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Applications of AI in Covid Detection, Prediction and Vaccine Development

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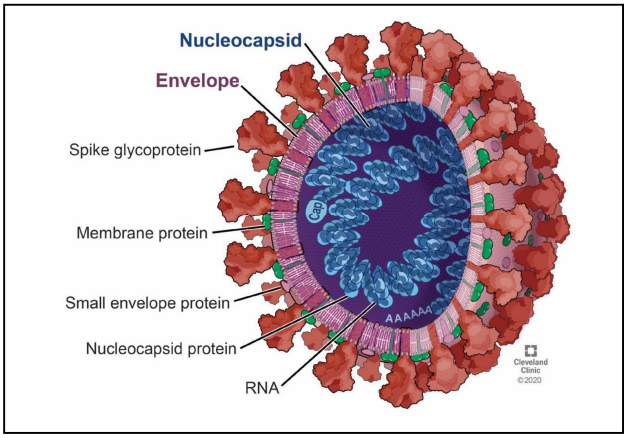
Abstract: ***The world has been in a panic since the global outbreak of the deadly virus that is Covid-19. The disease, first observed in Wuhan province of China, causes severe acute respiratory syndrome (SARS) in humans, with fever, shortness of breath, cough, and in some cases, loss of smell and taste as symptoms [3]. To fight the virus, it is important to first detect it efficiently to stop its spread. AI has so far been of great assistance in curbing the disease by assisting in covid diagnosis. This paper focuses on the various novel advances in the field of Artificial Intelligence with applications specific to Covid-19. It first explains the biological properties of the virus followed by different techniques and technologies using AI which includes applications of AI in covid detection, prediction, and vaccine development. Artificial intelligence has been used as an effective early diagnosis technique and also as a model for the prediction of Covid-19 behavior which includes predicting the curve and the mortality rate. Potential challenges and future scope are also discussed.***

Keywords: AI, Covid-19, Drug discovery, Image processing, medical diagnosis, SARS, Prediction

I. INTRODUCTION

Since the emergence of the Covid-19 virus in December 2019, healthcare systems around the world are trying to find a way to curb the disease. Science and technology have played a crucial role in limiting the spread of the Covid-19 virus[1]. One such technology that can be seen rising is Artificial Intelligence. Artificial intelligence, or AI, is the scientific study of intelligent agents, systems that perceive and act upon information in a human-like way. It's a broad term that includes different types of software and hardware that are capable of performing tasks normally requiring human intelligence. Artificial Intelligence is already being implemented in our daily lives and now the applications of AI are being extended to medical diagnosis as well. In an age where the applications of artificial intelligence seem limitless, it's easy to forget that AI has been around since the 1950s. Some of the earliest incarnations of AI were used for medical purposes one of which was an early application of machine learning in vaccine development. Vaccine development is an important process to prevent and eradicate deadly diseases. With the aid of artificial intelligence, this process can be made more efficient and accurate. In particular, AI can expedite the vaccine development process by screening through data collected from experiments and clinical trials to identify patterns that would otherwise be difficult to discern. By doing so, AI can speed up the identification of potential vaccine candidates and help researchers develop more targeted vaccines. By using machine learning techniques, health-related data can be analysed to predict diseases and assist doctors in providing better preventive care. AI has been used in several ways to help predict and prevent the spread of Covid-19. For example, researchers have used machine learning algorithms to accurately predict the movements of people in close contact with those infected with Covid-19. In another instance, Google has used its Street View data to identify residential areas that are at high risk for outbreaks. AI has the ability to process large amounts of data faster than humans can, making it an important tool in the fight against Covid. Automated machine learning models are being used by organizations around the world to detect Covid early on, helping to contain the spread of the virus.



II. BIOLOGICAL CHARACTERISTICS OF COVD-19

It is of utmost importance to understand the biological properties of the virus to develop an effective diagnostic technique for its detection and to find a way to stop its spread. SARS-CoV-2 consists of a single-stranded positive-sense RNA genome. It interacts with an enzyme which is known as the angiotensin-converting enzyme 2 (ACE2) receptor to enter into the cells. It is a type of enveloped virus with a positive-sense single-stranded RNA genome, that affects humans by binding to the host ACE2 receptor [9]. This enzyme is present in the arterial smooth muscle cells in the lungs, stomach, small intestine, colon, skin, liver bile ducts, kidney parietal epithelial cells, lymph nodes, and the brain. The transmission takes place through inhalation of the virus and interaction with an infected surrounding [3]. The virus is shaped as a spherical particle of 70–90 nm, with spikes of glycoprotein projecting from its surface that bind to receptor angiotensin-converting enzyme 2 on the cell surface. Because of these spikes, the virus appears in a crown-like shape [12].

III. ARTIFICIAL INTELLIGENCE IN COVID DETECTION

Different types of studies and research are conducted for the detection of coronavirus based on the dataset, imaging algorithms, and various other factors. Following are a few of the AI-based approaches that were designed for the detection of the SARS covid virus.
Image classification models are developed from CT scans of lungs of patients with confirmed Covid-19 infection [4]. The data comprised of over 900 patients from China, Japan, and Italy centres. The algorithm works on lung segmentation that identifies lung regions which are then given as an input for virus prediction. The code was developed on TensorFlow software and the Grad-CAM method was used for generating the predictions. The performance of the model was evaluated based on the accuracy, sensitivity, positive and negative predictive value. A strategy was adopted that involves maximization of data which allows the model to learn more features [5]. The model is trained to detect different class labels. The type of detection is differentiated into various detection scenarios like two-class, three-class, and four-class detection. Different labels were used for different classes of detection. To optimize model performance, hyperparameter tuning was utilized using the grid search method. The detection output is illustrated using heat maps. Reverse Transcriptase Polymerase Chain Reaction, or RT-PCR as habitually known, is the most customarily used technique for the diagnosis of coronavirus.

IV. ARTIFICIAL INTELLIGENCE IN COVID PREDICTION

Prediction of mortality rates and infection curves can help in decreasing mortality by proper assigning of resources and equipment. Early warning systems can be designed to provide useful information about vulnerable areas and risk reduction. AI systems are designed using neural networks that analyse chest X-ray images and perform risk evolution [6].
Using advanced artificial intelligence and immunologic profiling, the severity of Covid-19 is predicted [10]. The blood data or cytokines data is used for this purpose and a model is developed using Support Vector Machine and Random Forest, which is widely used to construct clinical prediction models. The collected blood samples were stored at −80°C until the analysis of cytokines. Three classification models were used in the prediction of Covid-19 severity. These were logistic regression, random forest, and Support Vector Machine. A cross-validation approach was used to select the model hyperparameters. To implement these algorithms, Python v3.7.5 and *scikit-learn* package v0.23.1 were used. Using the LSTM model, a type of recurrent neural network (RNN), and SEIR, a model was developed to predict the number of infections and peak in the virus spread in major regions of China [11]. SEIR is an epizootiological model used to predict infectious disease dynamics by differentiating the population into four possible states: Susceptible [S], Exposed or latent [E], Infectious [I], or Removed [R]. The parameters considered were probability of transmission, incubation rate, probability of recovery or death, and contact number.

V. ARTIFICIAL INTELLIGENCE IN VACCINE DEVELOPMENT

AI-based models can be applied to scanning and searching potential targets for vaccine development [7]. Because of the computational adaptation of methods to screen target proteins, the time for drug discovery is significantly reduced. Also, traditional approaches for vaccine development are costlier as compared to the AI-ML-based approach [9]. The screening can be differentiated for repurposed drugs and new entities. In the case of repurposed drugs, a model is used to predict existing medicines which can also be applied to SARS coronavirus. This is achieved mainly by analysing the genome sequence and relating them. The model predicts already available drugs that can be used to target the SARS-CoV-2 virus. Artificial Intelligence is utilized in predicting complex immune system behaviours. Using methods like Recurrent Neural Networks and Deep Neural Networks, candidate molecules can be assessed for potency against the biological target, selectivity for undesired targets, and ADMET properties (absorption, distribution, metabolism, excretion, and toxicity properties). Machine Learning technologies, such as support vector machines (SVM), Random Forests, and Bayesian learning, have been used for drug design.

VI. POTENTIAL CHALLENGES OF USING AI IN HEALTHCARE

Many machines can now emulate human cognition when it comes to simple reasoning, but humans are still superior at complex tasks like medical diagnosis. While we have made remarkable advancements in the field of artificial intelligence, there is still a long way to go before machines become truly intelligent.

A. Compatibility Of The Model In An Actual Clinical Trial As Compared To The Development Environment [5]

The expected outcomes may differ in a real-time scenario as compared to the development model. Moreover, it may be difficult for healthcare workers to efficiently operate and troubleshoot the AI model in case of any issues or difficulties [7].

B. Efficiency and Cross-disciplinary Collaboration

The systems designed should be easy to operate, with minimal supervision so that the time of assigned healthcare workers is utilized efficiently. The models are designed for specific purposes and most often cannot be applied to other disciplines. To overcome this, some multipurpose models can be designed such that they can be applied to more than one discipline.

C. Ethical Obligations and Data Protection

AI-based models work on the data of individual health records and need to share this data to make predictions and generate an output. Hence all the policies related to the right to privacy must be adhered to. Steps can be taken to analyse confidential data and share only the necessary without compromising on patients' privacy [8].

VII. FUTURE SCOPE

With the ever-rising costs of healthcare and long waiting lists, people are looking for alternatives. One of those alternatives is AI, which promises to make accurate diagnoses faster than a human doctor can. However, this isn't something that is going to happen overnight. There is also a lot of potential for AI to change the face of healthcare. Some of the ways in which AI can be used in the future are –

1) Artificial Intelligence and Machine Learning can be leveraged to predict the effects of a certain treatment on patients based on simulated data of previous such treatments on other hypothetical patients.
2) Developing an effective approach to speed drug discovery during this pandemic could aid in developing solutions and might reveal new design steps that might be advantageous during the next outbreak.

VIII. CONCLUSION

AI-based technologies have a vast scope in medical diagnosis and are also widely accepted. This paper summarises the use of AI in the diagnosis, detection, prediction, and forecasting of Coronavirus. It is observed that if utilized in the right way, AI has a great potential in fighting the disease and assisting the healthcare sector in limiting its spread. AI assistive technology is a productive alternative to human assistance during pandemics. The advancement of artificial intelligence poses unique opportunities and challenges for stakeholders. To maximize the positive potential of AI, it is important to invest in research and development while also creating policies that will help to mitigate unintended consequences.

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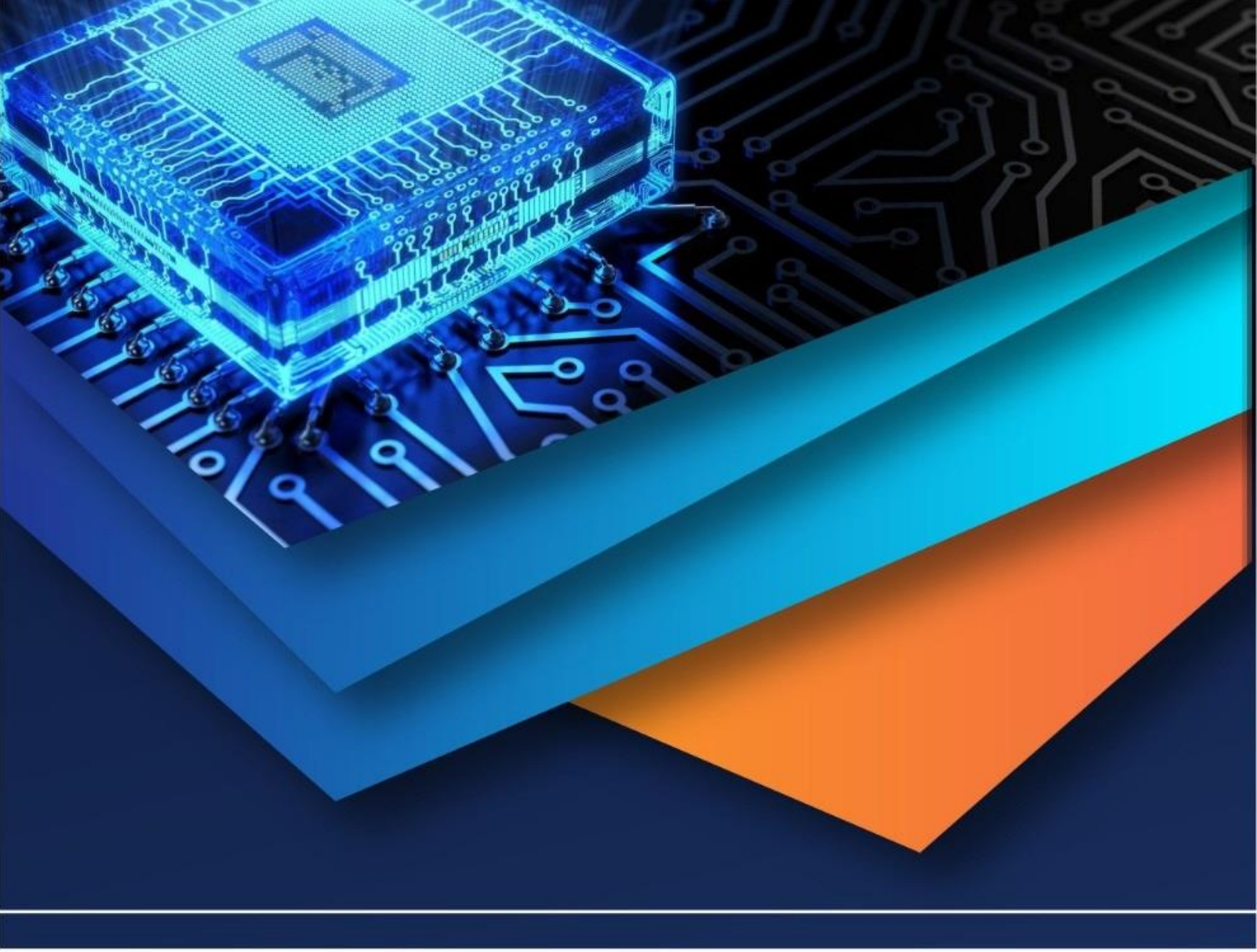

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