

Review on Deep Learning and IoT Techniques on Corono Virus

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Abstract: COVID is widespread and incredibly dangerous phenomenon for Indian society. It is uniquely threatening to the downtrodden lower-middle classes due to its potency as a highly contagious disease with vectors of transmission common to this sub-continent. Despite advances in detection and treatment, coronavirus is a danger. The hospitals are understaffed and heavily overworked. Coronavirus involves transmitting from individual to individual; and occur by sneezes and coughs droplets. The paper presents a review on various deep learning and IOT techniques applied for coronavirus.

Keywords: Gaussian Process Regression, GPR, Artificial Neural Networks, ANN, Convolutional Neural Networks, CNN, Internet of Things, IOT

1. Introduction

Many investigations for the existence of virus is done and whether it stays on the surfaces for long time. The transmission from surfaces is much lower risk than individual to individual is not clear till this time. The current metric for confirming a case of doing two kinds of tests are viral tests and antibody tests. The current infection is checked by viral test whereas past infection is checked by antibody test, and this test provides analysis and reports back to the patient. The process for requires a nurse and is usually invasive for the patient entire process is incredibly cumbersome, inefficient, and distressing on the staff while also being potentially threatening to the patients, During the period of pandemic situation the symptoms of COVID include pain, fever, dry cough and headache. The rate is growing day by day. The vaccine is also not been discovered

There are different categories of coronavirus tests that can be done:

- Special Swab Test – In this case, a special swab is used to take a sample from your nose or throat
- Nasal aspirate – In this case, a saline solution will be injected into your nose and, then a sample is taken with a light suction
- Tracheal aspirate – In this case, a thin tube with a torch, also known as a bronchoscope, is put into your mouth to reach your lungs from where a sample is collected.
- Sputum Test – Sputum is thick mucus that gets accumulated in the lungs and comes out with a cough. During this test, you're required to cough up sputum in a special cup or a swab is used to take a sample from your nose.
- Blood test – In this case, a blood sample is taken from a vein in the arm.

Deep learning and Internet of Things can be used for the detection of Coronavirus using both CT and Xray samples. The Deep learning and the machine learning, the subsets of Artificial Intelligence are widely used in applications related to medical. Both CT and Xray samples are used for Coronavirus and they can be used in deep learning related systems. The transfer learning pretrained models some

systems are made and some using customized networks. Data science and Machine learning are the key areas that are actively used for COVID diagnosis, prediction, and outbreak forecasting. Computer vision is also helped for the COVID reduction. The Internet of things, Big data and smartphone technology are moreover used for effectively solving the spread of COVID-19.

This paper has been organized as follows: Section two focuses on Convolutional Neural Networks. Section three is for Gaussian Process Regression (GPR) and Artificial Neural Networks (ANN) Based Prediction Models. Section four is for IOT devices for Health Monitoring. Section five gives performance measure parameters of. Conclusion is presented in Section five.

2. Convolutional Neural Networks

The special Neural networks are Convolutional Neural Networks that aim to use of the property of restricting the inputs to images to create techniques that can greatly speed up operations within the network to reliably work with image data, which is typically far too large in size for regular neural networks to effectively learn on. Eg: For an input of dimensions (200, 200, 3), we get a total of 120,000 weights *just in the first layer*. For a reference on how massive that is, our implementation of a 5-block deep network with multiple layers of learnable convolutions is only 400,000 parameters large.

The terms that are required to be understood in order to evaluate the architecture proposed are:

Learnable layer: In a CNN, the learnable layer is a convolution of a size defined by its window size. For a window size of 3, the filters in the layer will be of the size 3x3 and cover only a portion of the image. For this implementation, we use a receptive window of size 3.

Stride: A stride is the amount of steps your receptive window shifts by in order to do the convolution operation. Typically, unless down-sampling, this is set to 1. A stride greater than 1 will result in the output image being smaller than its input.

Pooling: A pooling operation aims to convolve over an image and down-sample it via some heuristic. For a window size of 3, a pooling operation will reduce a 3x3 area to a single 1x1 pixel. For this implementation, we use a max pooling operation with window size 3 and stride 2 which takes the maximum of a 3x3 grid. Every pooling operation will typically reduce the input size by half.

Loss function: The loss function is the function which a CNN aims to minimise. A loss function is defined by some mathematical formula which outputs a number based on actual output versus predicted output. The loss function in a CNN is minimised using a technique called the Stochastic Gradient Descent. For this implementation, we use a weighted categorical crossentropy loss function.

Activation function: An activation function is a function which “fixes” the output of a convolution layer such that it can then be fed into the next layer without problems. The ReLU function, is used in between convolution layers as it is empirically the fastest activation function we know of. The softmax activation function is used at the end of the network to convert the weights output from the final layer into class probabilities, which is then used for prediction

Dense layer: A dense layer is a fully connected layer. In a CNN based architecture, you typically require a Dense layer as the last layer with the number set. Then the dense layer output, once passed through the softmax function, is the class probabilities used in prediction.

Input dimensions: The input dimensions are typically represented by a tuple of (images, height, width, channels). Images is the total number of images in the array, height is the height of one image, width is the width of the image, channels is the number of colour channels. For an RGB image, channels=3. For our CXR input, the dimensions are then represented by (-, 512, 512, 1). Only having a single colour channel will be looked at later when we discuss pre-training.

Overfitting: This occurs when the model cannot generalise itself well and does very well on the data it was trained on, but poorly on outside data. The best diagnostic for this is checking the difference between the validation loss and training loss. If they're roughly equal, the model is not overfit and will predict on new data well. If the difference is significant, then the model is overfit and on new, unseen data, it won't perform well. Reducing overfitting is a key idea in Deep Learning and important to understand

Training and validation data: A model is never trained on all available data. It is typically split into train, test, and validation data. The training and validation data is first used and then testing for validating the data. Typically, for deep learning related training, splits of train: test: validation::: 80:10:10 are sufficient

Challenges: For medical imaging, the historical challenge has always been the unavailability of quality data and few methods to augment the data into a meaningful sample. Transfer Learning fails for CXRs due to the different number of input channels on typically pretrained large

models vs the ones in medical images. Imaging here is further hard because of the reluctance to change in the medical industry. AI based systems aren't trusted for diagnostics and therefore most research within this area is merely perfunctory. Medical Data is also prototypically quite large in size. CXRs come in resolutions of 3000x3000 and a pure, non down sampled dataset could be multiple terabytes large.

Structure: The structure of CNN architecture is typically determined by it's block length. A single block of CNN usually contains a convolution layer, then a batch normalization layer, then a relu activation function, and finally an optional pooling layer. We progressively stack these blocks, increasing the number of filters the deeper we go into the network. We can also do modifications such as resnet style skip connections and non-linear convolutions to create different blocks

ConvNets can be greatly optimised by using the following modifications.

1. **Data Augmentation:** a technique to increase the diversity of your training set by applying random (but realistic) transformations such as image rotation, shear, Gaussian blur etc. Essentially, we're artificially increasing the size of the dataset by multiplying the number of images available. This has the added benefit of regularizing the database by adding manipulated input to let your model better generalise and not overfit on the data provided to it. In the context of CXRs, there's a very specific set of transforms that do not distort the existence of the invariant while letting the model generalise better.

Learnable subsampling layers: Subsampling is typically done using a pooling operation to reduce the size of the input window. However, equivalently, we can substitute the pooling layer with another convolution layer with a greater stride and receptive window achieve the same down-sampling operation. However, converting the non-learnable pooling layer to a learnable one increases the amount of non-linearity in the model and therefore lets it generalise better to new inputs

Pre-training via transfer learning: Transfer learning is a machine learning method where a model developed for a task is reused as the starting point for a model on a second task.

It is a popular approach in deep learning where pre-trained models are used as the starting point on computer vision and natural language processing tasks given the vast compute and time resources required to develop neural network models on these problems and from the huge jumps in skill that they provide on related problems. Typically, in the earlier layers, a model first detects primitive shapes and then combines them in the later layers to learn about complex abstractions. As many classification tasks are similar in nature, substituting the earlier layers of your custom architecture with weights from a large scale, pre-trained model generally provides better performance. This, however, is not always the case with medical imaging. As suggested earlier, medical imaging has channel size of 1

whereas most big models (InceptionV3, VGGNet, ResNetetc) have been trained on RGB images.

The pretrained models can be used are AlexNet, GoogleNet, SqueezeNet, VGG,ofResNet, Xception, different forms of inception, diverse types of MobileNet, DenseNet, U-Net, etc[5]

For CT scan images, they used CNN (ResNet50 or other variants of ResNet are the pretrained models been used.

The different type of CNN (VGG19, MobileNetv2, Inception, Xception, and Inception-ResNetv2 was used for Xray images. It was revealed that the highest accuracy of 96.78%, sensitivity of 98.66%, and specificity of 96.46% are obtained for the second dataset using MobileNetv 2 [5]. Another suggestion was combining different techniques. They had combined CNN and Whale Optimisation Algorithm (WOA) for CT scans.COVID-19 infected (positive) cases from other (negative) cases using deep learning technique CNN are classified [5].

Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-COV-2) also known as COVID-19 has emerged as a pandemic throughout the globe recently. Different CXR (chest X-ray) scans show that the people suffering from pneumonia, COVID-19 and a normal person, all have slightly different grayscale images of their lungs. So this differentiation becomes necessary by means of deep multi-layered CNN.

The proposed methodology to detect and classify chest X-ray images is 10 fold cross validation technique and blind testing is applied.The accuracy obtained from blind testing is best technique and can be used as alternative for medical healthcare professionals for prediction of disease.

An machine learning based system can use the past data and actual day wise data and make predictions on the upcoming days .Linear regression, Least absolute shrinkage and selection operator (LASSO), Support vector machine and exponential smoothing (ES) have been used to forecast the factors related to COVID-19.The predictions made are newly infected cases ,the number of deaths and number of recoveries in the upcoming days.The results proved that ES performs best as compared to other models. SVM predictions are not good as compared to other models.LR

and LASSO are used for forecasting .as per the output of these two models the recovery rate will be slowed down and in the days coming the death rates will be increasing. SVM behaves poorly due to dataset values. It was very difficult to put an accurate hyper plane between the given values of the dataset. The forecast will be of great help to manage the pandemic.

Table III: Models performance on future forecasting for death rate

Model	R ² Square	R ² adjusted	MSE	MAE	RMSE
LR[1]	0.96	0.95	840240.11	723.11	916.64
LASSO[1]	0.85	0.81	324406.79	1430.29	1801.12
SVM[1]	0.53	0.39	160162.98	3129.74	4002.02
ES[1]	0.98	0.97	66228.72	406.08	813.77

Gaussian Procees Regression (GPR) and Artificial Neural Networks (ANN) Based Prediction Models for COVID-19

COVID-19 is affecting old people and people having blood pressure, lung problems, diabetes and cancer and also people having weak immune system.Machine learning models can predict the future behavior of COVID and take measures to overcome it. Linear regression, vector auto regression was also a popular technique.

The models used previously make use of time based data and the data is more deterministic in behavior and can be predicted by simple models. Artificial neural network model uses MLP architecture and various paramters are compared like MSE and RSME. They are tuned with parameters based on preprocessing, weights, activation function, bias, epochs, hidden layers, training and testing data set .

GPR is a non-parametric kernel-based probabilistic model [4]. Gaussian Process Regression takes the new input vector of test set and training set and predicts the output based on it. GPR utilizes the Bayesian principle to calculate the posterior distribution by first calculating the prior distribution associated with the data [4].The analysis was that age was the factor as compared to other factors like diabetes, smoking etc. ANN has randomness in the data and it was not successful in predicting the behavior. The probabilistic and non-parametric nature of the GPR system, it can be easily simulated and projected and GPR showed better performance [4].

Table I: ANN parameters for model analysis

Regions[1]	Number of hidden Layers[1]	Number of neurons in each layer[1]	Transfer function at each layer except output [1]	Training function[1]
Europe	2	6 each	Tan-sigmoid	Bayesian regularization backpropagation
America	2	6 each	Tan-sigmoid	Levenberg-Marquardt backpropagation
Middle East	2	6 each	Tan-sigmoid	Bayesian regularization backpropagation

Table II: GPR parameters for model analysis

Regions[1]	Sigma[1]	Basis Function[1]	Kernel Function[1]	Fit Method [1]	Active Set Method[1]
Europe [1]	139.9 8	linear	Rational quadratic	Exact	Random
America [1]	673.8 6	Constant	Squared Exponential	Exact	Random
Middle East [1]	3.134	Pure Quadratic	Rational quadratic covariance	Exact	Random

3. IOT devices for Health Monitoring

IoT in domain of healthcare is vital for remote monitoring and sending and also storing data in cloud. It is for monitoring the old people and also can self monitor them y using IOT devices. This further reduces the cost of hospitals.

The combination of IoT, wearable and mobile apps can help doctors to evaluate the vital parameters variations in health conditions of the patients For heart rate monitoring the PPG sensor, based on a system in reflection mode that includes two components such as a phototransistor and a green light emitting diode. They have selected the green light emitting diode, for use in the measurement of the heart rate. By lighting onto the surface of the skin and recording the variation in light intensity that is reflected/transmitted through the tissue as blood perfused the superficial layers green light strongly absorbed by haemoglobin and it is impossible to penetrate deeper into tissue [6]

For Temperature and skin moisture monitoring [6] they used a MCP9700 thermistor and a GSR sensor. The sensors are integrated, through PCB, to the ATmega32U4 shield.

For cloud computing services, they use the Ubi dots IoT platform. For web device interface, they used REST API and a token for API request for device connection.

The online apps can alert patients, doctors or relatives and indicate the values for pulse, temperature and humidity after signal de-noising [6]

A solution to use an IOIO microcontroller board, which obtains the bio-signal data from a person using ECG electrodes and sends it to the mobile device wirelessly using Bluetooth technology. When monitoring the ECG of the patient, the monitored data associated with the ECG waves being displayed on the mobile app is stored in the form of a binary file on the secure digital (SD) card of the device and the user has the ability to upload it to a structured query language (SQL) Server private database With the proper hardware components like the IOIO microcontroller and the ECG electrodes, the solution can monitor the ECG of a person in any environment at low costs, without having to purchase any costly ECG monitoring devices [5]

The Internet of things is in health related services and also keeping a check on distance to be maintained for such situations. A lightweight cheap IOT the node, smartphone the application, the fog based Machine learning tools can be used for data analysis and diagnosis of it. The node can track the variables related to health like body temperature, cough rate, blood oxygen saturation and respiratory rate and the updates regarding the health are displayed on application for further use. The notification from the app is given to the user to maintain a physical distance of 6 feet to control the spread of virus.

4. Conclusions

COVID is hazardous phenomenon for Indian society. It is uniquely threatening to the downtrodden lower-middle classes due to its potency as a highly contagious disease

with vectors of transmission common to this sub-continent. Despite advances in both detection and treatment, coronavirus is a danger. The current metric for confirming a case of doing two kinds of tests are viral tests and antibody tests. The current infection is checked by viral test whereas past infection is checked by antibody test, and this test provides analysis and reports back to the patient.

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For CT scan images, they used CNN (ResNet50 or other variants of ResNet are the pretrained models been used. A machine learning based system can use the past data and actual day wise data and make predictions on the upcoming days .Linear regression, Least absolute shrinkage and selection operator (LASSO), Support vector machine and exponential smoothing (ES) have been used to forecast the factors related to COVID-19. The predictions made are newly infected cases, the number of deaths and number of recoveries in the upcoming days. The results proved that ES performs best as compared to other models. SVM predictions are not good as compared to other models.

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