School of Computer Science and Engineering

The COVID'19 Dashboard and Implementation of Face Mask Detection and Social Distancing Detection Algorithm

CSE3020

Data Visualization Project Report

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The COVID'19 Dashboard and Implementation of Face Mask Detection and Social Distancing Detection Algorithm

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Abstract

With the outbreak of the global pandemic, India seemed to reach its peak with regards to the number of confirmed positive cases in the months of April and May. Hence, the decision was made to develop a data visualization project with one of the efficient visualization tools Tableau to help people analyse the scenario of the cases across the country. In order to contribute to state wise and country wise analysis of COVID cases in India, 2 dashboards have been developed. The first dashboard consists of analysis of cases across the country giving a holistic and overall view of the number of deaths, positive cases and density of cases in each state which is done through colour variation. On the other hand, the second dashboard gives a detailed state-wise analysis of cases with the necessary parameters and details catering to each and every individual state as per the preference of the user. On merging these components together, users can get an all-inclusive analysis based on different parameters on the COVID'19 cases across India at a glance. In order to prevent a further spike in cases, implementing a face mask detection system will also take place after conducting a thorough analysis on the possible machine learning algorithms. Two major object detection algorithms were taken into consideration and based on the conclusion drawn, the best algorithm – RCNN was used to implement the face mask detection system. This project is solely motivated by the current extreme situation in the world and as an attempt to provide a solution to combat the same.

Keywords – Visualization, COVID, Dashboard, Object Detection, RCNN, DNN

1. Introduction

In the current world, data visualization has been gaining immense priority and focus especially in cases where large volumes and variations of data are present, for instance – datasets on COVID'19. With the help of data visualization, information and content can be put forth through graphical and diagrammatic representation with the help of graphs, charts, networks, etc. Tableau is one such software which acts as a data visualization tool and is often applauded for its flexibility, aesthetics, and data driven approach. In order to organize and provide a compact dashboard with all necessary details pertaining to COVID'19, took up the project to curate two dashboards which are capable of giving users a complete overview on the state wise and country wise analysis of COVID cases. The dashboards consist of a plethora of graphical data representations including those of pic charts, line graphs, bar graphs, plotting on maps, and so on. The dataset used for this particular model has been extracted from Kaggle and contains details extending to more than 1000 data fields.

One of the other major trends in the tech industry is the arena of Artificial Intelligence (AI) and Machine Learning (ML). There are a number of algorithms in ML which promote the concept of object detection using computer vision. Computer Vision is a term using to define

a field of study that caters to develop techniques and methodologies that help computers/devices to retrieve useful information and necessary data from digital images including those of photographs, videos, or real time video feeds. There are numerous ML algorithms which help in computer vision in a number of fields including those of medical industry, cyber industry, surveillance, etc. However, some of the highly used algorithms are You Only Look Once (YOLO) algorithm, Single Short Detector (SSD) algorithm, Convolutional Neural Network (CNN) algorithms, etc. For our project, we have chosen YOLO and R-CNN (Regional CNN) algorithm for analysis. On the basis of the outputs obtained on implementing the two algorithms, the best and most efficient algorithm was chosen and used for implementing the Face Mask Detection and Social Distancing Detection system.

2. Feasibility Study

Based on the current grave scenario which the entire world is being exposed to, i.e. the COVID'19 pandemic, this project is indeed an essential and prime utility for the people in the society. The fact that people need to search through numerous papers, websites and applications to get the right analysis and insights of various parameters related to COVID'19 is one of the major motivations to develop the COVID'19 dashboard with the help of Tableau software. Apart from this, despite of strict rules and actions being enforced, a number of people fail to where masks while stepping out of their houses. The Face Mask Detection system which has been backed by ML and computer vision algorithms would help authorities and officials to keep a close track on people and would help them to take necessary actions against those who fail to do the same.

Both the components of our project do not call for highly expensive tools, simulators or applications for functioning and require only a few basic essential utilities to execute and develop the project. Moreover, surveys and researches conducted have proven the need for such systems and ideological implementations to help the society combat and overcome the deadly virus. Mentioned below are a few points which sight the feasibility and need of our project:

- ✓ Off late people have to go through different papers, websites and applications to arrive at a proper conclusion on the COVID cases in our country
- ✓ Finding the analysis of cases in a state wise pattern has proven to be even more difficult
- ✓ There's a need for a system which would provide a visual representation of analysed COVID cases
- ✓ Visual representation systems allow people from all walks of life to comprehend the data with ease
- ✓ Authorities and government officials require an efficient system to keep track of people wearing masks

The above-mentioned facts and perspectives throw light on the pressing need for a system which is capable of portraying data pertaining to the pandemic in an effective way along with the need of face mask detection. This also elucidates that this project is highly feasible and would be widely accepted by the society.

3. Datasets Used

The dataset of each of the two components of our project has been explained in brief below:

3.1 The COVID'19 Dashboard

The dataset used for curating the COVID'19 dashboard has been obtained from Kaggle. The data is stored in an excel sheet with more than 1000 fields. The different parameters included in the dataset include Date, Time, State/Union Territory, Confirmed Indian National, Confirmed Foreign National, Cured Cases, Deaths, and Confirmed Cases all of which pertain to the country of India.

3.2 Face Mask Detection System

In the initial phase, in order to analyse and compare the efficiencies of the different object detection algorithms, we have chosen YOLO and R-CNN algorithms. Before implementing any object detection algorithm in ML and computer vision, it is mandatory to train the respective models using necessary datasets.

- ✓ ***Dataset used for YOLO algorithm***

  Installing the appropriate datasets, parsing through the annotation file, developing the dataset object, testing the dataset objects, and then training the model to detect the objects forms a major part of the initial stages of developing the algorithm. We have made use of COCO dataset. This dataset has around 80 labels which include: People, Bicycles, Cars and trucks, Airplanes, Stop signs and fire hydrants, Animals, including cats, dogs, birds, horses, cows, and sheep, to name a few, Kitchen and dining objects, such as wine glasses, cups, forks, knives, spoons, etc.

- ✓ ***Dataset used for R-CNN algorithm***

  To train the CNN for feature extraction, an architecture like VGG-16 was initialized with the pre-trained weights from image-net data. The output layer having 1000 classes is chopped off. So when a region proposal image (warped to size 224x224) is passed to the network we get a 4096-dimensional feature vector as shown in the above image. We have made use of the coco dataset which trains the model with the following objects:

  'BG', 'person', 'bicycle', 'car', 'motorcycle', 'airplane', 'bus', 'train', 'truck', 'boat', 'traffic light', 'fire hydrant', 'stop sign', 'parking meter', 'bench', 'bird', 'cat', 'dog', 'horse', 'sheep', 'cow', 'elephant', 'bear', 'zebra', 'giraffe', 'backpack', 'umbrella', 'handbag', 'tie', 'suitcase', 'frisbee', 'skis', 'snowboard', 'sports ball', 'kite', 'baseball bat', 'baseball glove', 'skateboard', 'surfboard', 'tennis racket', 'bottle', 'wine glass', 'cup', 'fork', 'knife', 'spoon', 'bowl', 'banana', 'apple', 'sandwich', 'orange', 'broccoli', 'carrot', 'hot dog', 'pizza', 'donut', 'cake', 'chair', 'couch', 'potted plant', 'bed', 'dining table', 'toilet', 'tv', 'laptop', 'mouse', 'remote', 'keyboard',

'cell phone', 'microwave', 'oven', 'toaster', 'sink', 'refrigerator', 'book', 'clock', 'vase', 'scissors', 'teddy bear', 'hair drier', 'toothbrush'

- ✓ ***Dataset used for Face Mask Detection***

  The Face Mask Detection system which we have curated is initially trained with a large number of datasets to ensure that the system is accurate and efficient in identifying and detecting people with and without masks. This also ensures that after extraction of blobs/regions of the image from the frame obtained from the real time video feed can have multiple objects/people in it. The dataset is further subdivided into two classes: with_masks and without__masks. Each of these classes have nearly 2000 pictures with people wearing and people not wearing masks respectively from different angles and proportions.

4. Design and Flow of Models

In order to proceed with the execution and implementation of our project in a smooth and organised manner, our project has been divided into the following distinct modules:

- ✓ Dataset collection
- ✓ Tableau Dashboard 1 - countrywide analysis of positive cases
- ✓ Tableau Dashboard 2 – state-wide analysis of positive cases
- ✓ Object detection algorithms survey
- ✓ Selection of 2 best algorithms - YOLO and RCNN
- ✓ Analysing efficiency of the algorithm on various parameters
- ✓ Implementation of face mask detection algorithm with the most efficient algorithm

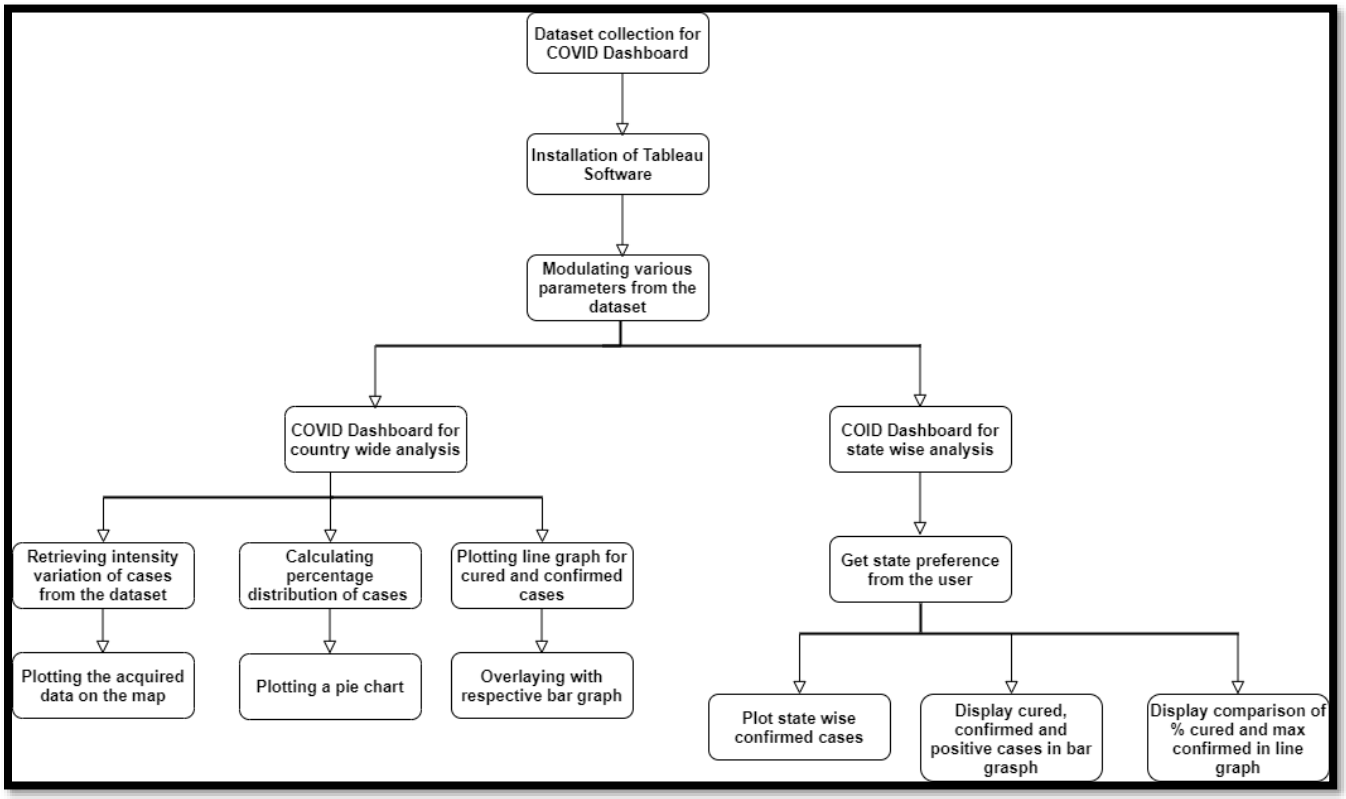
Each of the above-mentioned module have distinct and unique functionalities and aren't tightly coupled with the other modules. This ensures partial independence of modules and makes it flexible to work with.

5. Proposed Solution

The points discussed below gives insights on the solution being proposed with regards to the implementation of Face Mask Detection and Social Distance Detection algorithm.

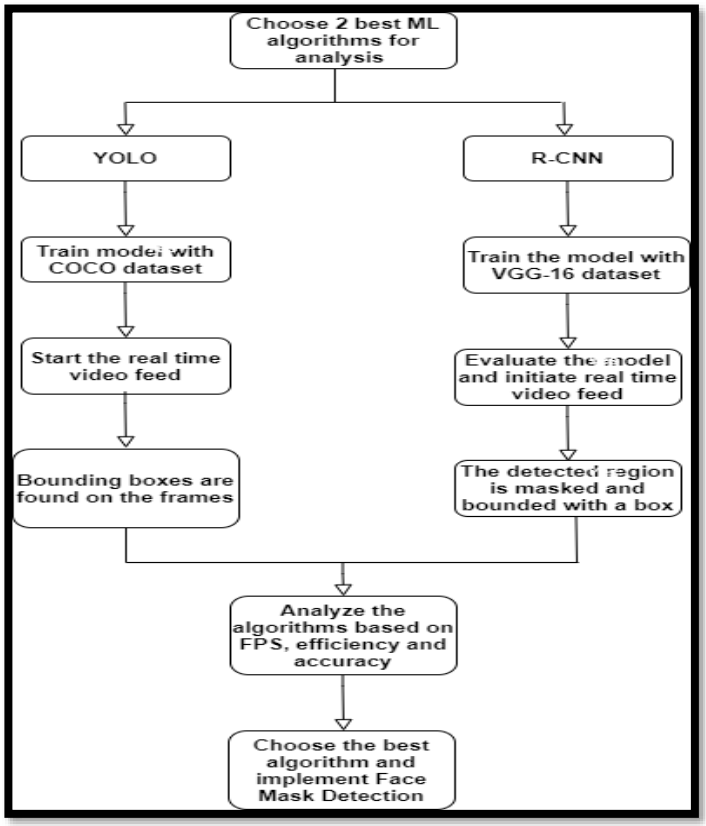
5.1 Strategy

The structure of flow of models for the execution of the COVID'19 dashboard is given below. It elucidates the step-by-step procedures of each and every step involved in developing the 2 dashboards for COVID data analysis.



Design and Flow of model for COVID Dashboard

After the design and execution of the COVID'19 dashboard, the next step is to analyse a few Machine Learning (ML) algorithms and come up with the best and most efficient one in order to implement the face mask detection system. The step-by-step flow of this process is given below:



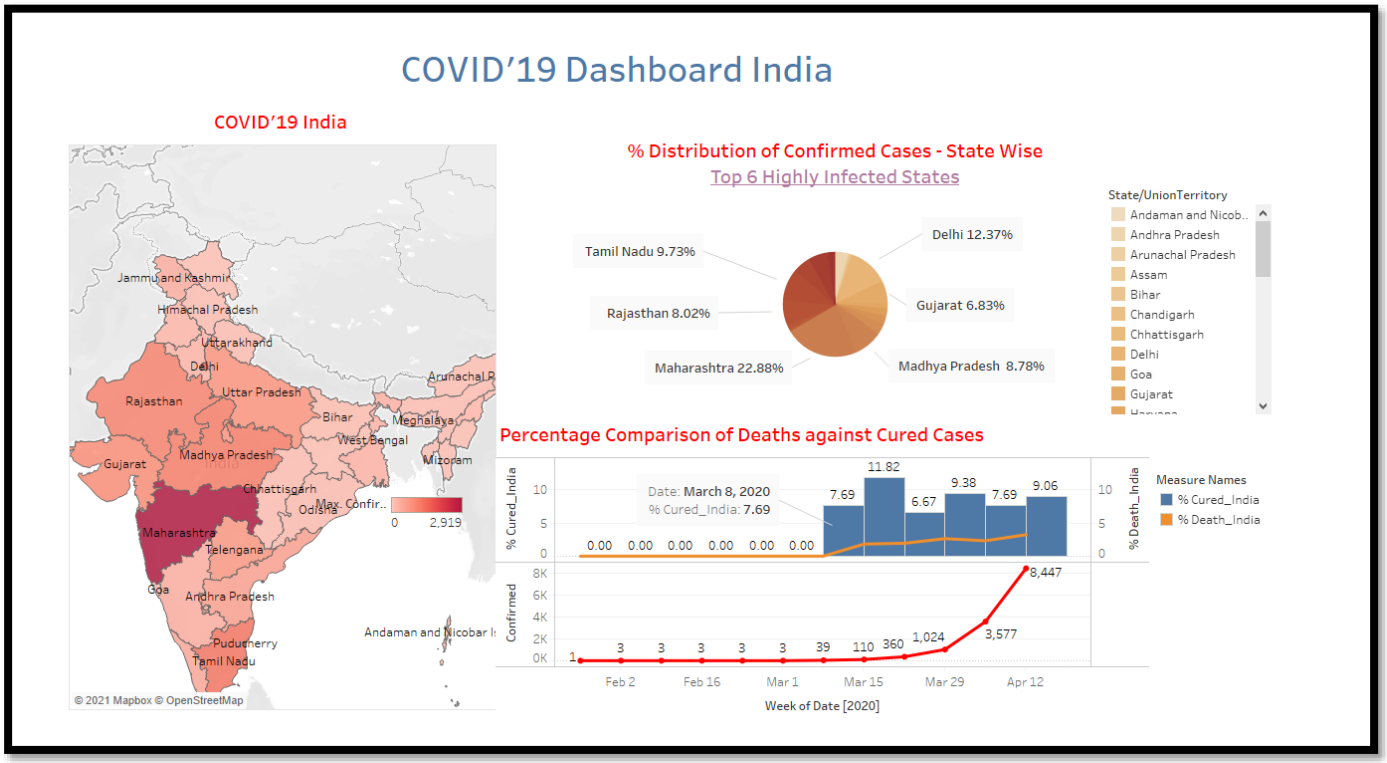
Design and Flow of model for Face Mask Detection System

6. Implementation

To ensure a convenient and organized execution of the project, our project has been divided into 7 modules each of which are interlinked to each other without much interdependence making the project flexible and dynamic in nature. The modules and the explanation of ach of the modules are given below along with the screenshots to support the better visualization of each module.Dataset is an extremely essential and integral component of any of the data visualization projects. And with a large volume of data available in today's world, it's equally important to choose accurate and precise data. This being the very first module of our project, we have chosen our datasets with caution. For the first component of the project, the dataset was chosen from Kaggle. It contained data pertaining to the different parameters of COVID'19 cases in a state wise manner throughout the months of April and May (2020). The data was stored in an excel sheet and had more than 1000 records to render from.

Any ML algorithm requires a predefined training process to ensure that the models are trained with suitable datasets and are capable of identifying and detecting the respective objects from the frames acquired from the video/image. For YOLO algorithm, the dataset we have used is the COCO dataset which has around 80 labels available for training. The dataset used for RCNN is based on the VGG-16 dataset model and consists of a number of labels for training the convolutional neural network algorithms. For the face mask detection system, a large sample of dataset needed to be used to train the model to learn and detect people with and

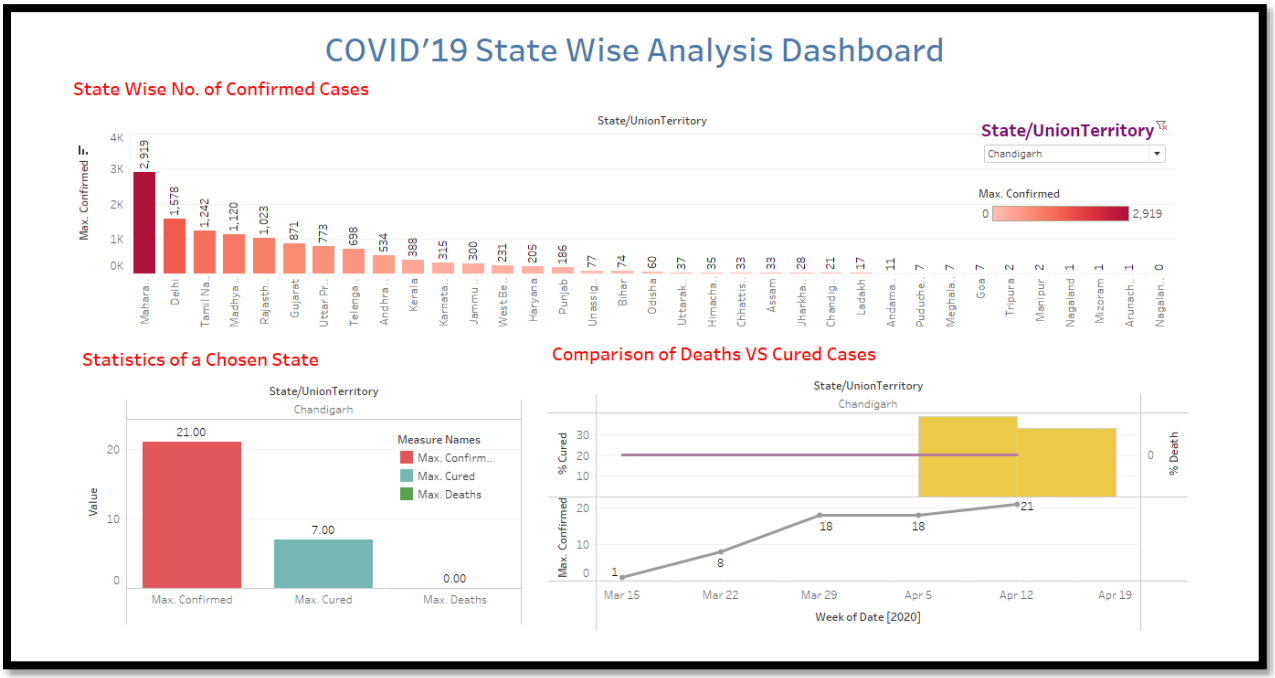
without masks. More than 2000 images of dataset were used in training the model to identify people with and without masks. With the outbreak of the pandemic, India has been exposed to a large spike in the number of confirmed and positive cases such that interpreting data through statistical means has become tedious. To enhance and improvise this concern, we decided to create a visual representation of the statistics using chart, graphs, and maps. The first dashboard gives a complete analysis on a number of different topics pertaining to COVID'19 analysis within one umbrella.



COVID'19 Dashboard 1

As observable in the above picture, the dashboard contains a map with different states labelled, giving an insight on the intensity of cases and proliferating virus rate across the country. Thee second element is the pie chart which shows the percentage distribution of confirmed cases all throughout and the top 6 highly infected states have been labelled for further interpretation. The third element of this dashboard is a line overlayed bar graph which gives a plotting of the percentage of population cured and those confirmed in our nation. This dashboard gives a complete overview of COVID'19 analysis across our country and deems to be simple to understand, comprehend and visualize.

The first dashboard gives a holistic view of COVID parameters and analysis from across the country. However, for those users who wish to avail analysis on a particular state of their choice, the second dashboard is most suited. The second dashboard produces graphs, data and visual analytics on the basis of the state entered by the user making it a highly customised dashboard.



COVID'19 Dashboard 2

As observable from the above images, the very first element of the dashboard is the bar graph which holds data pertaining to the state wise number of confirmed cases along with colour variation based on the different intensities across states. In order to obtain analysis revolving around one particular state, the dropdown menu on the upper right corner can be used to choose a preferred state. Based on the state that has been chosen, the remaining two elements of the dashboard will get customised and updated automatically. The second element of this dashboard is a bar graph which displays the statistics of the chosen states, portraying information about the number of confirmed, cure and deaths (in %). The third element is a line overlayed bar graph which shows a comparative study on the number of deaths versus the number of cured cases.

Object detection is a computer vision technique that allows us to identify and locate objects in an image or video. With this kind of identification and localization, object detection can be used to count objects in a scene and determine and track their precise locations, all while accurately labelling them. In more traditional ML-based approaches, computer vision techniques are used to look at various features of an image, such as the colour histogram or edges, to identify groups of pixels that may belong to an object. These features are then fed into a regression model that predicts the location of the object along with its label. After conducting a thorough research on a number of different object detection algorithms, we came up with the following top ML algorithms for object detection:

- ✓ ***Fast R-CNN:*** Faster R-CNN is a deep convolutional network used for object detection, that appears to the user as a single, end-to-end, unified network. The network can accurately and quickly predict the locations of different objects.
- ✓ ***Faster R-CNN:*** Faster RCNN is an object detection architecture presented by Ross Girshick, Shaoqing Ren, Kaiming He and Jian Sun in 2015, and is one of the famous

object detection architectures that uses convolution neural networks like YOLO (You Look Only Once) and SSD (Single Shot Detector).

- ✓ ***R-CNN:*** Region Based Convolutional Neural Networks (R-CNN) are a family of machine learning models for computer vision and specifically object detection.
- ✓ ***SSD:*** SSD has two components: a backbone model and SSD head. Backbone model usually is a pre-trained image classification network as a feature extractor. This is typically a network like ResNet trained on ImageNet from which the final fully connected classification layer has been removed.
- ✓ ***YOLO:*** YOLO is an algorithm that uses neural networks to provide real-time object detection. This algorithm is popular because of its speed and accuracy. It has been used in various applications to detect traffic signals, people, parking meters, and animals.

Based on the survey carried out, shortlisting of two main algorithms was done. R-CNN and YOLO were chosen by considering numerous factors and parameters which affect the feasibility, viability and implementation of the project. The necessary datasets (as mentioned in Section 6.1) were downloaded and utilized for training the models and collecting the samples from a real time video feed. Following the selection of the 2 ML algorithms, the next step was to identify which algorithm is the most efficient and accurate one. This module was an extremely essential module as based on the algorithm chosen, the effectiveness of the face mask detection system would vary insignificantly. YOLO and R-CNN algorithms were implemented and based on the outputs obtained, an analysis and comparative table based on a few integral parameters was done. The parameters on the basis of which the analysis has been carried out include accuracy, speed and FPS.

YOLO	Convolutional Network Algorithms
Better Speed and fast results	Comparitively Slower
Less number of overlapping boxes	Chances of overlapping boxes
Can be used for detection in crowd	Can be used for detection in crowd
Uses one network for classification and localisation of objects	Uses convoluted networks stacked over each other to optimize pooling
Less accuracy and precision	High accuracy and precision

Algorithm	Speed (FPS)	Accuracy (mAP)
YOLO	45	63.4%
R-CNN	7	73.2%

6.1 Implementation of face mask detection algorithm with the most efficient algorithm

Based on the analysis and comparison of the YOLO and R-CNN algorithms done in the sixth module, it was evident that the most efficient algorithm with respect to speed, accuracy and precision is R-CNN algorithm. Thus, the face mask detection system makes use of the R-CNN algorithm to execute and train the models and implement the detection procedure. There are mainly two programs involved in this system. The first python program is for training the model using a large collection of the dataset (as mentioned in section 6.1), while the second python program is to instruct the object detection model to extract regions/blobs of areas from the frames obtained from the processed video and to bound the identified face with a green/red box based on whether the person is wearing a mask or not.

6.2 Implementation of Social Distance Detection using YOLO

In order to ensure that the social distance detector was able to identify the people in the frames captured from the real time video feed, we decided to make use of Deep Neural Networks (DNN) component as it's much more efficient and accurate when compared to conventional CNN. Using DNN, the algorithm will be able to easily and precisely detect people in crowded frames and less crowded frames and will calculate the distance between the detected people using Euclidean formula. If the distance is less than the specified threshold, the detected people are bounded in green boxes. On the other hand, if the detected people are clustered together, they will be bounded in red boxes indicating a warning.

6.3 Integration with Drone for Navigational Purpose

With evolving technologies and advancements, drones and Unmanned Aerial Vehicles (UAVs) have been rapidly put to use for various fields of applications like surveillance, delivery systems, military and defence, etc. Similarly, with the outbreak of COVID and the global pandemic, one of the best ways to utilize drones is to implement face mask detection and social distance detection by automating the navigational control of the quadcopter/multirotor being used. Drones are simple UAVs which make use of rotors attached to propellers for manoeuvring and cutting through air to attain motion and hover through. It contains an in-built Geographical Positioning System (GPS) for identifying locations based on coordinates. The flight controller is the heart and soul of the drone which would take and extract sufficient inputs from the GPS and sensory modules and passes them forward to the Electronic Speed Controllers (ESCs) for controlling the speed and motion of the drone. ESCs are linked to the power distribution board and the flight controller for controlling and connecting all components of the drone. The drones are usually powered by LIPO batteries which support an average flight time of around 20-30 minutes. In order to integrate a ML algorithm and to automate the drone, a number of simulators are used for initially trying out and setting up the drone in a virtual environment and testing and verifying the results. The simulator used for this research is QGround Control. Using Python programming language, the process of automating the drone to carry out its task of face mask detection or social distancing detection by navigating through the mentioned coordinates without human control can be implemented. The drone will hover at around a height of 20 metres from the ground

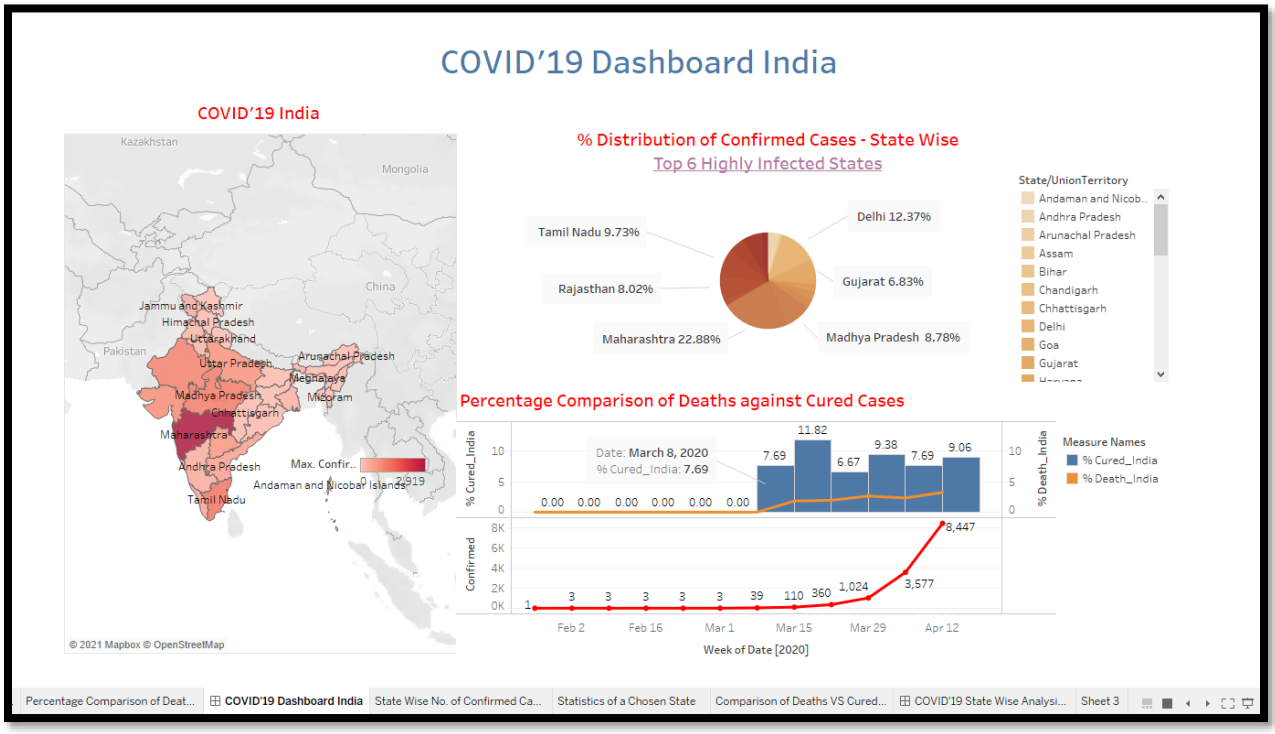
and capture the video frames which would then be parsed by the detection algorithms and make suitable predictions.

7. Conclusion

From the observations and analyses made so far, it can be inferred that data visualization plays an integral role in portraying the severity of any issue and to create awareness among the mass by portraying the data in an interpretable manner. The results obtained from the execution of the dashboards in Tableau have shown the intensity and grave scenario caused by the outbreak of the global pandemic. In order to curb and control the spread of the virus we have also executed and implemented a face mask detection system. The paper also conducts a detailed analysis on two of the highly suitable algorithms for object detection which include R-CNN and YOLO. From this, we have been able to conclude that the R-CNN algorithm is one of the efficient, viable and accurate object detection algorithms. Moreover, this project was developed with the main motive to throw light on the importance of staying safe and sanitized during the pandemic using visual data analytics and to develop a system that would help authorities to monitor people and keep a track on following the rules related to masks and social distancing.

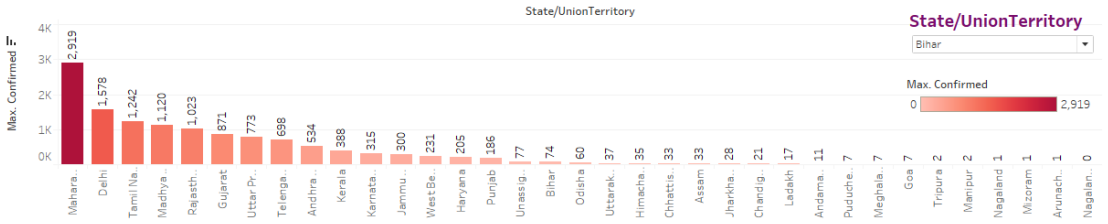
8. Results and Output

COVID Dashboard using Tableau

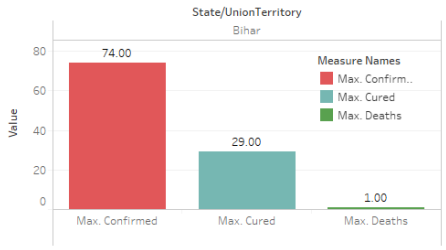


COVID'19 State Wise Analysis Dashboard

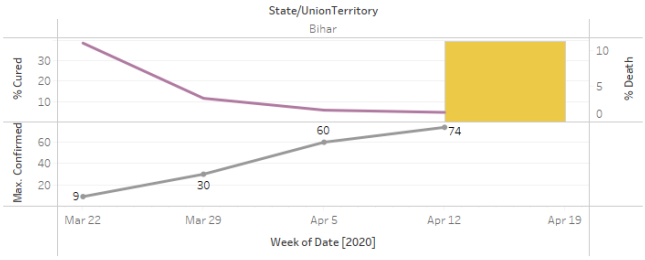
Statewise Maximum No. of Confirmed Cases



Statistics of a Chosen State



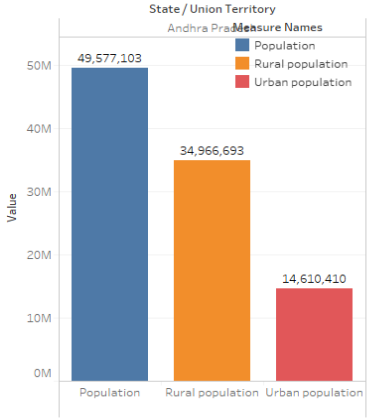
Comparison of Deaths VS Cured Cases



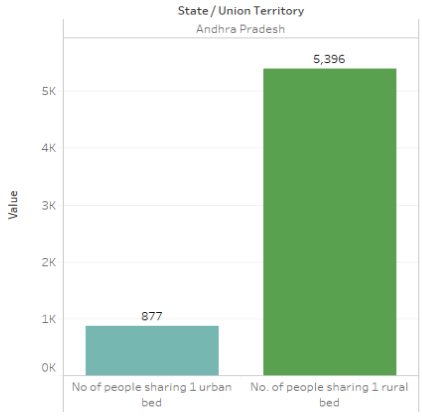
Percentage Comparison of Deat... | COVID'19 Dashboard India | State Wise No. of Confirmed Ca... | Statistics of a Chosen State | Comparison of Deaths VS Cured... | COVID'19 State Wise Analy... | Sheet 3

Hospital Facilities in India (State Wise)

Population of Chosen State



Availability of Hospital Beds in Chosen State



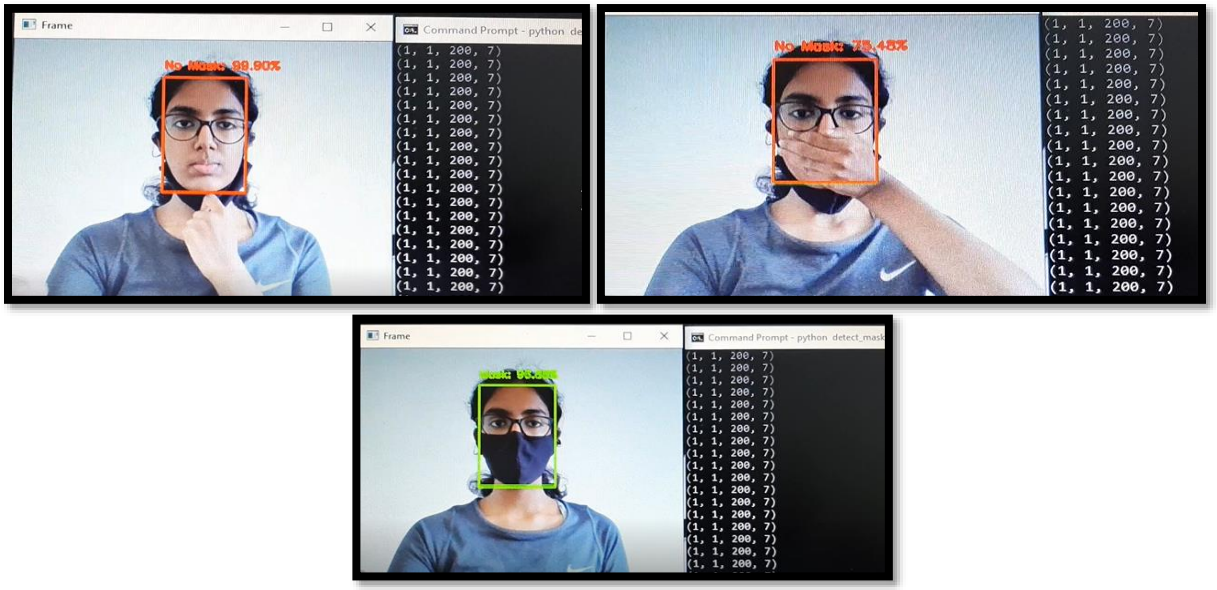
State / Union Territory: Andhra Pradesh

Statistics of Hospital Beds

State / Union Territory	NumRural Beds NH..	NumUrban Beds NH..
Andhra Pradesh	6,480	16,658

Population of Chosen State | Availability of Hospital Beds in C... | Statistics of Hospital Beds | Dashboard 1

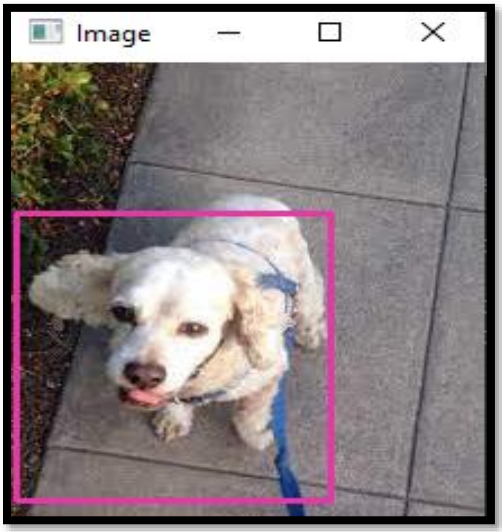
Face Mask Detection Implementation

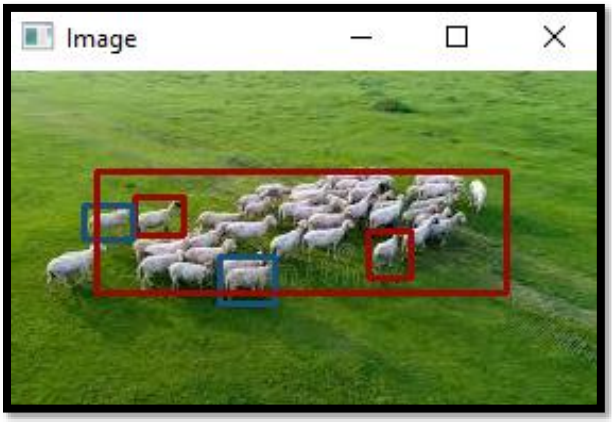


Social Distancing Implementation

Drone Navigation Implementation using QGround Control

Object Detection for Drone Images





9. Future Opportunities

With the rapid implementation of vaccines and precautionary measures across different countries across the globe, there are high chances that the world combats COVID for good or at least will be able to curb the virus to a great extent. In such scenarios, the drone integrate face mask detection and social distance detection systems will no longer be a necessity. However, using the very same concept of detection and efficient algorithms like YOLO and RCNN, the drone integrated with these codes can be put to further use in other fields of application. Criminal activities are one of the biggest problems faced in nearly all countries across the world. The R-CNN code can be used to train the models to detect the occurrence of any type of criminal activities in unsafe places during the day/night using specialized thermal cameras. Similarly, drone surveillance and detection on suspicious activities on the country borders are an extremely important and essential aspect and this can be used for the same.

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