A Comprehensive Survey on the Role of the Medical AI for the Healthcare Support

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ABSTRACT
The COVID-19 pandemic has caused widespread devastation, affected millions of lives and placed immense pressure on healthcare systems worldwide. As the viruses continues to ravage communities, the need for solutions that can support the early diagnosis of diseases and automate critical processes in the healthcare system has become more pressing than ever before. Artificial Intelligence (AI) has emerged as a versatile technology in various industries due to its ability to save time and lives by enabling machines to learn from experience, adapt to new inputs, and perform human-like tasks. In the medical industry, AI has become a crucial tool in developing new applications to combat diseases and save lives. Therefore, researchers have focused on exploring the potential of AI in the fight against diseases and commonly coronavirus. This survey paper presents a comprehensive review of recent AI models and techniques used in virus diagnosis, showcasing the different approaches used in both released and novel solutions depending on different types of inputs, such as images and biomedical data. The paper provides an overview of the models' performance, highlighting their strengths and limitations. The study emphasizes the contributions of previous trials, demonstrating how AI has helped in detecting, tracking, and predicting the spread of viruses. Moreover, the paper highlights the challenges encountered while developing AI models for virus diagnosis, including the limited availability of high-quality data, the need for more diverse datasets, and the ethical challenges related to data privacy and security. The study offers insights to guide future research in developing more accurate and effective models. The paper provides a sensible outlook for the future researchers to develop highly effective models by highlighting the need to address the challenges encountered in previous trials. Finally, the paper concludes by emphasizing the importance of continued research and development in AI-based solutions to combat diseases.

General Terms
Artificial Intelligence (AI), Machine Learning (ML), Artificial Neural Network (ANN), AI-as-a-Service (AIaaS)

Keywords
Medical AI, Novel Models, Diagnoses, Cloud-based AI, Inclusion Criteria.

1. INTRODUCTION
The year 2020 presented the global healthcare industry with an unprecedented public health challenge in the form of the COVID-19 pandemic. The rapid spread of the virus left the world in a state of shock and prompted researchers to focus their attention on modelling the virus's spread and the effectiveness of different measures to suppress it. In response, concentrated research efforts were dedicated to developing Medical AI solutions, which could serve as alternative approaches to support medical professionals and patients in obtaining faster and more accurate diagnoses.

Artificial Intelligence (AI) has emerged as a valuable tool in a wide range of sectors, including healthcare. By integrating AI technologies with the medical industry, Medical AI has been proposed as an intelligent approach to provide solutions to save lives. This paper focuses on articles that meet the inclusion criteria of providing original research on the use of AI in virus diagnosis, including machine learning, deep learning, NLP, images, clinical markers, and sound analysis.

After a systematic review of various databases, the final list of 74 articles was chosen for review, highlighting virus diagnosis based on various modalities, including images, biomarkers, and sound analysis. The paper presents a comprehensive review of current Medical AI models and their potential to support the healthcare sector, along with limitations and future research directions.

The paper is organized into five sections, beginning with an introduction, followed by a section on the main concepts related to Medical AI, a summary of Medical AI models, and a section on limitations and future directions. The paper concludes by summarizing the key outcomes and highlighting the importance of continued research into Medical AI solutions to tackle the challenges presented by various diseases.

2. MEDICAL AI OVERVIEW
Artificial Intelligence (AI) has gained significant attention in the field of medicine in recent years due to its ability to improve diagnostic accuracy, risk assessment models, and workflow efficiency. AI is a broad term that encompasses various forms of computer science, with its focus mainly on image processing, machine learning, deep learning, artificial neural networks, and cloud-based AI.

Image processing refers to the enhancement of images for clarity, retrieval of specific information, or pattern measurements. It aims to improve the image quality so that it can be easily interpreted by both humans and machines. Medical image processing is an active research field where various techniques are used to facilitate diagnosis. For instance, image segmentation techniques can be used to identify the region of interest in medical images, while registration techniques can be used to align different images for comparison.

Machine learning is a category of algorithms that allows software applications to become more accurate in predicting outcomes without being explicitly programmed. It builds algorithms that can receive input data and use statistical

analysis to predict an output while updating outputs as new data becomes available. For example, machine learning algorithms can be used to detect abnormalities in medical images with high accuracy, such as identifying early-stage tumors in mammograms.

In the field of medical research, machine learning has also been used to analyze large volumes of genomic data to identify potential drug targets for the treatment of diseases. By analyzing data on genes, proteins, and other molecular targets, ML algorithms can identify potential drug targets and predict how those drugs will interact with specific biological pathways. This can help accelerate the drug discovery process and lead to the development of more effective treatments for a wide range of diseases.

Another area of research is the use of machine learning algorithms to analyze data from wearable devices, such as fitness trackers and smartwatches. By analyzing data on physical activity, heart rate, and other biometric indicators, ML algorithms can provide insights into an individual's health status and identify potential health risks. This can help individuals make informed decisions about their health and well-being and can also inform healthcare providers about their patients' health status.

Machine learning algorithms can also be used to analyze data on patient outcomes to identify factors that contribute to better health outcomes. By analyzing data on patient demographics, medical histories, and other factors, ML algorithms can identify factors that are associated with better health outcomes and develop personalized treatment plans for individual patients. This can help improve the effectiveness of treatments and reduce the risk of complications.

In the field of drug development, machine learning algorithms can be used to predict the toxicity of new drug candidates. By analyzing data on the molecular structure of drugs and the biological pathways they target, ML algorithms can predict the likelihood of toxicity and identify potential safety concerns before the drugs are tested in human trials. This can help reduce the risk of adverse reactions and improve the safety of new drugs.

Another area of research is the use of machine learning algorithms to analyze patient data to predict the risk of developing chronic diseases such as diabetes, heart disease, and cancer. By analyzing data on patient demographics, medical histories, and other factors, ML algorithms can identify individuals who are at high risk of developing these diseases and develop personalized prevention strategies. This can help prevent the onset of chronic diseases and improve the overall health and well-being of individuals.

Machine learning algorithms can also be used to analyze data on population health to identify potential health risks and develop targeted interventions. By analyzing data on demographic trends, disease prevalence, and other factors, ML algorithms can identify populations that are at high risk of specific health problems and develop interventions to prevent or treat those problems. This can help improve the overall health of populations and reduce the burden on healthcare systems.

Deep learning is a particular kind of machine learning that achieves great power and flexibility by learning to represent the world as a nested hierarchy of concepts. It involves architectures that contain multiple hidden layers (deep networks) to learn different features with multiple levels of abstraction. In deep learning, meaningful representations from the input data are learned by building complicated mappings using a series of simple mappings. This technique has been particularly effective in image recognition and segmentation tasks, where it has achieved state-of-the-art performance in many applications.

Artificial Neural Network (ANN) is a machine learning algorithm used for classification, regression, and clustering problems. It imitates the human brain in processing various types of data and creating patterns for use in a decision-making process through neural networks. ANNs have been successfully used in medical diagnosis and prediction tasks, such as predicting the risk of heart disease in patients.

Cloud-based AI is the idea of providing artificial intelligence as a fee-for-service, allowing customers to access continuously updated algorithms. It merges the machine learning capabilities of artificial intelligence with cloud-based computing environments, making intuitive and connected experiences possible. SaaS providers are adding AI tools into larger software suites to provide greater functionality to end-users, while AI-as-a-Service (AIaaS) platforms provide AI technology for a monthly fee, offering processing power in the cloud that can be deployed anywhere. This significantly reduces upfront costs and can be scaled as business needs change. Cloud-based AI has enabled the development of numerous medical applications, such as telemedicine and remote patient monitoring, which can improve access to healthcare services and reduce costs for patients.

Cloud-based AI also enables real-time data processing and analysis, which can be particularly important in healthcare. For example, medical devices and wearables can collect large amounts of data on patient health and transmit that data to the cloud for analysis. AI algorithms can then analyze that data in real-time to identify potential health risks and alert healthcare providers or patients to take action. This can help prevent adverse health events and improve the overall quality of healthcare delivery.

This can also be used to improve the accuracy of medical diagnoses. By analyzing large volumes of medical data, including patient histories, lab results, and imaging studies, AI algorithms can provide more accurate and timely diagnoses. This can help reduce the risk of misdiagnosis and ensure that patients receive appropriate treatments in a timely manner.

Another area where cloud-based AI can have a significant impact is in drug discovery. By analyzing large datasets of molecular structures and biological pathways, AI algorithms can identify potential drug targets and predict how those drugs will interact with specific biological pathways. This can help accelerate the drug discovery process and lead to the development of more effective treatments for a wide range of diseases.

Cloud-based AI can also help improve the efficiency of clinical trials. By analyzing data from previous trials and other sources, AI algorithms can help identify patient populations that are most likely to benefit from a particular treatment. This can help streamline the clinical trial process and reduce the time and cost of drug development.

Finally, cloud-based AI can help improve the overall quality of healthcare delivery by enabling better coordination and communication among healthcare providers. By analyzing data from electronic health records and other sources, AI algorithms can provide insights into patient health and help healthcare providers make more informed decisions about patient care.

This can help improve patient outcomes and reduce the burden on healthcare systems.

In summary, cloud-based AI has the potential to revolutionize healthcare by improving access to healthcare services, reducing costs, and improving the overall quality of healthcare delivery. By enabling real-time data processing, improving the accuracy of medical diagnoses, accelerating drug development, and improving the efficiency of clinical trials, cloud-based AI can help address some of the biggest challenges facing the healthcare industry today. As technology continues to evolve, it's expected to see even more innovative applications of cloud-based AI in healthcare and other industries in the years to come.

3. SUMMARY OF THE MEDICAL AI MODELS

The healthcare industry is facing an urgent need for decision-making technologies to handle the current critical situation and provide real-time suggestions to speed up the diagnosis process. AI technology has emerged as a proficient solution that mimics human intelligence. It is being used for proper screening, analyzing, prediction, and tracking of current and potential future patients. AI-based applications are being used to track data on confirmed, recovered, and deceased cases, and to assist physicians in the treatment process. AI is also being used to control the spread of disease through accurate symptom and test analysis, reducing the total number of steps taken in the process and making it more accessible.

One of the significant applications of AI in healthcare is precision medicine. Precision medicine involves personalizing medical treatments based on an individual's specific genetic makeup, lifestyle, and environment. AI can help healthcare providers analyze vast amounts of data to identify patterns and make predictions about a patient's health. This can help providers tailor treatments to individual patients, improving the likelihood of successful outcomes.

AI can also be used to improve the efficiency of clinical trials for new drugs and treatments. Clinical trials are essential for testing the effectiveness and safety of new treatments, but they can be time-consuming and expensive. AI can help researchers analyze large amounts of data to identify potential candidates for clinical trials and predict the likelihood of success. This can help streamline the clinical trial process, making it faster and more cost-effective.

In addition to improving clinical decision-making, AI can also be used to enhance the patient experience. For example, AI-based chatbots can help patients schedule appointments, refill prescriptions, and access medical advice without having to leave their homes. This can help reduce the burden on healthcare providers and improve patient satisfaction.

AI can also be used to improve population health management. Population health management involves analyzing data from large groups of patients to identify health trends and develop targeted interventions. AI can help healthcare providers analyze data from electronic health records, insurance claims, and other sources to identify patients who may be at risk of developing certain conditions. This can help providers develop programs to prevent the onset of disease and improve overall population health.

Finally, AI can be used to improve healthcare delivery in low-resource settings. In many parts of the world, access to healthcare is limited, and resources are scarce. AI can help healthcare providers diagnose and treat patients in these settings by providing remote consultations, analyzing medical images, and developing predictive models to identify high-risk patients. This can help improve the quality of care and reduce the burden on healthcare providers in these areas.

Over the last two years, numerous research papers have been published on the application of AI in the healthcare sector. A set of AI models has been proposed to focus on solving various problems related to different phases, with the common goal of supporting the healthcare industry. These AI models are designed to aid in the detection and diagnosis of infections, monitor treatment progress, project cases and mortality rates, and prevent the spread of disease.

3.1 Released Models

Several AI-driven models have been developed and evaluated over the past two years to aid in the diagnosis, monitoring, and prevention of COVID-19. One early model utilized natural language processing and artificial intelligence to analyze unstructured patient data collected through telehealth visits. After parsing and segmenting documents, the model used a word embedding-based convolutional neural network to predict COVID-19 test results based on patients' self-reported symptoms. The model was subsequently applied to prioritize testing appointment scheduling [1].

Another AI-driven system was developed to provide hierarchical community-level risk assessment to support the development of strategies for combating the pandemic. The system provides risk indexes associated with specific locations in a hierarchical manner, enabling individuals to select appropriate actions for protection while minimizing disruptions to daily life [2].

A deep learning-based model was developed for the detection and analysis of COVID-19 on chest X-ray images. The model used deep learning-based CNN models to classify COVID-19 infected patients and healthy patients based on posteroanterior (PA) view of chest x-rays. The model achieved high performance with 90.8% accuracy, 84% sensitivity, and 93% specificity [3].

Another model was developed to diagnose COVID-19 pneumonia using CT scans. A series of deep learning algorithms were trained in a multinational cohort of 1280 patients to localize parietal pleura/lung parenchyma followed by classification of COVID-19 pneumonia. [4]

AI algorithms were also used to integrate chest CT findings with clinical symptoms, exposure history, and laboratory testing to rapidly diagnose patients who are positive. The AI system achieved almost equal sensitivity [5].

Another AI system was built to diagnose novel coronavirus phenomena (NCP) and differentiate it from other common pneumonia and normal controls. The system identified important clinical markers that correlated with the NCP lesion properties and provided accurate clinical prognosis that can aid clinicians in considering appropriate early clinical management and allocating resources appropriately [6].

An AI system for rapid COVID-19 detection was also developed and evaluated on a large dataset with more than 10 thousand CT volumes from COVID-19, influenza-A/B, non-viral community-acquired pneumonia, and non-pneumonia subjects [7].

Furthermore, machine learning models were developed to automate the severity assessment of diagnosed COVID-19 cases based on chest CT scans and clinical data [8][9].

Several hospitals in Europe utilized AI to diagnose COVID-19 based on CT images and prioritize the reading of suspicious cases for earlier identification and treatment. In Japan, Fujitsu and Tokyo Shinagawa Hospital launched a joint R&D project for AI technology to support diagnostic imaging via chest CT [10].

Machine learning algorithms have also been used to identify potential drug candidates for the treatment of COVID-19. One study utilized a deep learning-based virtual screening approach to identify potential inhibitors of the main protease of SARS-CoV-2, the virus responsible for COVID-19. The study identified several promising drug candidates that could be further investigated in preclinical studies [11].

Another area of research is the use of ML algorithms to predict the impact of COVID-19 on healthcare systems. By analyzing data on hospital admissions, ICU occupancy, and the availability of medical resources, ML algorithms can provide insights into the potential impact of the pandemic on healthcare systems. This can inform resource allocation decisions and help healthcare providers prepare for surges in demand [12].

ML algorithms can also be used to analyze social media data to identify patterns of misinformation and disinformation related to COVID-19. By analyzing data from social media platforms, ML algorithms can identify false or misleading information and provide insights into how it spreads. This can help public health officials and policymakers develop strategies to combat the spread of misinformation [13].

Another potential application of ML in the fight against COVID-19 is in the development of contact tracing apps. ML algorithms can be used to analyze data on individuals' movements and interactions to identify potential exposure to the virus. This can help public health officials identify and contain outbreaks before they spread [14].

ML algorithms can also be used to develop personalized risk assessment tools for COVID-19. By analyzing data on an individual's medical history, demographics, and lifestyle, ML algorithms can provide personalized risk assessments for COVID-19. This can help individuals make informed decisions about how to protect themselves and reduce their risk of infection [15].

Another area of research is the use of ML algorithms to identify potential COVID-19 hotspots. By analyzing data on population density, mobility patterns, and other factors, ML algorithms can identify areas at high risk of COVID-19 transmission. This can help public health officials target interventions and resources to the areas that need them most [16].

ML algorithms can also be used to analyze data on the effectiveness of vaccines. By analyzing data on vaccine efficacy, side effects, and distribution, ML algorithms can provide insights into how to optimize vaccine distribution and improve the effectiveness of vaccination programs [17].

Another potential application of ML in the fight against COVID-19 is in the development of virtual clinical trials. ML algorithms can be used to analyze data from virtual clinical trials, reducing the need for in-person visits and accelerating the development of new treatments. This can help accelerate the development of effective treatments for COVID-19 and other diseases [18].

3.2 Novel Models

Several studies have proposed novel AI-based models to fight COVID-19. One study proposed integrating AI with detection techniques to check the presence of anti-human microorganisms on various surfaces or in the environment to detect contagious diseases, including COVID-19. This would decrease the possibilities of getting infected and limit the spread of the virus. The proposed detector would gather extensive microorganism data on the surface and could also help in human infection detection. This measure would not only save lives but also limit economic damages through better resource management [19].

Another study proposed using AI to detect COVID-19 using built-in smartphone sensors, providing a low-cost solution, with the ability to be used by both radiologists and ordinary people on their smartphones for virus detection purposes. The AI solution reads the smartphone sensors signal measurements to predict the grade of severity of pneumonia as well as predicting the disease's result. However, each type of data collected needs different processing to provide the targeted output [20].

A team of researchers at MIT proposed an AI model that can distinguish asymptomatic people from healthy individuals through forced-cough recordings. They trained the MIT Open Voice model by building a data collection pipeline of COVID-19 cough recordings through their website, building the largest audio COVID-19 cough balanced dataset reported, with more than 5,300 participants. The AI speech processing framework controls the acoustic biomarker feature extractors to assess COVID-19 from cough recordings, providing an individualized patient saliency map to monitor patients in real-time [21].

A proposed CRISPR-based test for COVID-19 using a smartphone camera was also suggested in one of the studies. This test would allow individuals to swab their nostrils, put the swab in a device, and get a read-out on their phone in 15 to 30 minutes that tells them if they are infected with the COVID-19 virus [22].

Several studies have proposed the use of AI to analyze data from electronic health records (EHRs) to predict COVID-19 outcomes and identify patients at high risk of complications. By analyzing data on patients' medical histories, demographics, and clinical characteristics, ML algorithms can provide personalized risk assessments for COVID-19. This can help healthcare providers identify patients who may require more intensive treatment and support, improving patient outcomes [23].

A study proposed using AI to develop a chatbot that can provide personalized health advice and support for individuals with COVID-19 symptoms. The chatbot would use natural language processing and machine learning algorithms to analyze data on patients' symptoms, medical histories, and other factors to provide personalized advice on how to manage symptoms and when to seek medical attention. This could help reduce the burden on healthcare systems and improve patient outcomes [24].

Another potential application of AI in the fight against COVID-19 is in the development of drug repurposing strategies. By analyzing data on the molecular mechanisms of existing drugs and the molecular pathways of COVID-19, ML algorithms can identify potential drug candidates for repurposing. This can help accelerate the development of effective treatments for COVID-19 and reduce the time and cost of drug development [25].

ML algorithms can also be used to monitor the spread of COVID-19 in real-time. By analyzing data on COVID-19 cases, hospital admissions, and deaths, ML algorithms can

provide insights into how the pandemic is spreading and identify potential hotspots. This can help inform public health policies and interventions and help prevent further spread of the virus [26].

Another area of research is the use of AI to analyze data on COVID-19 clinical trials. By analyzing data on clinical trial outcomes, patient characteristics, and other factors, ML algorithms can provide insights into the effectiveness of different treatments and help inform clinical decision-making. This can help accelerate the development of effective treatments for COVID-19 [27].

ML algorithms can also be used to analyze data on COVID-19 vaccination campaigns. By analyzing data on vaccine distribution, uptake, and effectiveness, ML algorithms can provide insights into how to optimize vaccine distribution and improve the effectiveness of vaccination programs. This can help prevent further spread of the virus and reduce the burden on healthcare systems [28].

Another potential application of AI in the fight against COVID-19 is in the development of personalized treatment plans. By analyzing data on patients' genetic makeup, medical histories, and other factors, ML algorithms can provide personalized treatment plans tailored to individual patients. This can help improve the effectiveness of treatments and reduce the risk of complications [29].

ML algorithms can also be used to analyze data on COVID-19 testing and contact tracing. By analyzing data on testing rates, results, and contact tracing efforts, ML algorithms can provide insights into how to improve testing and tracing efforts and prevent further spread of the virus. This can help reduce the burden on healthcare systems and improve patient outcomes [30].

Another area of research is the use of AI to analyze data on the economic impacts of COVID-19. By analyzing data on employment, industry trends, and other factors, ML algorithms can provide insights into how the pandemic is affecting different populations and industries. This can inform policy decisions and help mitigate the economic impact of the pandemic on society [31].

Finally, ML algorithms can be used to analyze data on mental health outcomes related to COVID-19. By analyzing data on mental health symptoms and trends, ML algorithms can provide insights into how the pandemic is affecting mental health and inform interventions to support individuals who are struggling with mental health issues. This can help improve the overall health and well-being of individuals affected by COVID-19 [32].

4. LIMITATIONS AND FUTURE DIRECTIONS

4.1 Limitations

This section discusses the challenges and limitations encountered during the execution of previous models in the context of COVID-19 diagnosis using machine learning (ML) algorithms. Validations and new avenues for further research are also highlighted. The ultimate aim is to ensure that the ML models work efficiently in real-time, especially in hospitals and medical facilities. To achieve this, the accuracy, precision, and recall of the models must be tested and data balancing carried out using appropriate metrics.

One primary challenge is the unavailability of large-scale datasets, which is crucial for any ML algorithm to function optimally. Inadequate training data can lead to overfitting, and the validation of medical data requires qualified medical specialists. However, collecting large datasets from various hospitals worldwide, with appropriate verification from medical professionals, can make the models more reliable and trustworthy.

Another significant challenge is the presence of noisy datasets, which contain a considerable amount of meaningless information that reduces model accuracy. To address this, appropriate data preprocessing techniques can be utilized to remove duplicate and redundant data.

Working with unstructured data, such as ambiguous and erroneous data in unlabeled texts, is another challenge. A vast amount of data from numerous sources may be incorrect, and too much data makes it challenging to extract useful information. To tackle this, appropriate labeling by medical professionals can be done before releasing the dataset, and natural language processing techniques can be employed to detect incorrect data.

Data from a single source may not provide extensive validation. Therefore, it is crucial to acquire data from various geographical locations, although heterogeneous data is not readily available. Hospitals from different locations can collaborate to release a universal dataset containing details of patients from all around the world.

In addition to the challenges mentioned above, another limitation of using ML algorithms in COVID-19 diagnosis is the lack of interpretability. ML models are often considered as black boxes, making it difficult to understand how they arrive at their conclusions. This can be a significant concern in the medical field, where the decisions made by these models can have significant consequences. To address this, explainable AI techniques can be used to provide insight into how the model arrived at its decision, making it easier for medical professionals to understand and trust the model's recommendations.

Another challenge is the need for real-time analysis of medical data. In the case of COVID-19, early diagnosis and treatment are essential to prevent the spread of the virus and improve patient outcomes. ML models must be capable of analyzing medical data in real-time, and the results must be available to medical professionals immediately. This requires high-performance computing and storage infrastructure and efficient data transfer mechanisms.

Privacy concerns are also a challenge when using ML algorithms in healthcare. Medical data is highly sensitive, and patient privacy must be protected at all times. To address this, appropriate data protection measures, such as data encryption, access control, and anonymization, must be implemented. Additionally, ethical considerations, such as informed consent, must be taken into account when collecting and using patient data for research purposes.

Another limitation of ML algorithms in COVID-19 diagnosis is the potential for bias. ML models can be biased if the training data is not representative of the population being analyzed. This can lead to inaccurate or unfair conclusions, particularly in the case of minority or vulnerable populations. To address this, appropriate data sampling techniques can be used to ensure that the training data is representative of the population being analyzed.

ML algorithms must also be validated using appropriate metrics to ensure their reliability and accuracy. This requires a

standardized approach to testing and validation, including the use of appropriate performance metrics and statistical tests. Additionally, the models must be tested on a diverse range of datasets to ensure their generalizability.

Another challenge is the integration of ML algorithms into existing healthcare systems. ML models must be integrated seamlessly into existing healthcare workflows and systems, and the output must be presented in a way that is easy for medical professionals to understand and use. This requires close collaboration between data scientists and medical professionals to ensure that the models are designed with the end-user in mind.

The scalability of ML algorithms is also a concern, particularly in the case of large-scale pandemics such as COVID-19. ML models must be able to handle large volumes of data and be easily deployable in a variety of settings. This requires efficient data storage, processing, and transfer mechanisms, as well as the ability to run the models on a variety of hardware platforms.

Finally, the cost of developing and deploying ML algorithms in healthcare can be a significant barrier. Developing and validating ML models requires significant resources, including data scientists, hardware, and software. Additionally, the cost of deploying and maintaining these models in healthcare settings can be high. To address this, appropriate funding mechanisms must be put in place to support research and development in this area, and cost-effective deployment models must be developed.

4.2 Future Directions

In the context of viruses' diagnosis using machine learning (ML) algorithms, there are several potential avenues for further research and implementation. One such avenue is the exploration of remote diagnosis techniques, which can eliminate unnecessary contact with radiologists and medical personnel. Automation techniques can be leveraged to facilitate the entire diagnosis process entirely remotely, reducing the risk of transmission.

Another promising approach is to combine multiple modalities to increase the accuracy of the models. By integrating multiple models, false negatives and incorrect results can be significantly reduced, resulting in more reliable and accurate diagnoses.

Medical validation is crucial for the successful implementation of these algorithms in a range of treatment centers. Extensive validation by medical experts is required to ensure that the models are reliable and accurate. Once validated, these algorithms can be utilized in various medical facilities to aid in the diagnosis of COVID-19.

With the ongoing high-spread of the viruses, there is a growing need for rapid and accurate diagnosis. One potential avenue for future research is the development of real-time diagnostic tools that can be used in point-of-care settings. These tools would be portable, easy to use, and capable of providing accurate results in a matter of minutes. ML algorithms can be used to analyze data from these tools, improving their accuracy and reliability.

Another potential area of research is the development of predictive models that can forecast the spread of the virus and identify populations that are at high risk of infection. These models can be used to inform public health policies and interventions, improving the effectiveness of prevention and control measures.

ML algorithms can also be used to develop personalized treatment plans based on an individual's genetic makeup, medical history, and lifestyle. This can help healthcare providers tailor treatments to individual patients, improving the likelihood of successful outcomes.

Another potential area of research is the use of ML algorithms in vaccine development. ML can be used to analyze large datasets to identify potential vaccine candidates, predict their efficacy, and optimize their design. This can help accelerate the development of effective vaccines and improve their effectiveness.

ML algorithms can also be used to analyze the social and economic impact of the pandemic. By analyzing data from various sources, including social media and news outlets, ML algorithms can provide insights into how the pandemic is affecting different populations and industries. This can inform policy decisions and help mitigate the impact of the pandemic on society.

Another potential application of ML in healthcare is the development of virtual assistants and chatbots that can provide personalized medical advice and support. These tools can be used to improve patient engagement and education, enhancing the patient experience and improving health outcomes.

ML algorithms can also be used to analyze data from wearable devices, such as smartwatches and fitness trackers. This can provide valuable insights into an individual's health and fitness, helping healthcare providers tailor treatment plans to individual patients.

Another potential area of research is the use of ML algorithms in drug discovery. ML can be used to analyze large datasets and identify potential drug targets, predict drug efficacy, and optimize drug design. This can help accelerate the development of new treatments and improve their effectiveness.

Finally, the integration of ML algorithms into electronic health record (EHR) systems has the potential to transform healthcare delivery. By analyzing data from EHRs, ML algorithms can provide valuable insights into patient health and inform clinical decision-making. This can improve the quality of care and reduce healthcare costs.

Overall, ML algorithms have the potential to revolutionize healthcare delivery and improve patient outcomes. As research in this area continues, it is essential to maintain a focus on patient safety, privacy, and ethical considerations. By addressing these challenges, ML algorithms can be integrated effectively into healthcare systems, improving the quality and accessibility of healthcare for all.

5. CONCLUSION

Pandemics has had a significant impact on people's health worldwide, and the advancements in technology, particularly in the fields of AI and data science, have played a crucial role in the fight against the virus. This comprehensive review focuses on various diagnostic procedures that utilize machine learning and deep learning techniques to support the healthcare sector. The review provides an overview of the proposed models and highlights their limitations, thereby identifying gaps that need to be addressed to chart a better future direction for research. By doing so, the review aims to contribute to the development of more effective tools to support healthcare in the ongoing battle against different viruses.

It is important to note that while AI and data science have made significant strides in the fight against pandemics, they are not a

silver bullet. Their success relies on the quality and quantity of data available to them, and the ability to interpret the results of the analysis accurately. Therefore, it is crucial to ensure that data collection and sharing are conducted in a responsible and ethical manner to ensure the integrity of the results. Additionally, it is essential to ensure that the implementation of AI and data science tools in healthcare is done in a way that is accessible and equitable to all populations, regardless of socioeconomic status or geographic location.

In conclusion, the application of machine learning and deep learning techniques in healthcare provides a promising avenue for improving diagnostic procedures and enhancing the effectiveness of treatment options. The ongoing COVID-19 pandemic has highlighted the importance of investing in technological advancements to support the healthcare sector. By continuing to invest in research and development in this field, it's expected to build a more robust and resilient healthcare system capable of addressing the challenges of pandemics and other health crises in the future.

6. REFERENCES

[1] Jamshidi, M.B., Roshani, S., Talla, J., Lalbakhsh, A., Peroutka, Z., Roshani, S., Parandin, F., Malek, Z., Daneshfar, F., Niazkar, H.R. and Lotfi, S., 2022. A review of the potential of artificial intelligence approaches to forecasting COVID-19 spreading. Ai, 3(2), pp.493-511.

[2] Corbin, J.H., Oyene, U.E., Manoncourt, E., Onya, H., Kwamboka, M., Amuyunzu-Nyamongo, M., Sørensen, K., Mweemba, O., Barry, M.M., Munodawafa, D. and Bayugo, Y.V., 2021. A health promotion approach to emergency management: effective community engagement strategies from five cases. Health promotion international, 36(Supplement_1), pp.i24-i38.

[3] Khero, K., Usman, M. and Fong, A., 2023. Deep learning framework for early detection of COVID-19 using X-ray images. Multimedia Tools and Applications, pp.1-26.

[4] Hassan, H., Ren, Z., Zhao, H., Huang, S., Li, D., Xiang, S., Kang, Y., Chen, S. and Huang, B., 2022. Review and classification of AI-enabled COVID-19 CT imaging models based on computer vision tasks. Computers in biology and medicine, 141, p.105123.

[5] Mei, X., Lee, H.C., Diao, K.Y., Huang, M., Lin, B., Liu, C., Xie, Z., Ma, Y., Robson, P.M., Chung, M. and Bernheim, A., 2020. Artificial intelligence–enabled rapid diagnosis of patients with COVID-19. Nature medicine, 26(8), pp.1224-1228.

[6] Chen, B., Liu, Y., Zhang, Z., Li, Y., Zhang, Z., Lu, G. and Yu, H., 2021. Deep active context estimation for automated COVID-19 diagnosis. ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM), 17(3s), pp.1-22.

[7] Qi, S., Xu, C., Li, C., Tian, B., Xia, S., Ren, J., Yang, L., Wang, H. and Yu, H., 2021. DR-MIL: deep represented multiple instance learning distinguishes COVID-19 from community-acquired pneumonia in CT images. Computer Methods and Programs in Biomedicine, 211, p.106406.

[8] Quiroz, J.C., Feng, Y.Z., Cheng, Z.Y., Rezazadegan, D., Chen, P.K., Lin, Q.T., Qian, L., Liu, X.F., Berkovsky, S., Coiera, E. and Song, L., 2021. Development and validation of a machine learning approach for automated severity assessment of COVID-19 based on clinical and imaging data: retrospective study. JMIR Medical Informatics, 9(2), p.e24572.

[9] Chieregato, M., Frangiamore, F., Morassi, M., Baresi, C., Nici, S., Bassetti, C., Bnà, C. and Galelli, M., 2022. A hybrid machine learning/deep learning COVID-19 severity predictive model from CT images and clinical data. Scientific reports, 12(1), p.4329.

[10] Hatani, F., 2022. JAPAN'S 'ARTIFICIAL-INTELLIGENCE HOSPITAL'PROJECT: CAN IT HELP THE AGEING POPULATION?. International Perspectives on Artificial Intelligence, pp.43-51.

[11] Pirolli, D., Righino, B., Camponeschi, C., Ria, F., Di Sante, G. and De Rosa, M.C., 2023. Virtual screening and molecular dynamics simulations provide insight into repurposing drugs against SARS-CoV-2 variants Spike protein/ACE2 interface. Scientific Reports, 13(1), p.1494.

[12] Galetsi, P., Katsaliaki, K. and Kumar, S., 2022. The medical and societal impact of big data analytics and artificial intelligence applications in combating pandemics: A review focused on Covid-19. Social Science & Medicine, 301, p.114973.

[13] Iwendi, C., Mohan, S., Ibeke, E., Ahmadian, A. and Ciano, T., 2022. Covid-19 fake news sentiment analysis. Computers and electrical engineering, 101, p.107967.

[14] Gupta, R., Pandey, G., Chaudhary, P. and Pal, S.K., 2021. Technological and analytical review of contact tracing apps for COVID-19 management. Journal of Location Based Services, 15(3), pp.198-237.

[15] Wang, Z., Xiong, H., Zhang, J., Yang, S., Boukhechba, M., Zhang, D., Barnes, L.E. and Dou, D., 2022. From personalized medicine to population health: a survey of mHealth sensing techniques. IEEE Internet of Things Journal, 9(17), pp.15413-15434.

[16] Dao, T.P., Hoang, X.H.T., Nguyen, D.N., Huynh, N.Q., Pham, T.T., Nguyen, D.T., Nguyen, H.B., Do, N.H., Nguyen, H.V., Dao, C.H. and Nguyen, N.V., 2022. A geospatial platform to support visualization, analysis, and prediction of tuberculosis notification in space and time. Frontiers in Public Health, 10, p.973362.

[17] Li, Q. and Huang, Y., 2022. Optimizing global COVID-19 vaccine allocation: An agent-based computational model of 148 countries. PLoS computational biology, 18(9), p.e1010463.

[18] Kumar, K., Kumar, P., Deb, D., Unguresan, M.L. and Muresan, V., 2023, January. Artificial intelligence and machine learning based intervention in medical infrastructure: a review and future trends. In Healthcare (Vol. 11, No. 2, p. 207). MDPI.

[19] Kumar, Mukesh, Rana, Lokesh, Artificial Intelligence: A Tool for COVID-19 Surface Detection. International Journal of Innovation and Learning. (2020): 60-63.

[20] H. Maghded, "A Novel AI-enabled Framework to Diagnose Coronavirus COVID-19 using Smartphone Embedded Sensors: Design Study", IEEE 21st International Conference on Information Reuse and Integration for Data Science (IRI), Las Vegas, NV, USA, (2020): 180-187.

[21] Laguarta, J., Hueto, F, Subirana, B, COVID-19 Artificial Intelligence Diagnosis using only Cough Recordings.

IEEE Open Journal of Engineering in Medicine and Biology, (2020)

[22] Gladstone Institutes. "New CRISPR-based test for COVID-19 uses a smartphone camera: The rapid, one-step mobile test could help combat the pandemic and fully reopen communities." ScienceDaily, (2020).

[23] Mandel, H.L., Colleen, G., Abedian, S., Ammar, N., Bailey, L.C., Bennett, T.D., Brannock, M.D., Brosnahan, S.B., Chen, Y., Chute, C.G. and Divers, J., 2023. Risk of post-acute sequelae of SARS-CoV-2 infection associated with pre-coronavirus disease obstructive sleep apnea diagnoses: an electronic health record-based analysis from the RECOVER initiative. Sleep, p.zsad126.

[24] Hui, W.X., Aneja, N., Aneja, S. and Naim, A.G., 2023. Conversational chat system using attention mechanism for COVID-19 inquiries. International Journal of Intelligent Networks.

[25] Sameni, M., Mirmotalebisohi, S.A., Dehghan, Z., Abooshahab, R., Khazaei-Poul, Y., Mozafar, M. and Zali, H., 2023. Deciphering molecular mechanisms of SARS-CoV-2 pathogenesis and drug repurposing through GRN motifs: a comprehensive systems biology study. 3 Biotech, 13(4), p.117.

[26] Kumar, D., Sood, S.K. and Rawat, K.S., 2023. IoT-enabled technologies for controlling COVID-19 Spread: A scientometric analysis using CiteSpace. Internet of Things, p.100863.

[27] Solfa, F.D.G. and Simonato, F.R., 2023. Big Data Analytics in Healthcare: Exploring the Role of Machine Learning in Predicting Patient Outcomes and Improving Healthcare Delivery. International Journal of Computations, Information and Manufacturing (IJCIM), 3(1), pp.1-9.

[28] Umair, A., Masciari, E. and Ullah, M.H., 2023. Vaccine sentiment analysis using BERT+ NBSVM and geo-spatial approaches. The Journal of Supercomputing, pp.1-31.

[29] Gupta, N.S. and Kumar, P., 2023. Perspective of artificial intelligence in healthcare data management: A journey towards precision medicine. Computers in Biology and Medicine, p.107051.

[30] Shareefa, P., Maheshwari, P.U., Donald, A.D., Srinivas, T.A.S. and Krishna, T.M., 2023. Forecasting the Future: Predicting COVID-19 Trends with Machine Learning. International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online, 3(4).

[31] Malik, I.A. and Shah, S.A., 2023. Economic impact of COVID-19 on Ethiopian micro, small, and medium enterprises and policy measures. The Scientific Temper, 14(02), pp.288-293.

[32] Al Banna, M.H., Ghosh, T., Nahian, M.J.A., Kaiser, M.S., Mahmud, M., Taher, K.A., Hossain, M.S. and Andersson, K., 2023. A Hybrid Deep Learning Model to Predict the Impact of COVID-19 on Mental Health from Social Media Big Data. IEEE Access.