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CIA-CVD: cloud based image analysis for COVID-19 vaccination distribution

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Abstract

Due to the huge impact of COVID-19, the world is currently facing a medical emergency and shortage of vaccine. Many countries do not have enough medical equipment and infrastructure to tackle this challenge. Due to the lack of a central administration to guide the countries to take the necessary precautions, they do not proactively identify the cases in advance. This has caused Covid-19 cases to be on the increase, with the number of cases increasing at a geometric progression. Rapid testing, RT-PCR testing, and a CT-Scan/X-Ray of the chest are the primary procedures in identifying the covid-19 disease. Proper immunization is delivered on a priority basis based on the instances discovered in order to preserve human lives. In this research paper, we suggest a technique for identifying covid-19 positive cases and determine the most affected locations of covid-19 cases for vaccine distribution in order to limit the disease's impact. To handle the aforementioned issues, we propose a cloud based image analysis approach for using a COVID-19 vaccination distribution (CIA-CVD) model. The model uses a deep learning, machine learning, digital image processing and cloud solution to deal with the increasing cases of COVID-19 and its priority wise distribution of the vaccination.

Keywords Medical Infrastructure, Cloud computing, Central administrative authority, CT-Scan/X-Ray Images of chests, Decision support system, Vaccination task, Deep-learning algorithm, Machine leaning

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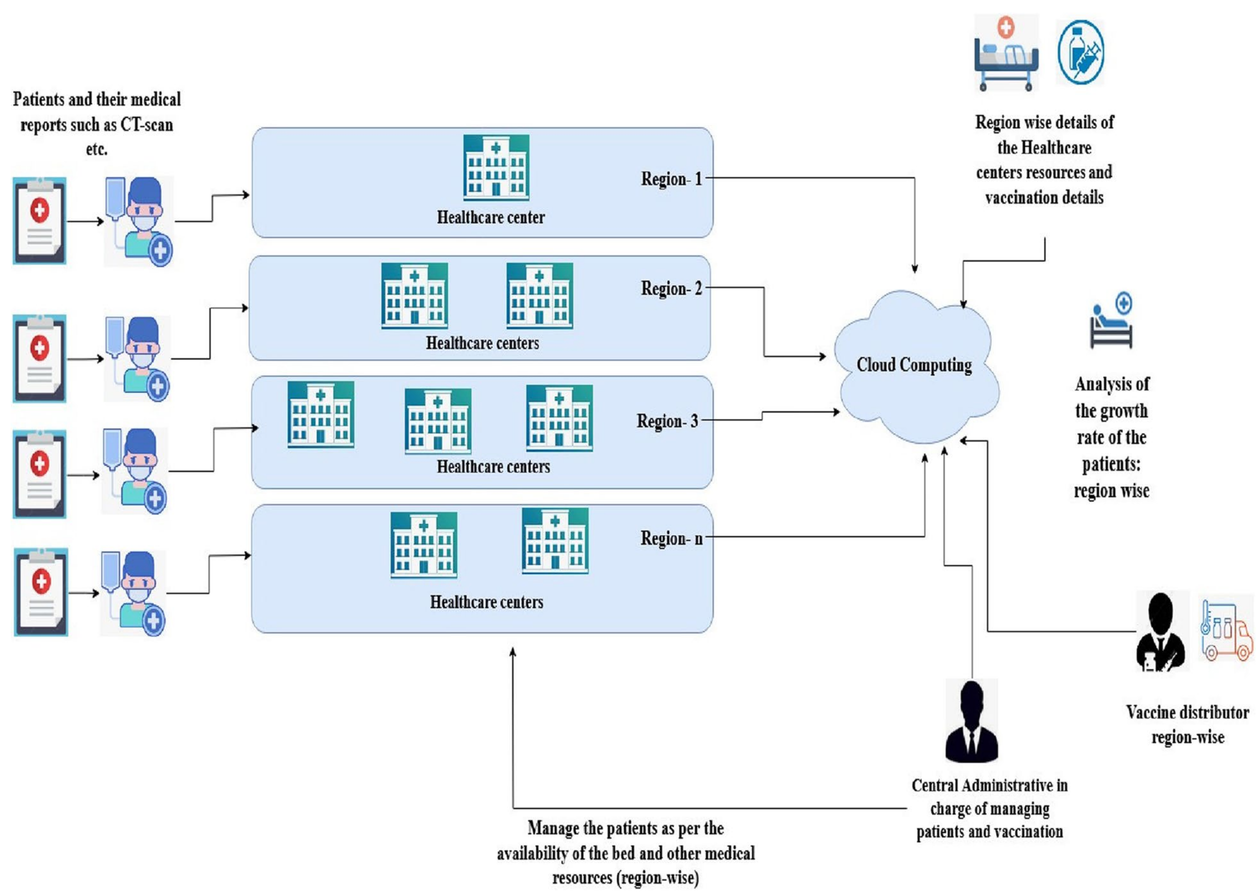
Graphical Abstract



Highlights of the research

1. The study discusses the COVID-19 pandemic's significant effects on a global level, emphasizing the lack of vaccines and medical supplies.
2. The study shows how a lack of centralized management leds to a reactive response to the crisis, which results in an astonishing number of instances around the world.
3. The study acknowledges the significance of RT-PCR testing, chest imaging (CT-Scan/X-Ray), and rapid testing as essential diagnostic techniques for detecting COVID-19 cases. For accurate patient treatment and early discovery, these procedures are crucial.
4. The study suggests a data-driven strategy to rank the COVID-19 vaccine distribution.
5. The methodology shows how vaccines are provided effectively, prioritizing locations with the need to save lives by identifying the most impacted regions and positive cases.
6. A Cloud-Based Image Analysis approach was presented using a COVID-19 Vaccination Distribution (CIA-CVD) model.
7. The proposed model makes use of cloud computing, DL, ML, and digital image processing technologies. It provides a thorough procedure for handling the rising number of COVID-19 cases and optimizing the vaccination schedule using data-driven insights.

Introduction

The present COVID-19 pandemic has resulted in loss of human lives and resources. Owing to the increasing number of cases, there is a high demand to deal with COVID-19 cases. Techniques adopted for COVID-19 detection must be autonomous and should be able to find the person who is infected with COVID-19 or not by checking the basic

COVID-19 symptoms such as cough, fever, cold, and throat itching, and so on. If a person is found with these symptoms, they need to go for a more advanced check of the disease via RT-PCR test, Rapid Antigen Testing, or through CT-Scan/X-Ray images [1]. As we know, these basic processes take more time to find identify the disease. Therefore, some advanced mechanism are required to detect the disease, treat it, and distribute vaccines to those with COVID-19.

For that, the suggested CIA-CVD model is intended to give the best detection accuracy in identifying the disease as well as the diving areas in respective and concerned regions. The test samples are collected and sent for testing and the results are stored at the Central Administrative Authority (CAA). CAA is used as a cloud for storing the whole testing and vaccination data of regions and after the data is stored, processing is done to find the highest positive case regions by applying analytic algorithms [2]. Priority is given to that resultant regions for the vaccination distribution process. After getting the Highest Positive cases in the regions based on 7 days [3], the CAA gives instruction to Vaccine Distribution Authority (VDA) to Dispatch vaccine to the priority regions first and with the interval of 7 days, the same task takes place and distribution will be done by VDA and the result will be sent back to the CAA.

But when the COVID-19 cases increase, there will be shortage of vaccines for distribution. In that, the cases will increase and vaccination will be affected in those regions as shown in Fig. 1 [4]. Therefore, we gave a 7 days interval in analysing the data [5] at CAA and thereafter, passed them to VDA to supply vaccination as soon as possible. Figure 1 depicts how COVID-19 instances in India are emerging, implying that technological approaches are essential for the administration of healthcare systems [6, 7].

Motivated by these factors, we suggested a Cloud Based Image Analysis for COVID19 Vaccination Distribution (CIA-CVD) system for managing healthcare services utilizing cloud computing to reduce the effect of the COVID-19 pandemic. This patient data is delivered and saved in a relational database so that the CAA can view it as an instance or a trend and respond accordingly. To make things easier, concepts like cloud-based image analysis and vaccine dissemination may be mapped using CIA-CVD systems. CAA and VDA can help physicians, nurses, patients, and their families in a variety of ways [8]. Better patient route organization, medication management, assistance in emergency circumstances or first aid, and finding a solution to the COVID-19 disease are all viable instances for CAA to be used to lessen the load on medical workers. The suggested framework has been used to illustrate this in Sect. 2.

Motivation

The following are the motivations for doing this research.

A framework for organizing COVID-19 patient data and severity analysis by area has been presented.

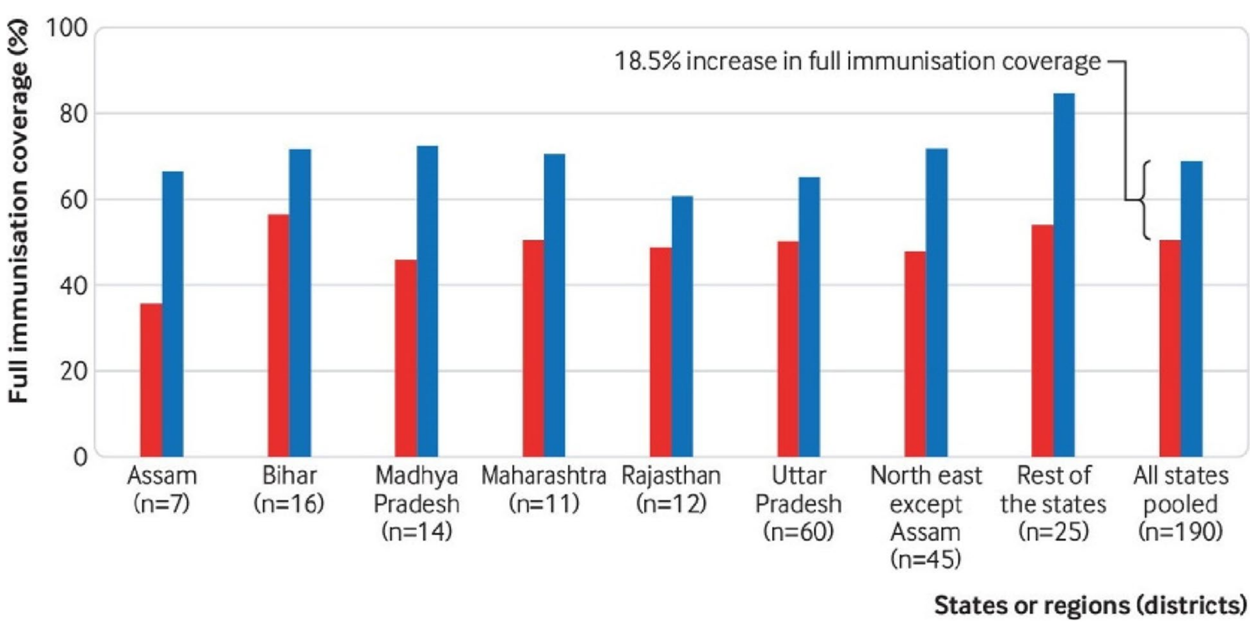


Fig. 1 COVID-19 cases on the rise in INDIA in the month of March 2020: Source Ministry of health and family welfare, business standard calculations

Identification of COVID-19 positive patients by area for faster vaccination delivery which help to reduce the impact of delays in the vaccine distribution method.

-The management of patients will be conducted by harnessing the capabilities of Cloud Computing (CC) and Machine Learning (ML)/Deep Learning (DL) algorithms.

The suggested method is used to identify locations where immunization must be provided on a priority basis. This will allow healthcare systems to provide COVID-19 patients with faster and more secure services. The framework proposed here will be used for the identification of the COVID-19 cases and highest positive cases regions to be process of vaccination. This will be beneficial for the healthcare systems to provide faster and secured services to the patients and physicians via cloud.

The remainder of the paper is organized as follows; Sect. 2 discusses the methods utilized. Section 3 goes through the numerous strategies utilized to combat the invaders and thereafter the suggested framework is discussed and its outcomes, followed by the CC SWOT analysis are presented by Sect. 4 and the conclusion is presented in Sect. 5.

Related work

With the ever-changing risk panorama and the emergence of new emerging risks and vulnerabilities, an increase in COVID-19 instances causes more deaths. Table 1 displays a number of reviewed literature and their descriptions. CAA stores patient information. The CT filters serve as the foundation for the planned COVID-19 screening technique. To do this, we expanded the engineering of the EfficientNet family and constructed models utilizing CT scans of solid and SaR-CoV-2-infected individuals. The CT images are extracted from the preceding section's datasets and processed using the pre-handling approach, which is a straightforward cycle in PC vision applications [9]. Pre-handling approaches can help to reduce unneeded disturbance, emphasize areas of the image that can help with the cognitive job, and even aid in the deep learning phase. In this study, a basic pixel power normalisation is applied to some extent. Without this pre-planning, model intermingling at the arranging step is improbable [10, 11]. To preserve similarity, data images for convolutional network models are often adjusted. Because EfficientNets have a low computational cost in terms of lethargy, they can include more significant standard knowledge images.

As a result, in the idea of the model [11], we also look at the effect of changing the data goal. As a consequence, this pre-taking care of move becomes yet another association cap. Deep learning assumes that a major back to back or reformist model is better than shallow models at game plan or backslide tasks. Discontinuous neural connections have hidden states that span time, allowing them to retain a large amount of knowledge about the past. Because of their ability to handle variable length successive data, they are most commonly used in determining applications. Irregular neural connections have a significant disadvantage in that they cannot resolve the vanishing propensity or exploding incline problem, and they can only store transient memory because they contain hidden layer inception components of the past time venture.

In this paper, we have utilized information created by regions sent to CAA and CAA track down the most elevated number of cases and afterward send back to CAA. After that C train the VDA to apply the antibodies and inform at whatever point it's finished and proceed with this chain until all areas not done vaccination.

Major contributions of the paper

1. This research introduces a novel approach called the Cloud-Based Image Analysis for COVID-19 Vaccination Distribution (CIA-CVD) model. This model leverages advanced technologies such as Deep Learning, Machine Learning, and Digital Image Processing, coupled with cloud solutions, to address the pressing issue of efficiently distributing COVID-19 vaccines.
2. The study emphasizes the importance of data-driven decision-making in the fight against COVID-19. By utilizing CT-Scan/X-Ray images of chests and other medical data, the CIA-CVD model empowers healthcare authorities with a decision support system. This system aids in identifying COVID-19 positive cases and determining priority areas for vaccine distribution, ensuring a more effective allocation of limited medical resources.
3. This research offers a complete strategy to lessen the pandemic's overall impact with a focus on areas lacking central administrative supervision. The CIA-CVD model presents a viable approach for targeting COVID-19 imapct on a global scale, ultimately protecting human lives, by integrating medical infrastructure, CC, and DL algorithms.

Table 1 Literature review and their descriptions

Author Name	Title	Objectives	Approaches	Solutions
Keeling et al. [12]	The effectiveness of contact tracing for the containment of the 2019 novel coronavirus (COVID-19)	The aim of this study was to see how effective contact tracing was at containing Covid-19	A postal and online cross-sectional survey was used to characterize contact trends	All of the contact tracking can be done quickly, and the basic reproductive ratio can be reduced from 3.11 to 0.21, allowing the outbreak to be contained. Each new case necessitates the tracing of an average of 36 people, with 8.7% of cases having more than 100 near-traceable contacts
Hu et al. [13]	Evaluation and prediction of the COVID-19 variations at different input population and quarantine strategies	Simulate and forecast disease variations in Guangdong province, as well as investigate the effects of the input population and quarantine policies	The simulation was used to assess the influence of the input population	The confirmed cases' simulated peak value is 1002 on February 10, 2020. With a peak value of 1397 on May 11, 2020, the disease will become extinct. Increased input population numbers will primarily shorten disease extinction days and increase the percentages of exposed individuals
Gostic et al. [14]	Estimated effectiveness of symptom and risk screening to prevent the spread of COVID-19	Provided current knowledge of the main COVID-19 life history and epidemiological parameters, estimate the effect of various screening programs	We gathered information on confirmed and suspected COVID-19 acute respiratory disease cases recorded by cities and provinces throughout the United States	The median proportion of infected travelers found in a spreading epidemic is just 0.30, even under ideal conditions when only one infection in twenty is subclinical and all travelers undergo departure and arrival screening. Based on the middle-case assumption that 25% of cases are subclinical, it is predicted that arrival screening alone would catch around one-third of infected travelers in a stable epidemic, and that arrival and departure screening together would catch about half of them
Wang et al. [15]	A deep learning algorithm using CT images to screen for Corona Virus Disease (COVID-19)	Screening large numbers of reported cases for effective quarantine and care is a priority for managing the spread of Corona Virus Disease (COVID-19). Based on COVID-19 CT picture radiographic changes	They gathered 1,119 CT images of COVID-19 cases with pathogen confirmation as well as those who had previously been diagnosed with standard viral pneumonia. They changed the Inception transfer-learning model to construct the algorithm, which was then evaluated both internally and externally	With a precision of 0.88 and a sensitivity of 0.87, internal validation had an overall accuracy of 89.5%. The external research dataset's total accuracy was 79.3%, with precision of 0.83 and sensitivity of 0.67. Furthermore, the system accurately identified 46 of the 54 COVID-19 photos as COVID-19 positive, with an accuracy of 85.2%, despite the first two nucleic acid test results of the 54 COVID-19 images being negative

Table 1 (continued)

Author Name	Title	Objectives	Approaches	Solutions
Shah et al. [16]	A Comprehensive Survey of COVID-19 Detection using Medical Images	To estimate the cost and time required for standard Reverse Transcription Polymerase Chain Reaction (RT-PCR) tests to detect COVID-19 is uneconomical and unnecessary, researchers are attempting to use medical images such as X-Ray and Computed Tomography (CT) images to detect this disease using Artificial Intelligence (AI) based systems to assist in automating the scanning process	COVID-19 can now be detected using AI-based models from X-ray or CT lung images	They looked at datasets, preprocessing techniques, segmentation processes, feature extraction, classification, and experimental findings to see where future research could go in the field of COVID-19 disease automated diagnosis using AI-based frameworks. There is also a shortage of annotated medical images/datasets of COVID-19 affected individuals, which necessitates enhancing, segmentation in preprocessing, and domain adaptation in transfer learning for a model, resulting in the best possible model output
Pallasch et al. [17]	Cost-effectiveness of tuberculosis control strategies among immigrants and refugees	Immigrants and refugees from high-to-low incidence countries will be vaccinated	Both Tb-related diagnostics rely on screening and disease identification, as well as prioritising vaccination based on regional data	The effect of a previously used chest X-ray is negligible. Global investment in high-incidence countries will be an ideal control technique. Since cell-mediated strategies are costly, they were not tested for screening purposes
Charlotte et al. [18]	Effectiveness of interventions for diagnosis and treatment of tuberculosis in hard-to-reach populations in countries of low and medium tuberculosis incidence	To vaccinate the refugees and immigration people and give aeffictive approach	Treatment of active tuberculosis in OECD, EU, EEA, and EU candidate countries	The quality assessment's findings. A meta-analysis was not sufficient due to the heterogeneity of the included studies in terms of the form of hard-to-reach population, treatments, published results, and study design. Active referral to Tb clinics has been shown to improve care adherence in migrants. A group DOT led by non-family members tends to be the most successful, despite some inconsistencies

This research represents a significant step towards addressing the challenges posed by the COVID-19 pandemic, offering a data-driven, technologically advanced approach to optimize vaccination distribution and healthcare resource allocation.

Methodology

Proposed model and algorithms

As we discuss the Methodology of the CIA-CVD is needed to do Image analysis, trends of regions and Vaccination process under the observation of CAA. The model architecture for CIA-CVD is shown in Fig. 2.

In the architecture, we proposed that for a smooth process of COVID-19 identification and vaccination, the image areas be divided into respective regions, and in each cycle, images are collected from the respective defined regions, i.e., A, B, C, D, and the Leaky ReLU algorithm 2 is used to classify whether the given image is Covid infected or not, and region-wise results are sent to CAA. CAA then identifies the regions with the highest number of positive cases, and each result analysis process is completed after a predetermined period of time, and the same result analysis is sent to CAA, a cloud-based administration, to handle the process as well as data in relation to the applied algorithms. After getting the result analysis, CAA needs to share this information and instruct VDA to do vaccination to the resultant regions with higher number of cases and from that, a trigger will be fired with notification to the respective regions people about the vaccination task and gets completed as soon as possible. After the completion of task, VDA needs to send the status to CAA and it instructs new regions as per result analysis and updates the respected data. This Process continues until all the regions are not vaccinated and the new cases will not be stopped. The identification and vaccination task runs in a parallel way, so that it is not delayed to get the harvest effect of the COVID-19. For the same, different algorithm was prepared to give more idea about the process and mark a flow using the flowchart which direct reader about the process and give clarity about the model. Figure 3 shows the flowchart of the CIA-CVD process.

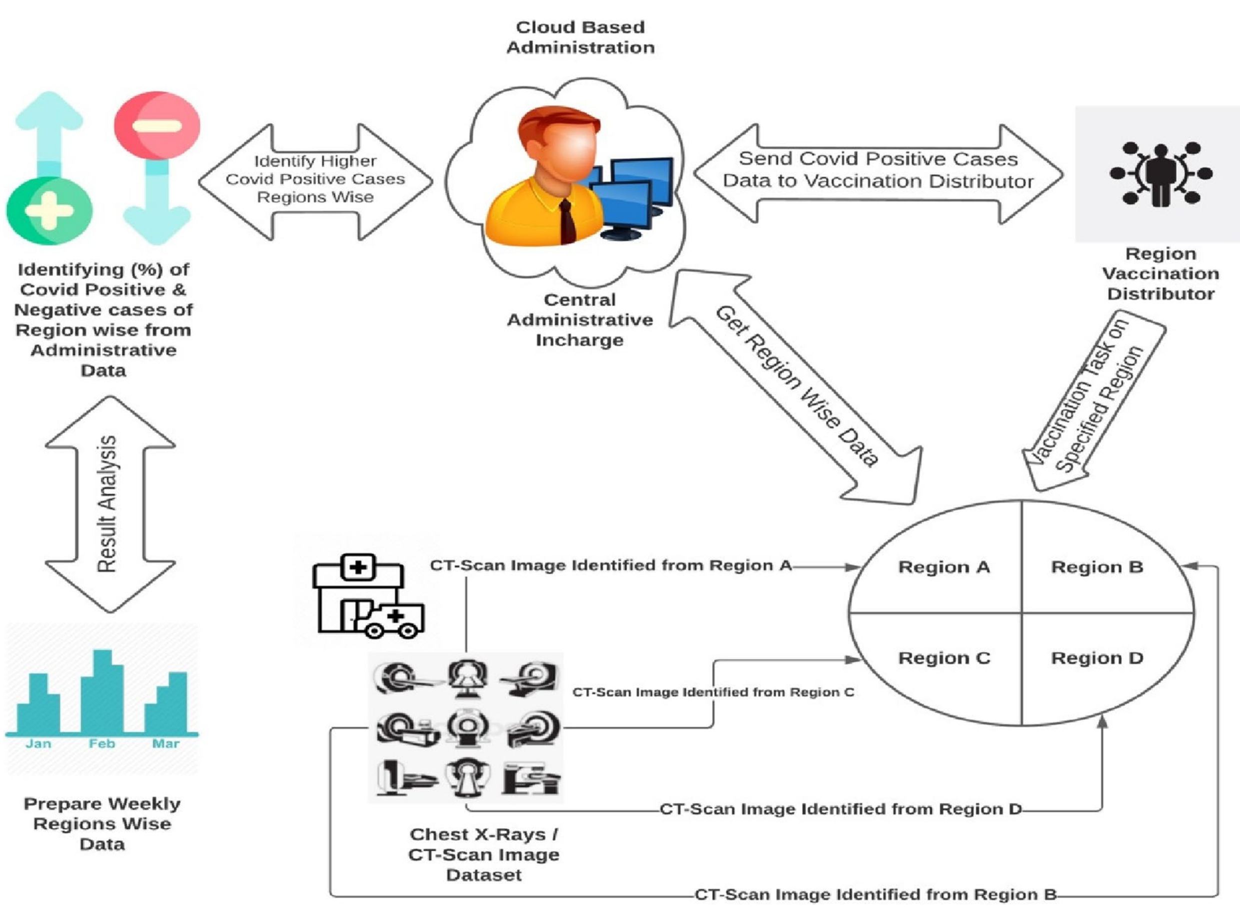


Fig. 2 Architecture of the proposed model

Algorithm 1 shows the strategy of how COVID-19 detection and what is the process to run Vaccination Program region wise is mention with association of different types of module [19], where collection of dataset and processing of dataset is included and how region wise data (R1(D)) was stored in the Central Administration in charge (Y) or Cloud (C). After identifying the positive/negative cases, the formula for finding highest positive cases was described and at last how the vaccination process takes place towards the priority regions was mentioned. Algorithm 2 defines how to detect the positive/negative cases was found by using deep learning models and classifiers [20].

1: Input: TASK (D, V)

2: Output: Coivd-19 Cases (D) Detected and Region wise Vaccination (V) Started

/* Initialization and Declaration of the Variables*/
Initialize Detected No. of Covid-19 Cases D = 0
Initialize No. of Vaccinated Regions V = 0
Initialize Total No. of Dataset X = 0
Initialize No. of Regions R = 0
3: Collect Dataset from Regions to detect the Positive Negative Cases, R = D.

4: Follow Algorithm 2 to Find out Positive Cases from CT-Scan Images.

5: Store Region wise data (R1) of D to Central Administrative Incharge(Y) or to the Cloud(C), with the details of insufficient total number of vaccines (ISV).
Y = R1+ISV OR C = R1+ISV,

6: To Identify Higher No. of Positive Cases (HPC) from weekly Wise Data(X), HPC <— X, For this Follow Algorithm 3.

7: After weekly Data(X) Analysis Region wise Record(R) will be Updated to Y, Y = R.

8: Y need to Send data about HPC, Y <— HPC. to Update Vaccinate Regions and also Send Data to Vaccination Distributor (VD), VD <— HPC And Update(R).

9: VD Can Apply Vaccination According to V and Follow Algorithm 4.

10: Repeat Process from Step-1 to Detect (D) and Vaccinate another Regions(R) with updating (V).

Algorithm 1. Covid-19 Detection and Vaccination Region wise

1: Input: CT-Scan Image (I)
2: Output: Positive/Negative Coivd-19 Cases (D) Detection.

3: Prepared the image by pre-processing it (I), i.e., I = P.
We used Keras Data Generation for pre-processing the dataset:
i) Image (P) should be reshaped to (128, 128, 3).
ii) Range of random rotation is 10°.
iii) Horizontal Flip is True.
iv) Range of Zoom is 0.4.

Note: Now, Shape = (128, 128, 3), and for Fast Processing use Shape = (256, 256, 3) which gives better Performance.

4: Apply the Image to a pre-trained model's input:
Normal (A) = 0.98%
Covid-19 (B) = 0.99%
Pneumonia Accuracy (C) = 0.97%.

5: Fetch the output of the given model's last Convolution Layer = Y.

6: Reduce the X Dimensions to X — 1 to flatten the dimensions.

7: Build a Dense Layer:
For Xception Net and Inception Net, the units are 256.
For ResNext, the units are 128.
Y = We * D + e.
Where, We = Weights and D = Bias

8: Activate the model:
D = LeakyReLU(Y)

9: For Inference, Apply a Dense Layer:
Y = We * D + e

10: For classification, use Softmax:

$$\text{Softmax}(Y_i)=\frac{e^{y_i}}{\sum_{j=1}^{k} e^{y_i}}$$

11: Getting Result Information of:
LeakyReLU(Y) = max(0.01, 2)

Algorithm 2. Covid-19 Disease Detection Based on CT-Scan Images Using Deep Learning

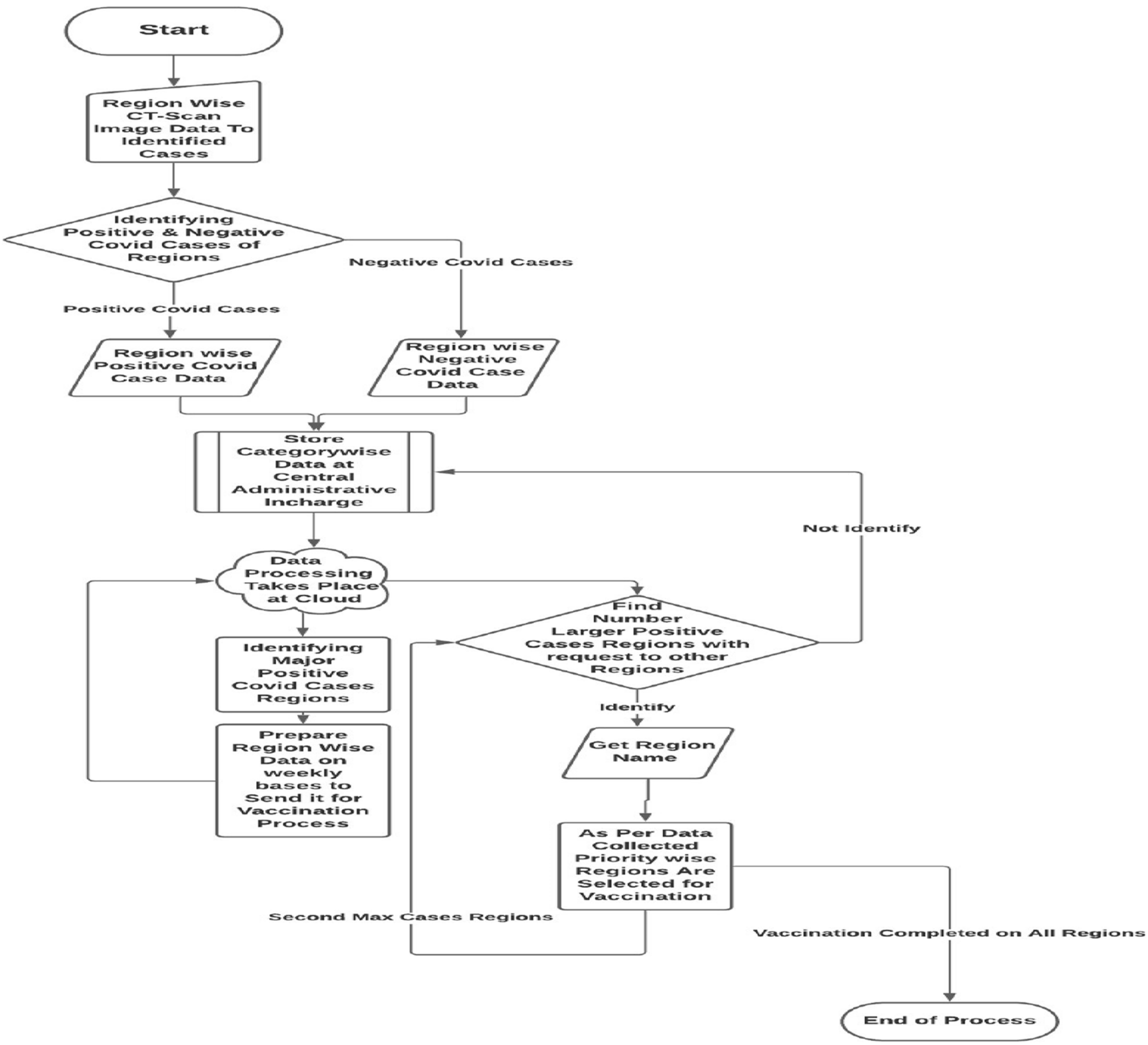


Fig. 3 Flowchart of the CIA-CVD process

The pre-processing of different sizes and types of images are done by reshaping the images to (128, 128, 3) and Zoom up to 0.4% and all the images are in horizontal form. Thereafter, the images are fed into the pre-trained model to find the accuracy of the normal and COVID images [21]. Then Convolutional Layer is applied on the images of the given model (Y) and flatten the dimension by reducing the X dimensions to X-1 and then apply dense layer which is fully connected with all the neurons by using the architecture ResNet and Xception Net and Inception Net. Then activation of Dense layer is done by sending the Parameters to the Function Leaky ReLU(z) and at last the classification is done by using Softmax classifier. Algorithm 3 describes how the data was collected from Y or C in the form of S and from different regions n to find out the highest region/state that reports the highest number of cases on weekly data [22, 23]. Algorithm 4 describes how the vaccination process takes place. Using the data from Y or C about R, the first thing to be done is to send information to the Vaccination Distributor (VD) [24] and the VD apply the vaccination to R. This process will continue until all the people of all the regions/states are not vaccinated [25].

```
1: Input: Positive Cases Data (S).
2: Output: Detect Highest Positive Cases Region.

/* Initialization and Declaration of the Variables*/
Get the Positive Cases Data Region wise = S.
Total No. of Regions = n. Store Max. Value = max.

/ *i (selected region for positive cases) and j (positive
cases day-wise) variables are used to identify the max
regions from the month-wise information as available
in the Dataset */

3: Find out the Higher No. of Positive Cases Region on a weekly Data Basis for a month:
        While j ≤ 30        do begin

          Procedure: Find_Large_Region(S,n)
          /* Assuming the i :=1 is an initial max Region,
             Where vaccines were insufficient and then
             moving to another max Region   */

          large := Si
          i := 2
          While i≤ n do begin

            if  Si>large then
                large:= Si
                  i:=i+1,  max := large
            end
          end
          Find_large_Region =max
        end

4: Send Maximum Values to the Central Administrative In charge(Y) and Do Vaccination Process in
      Regions(V), Y <— max.
```

Algorithm 3. Identifying Higher Positive Covid-19 Cases Regions using Administrative Data

1: Input: Higher Region Data(R)
2: Output: Done Vaccination Task.
3: Get Highest Positive Cases data From Central Administrative Incharge = R.
4: Send Vaccination to Vaccination Distributor = VD.
5: Apply Vaccination on Specified Regions(R) by VD to People(Z), R <— VD.
6: Apply Vaccination to Regions People till:

    While Y != X   do begin
        Vaccination to Z.
    end

7: Repeat Steps 1 to 4 until all the Regions have not got Vaccinated with Finding Second Highest Regions.

Algorithm 4. Do Vaccination Task on Higher Cases Region

For finding the region with the highest positive cases one procedure was defined namely Find_Large_Region which processes each month's data and gives the result about which region has the largest amount of cases and sends it to Y or C with Region specification R [23].

In this research paper we are focusing on the concept of detecting COVID-19 Cases and Vaccination Process by making use of intelligent AI and deep learning based CT-Scan Images to identify and handled data and vaccination process on the cloud computing. The proposed framework's outcome analysis (CIA-CVD) is defined in Sect. 4.

Result analysis of the proposed framework

Figure 3 shows the proposed architecture where the CAA are used to manage the information between the Regions (R) and the VDA for smooth management of the services. New images are generated from different regions who aim to find the positive cases and lives better are in demand. Images, CAA, computer programs or identifying highest regions algorithm and Region Vaccination Distributor are the one that conducts conversations using imaginary or textual methods are becoming increasingly common and popular. CAA is the Central authority, that maintains the region wise detection data and highest region cases data with which vaccination status of the regions by using this frameworks have expanded and take their place in healthcare system, too. The Medical Futurist claim that they can reduce physician fatigue and teach individuals how to properly care for their health [26]. Numerous activities can be carried out using CAA in Cloud-based medical systems, such as disease detection, providing patient information to CAA regions/states, providing Highest cases regions from the previous month, the ability to scale range of dates when patient numbers increase, offering vaccination priorities to the specified region by CAA to VDA, and sharing data with the VDA / stakeholders and the Algorithms. This study, therefore focused on detection and vaccination using the concepts of CNN based ResNext architecture for detection of COVID-19 and CAA for the central administration of vaccination using region based data. It is obvious that the CAA will be making the decisions based on the "dataset available for the analysis purpose" in the

Table 2 Combination of COVID and non-COVID dataset using randomization

Image	Id of Disease	Type of Disease
COVID/Covid (54).png	0	COVID
COVID/Covid (1035).png	0	COVID
non-COVID/Non-Covid (21).png	1	non-COVID
non-COVID/Non-Covid (248).png	1	non-COVID
COVID/Covid (409).png	0	COVID

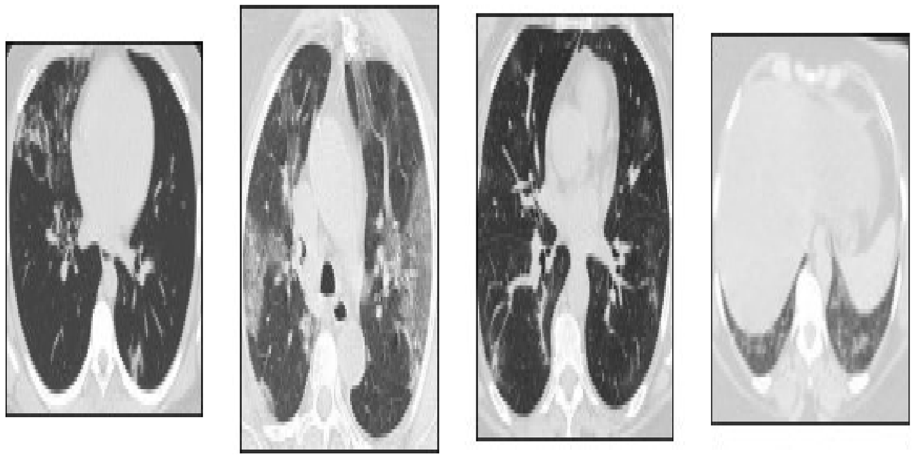


Fig. 4 COVID-19 Disease Images of CT-Scan

cloud computing environment [27]. Hence, if the genuine/original dataset is available, CAA can pass the correct information to the VDA and other management authorities without the involvement of human need. Hence, the dataset from where the CAA is making the decisions play an important role. Table 2 presents a combination of COVID non-COVID dataset using randomization.

But when the dataset itself is anomaly-based, the resultant information passing to the patients/doctors and others will be of no use; instead, this will create havoc in the system and improper management of the computing resources. Hence, the CAA have to identify the anomalies along with concerning their own jobs. Therefore in this research paper, we are focusing on the region wise data for disease detection using deep learning concepts. The dataset in Table 2 contains COVID-19 X-ray/CT-Scan image consisting of Virtual Machines, and the parameter that we are considering here is the COVID or non-COVID cases. Figure 4 shows the readings of dataset of the images without the anomaly and data is clear with the disease COVID-19. Figure 5 shows the readings of the dataset of the images without the anomaly and data is clear with the result as non-COVID-19.

Figure 6 depicts the increasing cases of COVID-19 in each region/state with counts, and this information is sent to the algorithm, which uses CAA to find the largest COVID-19 cases in each state/region [28]. As we all known, this identification of highest no. of cases is done

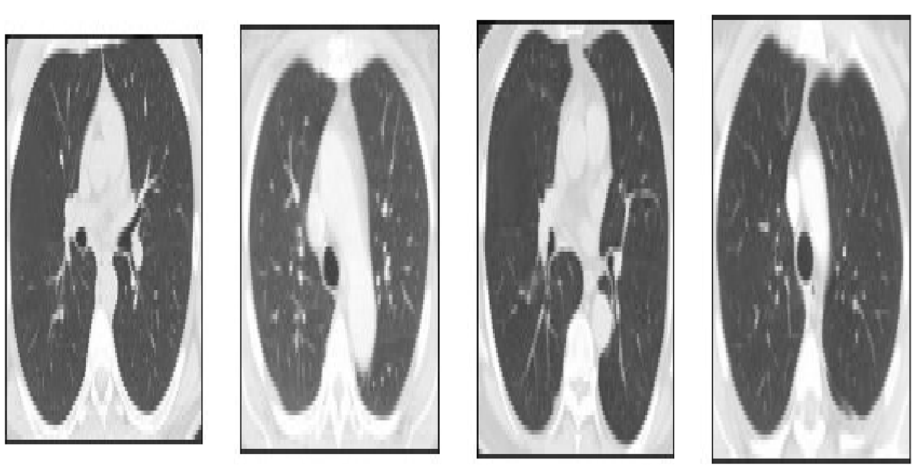


Fig. 5 Non-COVID-19 Disease Images of CT-Scan

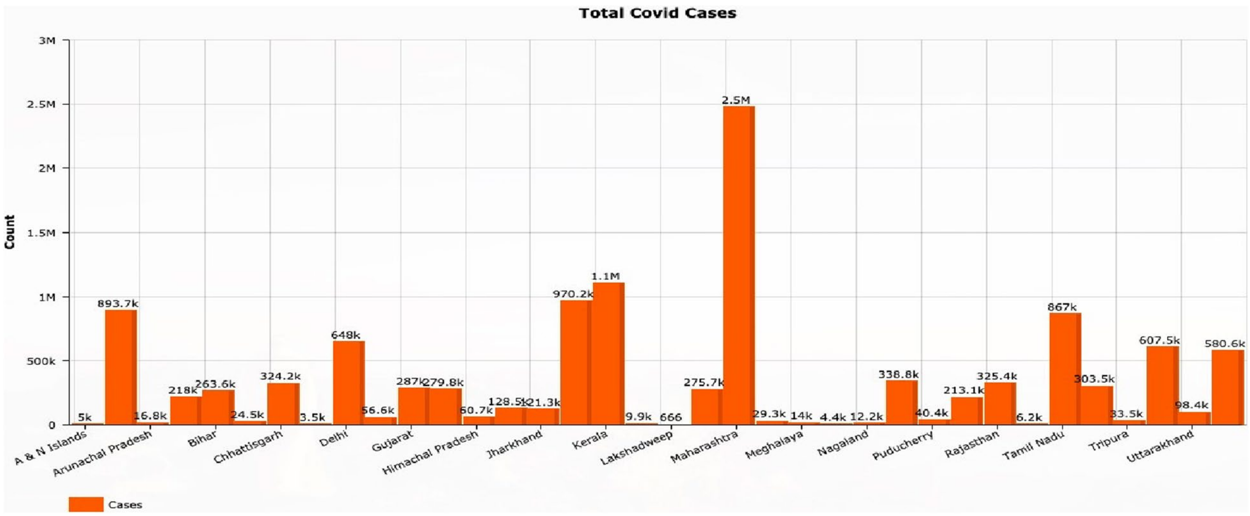


Fig. 6 Total No. of COVID-19 cases state wise

after the given period of time which is called phases and this phases data of the particular region is shown in Fig. 7 with respect to dates and counts.

After getting regional/state wise data from CAA to VDA, how the vaccination progress and how much amount of vaccination is done in respective regions/states are shown in Fig. 8 [29].

The machine learning-based isolation graph, which is implemented in Figs. 9, 10, and 11, identifies consumption in terms of High, Low, and Average between timestamps of 0 ms and 8100 ms and in the range of CPU usages from 0 to 100% [30].

When the anomaly is discovered, CAA will take the necessary steps to reduce the effect of the anomaly or bug. If there is no abnormality, CAA can securely transmit the data to the end users. The computed accuracy was 0.92. These findings and analyses can assist CAA and VDA determine if the information provided to patients, clinicians, and others is accurate. We made the assumption that the cloud resource management had already created the workload patterns. If the model differs from the current one, machine learning-based isolation graphs will identify this and inform the CAA. Until the anomaly is averted, CAA will stop exchanging messages with the VDA of the healthcare system.

SWOT analysis for implementing cloud in the healthcare system

SWOT analysis helps us to find out the efficiency of deployment of evolving technology in the Healthcare domain. The parameters for the SWOT analysis is presented in Table 3.

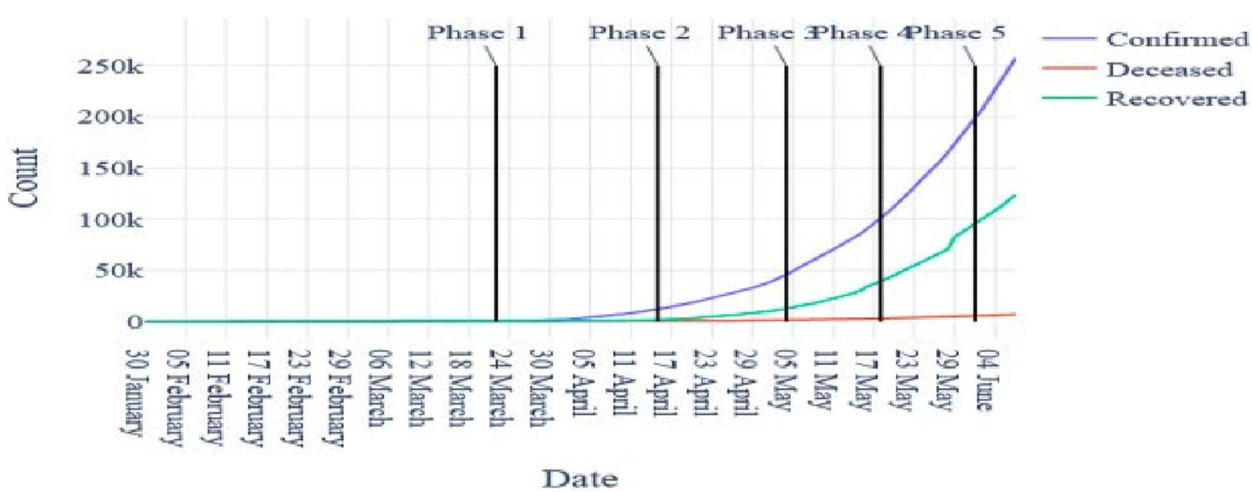


Fig. 7 Phase wise impact of COVID-19 in regions/states

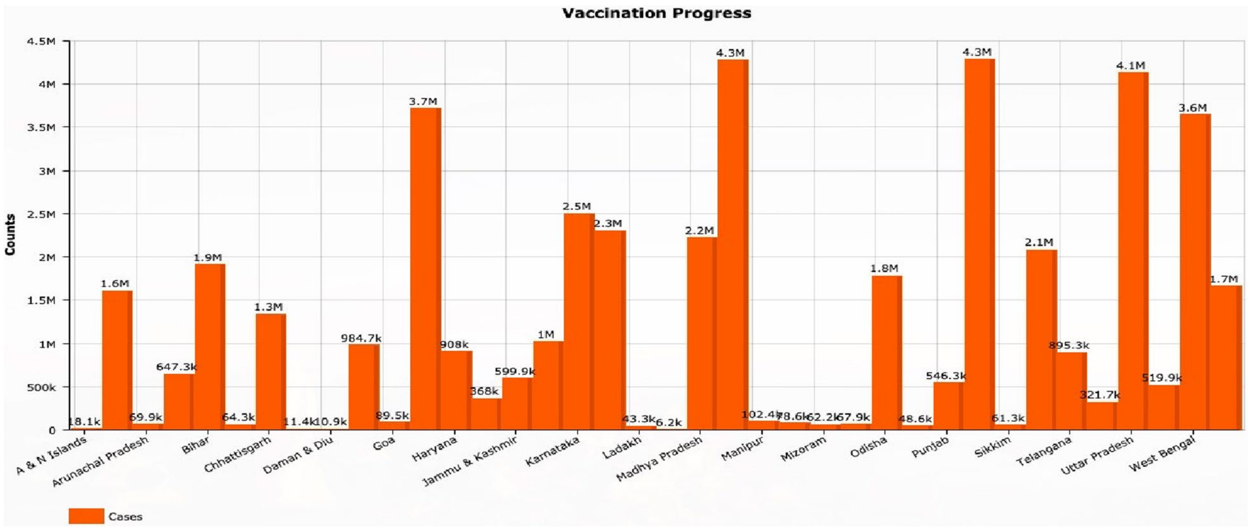


Fig. 8 State wise vaccination data

The results show that none of these models proved to be as reliable to replace RT-PCR test and still researchers are trying to improve these techniques. From our survey, it is noticeable that the X-Ray image dataset is more widely available than the CT Image dataset as a CT scan is costly and more time-consuming. As a result, the majority of the researchers relied on chest X-ray images to diagnose COVID-19. After getting results of disease, region wise cloud computing plays an important roles in the healthcare systems [31], and CAA can get and provide details of the appointment to health care professionals like VDA and help them update medical records into the Cloud and its security is also an important factor [32]. The service combines integrated medical information with natural language abilities, extendable techniques, and enforcement components to provide forecasts to healthcare organizations by simply running the model in a loop [33–37]. In this study report, the framework known as CIA-CVD has been applied, which works with Deep Learning and machine learning-based images to detect disease using a pre-defined dataset. This will increase the trustworthiness of CIA-CVD for medical services.

Conclusion and recommendation for future work

Conclusion

In this paper, we presented deep learning models for predicting the number of COVID-19 positive cases in Indian regions. An exploratory data evaluation of the growth in the number of positive cases in India was conducted. States are classified into mild, moderate, and extreme zones based on the number of cases and the regular growth rate in order to implement effective lockdown measures of state by state rather

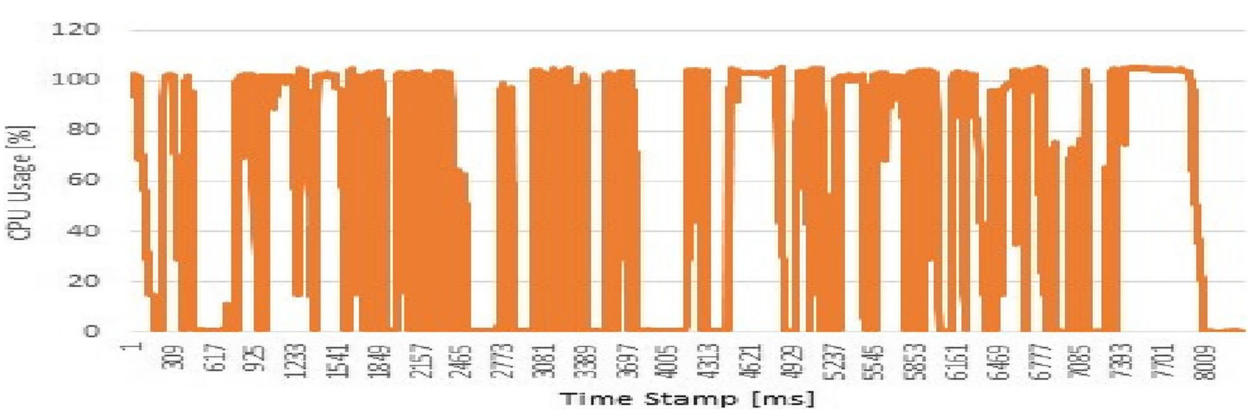


Fig. 9 CPU utilization for High CPU usage with upper bound of 100%, in graph x-axis: Timestamp (ms) and in Y-axis: CPU Usage in [%]

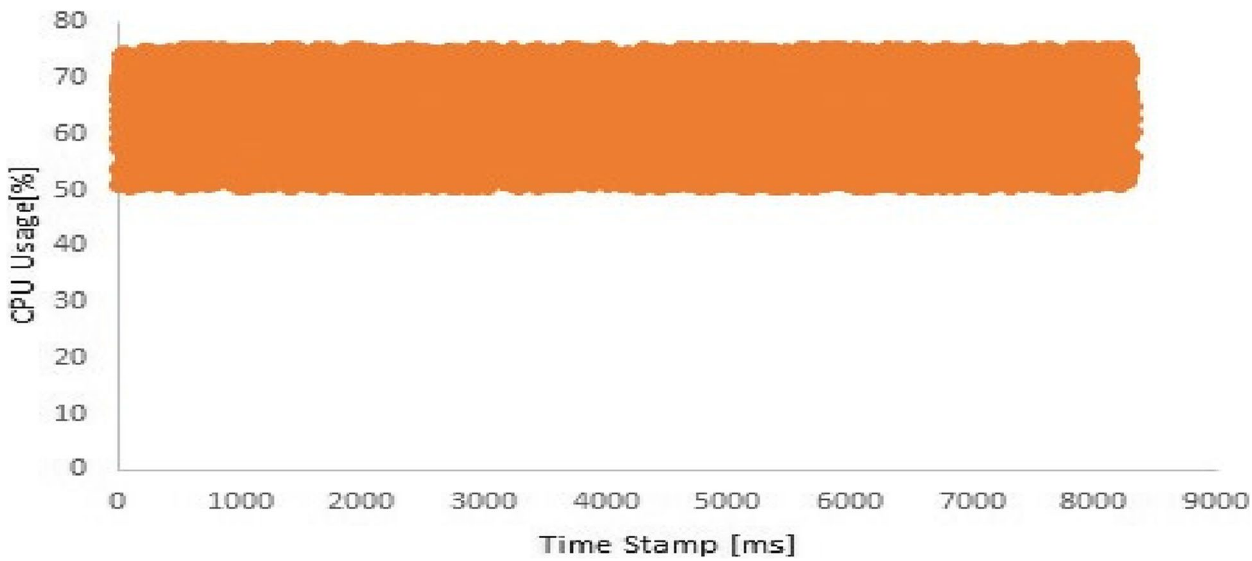


Fig. 10 CPU utilization for AVG CPU usage with upper bound of 70%, in graph x-axis: Timestamp (ms) and in Y-axis: CPU Usage in [%]

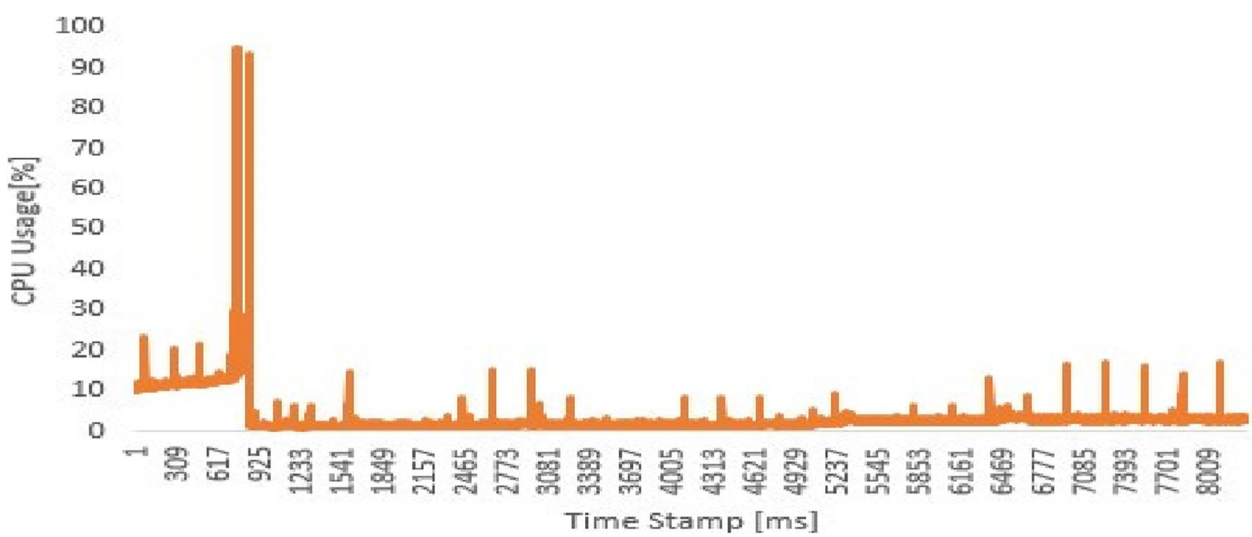


Fig. 11 CPU utilization for LOW CPU usage with upper bound of 100% and lower bound of 0%, in graph X-axis: Timestamp (ms) and in Y-axis: CPU Usage in [%]

Table 3 SWOT analysis

STRENGTH	WEAKNESS
Energy Efficient, Flexible, Easy to Customize, Cost efficacy	Privacy Laws, Blending with local software, QoS
OPPORTUNITY	**THREAT**
Elastic to new requirements, Adoption of New technology	Loss of data, Lack of Standards, Data Privacy

than locking down the entire country, which might cause socioeconomic concerns. As COVID-19 is spreading worldwide at a rapid rate, accurate and faster detection has become essential. In this study, we tried to present a comprehensive survey of AI assisted methods that used medical images to combat the COVID-19 pandemic challenge by detecting it at a small cost and relatively faster time. We surveyed 80 COVID-19 diagnosis models among which 28 used CT images, 50 used X-Ray images and 2 used both CT and X-Ray images.

Recommendation for future work

The following are potential directions for future research:

1. *Enhancing Accuracy and Speed*: Improve the CIA-CVD model's DL and ML algorithms to increase the efficiency and accuracy of COVID-19 identification from medical photos.
2. *Integration with Real-Time Data*: By adding the most recent epidemiological data and medical imaging technology, develop methods for real-time data integration to guarantee that the model can adapt to changing pandemic conditions.
3. *Deployment and Scalability*: Look into ways to make the CIA-CVD model widely available to medical facilities all across the world. To guarantee its efficacy in areas with different healthcare infrastructures, scalability is essential.
4. *Privacy and Ethical Considerations*: Utilize effective data anonymization techniques and adhere to data protection laws to address privacy issues related to medical picture data.
5. *AI Explainability:* To win the trust of medical professionals and legislators, look into ways to make the AI-driven decision-making process more visible and understandable.
6. *Continuous Model Training:* To keep the model updated and efficient, implement ongoing model training to adjust to new COVID-19 variants and adjustments in diagnostic procedures.
7. *Security and Resilience:* To safeguard sensitive medical data, the cloud-based solution's security should be strengthened. Put resilience mechanisms in place to guarantee the system's availability even in difficult circumstances.
8. *Cost Optimization*: For healthcare organizations with limited resources, looking into ways to lower the operational expenses related to cloud-based technologies to make the CIA-CVD model economically feasible.
9. *Human-AI Interaction*: Look into ways to make interactions between medical experts and the AI system better, making sure that the model's outputs are understandable and useful.
10. *Long-Term Pandemic Preparedness*: Research should be expanded to address long-term pandemic preparedness by creating flexible AI systems that may be used to combat future outbreaks of infectious diseases.

Abbreviations

CIA-CVD	Cloud-Based Image Analysis for COVID-19 Vaccination Distribution
CC	Cloud Computing
CAA	Central Administrative Authority
CT	Computed Tomography
D	COVID-19 Cases Detected
DL	Deep Learning
HPC	Higher Number of Positive Cases
I	CT-Scan Image
ISV	Insufficient Vaccine
Leaky ReLU	Leaky Rectified Linear Unit
ML	Machine Learning
P	Image
R	Analysis Region Wise Record
R1	Region Wise Data
S	Positive Cases Data
V	Region Wise Vaccination
VD	Vaccine Distribution
VDA	Vaccine Distribution Authority
X	Weekly Wise Data
Y	Central Administrative In charge

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Code availability
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Authors' contributions
Vivek Kumar Prasad: Conceptualization, Methodology, Software, Writing- Original draft preparation Debabrata Dansana: Data curation, Visualization, Investigation.S Gopal Krishna Patro: Investigation, Visualization, Investigation. Ayodeji Olalekan Salau: Data curation, Methodology, Writing- Reviewing, Editing and Validation. Divyang Yadav: Data curation, Visualization, Investigation. Madhuri Bhavsar: Validation.

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Competing interests
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