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A review of modern technologies for tackling COVID-19 pandemic

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Objective: Science and technology sector constituting of data science, machine learning and artificial intelligence are contributing towards COVID-19. The aim of the present study is to discuss the various aspects of modern technology used to fight against COVID-19 crisis at different scales, including medical image processing, disease tracking, prediction outcomes, computational biology and medicines.
Methods: A progressive search of the database related to modern technology towards COVID-19 is made. Further, a brief review is done on the extracted information by assessing the various aspects of modern technologies for tackling COVID-19 pandemic.
Results: We provide a window of thoughts on review of the technology advances used to decrease and smother the substantial impact of the outburst. Though different studies relating to modern technology towards COVID-19 have come up, yet there are still constrained applications and contributions of technology in this fight.
Conclusions: On-going progress in the modern technology has contributed in improving people's lives and hence there is a solid conviction that validated research plans including artificial intelligence will be of significant advantage in helping people to fight this infection.

1. Introduction

Ever since the first report of Coronavirus Disease 2019 (COVID-19) at Wuhan, China in December 2019, it has affected over 200 countries and territories around the world with two million cases and more than 120,000 deaths as on 21 April 2020. With this growing crisis, companies & researchers over the world are looking for the ways to address the challenges of this virus, to mitigate the spread and develop a cure for this disease. In this baffling battle, science and technology is playing a vital role. For example, early in the outbreak when China initiated its response to virus it focused on artificial intelligence (AI) by relying on like facial recognition cameras to track the infected patients with travel history, robots to deliver food and medicines, drones to disinfect public places, to patrol and broadcast audio messages to public encouraging them to stay at home [1]. AI has been used extensively to discover new molecules on the way to find aid for COVID-19. Many researchers are using AI to find new drugs and medicines for the cure, along with some computer science researchers focusing on detecting the infectious patients through medical image processing like X-rays and CT scans [2]. AI is even developing tracking software's like monitoring bracelets that helps in classification of peoples breaching the quarantine rule. Smart phones and AI enhanced thermal cameras are also being used for detecting fever and infected people [3]. Countries like Taiwan infused the national medical insurance database with inputs from the immigration and customs database, hence confronting the coronavirus patients on the basis of their travel history and symptoms [4,5].

In all, AI is used to identify, track and forecast outbreaks, it is helping in diagnosing the virus. It is used in processing the healthcare claims. The drones and robots are used to deliver food and medicine supplies as well as in sterilizing public places. AI is helping to develop drugs and coronavirus vaccine using super computers [6].

This present study focuses on the use of artificial intelligence advances in the fight against the Coronavirus epidemic. It gives a thorough review of the technology advances used to decrease and smother the substantial impact of the outburst. The motivation for the present study is not only limited to assess the effect of the portrayed procedures but also to prescribe their utilization as well. This paper shows the reader the applications of AI and presents an underlying picture of how modern technology could react to the COVID-19 pandemic.

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2. Role of modern technology to quell COVID-19

Technology refers to techniques, frameworks and devices which are the after effect of scientific information being utilized for practical purposes. Artificial intelligence can be characterized as Machine Learning (ML), Natural Language Processing (NLP), and Computer Vision applications. These abilities instruct computers to use huge information based models to design, depict, and predict. In Table 1, we discussed various applications of modern technology in the COVID-19 epidemic. To combat coronavirus, AI majorly focuses on diagnosis of the patients and virus, medical imaging process, disease tracking and its prediction. On the other hand, it also covers alerting, creating awareness and social control through the internet. Following are some ways where technology is being used in the fight against COVID-19.

2.1. Patient's perspective

The overall pandemic of COVID-19 significantly challenges open clinical frameworks. With restricted clinical assets, treatment needs are controlled by the severity of the patient. Though numerous mild outpatients rapidly turned into serious or critical stage, it's more significant to recognize them early and give opportune treatment for optimizing treatment procedure and lessening mortality. AI capacities can be valuable to analyze, predict and clarify (treat) COVID-19 contaminations, and help oversee financial effects. So far, most clinical utilizations of artificial intelligence to the COVID-19 reaction have concentrated on diagnosis dependent on clinical imaging. The quality of the present diagnostic methods at the initial introduction of the disease has been questioned. In recent writings, it has been discovered that a few research works use artificial intelligence to help analyze computational tomography (CT) scans, while other research works use patient's clinical information to predict the advancement of the infection [7,8].

2.1.1. Diagnosis using radiology images

Lives can be saved, expansion of the ailment might be curbed and huge data could be generated from AI models with the quick and precise diagnosis of COVID-19. Scientists working on AI applications show that it can give extra time to radiologists and do a diagnosis quicker and less expensive than with coronavirus regular tests. For this purpose, the doctors can use X-rays as well as CT scans, Computed Tomography [9]. Table 2 explains different artificial intelligence applications in CT diagnosis of COVID-19. Coronavirus tests are short in supply and costly, however, all emergency clinics have X-Rays (or CT) machines. With the assistance of Deep Learning, radiologists can diagnose COVID-19 using X-ray pictures. COVID-Net an artificial intelligence application is created to analyze COVID-19 symptoms in chest x-rays utilizing information of different lung conditions and COVID-19 from patients [10]. In a diagnostic study, an AI platform was established using inception migration neural network for extracting COVID-19 symptoms using CT images, achieving 89.5% accuracy [11]. An initial detection model was created to recognize COVID-19 pneumonia from Influenza-A viral pneumonia and sound cases with pulmonary CT pictures utilizing deep learning systems. The patient's infected parts were proportioned by using a 3-D deep learning model. This study showed 86.7% accuracy of the model [12,13]. Jin et al. developed a deep learning model that can precisely identify corona

Table 1
Applications of modern technology during COVID-19 pandemic.

S. No	Application	Description	References	Status in India
1	Diagnosis using radiology images	• AI is used to extract radiological features for timely and accurate COVID-19 diagnosis • Early detection of COVID-19 cases using different CNN models can be tested by increasing the number of images • COVID-Net, a deep CNN design can be used for detection of COVID-19 cases from CT images and X rays. • COVID-19 detection neural network (COVNet) detects COVID-19 and distinguish it from community acquired Pneumonia and other lung diseases. • 3-dimensional deep learning model can be used for early detection of the COVID-19 Cases	Wang et al. [7], Narin [8], Wang et al. [10], XU et al. [12]	Yes [49,51,53]
2	Disease tracking	• Abnormal respiratory patterns classifier may contribute to large-scale screening of people infected with COVID-19 • Time-dependent SIR model is used to estimate the infected persons. • GRU neural network with bidirectional and attentional mechanisms (BI-AT-GRU) for classifying respiratory patterns. • SEIR - Susceptible, Exposed, Infectious, and Removed or Recovered model is used to forecast the trajectory of the outbreak.	Wang et al. [19],	Yes [46]
3	Prediction outcome of patient's health condition	• Supervised XGBoost classifier provides a simple and intuitive clinical test to precisely and quickly quantify the risk of death. • he machine learning-based CT radiomics models showed feasibility and accuracy for predicting hospital stay in COVID-19 patients	Yan, Zhang, Goncalves et al. [27], Qi et al. [29]	No [46]
4	Computational Biology and Medicines perspective	• BenevolentAI used to search for baricitinib, which is predicted to reduce the ability of the virus to infect lung cells.	Richardson et al. [31]	No [50]
5	Protein structure predictions	• Critical Assessment of Techniques for Protein Structure Prediction (CASP) using deep neural networks predict properties of the protein from its genetic sequence. • Convolutional network architectures is examined for dense prediction. • Residual learning framework is used to ease the training of networks that are substantially deeper for image recognition.	Jumper, Hassabis and Kholi [33], Yu and Koltun [34], He at al. [35]	Yes [52]
6	Drug discovery	• Integrated AI-based drug discovery pipeline to generate novel drug compounds. • Adversarial autoencoders is used to disentangle the style and content of images, unsupervised clustering, dimensionality reduction and data visualization.	Zhavoronkov et al. [37], Makhzani at al. [38]	Yes [48,54]
7	Awareness and social control through Internet	• Smartphone thermometer as an authentic and alternative apparatus for assessing temperature of infected people. • Cough type detection using an extensive set of acoustic features applied to the recorded audio from a relatively large population of both healthy subjects and patient	Maddah and Beigzadeh [41], Nemati et al. [42]	Yes [47]

Table 2
Applications of artificial intelligence in CT diagnosis of COVID-19.

Place of Study	Authors	Application used	Sample Size	Accuracy
China	Wang. et al. [7]	Modified inception transfer-learning model	1065 CT images (325 COVID-19 and 740 viral pneumonia)	Accuracy: 79.3% Specificity: 0.83 Sensitivity: 0.67
	Cheng et al. [9]	2D deep convolutional neural network	970 CT volumes of 496 patients with confirmed COVID-19 and 1385 negative cases	Accuracy: 94.98% AUC: 97.91% Sensitivity: 94.06%, Specificity: 95.47%
	Xu et al. [12]	3-dimensional deep learning model	A total of 618 CT samples were collected: 219 from 110 patients	Accuracy: 86.7%
	Li et al. [13]	COVID-19 detection neural network (COVNet)	4356 chest CT exams from 3322 patients	Accuracy: 95%
Toronto, Canada	Wang, Lin, Wong [10]	COVID-Net: A deep CNN	16,756 chest radiography images across 13,645 patient	Accuracy: 92.4%
Thailand, Hong Kong etc.	Shannon [16]	real-time RT-PCR assay	340 clinical specimens from 246 patients with confirmed or suspected SARS-CoV infection	Potential detection limit of <10 genomic copies per reaction
Global	Narin, Kaya, Pamuk [8]	Chest X-ray images of 50 normal and 50 COVID-19 patients	ResNet50, InceptionV3 and Inception- ResNetV2	ResNet: 50 98% Inception V3: 97% Inception-ResNetV2:87%

virus symptoms from the community acquired pneumonia (CAP) and other lung diseases. A 3D deep learning framework using chest CT was constructed using a neural network (COV-Net) [14]. For Coronavirus diagnosis; a deep learning model was proposed which straightforwardly accepts CT scans information as input and implements lung division, diagnose COVID-19 and finds abnormal slices. Furthermore, the study trusts that the diagnosis outcomes of AI framework can be quantitatively clarified in the initial picture to mitigate the disadvantage of deep neural systems as a black box [15]. An automated tool was created to quantifying the symptoms of this virus in the lungs of the patient and to observe the growth of the infection or reaction to cure, using a deep learning method. The capability of AI in diagnostics isn't yet practiced, though Chinese hospitals have installed "AI-assisted" radiology technology. Reverse. Transcription Polymerase Chain Reaction (RT-PCR) tests are the key methodology used for diagnosing coronavirus, yet they have restrictions as far as specimen assortment, time required for the study, and execution [16]. Specific abnormality in images and designs in CT scans showing COVID-19 symptoms has been discovered [17].

2.1.2. Disease tracking

Artificial intelligence can be used to track illness will spread of COVID-19 with time and place. Ongoing discoveries recommended that COVID-19 has respiratory patterns which are different from seasonal influenza and regular cold, eminently that they display tachypnea (fast breathing) [18]. Forecast of tachypnea could be a first-order diagnostic feature that may add to enormous scope screening of potential patients [19]. Different proposition have been made to use cell phones in COVID-19 identification, either utilizing implanted sensors to recognize COVID-19 side effects or phone based surveys to channel high-risk patients dependent on reactions to key questions [20]. Berlin utilizes an epidemiological SIR model that considers containment measures by governments, for example, lockdowns, quarantines, and social distancing solutions [21]. A likewise expanded SIR model, considering general public health measures against the pandemic and utilizing information from China, has been pre-published and made accessible in R for [22]. GLEAMviz epidemiological model is used to track the spread of the infection [23]. Similarly, Metabiota [24] offers an Epidemic Tracker [25] and a near-term forecasting model of infection spread, which they used to make forecasts. Tracking the spread of COVID-19 can be significant information for general public health authorities to design, plan, and deal with the pandemic [26].

2.1.3. Prediction of a patient's health condition

A novel methodology was proposed dependent on features contained in patients' clinical data and blood tests to assist doctors in identifying high-risk patients as early as they can under these circumstances, thus improving the forecasting of patients and lessening the mortality of those that are seriously sick [27]. In lieu of this, a forecast model dependent on the XGBoost calculation was made to predict mortality risk and distinguish key features which can be estimated in clinics. The researchers found out three key clinical pointers (lactic dehydrogenase, lymphocyte and high-affectability C-receptive protein) for assessing a patient's mortality. A plus point of this method is its interpretability, the three indicators identified by the methodology correspond to the most significant factors in the pathophysiological progress of COVID-19, specifically cell injury, cell immunity, and inflammation [28]. A corresponding report meant to forecast if existing COVID-19 patients would require a long stay in hospitals or not, based on a U-Net subsidiary trained on CT imaging data [29]. These two methodologies can help in recognizing the patients that may require escalated and long-term care, helping clinics deal more adequately. At last, while both of these investigations were constrained in scope and information, they establish significant roads of research that can be supplemented and stretched out with clinical information from approaching cases the world over.

2.2. Computational biology and medicines perspective

Computational Biology includes the development & use of data analytics, mathematical modeling and computational simulation procedures to study biology. Computational biologists are assisting with battling coronavirus through disease modeling and finding another medication for this pandemic. Disease dynamics modeling contributes in understanding the effect of parameters that rules the spread of the infection, and the impact that mediations can have in controlling this spread [30]. As soon as virus advances in the deceased body, both lungs start showing ground glass and infiltrates. Numerous data driven drug repurposing (drug repositioning) approaches have been proposed with the point of identifying illnesses, conditions or groups of patients that could be treated with existing medications not known for this disease [31].

2.2.1. Prediction of protein structure

When virus RNA genome first enters a cell, it mingles with the host's protein-production, utilizing it to make proteins that can duplicate RNA molecules. These RNA-replicating proteins, called "polymerases," make a target for treatments [32]. Proteins have a 3D structure, which is evaluated by their genetically encoded amino acid sequence, and this structure impacts the role and purpose of the protein [33]. There are two primary ways to deal with the forecast task: template modeling, which predicts structure utilizing similar proteins as a template sequence, and the other is template free modeling, which predicts structure for proteins that have unknown related structure [34]. The AlphaFold model depends on an enlarged ResNet architecture and uses amino acid sequences, and also features taken out from parallel amino acid sequences using several sequence arrangements, to foresee the distance and the dispersal of angles between amino acid residues [35]. This framework has been applied to anticipate the structures of six proteins identified with SARS-CoV-2 (SARS-CoV-2 membrane protein, protein 3a, Nsp2, Nsp4, Nsp6, and papain-like proteinase) [33]. It is projected that these predictions will help to see coronavirus capacities and possibly lead to future improvement of cures against COVID-19.

2.2.2. Drug discovery

Group of specialists at the Massachusetts Institute of Technology are building an approach to obstruct the novel coronavirus that causes COVID-19 by making a "decoy" receptor, or protein, that could be taken as a medication. Coronaviruses cause sickness by binding the body's ACE2 receptors. The MIT specialists are utilizing an AI model trained on data about the ACE2 receptor to simulate the connection between the baits and the virus [36]. Some research focuses to find novel compounds for use in focusing on SARS-Cov2 by utilizing an exclusive pipeline to discover inhibitors for the 3C-like protease [37]. Such models utilize three sorts of information: the crystal structure of the protein, the co-crystalized ligands, and the homology model of the protein. For each info type, various models including Generative Auto-encoders and Generative Adversarial Networks are utilized [38]. The researchers investigate potential applicants using a reinforcement learning approach with a prize capacity that consolidates factors, for example, measures of medication, likeness, novelty, and assorted variety.

2.3. Awareness and social control through internet

Though national and worldwide associations have utilized social media platforms to communicate with the general population, but apparently this is leading to a crisis in which populaces can become overwhelmed with information, and the propagation of misinformation is progressively common. WHO's reaction to fighting this infodemic is using its Information Network for Epidemics (EPI-WIN) stage for imparting data to key partners [39]. Apart from that, the Facebook promotions with content identified with the infection is analyzed. The Facebook Ad Library [40] scans all commercials utilizing the catchphrases "coronavirus" and "COVID-19" and gathered 923 outcomes across 34 nations, with most in the US (39%) and the EU (Italy made up 25% of the ad showcases). A system for COVID-19 detection utilizing information found from smartphones' sensors, for example, cameras, microphones, temperature and inertial sensors is proposed in Refs. [41]. On the other hand, sound information received from a cell phone's microphone is utilized for cough type detection [42]. This information is significant for AI calculations to learn and foresee the contamination threat of every being, subsequently helping in early identification of high-risk cases for quarantine purpose, thus diminishing the spread of the infection to the helpless populations [43]. A few drones are utilized to trail people, not applying facemasks, while others are utilized to broadcast information to bigger crowds and furthermore to sanitize open spaces. Small-Multi-Copter [44], a Shenzhen-based innovation, has assisted with decreasing the infection transmission hazard in city-wide transport of clinical supplies and quarantine materials through drones. To battle the spread of the novel coronavirus spread in India, the administrations launched Aarogya Setu [45] mobile application that trails coronavirus cases around and helps in battling the infection on an individual level. It helps in tracking the coronavirus contamination by utilizing the cellphone's GPS framework and Bluetooth and give data that will help in deciding whether you have been close to a COVID-19 tainted individual or not.

3. Conclusion

Researchers are investigating each possible choice for fighting the coronavirus pandemic, and Modern Technology represents to a captivating road. While technology advances have entered into our day by day lives with numerous victories, they have additionally added to helping people in the very intense battle against COVID-19. The papers talk about the troubles while using these algorithms in real world clinical practices. Likewise, there is an interest for a future work on building up a benchmark framework to assess and look at the current techniques. The present models acquired extraordinary accuracy in recognizing COVID-19 symptoms with different kinds of viral pneumonia utilizing radiology pictures but lacks transparency and interpretability. It can be conclude that there is a wide scope of potential utilizations of modern technologies covering clinical and cultural difficulties made by the coronavirus pandemic; but not many of them are right now develop enough to show operational effect.

Declaration of competing interest

Nil.

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