CSE3999 - Technical Answers for Real World Problems
(TARP)

TITLE: Efficient bus management by face mask detection

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Problem Statement :-

Considering any where in the world it is being affected by the corona virus and people suffered a lot and many even passed away as the seriousness of the pandemic reduces the government is not restricting the people that much and letting them free .The main problem arises here it self the situation is not going to end at this point this is going forward and attacking many times like the wave of the sea hitting the shore again and again .So author need to be safe in every aspect that author are doing even the severity of the pandemic ends .Using sanitizers often and wearing mask are the ones that are must wherever people go and whatever they do .So our project is making sure that everyone in the bus in wearing a mask or not if this can be achieved we can be sure that in bus at least due to one passenger another passenger won't get affected .

 From the 2019 December the most concerning issue in the world became COVID many researches many vaccines and many medicines but none helped the world that much they were useful for a shorter time to develop some immunity power and after that period it is of no use but always the shield to save ourselves from that quick spreading disease is mask.COVID is a deadly disease that is caused by severe acute respiratory syndrome coronavirus .This virus has various variable symptoms but often include fever, cough, headache, fatigue, breathing difficulties, and loss of smell and taste Symptoms may begin one to fourteen days after exposure to the virus

Introduction :-

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Because of these symptoms only many people died .Just because of this only at least a third of people who are infected do not develop noticeable symptoms .Of those people who develop noticeable symptoms enough to

be classed as patients,most(81%) develop mild to moderate symptoms while 14% develop severe symptoms and 5% suffer critical symptoms .

One of the best methods to get rid of this virus is to keep a mask and use sanitizer .But people are using public transport due to many reasons like economic downfall, the cost of petrol increasing gradually etc.. are effecting the life of a common man .But even though they use this they may be affected if the previous passenger who is affected by the virus sits in the same place and coughs or releases the semun that contains the virus so the person who comes next if he touches the place with the hand and touches his body parts especially the facial parts like eyes,nose ,ear it would become an easy entry for the virus to attack them so to avoid this condition that need be sure that the person who are entering the bus need to put a face mask so that it may not cause problem for the passengers who are coming next.

So author wanted to make an algorithm that detects whether a person sitting in a bus is putting on his/her mask so that author could get rid of threats like this and create a safe and healthy travelling environment .Previously there were algorithms that detects if a person is wearing a mask or not when a standard photo is given but author is using the algorithm similar to it that can detect if all the people in the bus are wearing mask as the people and the number of seats present in the bus are limited author can add additional features like having an view on driver if he is sleeping or he is awake so that author can even generate a fully safe travelling environment .author can give a data set containing some good number of images and can train the algorithm that is convenient for us like SVM CNN etc.. using python libraries like numpy ,pandas etc.. as per solutions created for previous problems, in many cases CNN worked better in aspects like time efficiency etc..

Abstract :-

Coronavirus disease 2019 has affected the world seriously. One major protection method for people is to wear masks in public areas. Furthermore, many public service providers require customers to use the service only if they wear masks correctly. However, there are only a few research studies about face mask detection based on image analysis. Through this project the author proposes a whole bus management system where the bus will have a limited number of passengers so as to maintain social distance along with a mask on everyone"s face to avoid direct virus contact. The project uses a Conventional Neural Network which will detect whether a passenger is wearing a mask or not. A dataset of 2000 images will be used. The input image will be compared to the images of the dataset. The CNN used will be a binary classifier with a range of hidden layers to detect the mask. The bus door opens only if the mask is detected. In addition to that the project aims to provide live gaze avoidance to the driver by continuously monitoring his eye activity and an alarm is raised if eyes are closed for a certain time. The dataset used will consist of images of eyes on the road and off the road. This will prevent accidents and strengthen the overall system. Python libraries such as scikit learn, NumPy, pandas, cv2 etc. will be used so as to get an accurate and precise output with the help of CNN. The live detection of gaze strengthens the approach along with high validation accuracy.

Motivation :-

The main motivating of this idea is seeing the people(friends , relatives ,neighbors) who have suffered more minimum of fourteen some till a month without seeing the outside world is like hell .As from my side I am thinking of applying some machine learning algorithms like CNN where author can cluster things up in the way required and check if a person is wearing mask or not so that he have a hope that at least he could reduce some part of the people being affected by the ferocious virus and

increasing the faith in people that even bus transportation is safe after facing this much impact .

Literature Survey :-

ResNet is being used so that it can increase accuracy by doing activities like deepening the network and reducing the calculation and parameter quantity. .GN, FPN neck and bounding box head of the model regarding MASK R-CNN, to ameliorate and make into parts. These groups are taken and arithmetic operations like mean variance are calculated .Cascade training is adopted. If the output obtained is of higher grade then it will be taken as input for others .(Object detection based on RGC mask R-CNN. *IET Image Processing*, *14*(8), 1502-1508.Wu, M., Yue, H., Wang, J., Huang, Y., Liu, M., Jiang, Y., ... & Zeng, C. (2020).)

The technologies adopted are ResNet ,MobileNet which are used for comparison ,reducing computation with limited computing resources, FPN is also being applied ,for extracting good semantic information and combining with past layers .This utilizes three feature maps, and each of them is fed into a detection head. Inside each detection head, the author further adds a context attention module to adjust the size of receptive fields and focus on specific areas. Limitations are: This method is good for a normal face but the accuracy decreases to 78% when the face is wider . Even the side angled images aren't performing that good(Jiang, M., Fan, X., & Yan, H. (2020). Retina facemask: A face mask detector. *arXiv preprint arXiv:2005.03950)*

In this paper the author used raspberry pi to detect if a person is wearing a mask or not the images/captures are being taken from the ctv location .Initially the data is collected and the background is removed then there is a check if a person is wearing a mask or not using the SSD algorithm.now the images are resized and MobileNetv2 and some packages like tensor flow are used mostly the processing is done in oneshot .The model is being

implemented on continuous collection of data from cctv and filtering. Limitations :-The storage of data becomes a tedious task to implement .Social distancing is not having good accuracy .(Yadav, S. (2020). Deep learning based safe social distancing and face mask detection in public areas for covid-19 safety guidelines adherence.)

They used 6 CNN networks including 3cnn for face vs. non-face binary classification and 3 CNNs for bounding box calibration .Consisting the 12 net,24 net and 48 net for the training purpose. They resize all the images into the 12 X 12 and randomly sample 200,000 non face patches from the background images to train the 12 net and 12-calibration net on subset of AFLW images .Author of this paper was the research intern while he was doing this experiment hence this is the initial phase of development for this project .(A convolutional neural network cascades for face detection. In *Proceedings of the IEEE conference on computer vision and pattern recognition* (pp. 5325-5334).)

They introduced their own learning for SDM and then they compared this with existing models, their own methods used gradient boosting the regression .Here for future work author can apply the support vector machine many others Non-linear least square problems that are there in computer vision like camera calibration and structure from motion and then proceed in the deeper analysis in SDM(Supervised descent method and its applications to face alignment. In *Proceedings of the IEEE conference on computer vision and pattern recognition* (pp. 532-539).)

[6]The work can be summarised by three key contributions. The first is "Integral lineage" which permits the highlights utilized by our identifier to be registered rapidly. The second is a learning algo, in view of AdaBoost, which chooses few basic visual highlights from a bigger set .The third is for consolidating progressively more mind boggling classifiers in a "cascade" which permits foundation districts of the picture to be immediately disposed of while spending more calculation on promising article like areas(Viola, P., & Jones, M. (2001, December). Rapid object detection using a boosted cascade of simple features. In *Proceedings of the 2001 IEEE computer*

society conference on computer vision and pattern recognition. CVPR 2001 (Vol. 1, pp. I-I). Ieee.)

[7]they propose another strategy for eliminating glasses from a human frontal facial picture. They initially recognize the locales impeded by the glasses and produce a characteristic looking facial picture without glasses by recursive error compensation utilizing PCA reconstruction. The subsequent picture has no hint of the glasses outline or of the reflection and shade brought about by the glasses. They used mainly two methods 1) Glasses removal method 2) Recursive Error Compensation procedure

Limitations :-They had proposed a new glasses removal method based on recursive error compensation using principal component analysis Proposed method can extract and remove various kinds of impediments brought about by glasses and create a more characteristic looking facial picture without glasses contrasted with different strategies Future work includes the more efficient performance evaluation using general facial database

[8]A pixel level feature called Normalized Pixel Difference (NPD) is used. Along with this a deep quadratic tree learning method has been proposed. It uses a single soft-cascade AdaBoost in order to handle complex conditions such as different facial expressions and illumination conditions. So, NPD features along with AdaBoost algorithm are used to extract the most important features(Liao, S., Jain, A. K., & Li, S. Z. (2015). A fast and accurate unconstrained face detector. *IEEE transactions on pattern analysis and machine intelligence*, *38*(2), 211-223.)

[9]The proposed model consists of 2 components, the first one is deep transferring learning (ResNet50) which extracts features from the face. The second one is machine learning algorithms such as decision trees, SVM, and ensemble. In order to improve the performance of this model, the last layer is removed and replaced with machine learning classifiers. The main task is to construct these algorithms to fit into the model and reduce the

training process.(Loey, M., Manogaran, G., Taha, M. H. N., & Khalifa, N. E. M. (2021). A hybrid deep transfer learning model with machine learning methods for face mask detection in the era of the COVID-19 pandemic. Measurement, 167, 108288.)

[10]Here, by using a 3D model, the system estimates the direction of gaze and the position of the head. The system proposed here will work for 25 FPS in MATLAB and doesn't require any type of calibration or initialization. It works on both day and night times.

Limitations :-This system makes use of a video camera in order to track the driver. There is a chance that the camera could fail at any point of time. If this camera is not fixed properly, then it may fall off during speed bumps.Based upon the results, author can see that the system is not 100% accurate. There is a chance for false alarms. There are many different challenging conditions out there that must be taken into account. Authors are working on Pupil detection system using Hough transform based techniques in order to improve gaze estimation(Vicente, F., Huang, Z., Xiong, X., De la Torre, F., Zhang, W., & Levi, D. (2015). Driver gaze tracking and eyes off the road detection system. *IEEE Transactions on Intelligent Transportation Systems*, *16*(4), 2014-2027.)

[11]A residual neural network (ResNet) is a kind of deep transfer learning based on residual learning . ResNet-50 with 50-layers are deep, start with a convolution layer, and end with a fully-connected layer, and in between followed by 16 residual bottleneck blocks each block has three layers of convolution layer .(Jiang, M., Fan, X., & Yan, H. (2020). Retinamask: A face mask detector. *arXiv preprint arXiv:2005.03950*.)

[12] This paper discusses temperature checking and face mask detection specifically in the library. For this basically the first equipment use for the FMT sensors where due to this track students temperature entering the building,check

and remind students to wear masks and even give a warning for the students whose temperature is above 37.5C.For this project they have used webcams ,MLX 90614 thermal contact less sensor ,Raspberry Pi 3B board,LCD display ,piezo buzzer associated with power brick sound.This project used Thermal infrared detector due to fact that contact sensor cannot deal with moving objects and persons from long distance with high voltage or high temperature.With regard to face recognition system generally author use face detection algorithm to identify the face with specifications of nose eyes etc,but keeping the data privacy and breaching in mind the FMT detectors have a software to only identify face masks not face and with respect to implementation python programming language is used and it used because it has a library with many functions for MLX90614 thermal sensor .and a VNC client is also used with associated to Raspberry pi where it represents the screen data from server.and the sensor detects the body temp and shows as face mask='/' with body temp if a person wears mask if not then it displays face mask='X'.Here the limitation is now days the corona is mutating and single mask is no longer found useful and even some people wear just cover some sort of handkerchief or some cloth just to cover their face which is absolutely useless and still the system confirms the state of wearing as mask as true.(Damodar Krishna Lim Nimai,Lee Song Yi,Noor Binti Ismail Face Mak and Contactless Temperature Detector (2019). JACSSE Journal-InternationalJournalofAdvanced Computer Systems and Software Engineering)

[13] This paper discusses the face mask detection using   Fully Convolutional Neural Networks to semantically segment out the faces present in that image. Feature detection and feature extraction techniques help us identify whether a person is wearing a mask or not. The face mask detector will use a dataset of morphed masked images. Therefore, the created model will be accurate and it will also be computationally efficient and easily deployable in embedded systems since the MobileNetV2 architecture will be incorporated (Raspberry Pi, Google Coral, etc.). This framework can also be used in real-time applications that, due to the outbreak of Covid-19, require face-mask detection for safety purposes. This project can be merged with embedded application systems at airports, train stations, workplaces, schools, and public places to ensure compliance with the

guidelines for public safety. The above topic is very prominent in recent times as the identification process will not only help us classify individuals but also will reduce the workforce required to do the same exponentially.The evaluation is done by metrics like F1 Score,precision,Recall.The results have shown that results for both with mask and without mask are pretty much equivalent with very minute least square error rate.The problem with this project is that since it only detects masks there might be times where the person it having mask and he or she is is not wearing or covering there mouth nose completely with the mask but still the model gives accurate results since the training datasets have not been fed with these type of edge cases.(Mayank Arora,Sarthik Garg Face mask detection.International Journal of Engineering and Advanced Technology (IJEAT))

[14] This paper discusses face detection using the ResNet which is a neural network model. Initially preprocessing step start where they have used the real world masked face recognition dataset(RMFRD) which is currently largest masked face dataset.Now scaling and normalization must be done where they have used random resizing cropping and random vertical flip because most ResNET images need a square size type images generally of size 224*224. Next step involves data augmentation where it used to enlarge the dataset of images by proving the updated versions of images generally neural networks need large datasets that will results in more robust and enhanced model where the more data and its variations will lead to right fit then fine tuning is done where a CNN model called ResNet is used where this residual neural network is a basis for computer vision .this ResNet has successfully trained 150+ deep neural networks they have used three versions of ResNet ,ResNet 9 have 4 layers 2 residual and 2 linear ResNet 15 has 3 residual and 3 linear while the later one has 4 stages The network will accept an input image with such a height, width as multiples of 32, and 3 as a channel width. the author perceived the input size to be 224 x 224 x 3. Each ResNet architecture uses 7×7 and 3×3 kernel sizes for preliminary convolution and max pooling.they have used Caffe based face detector which is available in deep neural network samples and have set the confidence parameter to override the weak face detection.then the image is passed onto for mask detection and have evaluated the class based on

probabilities returned by detector.they have even done this same process for all the models of ResNet and have done comparison between them.(CMAK. Zeelan Basha, B.N. Lakshmi Pravallika An Efficient Face Mask Detector with PyTorch and Deep Learning(2021).EAI Endorsed Transactions on Pervasive Health and Technology)

[15]Md. Abdur Rahman, M. Shamim Hossain, Nabil A. Alrajeh, and Nadra Guizani.B5G and Explainable Deep Learning Assisted Healthcare Vertical at the Edge: COVID-19 Perspective.This framework leverages mobile edge computing, in which deep learning takes place both at the edge and in the cloud deep learning environment. (Md. Abdur Rahman, M. Shamim Hossain, Nabil A. Alrajeh, and Nadra Guizani.B5G and Explainable Deep Learning Assisted Healthcare Vertical at the Edge: COVID-19 Perspective.)

[16]Maliha Khan,Sudeshna Chakraborty,Rani Astya,Shaveta Khepra.2019 International Conference on Computing, Communication, and Intelligent Systems (ICCIS) ISBN: 978-1-7281-4826-7/19/$31.00 ©2019 IEEE 116 Face Detection and Recognition Using OpenCV.One challenge is to plan the picture before use of the tool. It may be possible to obtain consistency in classification when multiple spaces are spectrum-scale individuals in one section.(Maliha Khan,Sudeshna Chakraborty,Rani Astya,Shaveta Khepra.2019 International Conference on Computing, Communication, and Intelligent Systems (ICCIS) ISBN: 978-1-7281-4826-7/19/$31.00 ©2019 IEEE 116 Face Detection and Recognition Using OpenCV.)

[17]Samantha Denise F. Hilado, Elmer P. Dadios, and Reggie C. Gustilo, Member, IEEE.Face Detection using Neural Networks with Skin Segmentation.It could be introduced in cabs where the drivers drive at night. (Samantha Denise F. Hilado, Elmer P. Dadios, and Reggie C. Gustilo, Member, IEEE.Face Detection using Neural Networks with Skin Segmentation)

[18]Kruti Goyal ,Kartikey Agarwal ,Rishi Kumar.International Conference on Electronics, Communication and Aerospace Technology ICECA 2017.Face Detection and Tracking Using OpenCV.The face detection algorithm developed is proven to be up to 87% accurate.(Kruti Goyal ,Kartikey Agarwal ,Rishi Kumar.International Conference on Electronics, Communication and Aerospace Technology ICECA 2017.Face Detection and Tracking Using OpenCV.)

[19] Shilpa Sethi, Mamta Kathuria, and Trilok Kaushik.J Biomed Inform. 2021 Aug; 120: 103848.Published online 2021 Jun 24.Face mask detection using deep learning: An approach to reduce risk of Coronavirus spread.The proposed technique can be integrated into any high-resolution video surveillance devices and not limited to mask detection only.(Shilpa Sethi, Mamta Kathuria, and Trilok Kaushik.J Biomed Inform. 2021 Aug; 120: 103848.Published online 2021 Jun 24.Face mask detection using deep learning: An approach to reduce risk of Coronavirus spread.)

Methodology :-

The project has been mainly divided into 2 parts which as explained as:

1. Face Mask Detection

2. Live Gaze Detection

1. FACE MASK DETECTION

This part of the project uses libraries like tensorflow(an end-to-end open source platform for machine learning) , keras(used for reducing cognitive

load), matplotlib(used for creating static, animated and interactive visualizations) and so on..

The model is initially trained .In the training author will load the data along with their label like with mask or without mask .The image is converted into a uniform size of 224*224 and then transform the image into an array, to make the processing better convert the array into numpy arrays .Applying few operations on these arrays like preprocessing etc.. author makes the model ready for training.

The dataset that author have taken is small so by applying few operations to data like rotating by a certain angle, zooming photos , shifting towards right and left can create a huge data set and training by these will make the model more accurate .This dataset is now divided into two parts in the ratio of 80:20 where 80% of data is used for training the model and rest 20% is used for testing .

In order to train the model author have to make two sets the one is base and the other is head , to make this author take a 224*224 space as it is the size to which author are converting the image to and then create a model and combine the base on to the head to make a complete model .Once the model is created all the dataset that is created for training along with their labels will be passed as the input and the base head model will be trained for all the possible inputs .Later on with the testing data testing will be done

Predefined models for defining and describing the face and mask are added and they will be included in the main part of the code .This part will be taking the input as a video stream and making into parts called frames from each frame the image will be parsed and then few modifications will be done so that any noise or external disturbance present will be removed in order to get better result .

The parsed image will be made to identify the face through the downloaded package and this identified face coordinates will be saved .The identified face is passed as an input to the trained code so using the base

and head training it will identify if the person is authoraring the mask or not once the detection is done then a rectangular box will be drawn across the detected face in red colour if the person doesn't wear mask and a label "no mask " along with the percentage of mask present will be displayed else if the case is the person wore mask the a green colour rectangular box will be drawn on the image displaying "mask" along with the percentage till which extent it is present .Then all these frames again combine together in order to get the video and it will be displayed .

LIVE GAZE DETECTION:

The header files involved in this project phase are Opencv where the contours ,using Numpy the euclidean function the aspect ratio which is the sum of 2 distinct vertical distances between the eyelids divided by its horizontal distance eyes with horizontal and vertical distance marked for Eye Aspect Ratio .Now the aspect ratio is checked if the aspect ratio value is less than 0.25 (0.25 was chosen as a base case after some tests). If it is less, an alarm is sounded and the user is warned it here first the camera is switched on using videocapture and then the functions of get frontal face detector and then landmark detector using shape predictor and we use dlib.68 face landmarks.data as a argument for shape predictor as it is already a trained model of pre trained model of landmark predictors and it identifies 68 points on human face and this points refer to like eyes,nose,jaw ,eyebrows ,chin ,jaw, so then the while loop is used to and it is set to true stating as infinity loop because here the camera should be on 24/7 all time he is driving author need to capture his face and then do analysis by capturing landmarks of left eye and right eye and the landmarks for left eye is 36,37,38,39,40,41 and for the right eye it is 42,43,45,46,47 and these landmark points are passed as arguments to function "detect" in this function with these six parameters u detect the euclidean distance with reference to this points and then author compare it i.e if the distance is 0

means the distance between eye lids are completely 0 which indicates the sleeping status if the distance is between 0.21 and 0.25 it means he is drowsy and the else he is pretty active and since the camera is on everytime u take arrays of faces all time and each time a face from array is taken and then a copy is taken from it so that author don't loose anything original data of input data while trying to edit the original image and the images are all gray scale with (0,0,0) so then author try to highlight the landmarks of eyes using cv2.rectangle and then calculate distance and then author depending on the distance he increment the three variables which are sleepy,drowsy,active and he keep on incrementing this depending up left blink answer from detect method and right blink answer from detect method and if any of variable is 0 then increment sleepy if it is 1 increment drowsy else increment the active author kept the threshold count as 6 which mean if any variable reaches 6 then it beeps or alerts a status with either sleepy with red colour drowsy with blue and active with green colour status to the other side person sitting

Innovation :-

As the pandemic COVID began wearing a mask and social distancing has become an important feature on an ordinary man.So many algorithms were found in order to find if a person is wearing a mask and maintaining social distance , new and easy algorithms are being developed and are being applied at various places like theatres, public places etc.. Now the author is implementing this face mask detection in one of the key places (bus) which plays a crucial role in many people's daily life .
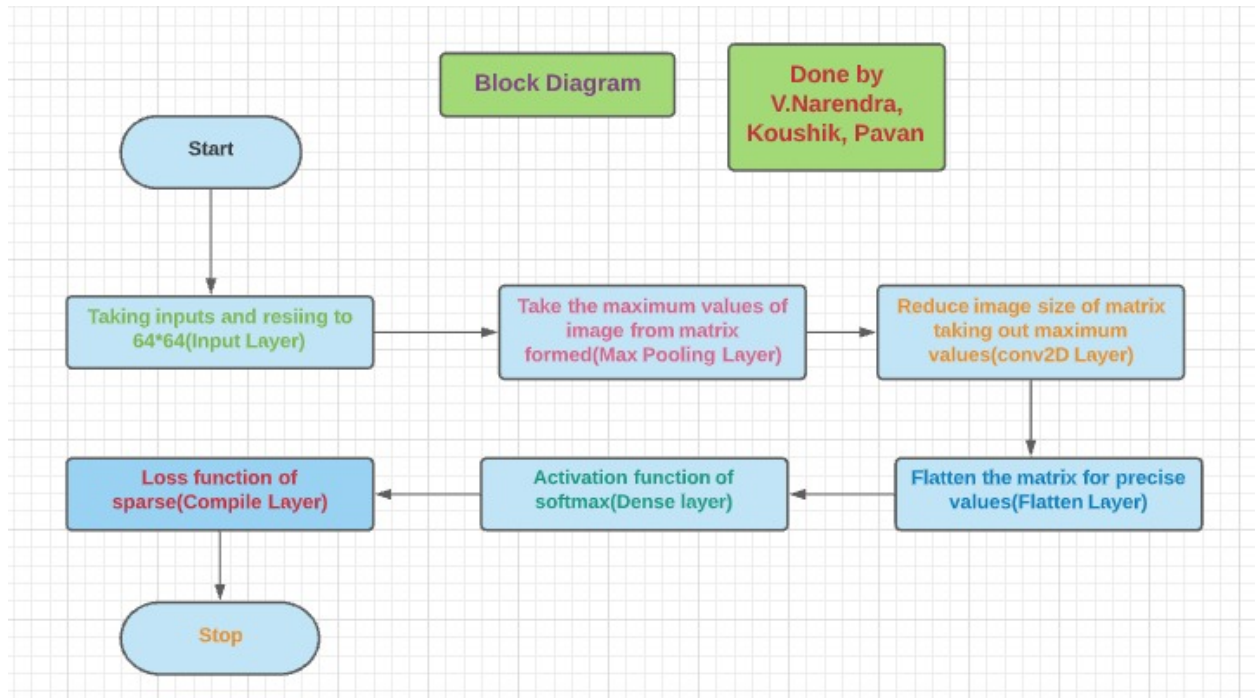
Previously there were many projects that were done .The algorithms that they followed are like k-NN in which the algorithm combines the 'k' equivalent nearby pixels(as author is considering an image)and merge them together later on few operations are applied to it such that he can subtract the part other than k-nn part and verify if it is the shape of a mask or something else .If it is in the shape of

mask he will be like checking if it is in correct position on the face and covering the most keen and sensitive parts of face like nose and mouth for this they will be training the algorithm with various image datasets in which people wear mask and some of not a correct way of wearing the mask .

Another algorithm that few previous papers used are SVM which is a bit similar to k-nn in case of implementation here a line is taken and the points(pixels) are taken that are close to the line and form a cluster here author can differentiate the positive and negative pixels like that the process after combining the mask pixels is almost the same in both the cases and then finally displaying if the position is correct or not . Some papers also used techniques like RGC masking and then using R-CNN , some used deep learning techniques while others went with rapid object recognition techniques .

The perspective in which the author is different or innovative when compared to others is that author used CNN algorithm but author used it as a binary classifier with a range of hidden layers to detect the mask. The bus door opens only if the mask is detected, if not a message will be displayed asking to wear the mask properly if the mask is not present to keep a mask . There are many applications of mask detection like in public places etc.. but none of them were applied inside a bus which is so crucial during this time. The other feature that he can implement which makes this a complete controlled and safe bus management is that author can add the feature of checking if the driver is driving carefully or not for this he can use a technique if the driver is viewing at a correct direction/angle to make this feature better there are few algorithms like removing the spectacles if they wear it so that the result can be more accurate and precise

Flow Chart :-

Block Diagram

Done by V.Narendra, Koushik, Pavan

Start → Taking inputs and resiing to 64*64(Input Layer) → Take the maximum values of image from matrix formed(Max Pooling Layer) → Reduce image size of matrix taking out maximum values(conv2D Layer)

Loss function of sparse(Compile Layer) ← Activation function of softmax(Dense layer) ← Flatten the matrix for precise values(Flatten Layer)

Loss function of sparse(Compile Layer) → Stop

Result and Conclusion :-

In the face mask detection the data is very important and any loss of important features in the dataset used while preprocessing of data cleaning can lead us a far margin behind in terms   of accuracy so in this project the 8 layer neural network is used to prevent loss of important data in dataset while removing unwanted pixels so the graph of data loss is

Training Loss and Accuracy
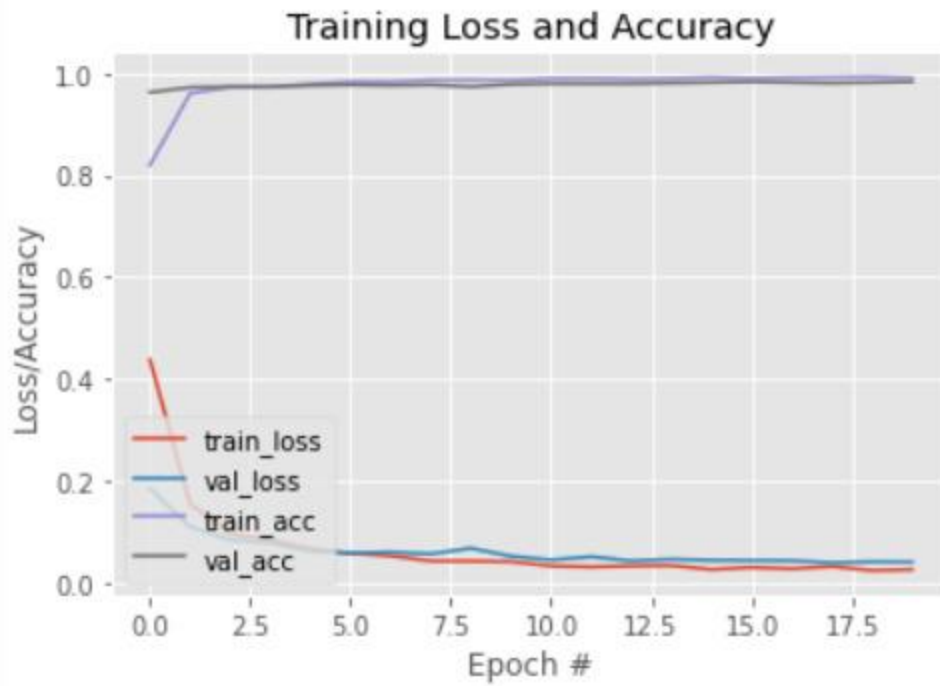
TEST ID	TEST CONDITION	SYSTEM BEHAVIOUR	EXPECTED RESULT
1	Straight Face, Good Light, With Eyes Open	Active	Active
2	Tilted Face, Good Light, No Glasses, Eyes Partially Opened	Drowsy	Drowsy

		sleeping	sleeping
3)	Tilted Face, Good Light, Eyes closed		
4)	A photo with a person wearing mask	With mask and percentage	With mask and percentage
5)	A photo with out a person wearing mask	Without mask and percentage	Without mask and percentage

FutureWorks:-

        In this project author has done face mask detection for the people who are entering the bus and then displaying if they are wearing the mask or not along with that the author has done live gaze detection so that he could identify the status of the driver if the driver is sleeping ,active or drowsy based on his eyelids movement .Along with these implementations this project could made better by adding few other features like :

1.Checking the temperature of the passengers entering the bus and allowing them only if their temperature is at a particular threshold .

2.Adding a heart rate monitor so that we can allot better seats to the persons who are a bit ill or having any effects .

3. Counting the numbers of passengers entering the bus could be a good practice in order to maintain physical distance inside the bus .

4. Other measures like detecting the shortest paths for the bus to travel or arranging a sensor to track the bus movement could be some other features that could be added in order to make a complete and better bus management system .

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