DESIGN THINKING APPROACH FOR DRIVER DETECTION USING CONVOLUTION NEURALNETWORK AND ANDROID

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ABSTRACT

The rise in road accidents taking place in India has been rapid and distracted driving is responsible for a considerable portion of it. A cause of these accidents is driver error as a result of getting distracted, primarily by using a mobile phone whilst driving. Thus, giving attention to the issue is paramount to reduce these figures of fatalities due to reckless road mis happenings. This paper proposes a solution to detect the distraction of a driver, thus averting possible accidents that might occur inflicted by a distracted driver. The Android application contains the use of CNN (Convolution Neural Network) model, regarding classification of distracted drivers. The library of deep learning used here is Keras which runs on top of Tensor Flow.

Keywords: Classification, CNN, Design Thinking, Keras, Tensorflow, Android.

INTRODUCTION

According to the Road Accidents Dashboard displayed on the Ministry of Road Transport and Highways website, a road accident happens every minute in India. India has only 3.5% of all the vehicles in the world, yet it accounts for 10% of the global car crash deaths worldwide [1] The Indian Government, in a 2019 report revealed that 9,039 accidents took place due to use of mobile phones.[2]

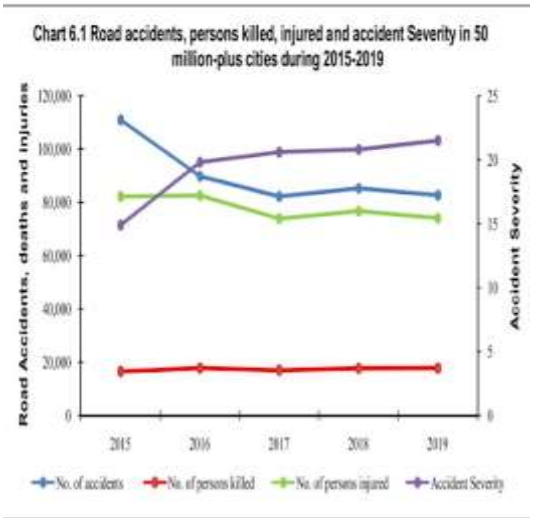


Fig 1: Road accidents, persons killed, injured and accident severity in 50 million plus cities 2015-19

Source: morth.nic.in

Distracted driving can be defined as any activity responsible for taking the driver's attention off the road. Three kinds of distraction while driving have been identified: visual distractions- the driver is looking elsewhere, manual distractions- the driver's hands are not on the steering wheel and cognitive distractions- the driver's mind is off the driving task. [3]

According to research among IIIT Hyderabad, IIIT Delhi and Carnegie Mellon University, 4 of the top 10 cities found with distracted driving are Indian – Chandigarh, Amritsar, Ahmedabad, and Lucknow. [4] In a survey called 'Distracted Driving in India- A Study on Mobile Phone Usage Pattern and Behaviour' by the SaveLIFE Foundation, it was found that due to the surge of mobile phones in the market,1 in every 2 participants of this survey used a mobile phone while driving. In the USA, the data collected reported that 10% of all fatal crashes involved distraction, out of which 385 were said to be caused by mobile phone distraction.[5] The National Highway Traffic Safety Administration (NHTSA) notified that 36,750 people died in motor vehicle crashes in 2018, and 12% of it was due to distracted driving.[6]

In lieu of this, we propose a system which aims to detect the inattentiveness of a driver by classifying the driver's behaviour while driving into ten classes based on the source of distraction. The need of such a model is paramount to significantly reduce distracted driver accidents.

METHODOLOGY

The model uses CNN (Convolutional Neural Networks) which can solve the task in hand. The training data has been divided into 10 classes based on the three types of distractions discussed above, visual, manual and cognitive. The ten classes are: c0: safe driving, c1: texting - right, c2: talking on the phone - right, c3: texting - left, c4: talking on the phone - left, c5: operating the radio, c6: drinking, c7: reaching behind, c8: hair and makeup, c9: talking to passenger. The classes c1, c2, c3, c4, c6, c8 can be categorized as manual distractions while c5, c7, c9 can be categorized as the visual distractions. Our system does not pertain to cognitive distractions. This Deep Learning model will run on an Android application using TFLite, to make it more accessible.

DATA SET DESCRIPTION

The Data Set used is a subset of the Data set provided on Kaggle, State Farm Distracted Driver Detection. [7][8] State Farm is known to be a group of insurance and financial services companies in the US. The Dataset of 2D dashboard images were released for a Kaggle challenge. The dataset used here is a shrunken and compressed form of original data set having a total of 17462 training images with original resolution 240*320 pixels. These training images have corresponding labels available belonging to the 10 classes mentioned above. To avoid Data set biasing, a close sample size is taken for each available class. The sample size of each class is depicted using the given chart below.

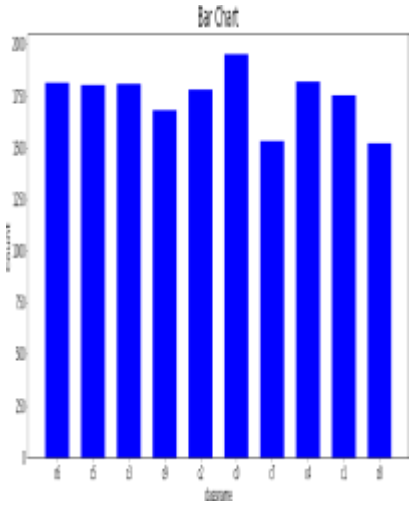


Fig 2: Sample size of each class

The images have been split in such a way that the same driver doesn't appear in both training and testing images set. This has been done due to the presence of high correlation between the images. The training data of 17462 images has further been split into validation and training data using Sklearn train_test_split to keep the split random and keep the correlation in check.

TECHNICAL APPROACHPreprocessing Data

The trained images after being further split into training and validation data, separate input tensors are created for the model. Due to lack of memory and computational power, the images tensors have been resized from (240*320*3) to (1*64*64*3).

The difference before and after resizing can be seen below:

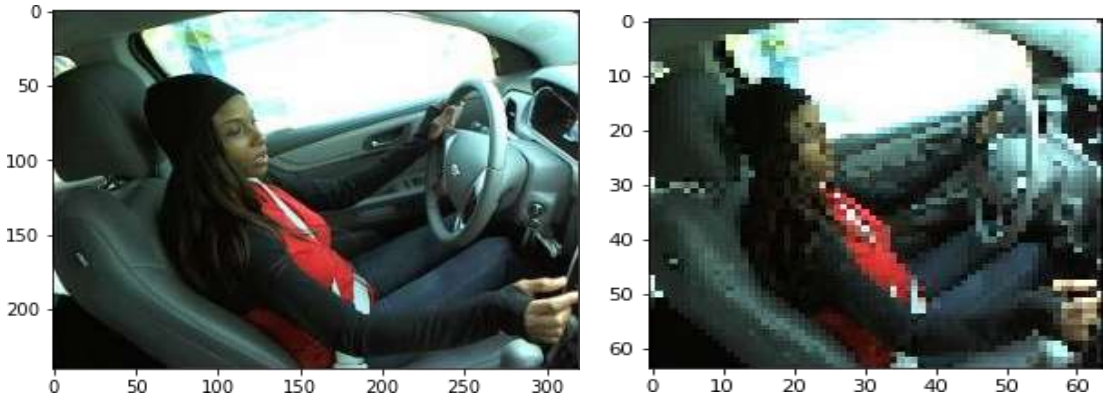


Fig 3 (a): Image in (240*320*3), **3 (b):** Image in (1*64*64*3).

The tensors are then scaled by dividing the tensors by 255.

CONVOLUTIONAL NEURAL NETWORK

Neural network is a multilayered architecture containing neurons/ perceptrons. We feed in data to the neural network, the interconnected layers are assigned some initial weights. As the model is trained, the weights in the network get updated indicating that our deep learning model has fit the data in itself and learnt its features. [9]

A CNN (Convolutional Neural Networks) is similar to a neural network but specifically designed for images to understand its features in a better way. A CNN consists of an input layer (takes images as input), output layer (usually pushes their output to a network of hidden layers) and number of hidden layers. The network may contain the following layers: Convolution layer, Pooling layer, Dropout layer and Fully Connected layer.

Input Layer

The Input Layer is fed raw unflattened pixel values of the images in the training data set. In this case, images are 3 channel rgb images with resolution 240*320 pixels scaled down to 64*64 to reduce training time and space requirement.

Convolution Layer

The Convolution Layer has numerous learnable filters of flexible dimensions. These filters hover through the entire input image and at every fixed step, a dot product is calculated with the weights of the filter and the window of the image under the filter.

Pooling Layer

To minimize overfitting or computing inefficiencies, the Pooling layers lower the 2D dimensions of the input volume. This is accomplished by applying a tiny filter to the data input on each slice of depth. There are several sorts of pooling. In Max pooling, for example, a filter that selects the maximum value, average pooling, and so on.

2. 3.4 ReLu Layer

It applies an activation function to each element to increase the model's non-linearity. The activation function max(0,x) is an example.

Dropout Layer

To prevent the model from overfitting, the Dropout layer is used. It's a regularisation strategy that removes some feature detectors by setting their activation values to zero at random.

FC Layer

Each neuron in this layer is connected to the previous layer's outputs. This layer provides the final forecast for each class. The FC layer contains ten neurons since our project has ten classes.

I. MODELING AND ANALYSIS

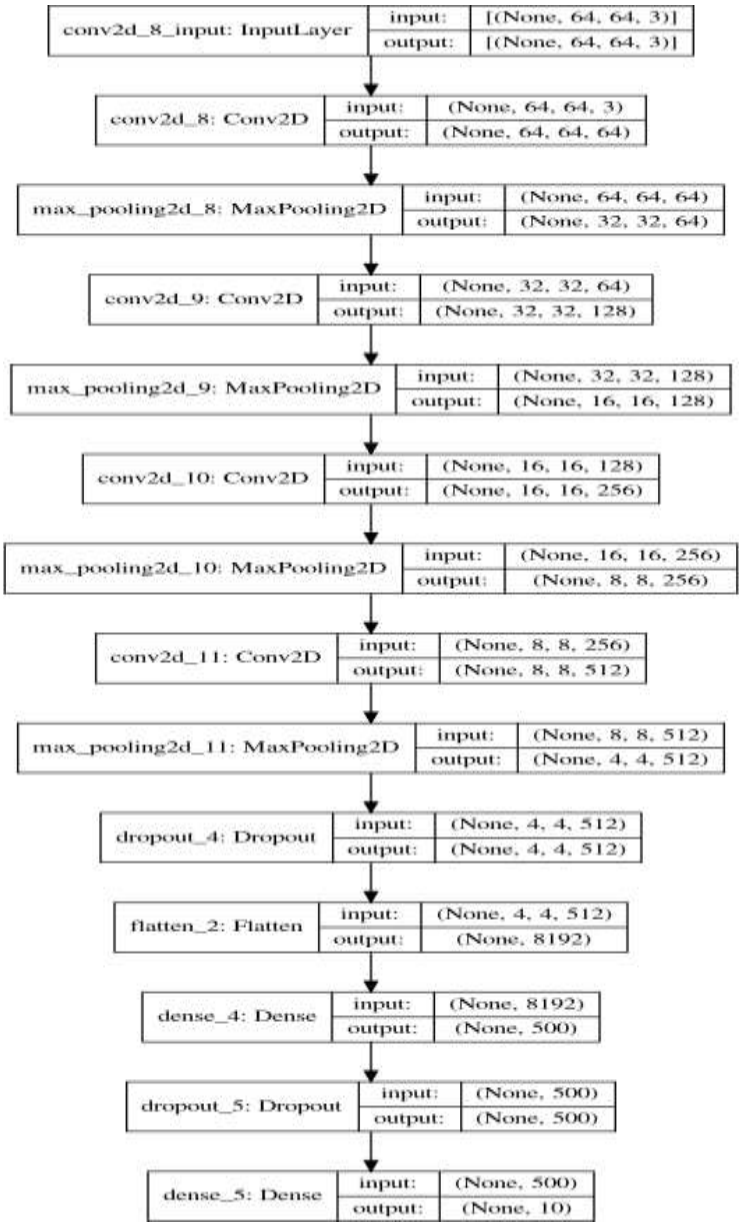
Model Definition- Minimal CNN

We have attempted to create a minimal CNN model from scratch instead of using most adapted Transferlearning techniques and VGG-16 and VGG-19 network architecture. The model has 4 Conv2D layers having 64,

128, 256, 512 filters respectively. The kernel_size is set to be 2 in each Conv2D layer and padding is

set to be “same” in each case. After each CNN layer, there is a MaxPooling layer with pool size of 2*2. The last MaxPooling layer is followed by a dropout layer with a dropout value of 0.5. Then, the output of the dropout layer is flattened and passed on to a dense layer with 500 units which eventually connects to the last dense layer with 10 units which is the number of classes we have. The figure below shows the model architecture with input sizes that different layers receive output shapes they give out.

Fig 4: Model Architecture flowchart



The model uses ADAM optimizer with categorical_crossentropy as the loss and evaluation metrics used here is accuracy. The model is fit with batch size of 40 for 25 epochs and shuffle is set to be true. The output of model isas follows:

After 25 epochs, the training accuracy reached 99.53% and the validation accuracy was noted to be 99.28%. Such high values in validation accuracy indicates high correlation in training and validation data. The training loss is 0.0238 and validation loss is 0.1125.

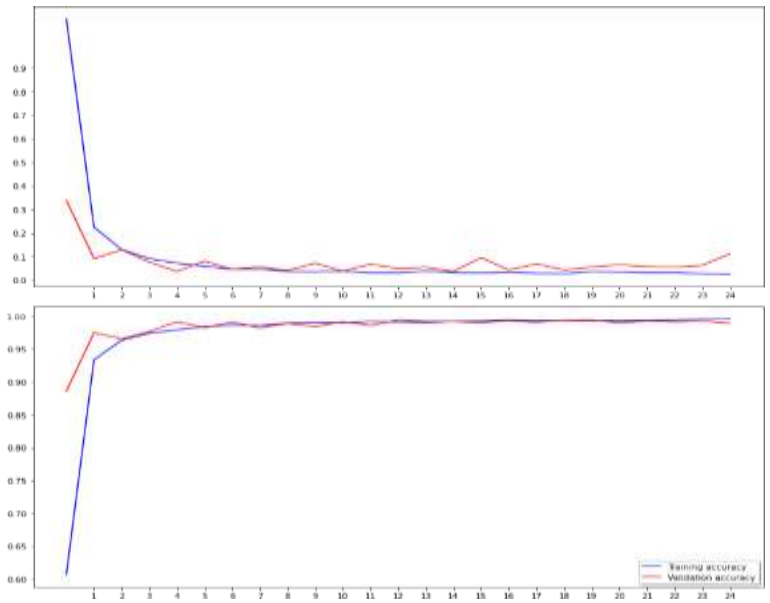


Figure 5 (a): Training and Validation loss,

5(b): Training and Validation accuracy

II. RESULTS AND DISCUSSION

The confusion matrix is used to verify if our model is biased with any classes and its performance with all the classes in the validation data.

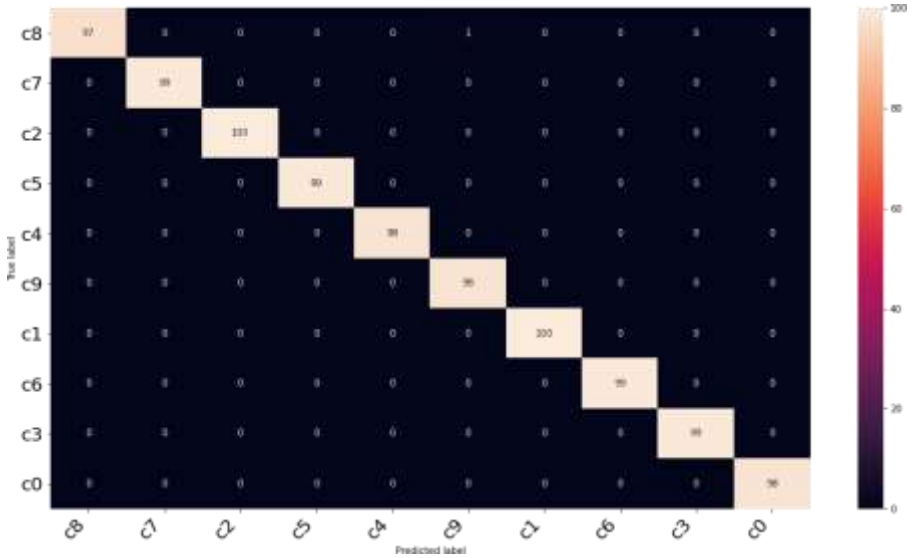


Fig 6: Confusion matrix with Heatmap

Table 1: Class-wise Validation Accuracy

Class	Validation Accuracy
c0	98 %
c1	100 %
c2	100 %

c3	99 %
c4	98 %
c5	99 %
c6	99 %
c7	99 %
c8	98 %
c9	97 %

CONCLUSION

The CNN Model constructed by us and described in the paper holds high significance in the real world. It can help prevent a significant number of motor vehicle accidents caused by distracted driving. Our model shows great accuracy on validation data and gives promising results. It is our sincere hope that this model will help drivers worldwide.

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