Application of Deep Learning in Covid Diagnosis and Social Distancing

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Table Content

Abstract

- The covid 19 pandemic has dramatically changed the dimension of today's world and life worldwide.
- The days are leaving us with unprecedented challenges around public health,work-life and daily necessities.
- This situations encouraged us to come up with the deep learning model that can help in diagnosis of corona virus using chest x-rays.
- A Deep learning model will be used to classify the X-Ray images. More precisely there will be different variations of CNN to get a more accurate model for classification of x-ray images.
- It can be very helpful to medical practitioners and radiologists to aid them in diagnosis of covid-19 cases.

Introduction.

Background

- As the disease was connected with the lungs and respiratory organs ,we tried out experiments of covid affected patients with their chest x ray images.
- Early rapid rise in the epidemic demanded the need for expertise in this field.This has increased leaning in creating the automated detection systems based on Machine Learning techniques.
- With the radiologists and their conclusions , the x rays can be treated With image processing techniques.

Problem Statement

- To create a deep learning model which will detect whether the patient is corona infected or not based on his/her x-ray image of lungs.
- Transfer learning techniques are aimed to increase accuracy of the neural network model as the dataset of lungs X-ray images associated with covid -19 is insufficient for the cause .
- To manage the small dataset of the chest X-ray and train the model on those datasets.

Introduction

Objective

- We aim at developing quicker and precise technique for covid 19 detection classifying the x-ray images into three different classes : normal, pneumonia, and COVID-19 based on the convolutional neural network trained on the limited set of covid 19 x ray images.
- We attempt some training techniques that help the network learn better when we have an unbalanced dataset in which covid data is limited .
- Along with that, our objective is oriented towards developing a neural network with the accurate and precise result with the dataset of unbalanced data items and an architecture with optimal results in case of the the current dataset available of less the covid -19 x ray images.

Literature Review

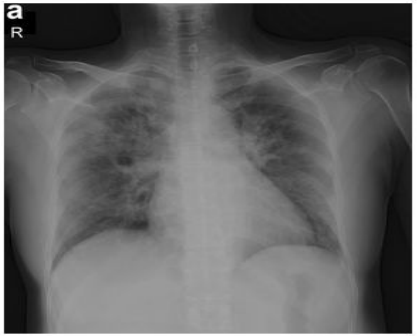
Sr No.	Paper Title	Methodology Used	Review
1.	Informatics in Medicine Unlocked.	Pre-trained ResNet50V2 and Xception(Concatenated.)	Unique technique to run in 8 phases
2.	Computer Methods And Programs In Biomedicine	Xception as base dropout and two fully connected layers	Four class classification with good accuracy
3.	Computers in Biology and Medicine	DarkCovidNet	There are moderate chances of overfitting if latter layers are not trained with sufficient data.
4.	Medical Image Analysis Deep-Covid	Four pre-trained model: ResNet18, ResNet50, SqueezeNet and Dense-net121	No combination of models tried. The dataset is augmented.
5.	Computer Vision and Radiology for Covid-19 detection.	ResNet34 and ResNet50 are used.	Lacks data quality and accuracy.

Materials and Methodology

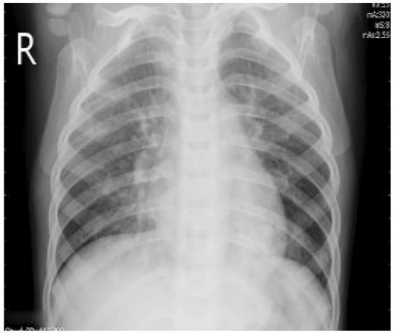
Datasets

1. 1199 Chest X-Rays of Covid-19 patients.
2. 1341 Chest X-Rays of Normal people without any viral disease.
3. 1345 Chest X-Ray images of Viral-Pneumonia Patients.

This dataset was collected from Kaggle. It was developed by a team of researchers at Qatar University, Doha. This dataset was the winner of Covid-19 dataset award by Kaggle.



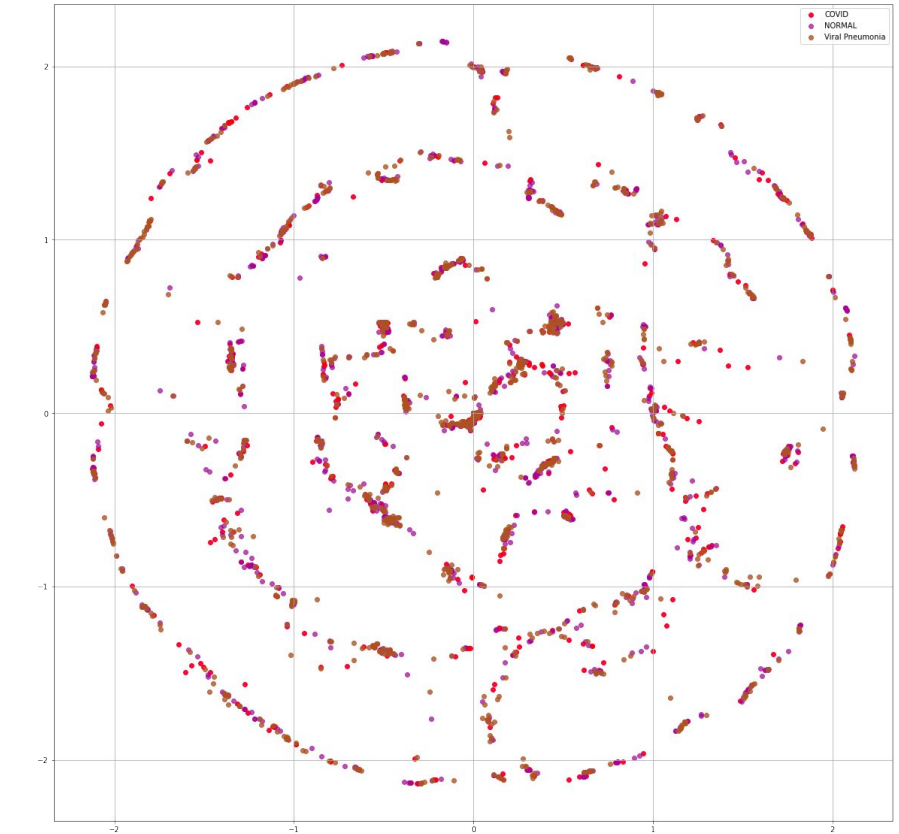
a) Covid - 19

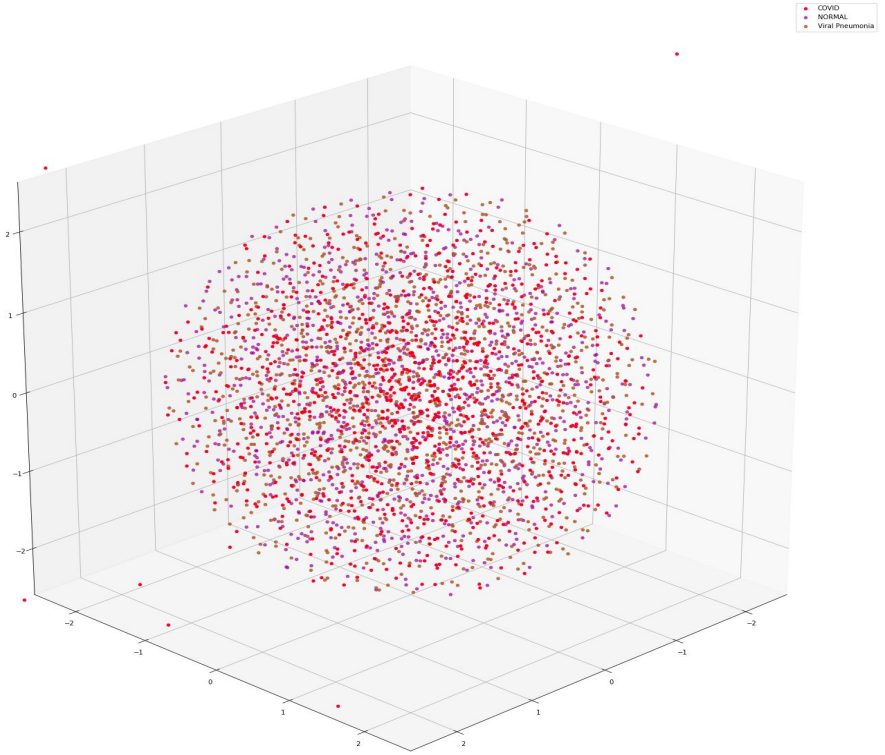


b) Pneumonia

c) Normal

Images of X-rays





Visualisation of DataSet with t-SNE

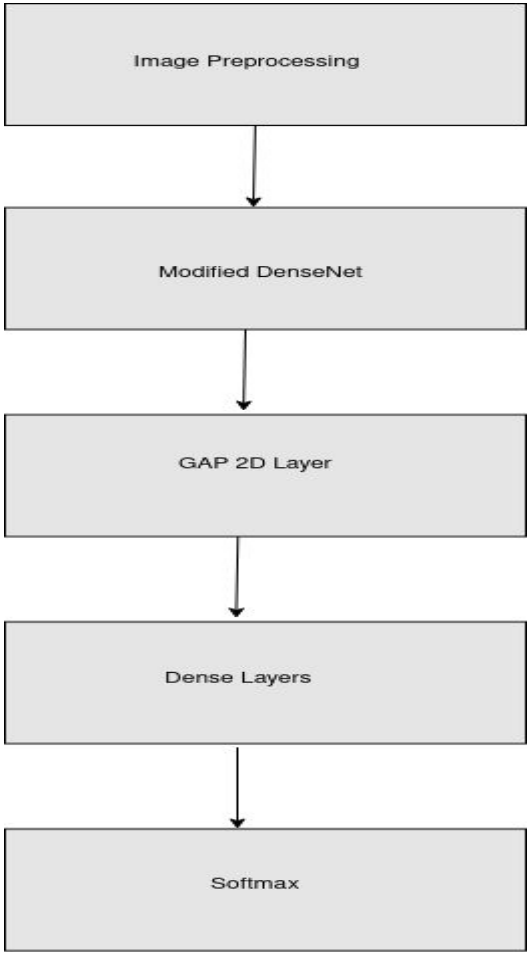
Methodology

Image Preprocessing

- Rescale
- Rotate
- Zoom

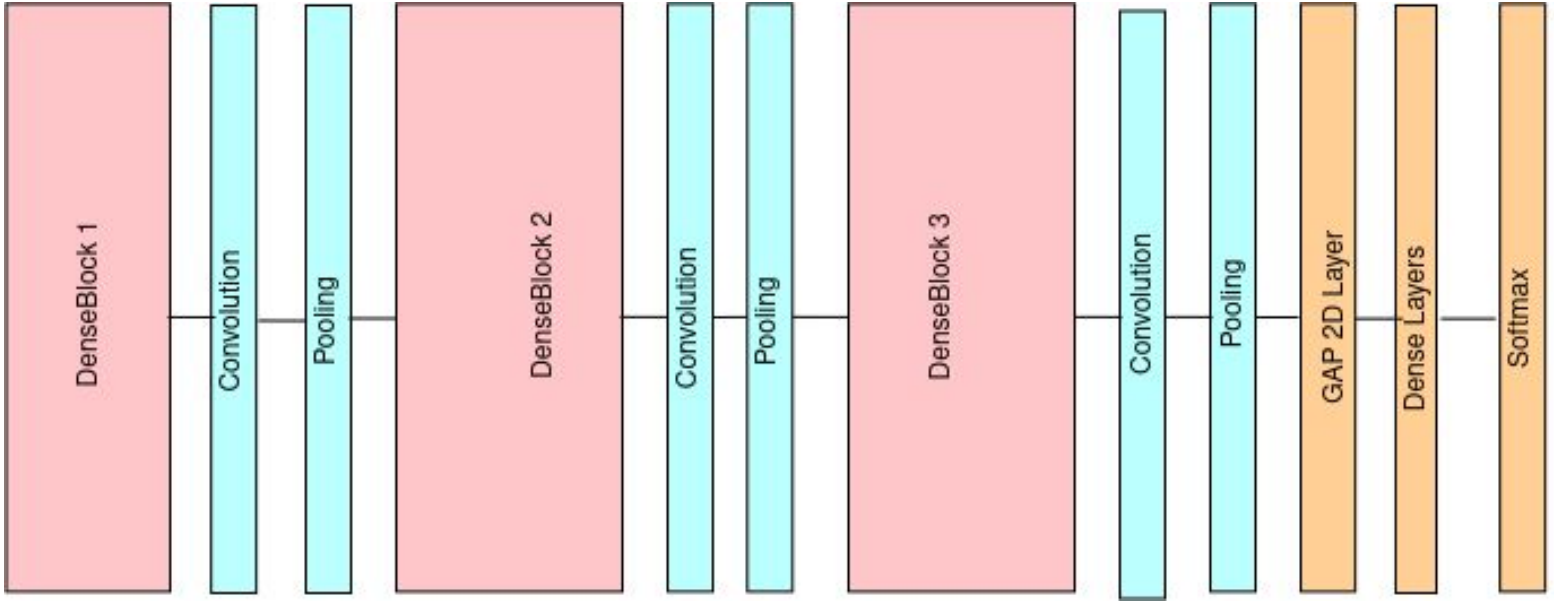
Proposed Algorithm

- Image Preprocessing
- Model
- GAP 2D
- Dense Layers
- Softmax



Proposed Model

The model proposed in this project is a modified version of **DenseNet121**



Experimental Results and Comparison

Metrics Used

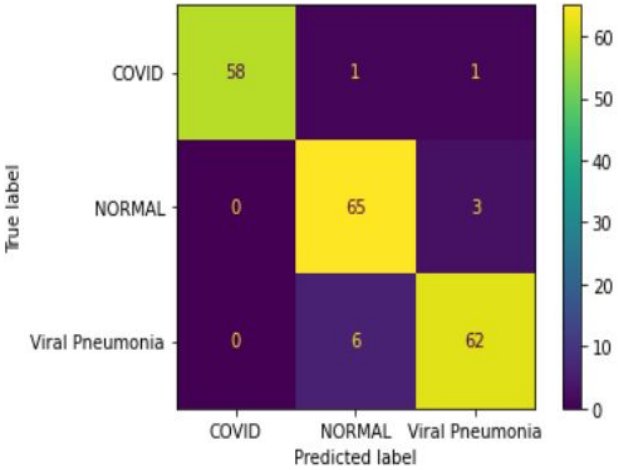
- F-1 Score
- Accuracy
- Recall
- Precision

The support for the Covid, Pneumonia and Normal classes is 60,68 and 68 respectively.

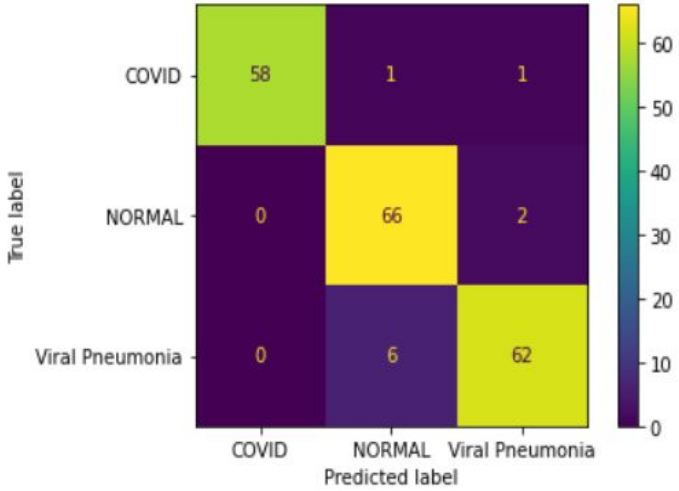
Note - Class 0 is Covid, Class 1 is Viral Pneumonia, Class 2 is Normal.

Results

From **DenseNet121** for class 0 precision is **0.95**, recall is **0.93** and F-1 score **0.939** , for class 1 precision is **0.937**, recall is **0.913** and F-1 score is **0.924**, for class 2 precision is **0.954**, recall is **0.944** and F-1 score is **0.948**. The average accuracy is **0.94**.



From **DenseNet121 (Cut Last DenseBlock and attached GAP + Softmax)** for class 0 precision is **1.00**, recall is **0.97**, F-1 score is **0.98**, for class 1 precision is **0.89**, recall is **0.99**, F-1 score is **0.94**, for class 2 precision is **0.97**, recall is **0.99**, F-1 score is **0.93**. The average accuracy is **0.95**.

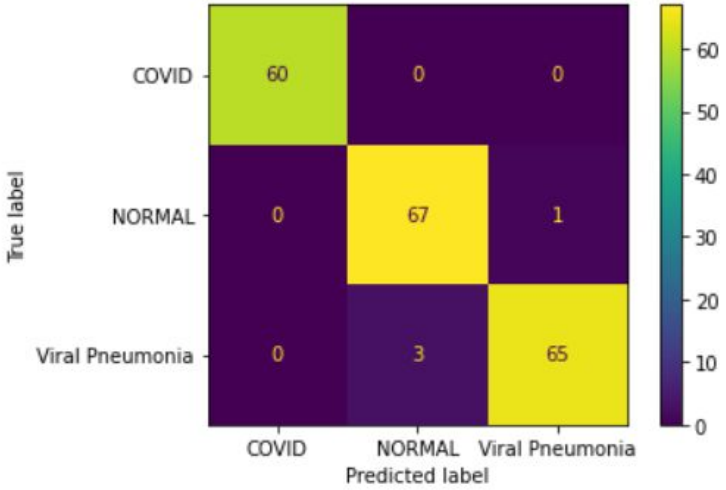


Result

Proposed Model

Classes	Precision	Recall	F-1 score
0	0.995	0.981	0.985
1	0.937	0.97	0.955
2	0.968	0.944	0.957

Accuracy = 0.964



Model Comparison

Model/ Performance Metrics	Recall	Precision	F-Score	Accuracy
VGG16	0 0.967 1. 0.956 2 0.933	0 0.986 1 0.93 2 0.943	0 0.977 1 0.943 2 0.936	0.946
Resnet50	0 0.93 1 0.85 2 0.87	0 0.97 1 0.89 2 0.81	0 0.95 1 0.87 2 0.84	0.88
Xception	0 0.98 1 0.87 2 0.93	0 0.98 1 0.96 2 0.84	0 0.98 1 0.91 2 0.88	0.92
Proposed Model	0 0.981 1 0.97 2 0.944	0 0.995 1 0.937 2 0.968	0 0.985 1 0.955 2 0.957	0.964

Conclusion

- We presented different types of neural network-based models in this project and chose the best one. As a result, DenseNet121 produces the best results when it comes to classifying chest X-ray images into three categories: regular, pneumonia, and Covid-19.
- We proposed a method for training the neural network in which we removed the last block of the neural network and replaced it with additional layers such as GAP, softmax, and dense layer.
- We chose a number of each class that is nearly equal to one another so that our network can learn Covid-19 characteristics in addition to the other two classes.
- As a result, we were able to achieve an overall accuracy of 96.4 percent. We hope that our model will be useful for medical diagnosis in the future.
- We also hope that larger datasets from Covid-19 patients will become available in the future, allowing us to improve the accuracy of our model even further.

Part 2:

Social Distancing Monitoring Using Deep Learning

Introduction

Background

- COVID-19 is distributed primarily among people who are in close proximity (within 6 feet) for an extended period of time. When an infected person coughs, sneezes, or speaks, droplets from their mouth or nose fly into the air and land in the mouths or noses of others who are nearby.
- In addition, the droplets can be inhaled into the lungs. According to recent research, people who are infected but do not show symptoms.
- For people who are at a higher risk of serious mental illness, social distancing is particularly necessary.
- If you have COVID-19, have signs that are consistent with COVID-19, or have had near contact with someone who has COVID-19, it is important that you remain at home and away from other people until it is safe to do so.

Problem Statement

To implement the system of technology using convolutional neural network for the control ,measure and management of the social distancing at the public places using snapshots of the CCTV footage(with the consent of privacies) taken at a regular intervals.

Objective

We aim at developing a neural network model to measure the extent of social distancing protocols being followed, control the violations and irregularities accordingly.The paper includes the human detection , social distancing violation detections ,the measure of social distancing in the form of social distancing index score to keep the danger of spread in check and act accordingly.This system in the longer run can turned into the controller of covid-19 virus in all the public places .

Scope Of Work

The objective of the project is to use the human detection model of convolutional neural network for social distancing violations and tune it into a system of surveillance to keep the spread of the virus in check in the public places .The major deliverables of the project are human detection using yolov3 convolutional neural network model , social distancing violations detections and based on that finally the quantization of the safety in the form of contamination zone classification.

Contributions of this paper are summarized as follows:

1)The Idea of bridging neural networks to the medical field is the trending topic of research. but the concept of implementing the system of technology using convolutional neural network for the control ,measure and management of the social distancing at the public places was unexposed at the time the project idea was proposed.

2)The paper suggests an algorithm to measure the social distancing in the numeric form in order to check the relative danger in check.it also consists of the standardization protocol to project the danger in the form of green,orange and red zones.

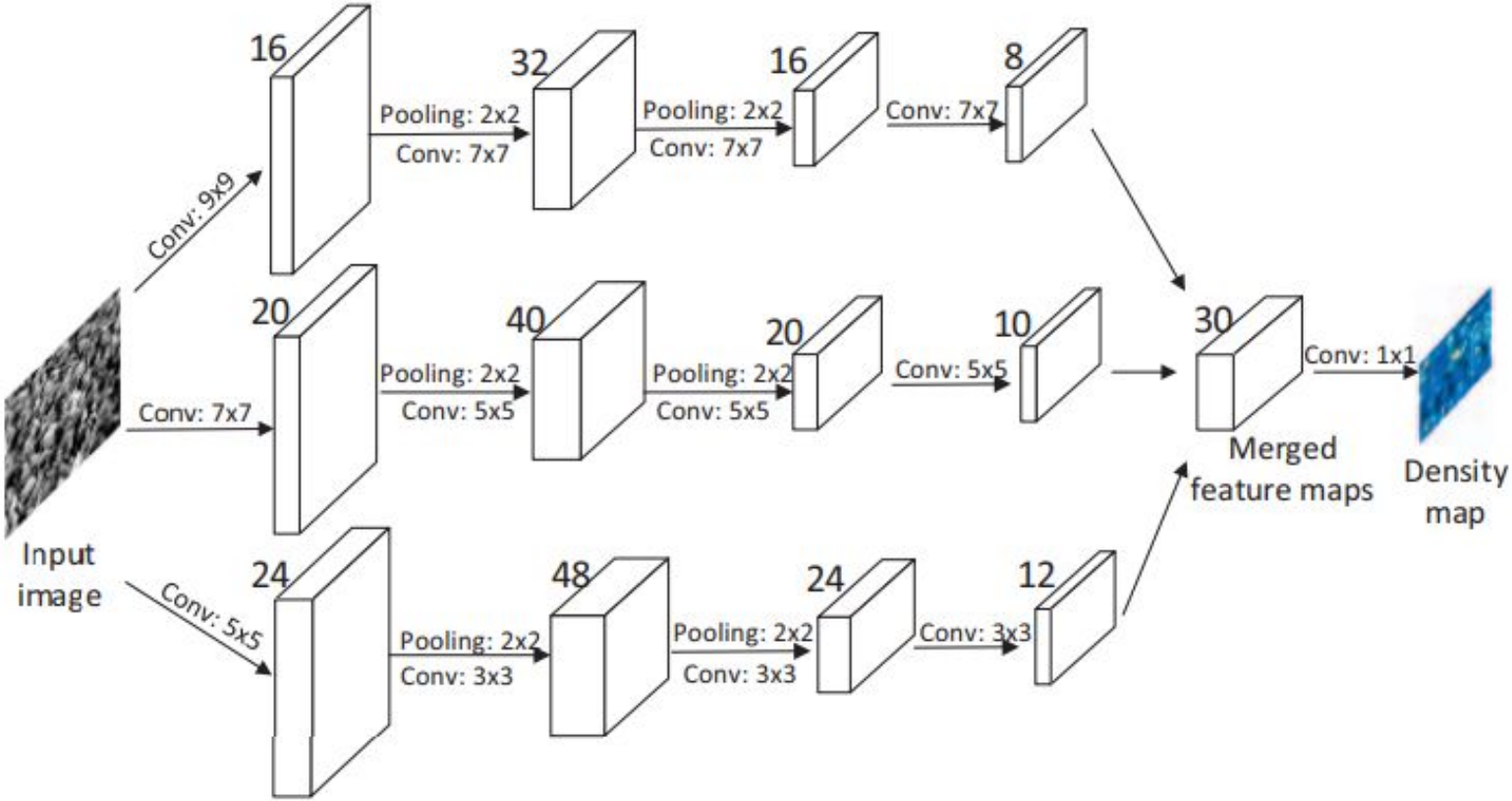
LITERATURE SURVEY

1. Single-Image Crowd Counting via Multi-Column Convolutional Neural Network By Yingying Zhang Desen Zhou Siqin Chen Shenghua Gao Yi Ma Shanghaitech University

- The research paper developed a method with estimate crowd counting with arbitrary crowd density and arbitrary perspective.Proposal consists of Multi-column Convolutional Neural Network (MCNN) architecture to produce crowd density map .
- Major contributions:

  i.The most significant contribution of the paper is the use of multi-column CNN as to tackle the problem of differences in the size of people and heads in the image due to perspective ,focal proportions.

  ii.The neural net takes input can be of arbitrary size to avoid distortion. In this MCNN, the fully connected layer is replaced with a convolution layer whose filter size is 1 × 1.
  iii.one of the important contributions is the performance of the model on the toughest of datasets like The UCF CC 50 dataset,The WorldExpo'10 dataset,The UCSD dataset.These datasets truly evaluates the toughness of the model.the neural net performs with the best of accuracy in the category.


16
32
16
8
Pooling: 2x2
Conv: 7x7
Pooling: 2x2
Conv: 7x7
Conv: 7x7
Conv: 9x9
20
40
20
10
30
Conv: 1x1
Pooling: 2x2
Conv: 5x5
Pooling: 2x2
Conv: 5x5
Conv: 5x5
Conv: 7x7
Merged
feature maps
Density
map
Input
image
24
48
24
12
Conv: 5x5
Pooling: 2x2
Conv: 3x3
Pooling: 2x2
Conv: 3x3
Conv: 3x3

2) Application of Deep Learning for Object Detection
By Ajeet Ram Pathak , Manjusha Pandey , Siddharth Rautaray

- This paper is about application of deep learning for object detection.
  In this paper authors have discussed about importance of object detection in computer vision, different frameworks and services available for object detection, application domain for object detection and state of the art approaches for object detection.
- Some deep learning frameworks and services are mentioned in this paper, this frameworks are listed from the point of view of features exhibited, interface support for deep learning models(CNN, RNN, etc.) and support for multi-node parallel execution. following are some of the frameworks mentioned in the paper:
- Microsoft cognitive toolkit, Theano, Keras, Tensorflow.

3)Pedestrian tracking by learning deep features
Honghe Huang ⇑ , Yi Xu, Yanjie Huang, Qian Yang, Zhiguo Zhou

- This paper is about human detection and tracking by using deep learning techniques.
  In this paper authors discuss about the method or approach to detect humans and track them using bounding boxes in videos. The issues in human detection like the detection of appendant (bag , purse) and the different human postures are also addressed in this paper.
- following is the methodology proposed in this paper:
  i. To begin, training images are divided into subregions in order to reduce the influence of easy-to-influence areas, such as dependent. The remaining regions are almost set. The photos are then fed into CNNs, which are trained to learn deep features.Finally the features obtained are used for human tracking.

  ii. The main problem with human tracking is the appendent such as book or bag or sack. Now to reduce the influence of these appendent on the detection they divided training images into diffrent regions manually. So the regions like middle portion of the human body where book, bag , sack normally go are labeled as easy to influence regions and other regions are labeled as fixed regions and these fixed regions are used as training examples.

  iii . For tracking the detected humans they used the optical flow mathod.

Dataset description

COCO dataset:

- We used this dataset to train our model.
- MS COCO is a large-scale dataset for target identification, segmentation, key-point detection, and captioning. There are 328K images in the dataset.
- The COCO Dataset has 121,408 images ,883,331 object annotations and 80 classes. The COCO Dataset median image ratio is 640 x 480.

MOT16(Multiple object tracking) dataset:

- The MOT16 dataset is used to monitor objects. It’s a collection of old and new data (some of the references are from and), with 14 daunting real-world recordings, 7 for training and 7 for research, of both static and moving scenes.
- We used this dataset to test the social distancing social distancing monitoring.

Methodology

1. Human detection using YOLO:

   We used YOLO for the human detection task in the project. We chose YOLO because in cctv we need real time processing of data and YOLO does exactly that with precision.

   YOLO is a smart convolutional neural network (CNN) that does real-time target detection. The algorithm divides the image into regions and predicts bounding boxes and probabilities for each region using a single neural network applied to the entire image. The estimated odds are used to weight these bounding boxes.

   YOLO is famous because it has a high level of precision and can run in real-time. The algorithm needs only one forward propagation pass through the neural network to make predictions, so it ”only looks once” at the picture.It then outputs known objects together after non-max suppression (which ensures that the target detection algorithm only recognises each object once).

Methodology

1. Human detection using YOLO:

   Output of object detection.

Methodology

2. Distance Calculation:

The output of the previous stage was the bounding boxes around the humans detected in the video frame. Now the objective of this stage is to calculate the real world distance between the detected humans.

consider an imaginary line in 3d joining two humans. If we take image of those people, then in image line joining them will be the projection of the 3d line on 2d plane parallel to the camera.

Now suppose the 3d line is making angle theta with the plane parallel to the camera and its length is x. suppose the length of the projected line in the image is y. Then $y = x \cos \theta$ . . . .(1)

Methodology

2. Distance Calculation:

If we observe in the image as the theta increases the slope of the projected line also increases. so change in the theta is directly proportional to the slope of the projected line. We used the slope of that projected line to estimate the rough value of theta.

After getting the value we can easily find the real world distance by using $y = x \cos \theta$ this equation.

Methodology

3. Detection of violations:

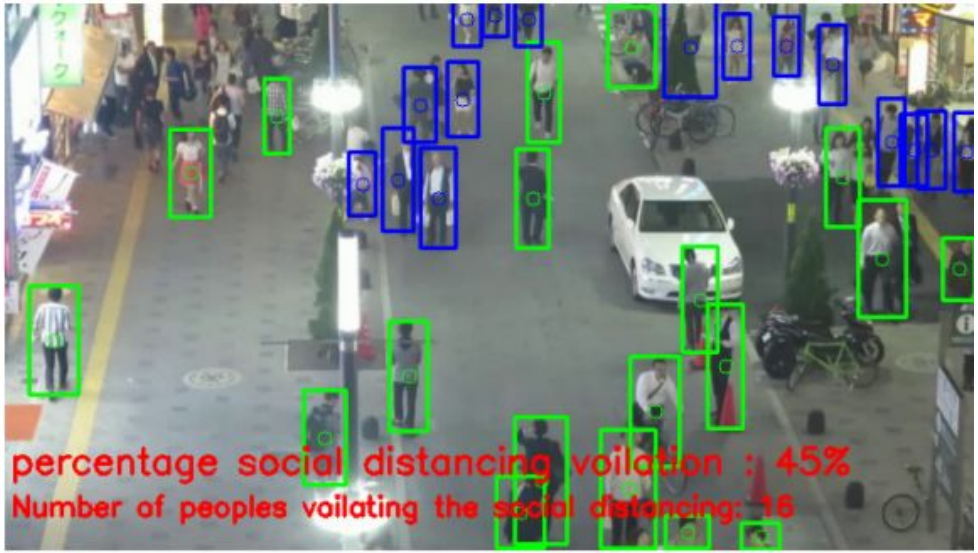
It is considered as violation of social distancing if two individuals are not keeping the distance of minimum 6 feet between them. This is real world distance, but we need the minimum distance for the video frame.

This distance of 6 feet can be easily can be converted into image distance by using lens equation for convex lens. We used equation for convex lens because all of the cctv cameras use convex lens.

After the calculations it turned out 40 pixels for cctv camera of average specifications.

Methodology

Purple boxes in the image indicates that those peoples are not following the social distancing rules.



Methodology:

4. Calculation of social distancing score:

- Social distancing score gives the idea of how well social distancing is getting followed in the area under cctv surveillance.
- The social distancing score mainly depends on the number of violations and total number of people present in the the area.
- We used following formula for calculating the social distancing score for the area under the cctv surveillance.

  social distancing score =

Conclusion and Future work:

- Here in this paper we have implemented the human detection and tracking and estimation of distance between them. By using this information we tried to determine the social distancing index of the area and whether area classifies as the containment zone or not.
- We found the new method for estimating the distance between two humans in the video frame. But for testing the accuracy of this method we have to calculate the real world distance in the frame and compare it with the value given by the method.
- We used the COCO dataset to train the YOLO model for human detection and calculation of social distancing. We don't have the real world distance between the humans in these videos in these data sets, due to this we wouldn't be able to test our method of distance calculation.
- And due to pandemic and lockdown we are unable to collect the data that would've enabled us to test our model. So our future goal will be to collect the data and test our distance calculation method.

Thank you