventually reveal more data on this and on the level and extent of the immunity if present.

4. Limitations

The accuracy of these tests depends entirely on the timing and type of antibody tests taken. If done too early in the course of infection, the test may not detect antibodies as the immune response is still building up in your body. So, antibody testing should not be done any sooner than 14 days after the onset of symptoms. Thus, antibody tests don't help detect the virus itself, but only detect antibodies the immune system develops in response to the virus.

So, the question arises-if serological tests do not determine the current status of infection in the patient, what is its use? It is used for-

- In a population under study, inferences can be made about the extent of infection as measured by antibody levels. Initial seroprevalence of any new virus, including SARS-CoV-2, is assumed to be low or non-existent due to the fact that the virus has not circulated before.
- The occurrence of mild or asymptomatic infection
- The proportion of fatal infections among those infected
- The proportion of the population who may be protected against infection in the future
- Another benefit of accurate antibody testing is that it can also help identify prospective blood-plasma donors. Patients after recovery from COVID-19 may be eligible to donate plasma- called convalescent plasma- a part of their blood that could be used to help others boost their ability to fight the virus.

Swab Tests Vs Serological Tests

Swab Test	Serological Test
• A sample is collected from the patient, usually with a nasopharyngeal (NP)-nose swab or oropharyngeal (OP)-throat swab which is then tested. In some cases the saliva might also be taken directly. • Results are received within 24-48 hours or up to a week (longer in some locations with many tests). • This test is usually more expensive and requires to be carried out in a lab. • This test is usually highly accurate and does not need to be repeated. • This test diagnoses active coronavirus infection, not past infection. It helps determine whether the infection is there currently or not.	• It is carried out by taking a blood sample, usually by a finger prick or by drawing blood from a vein in the arm. • Results are received on the same day within minutes (in most locations) or may take 1-3 days. • This test is substantially cheaper and can also be carried out on the spot in minutes. • Frequently, more antibody tests are needed for accurate results. It may also be followed up by a swab test. • This test shows if you've been infected by coronavirus in the past, not if you have an active infection.

Reducing the impact of the virus

AI, with its vast and intelligent platform, can help with automatic monitoring and prediction of the spread of this virus. It has the ability to provide day-to-day updates of the patients and other relevant statistics, which can help the doctors, scientists, and other authorities to come up with and provide solutions to be followed in the COVID-19 pandemic. Thus, it can predict the future course of this disease and likely reappearance.

AI-powered apps, along with AI robots have assisted in contact tracing which has helped reduce the overall spread of the virus significantly. These measures implemented during the pandemic have proven efficient in containing the virus.

Contact Tracing

Advances in digital technology have enabled us to use various devices to help analyze the level of infection in a person, thus helping in the contract-tracing process. AI can also help defeat this virus by identifying the clusters and 'hot spots' and monitor them. Contact tracing is of the utmost importance when dealing with a pandemic, as it provides rapid identification of cases based on the data collected from infected individuals which helps prevent the same from spreading to other individuals they may or may not have had recent contact with.

Governments have proposed and implemented various applications created with the help of AI to track contacts. These contact tracing apps work mainly on Bluetooth to track the patients who test positive and those they've been in contact with. Data collected from these apps are used to limit the spread of infection and arrange for methods to help those who might be newly infected. The main purpose of these apps is to prevent the future spread of the virus by timely detecting and isolating potentially infectious people. Thus, contact tracing identifies potential cases and allows for the follow-up and immediate quarantining of susceptible individuals.

However, there are critical ethical issues of data protection, security, and privacy of data as there is a potential risk of users' personal information being stolen collated by the smartphone apps. Thus, there is a need to develop privacy-preserving app alternatives for the same.

Monitoring and Surveillance

With the help of the data collected from these apps, social media, and other media platforms, AI can help track and forecast the nature of the outbreak. It can help spread awareness about the risks of the infection and its likely spread. Further, it can predict the number of positive cases and death in a given population, thus helping identify the most vulnerable regions, people, and countries and take measures accordingly.

A range of sources, such as Twitter, Facebook, Instagram, local news outlets, and public platforms provide large amounts of data that can be aggregated quickly using AI-powered devices to help reconstruct and then potentially predict the spread and the behavior of the virus. Social media analysis could be triangulated further with mobile phone data that capture people's movements to give a second-by-second prediction of risk and disease spread. With the help of this real-time data analysis, AI can provide updated information to help predict the probable sites of infection, the number of positive cases and deaths in a particular region, and calculate the extent of spread of infection. It can also predict the future course of the disease and likely strike back by analyzing past and present data.

Thus, AI is helpful for future virus and disease prevention, with the help of previous mentored data and ongoing information. It identifies the traits, root causes, and reasons for the spread of infection. In the future, this will become an important technology as it will play a vital role in providing more predictive and preventive healthcare to fight against other epidemics and pandemics.

AI based robots in fight against COVID-19-

Humans tend to bear optimal workload for best results, whereas an increasing number of cases, therefore higher risk factor, involves a huge workforce and workload for treating COVID-19. This is where AI-enabled robots come into action. As the COVID-19 exploded into a full-blown pandemic in early 2020, most businesses were forced to shut down, leading to their downfall. On the other hand, tech industries and robot-making companies saw a surge in business. Robots not only reduce human workload, but also break the chain of human to human transmission as they can be easily disinfected, and, of course, don't get sick. Robots can act as an interface between a doctor and a patient by carrying out simple diagnostic and treatment processes, reducing human contact and risk of transmission of infection during the pandemic, as well as increasing time management efficiency. Monitoring of patients infected by COVID-19 with the help of automatic surveillance robots at hospitals, make it easier for diagnosing, delivering food, sanitizing surfaces, and so forth.

To prevent community-level transmission of COVID-19, social distancing is implemented, which, although is difficult for most people to follow in their day-to-day tasks, is near to impossible at hospitals. Most of the works at hospitals is taken care of manually like delivering treatment to infected people, supplying food and medicines, disinfecting surfaces, etc. So, the only alternate and best solutions are deploying robots, to replace humans in these menial tasks. With minimal to no interaction with humans, autonomous robotic systems can undertake tasks independently. Therefore, an army of automatons has been deployed all over the world to help with the crisis.

Instances Where Autonomous Robots Have Assisted In Reducing Contact-

A squad of robots, right at the entrance, serves as the first line of defense against human-to-human transmission in hospitals. There, the patients before entering the facility, get their temperature checked by the machines, which are equipped with thermal cameras atop their heads.

To speed up the testing process, a team of Danish doctors and engineers at the University of Southern Denmark and Lifeline Robotics are developing a fully automated swab robot.

In medical facilities, robots are taking over repetitive and menial chores so that nurses and physicians can spend their time doing more important tasks.

Drones were flown in an attempt to enforce lockdowns and social-distancing rules, and for making deliveries. In the United States, start-up Zipline deployed its fixed-wing autonomous aircraft to connect two medical facilities 17 kilometers apart. Masks, gowns, and gloves were delivered to the staff at the Huntersville Medical Center, in North Carolina, through drones. Technologists are working towards developing more drones like Zipline's to deliver other critical materials such as test samples, and drugs, and vaccines.

COVID-19 spreads not only from Droplet transmission, which occurs when a person is in close or direct contact with an infected person, but it also spreads through transmission from the immediate environment around the infected person or contact with objects used on the infected person. Therefore, scientists have been examining various old and new methods as potential solutions to eliminating this problem and came up with one of the greatest examples of autonomous systems that have been deployed during the COVID-19 pandemic- UV sterilization robots. One of its applications is in Ultraviolet germicidal irradiation (UVGI). UVGI is a known disinfection method wherein the DNA or RNA of various microorganisms is disrupted by using short-wavelength ultraviolet C (UV-C) light is used to kill or inactivate them. Wheeled mobile manipulators are another aspect of cleaning healthcare facilities. They can be used to remove bedding and other contaminated materials from hospital rooms before autonomously disinfecting the equipment.

However, not all robots operate autonomously—many require direct human supervision, and most are limited to simple, repetitive tasks.

Telepresence robots which were originally designed for offices are becoming an invaluable asset for medical workers involved with the treatment of highly infectious diseases like COVID-19. They help reduce the risk of contracting the pathogen they're fighting against. Telerobots, with a user interface for their remote control by a human operator, have highly assisted the healthcare system during the COVID-19 pandemic which allows the hospitals to continue carrying out menial emergency surgeries without increasing the risk to the physician.

Around the world, the supply of PPE has become limited as many workers use PPE for long periods, reuse PPE, and even use makeshift PPE. These practices increase the risk of infection to frontline healthcare workers and the risk of transferring infection from one patient to the next. Thus, telerobots are essential to the medical community as they can provide true physical isolation and can reduce the quantity of PPE required for patient intake and treatment. For instance, telerobotic systems can allow a doctor to work using a robot arm remotely using minimal PPE. Thus, helping to operate and monitor medical equipment for patient care. Healthcare staff can interact with medical equipment in the ICU without the need for PPE with the help of remote-controlled manipulators that consist of virtual buttons and dials on a touch screen. This is essential in ICUs where the risk of acquiring COVID-19 is particularly high for frontline healthcare workers.

Drug Repurposing and Vaccine Development

Drug repurposing or repositioning is a technique whereby existing drugs are used to treat emerging and challenging diseases, including COVID-19. It involves identifying new uses for approved or investigational drugs. Drug repurposing has become a promising approach because of the reduced development timelines and overall costs to find a therapeutic agent in comparison to the complete discovery process for a new vaccine.

A recent study that presented integrative network-based systems helped quantify the interplay between the coronavirus–human cell interactome and drug targets in the human protein-protein interaction network which helps in the rapid identification of repurposable drugs against SARS-CoV2. 30 potential repurposable drugs against COVID-19 were identified through such studies.

Several examples of repurposed drugs having been tested in clinical trials for COVID-19, including antiviral drugs and host-targeting therapies, are-

Remdesivir, a monophosphate prodrug of an active C-adenosine nucleoside triphosphate analogue, which was originally discovered for the potential treatment of Ebola virus disease has shown promise in the treatment of COVID-19.

Toremifene, a first-generation selective estrogenic receptor modulator that is non-steroidal, was identified as a top candidate for the treatment of COVID-19.

Other such examples are Favipiravir, Ribavirin, Darunavir, Interferons (pegylated IFNα-2a and pegylated IFNα-2b), Lopinavir-ritonavir and interferon-β combination, Chloroquine, and hydroxychloroquine.

Despite the benefits of drug repurposing in treating COVID-19, challenges remain. The host environment of the virus infection in humans might not be reflected by the cellular or animal assays. The drug's clinical benefits and biological questions were not optimized by many tests because of their expedient design, lack of clinical endpoints, a small number of patients enrolled (thus lack of statistical power), etc.

For example, potential anti-SARS-CoV-2 activities are seen in hydroxychloroquine in vitro assays. However, hydroxychloroquine has shown very little to no efficiency in preclinical and clinical trial studies. Other factors that cause a setback in finding an appropriate drug are using drugs that do not affect the target, intervening at the wrong stage of the disease, lacking translatable pharmacodynamic and pharmacokinetic (ie, poor lung penetration) biomarkers; depending on in vitro antiviral activities and not using appropriate animal models, not addressing the rapid disease progression of COVID-19 in a short period, and not accurately monitoring the complexity of the clinical and biological characteristics to therapeutic intervention, or the presence of heterogeneous populations with different genetic backgrounds which might affect the results.

Regardless of the challenges and limitations of drug repurposing, it is essential as the development of a vaccine for any disease including COVID-19 takes time and even if the process is given priority and sped up, it would take 18–20 months to introduce it ready as a product. Therefore, in the initial stages, repurposed drugs are the only solution.

Now, after over a year of Covid-19, vaccines have and are still being developed. Therefore, it is essential in some way or another to help track the side effects of the vaccine rollout. This is where AI and other digital tools are applied. When the distribution of a vaccine takes place, technology is required to track the batch and lot numbers to know exactly where each dose is and who received it. Eric Sandor, drug safety AI lead at Genpact stated- “There’s a lot of information, in a number of different formats, and it’s very manually intensive to try to codify it in a way that makes sense. AI will help with processing all that data faster than humans can. It’s quite complicated at scale, but is a critical element to overall public health.”

5. Conclusion

To conclude, it is evident that AI has played a major role in the fight against Covid-19. Without its applications, we would have a significant increase in the number of cases and would be nowhere close to finding a virus for further prevention. It has helped from the very beginning-in early detection using various methods which could only be tested in time due to our complex technology and algorithms, in controlling the spread using AI robots and in future prevention in terms of drug repurposing and vaccine development. However, the full extent of technology is nowhere near to be utilized, and with the gradual discovery of its further uses, more complex and in-depth machinery can be built which would help not only the healthcare industries evolve, but our overall world.

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