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REVIEW ON DRIVER DISTRACTION CLASSIFICATION TO AVOID ACCIDENTS USING DEEP LEARNING

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ABSTRACT

Driver distraction means driver engaging in another activities which is distract the driver attention away from the road, including talking on the phone, texting on the phone, Hair and Makeup, operating the radio, reaching behind, etc. Automatic interpretation of the driver 's distraction is one of the most crucial problem in the field of smart transportation systems. This crucial problem of distracted driving is solved by many approaches. There are many applications of Driver Distraction Such as, insurance company and investigation. Types of Driver Distraction classifications Is Normal driving, Texting, talking on the phone, operating the radio, drinking, reaching behind, etc. So, we aim to develop a system that will classify the driver distraction. We discuss application of driver distraction. Then, we firstly, discuss about different method for driver distraction classification. Our main focus on deep learning based classification of driver distraction, which can able to give more accurate results. Also, we discuss the datasets and the confusion Metrics which used for classification.

Keywords *– Driver distraction, Action recognition, Deep learning, Machine learning, classification, Convolutional neural network***.**

1. INTRODUCTION

Vision is one of the strongest human powers. Human eyes can see anything like any object that comes before them and recognize form, picture, video texture, color, and scale. But machine can be very hard to identify and understand. Such functions are made possible by the processing of images and field of computer vision. Image processing is a way of conducting such operations on an image, to get a better picture or extracted meaningful information from it [1]. It is a form of signal processing in which input is image, such as photograph, or video frame and output may be picture or features, or characteristics associated with that image. Nowadays developments are increasing in image processing. Thus, it has many different types of application such as medical imaging, film industry, Remote sensing, Forensic studies, Graphic arts, and many more [2]. There are two types of methods for image processing, namely the digital image processing and analog image processing.

There are many image processing techniques such as Image representation, Image pre-processing, Image enhancement, Image restoration, Image analysis, Image reconstruction, Image data compression etc. Computer vision is an approach of AI that deals with how computers can see andgain high level understanding of the digital images or videos [3]. Today, computer vision is one of the hottest filed of artificial intelligence and machine learning that gives wide range of applications. Computer vision main goal is to reproduce the power of human vision. Image processing is a subset of computer vision [4]. Computer vision used the image processing algorithm to perform like human vision. Computer vision can solve complex problem because of that it has a wide variety of applications such as healthcare, autonomous vehicles, agriculture, behavioral tracking and many more.

Distracted driving refers to driving behavior simultaneously with other activities that distract drivers from the road. Vehicle distraction are shown to activity of passengers, drivers and people. Distracted driving means “Any behavior that distracts a driver’s focus from the driving task” which involves distractions like cognitive, manual and visual. Visual distraction means the eye of the driver off the lane. Manual means hands off the wheel by the driver. Cognitive means the mind ofdriver off the driving [5]. Due to its variety of applications, including driver and passenger safety, offering driving assistance and even self-driving cars where it might be appropriate for people to take control of the vehicle [6]. The identification of driver actions has been slowly gaining interestover the last decade and lots of research are going for driver distraction [7].

The Center for Disease and Prevention (CDC) found that almost one in five accidents in motor vehicles were caused by Distracted driving. This more than 4,24,000 injuries and 3,000 deaths peryear in United States [8]. According to data released by the National Highway Traffic Safety Administration (NHTSA),3,91,000 people were injured in the United States in 2015 as a result ofdistracted driver motor vehicle collisions, and 3,477 were killed [6]. According to the National Highway Traffic Safety Administration (NHTSA), about a quarter of automobile collisions are caused by a distracted driver, with around 90% of road injuries in the United States attributed to human error. Mobile phone use was the key cause of such incidents.

Distracted driving is a significant cause of the traffic accident. Every year distracted driving leadsto more deaths than people around the world. This is primarily attributed to secondary activities such as talking over the phone, reaching behind, smoking, texting, running the radio, talking to co-passengers [7]. The project’s purpose is to determine exactly what drivers are doing and if they are distracted, motivated to that such statistics.

Driver distraction is a big issue of safety driving. For many people, driving is a common activity which makes driving safety an important issue in everyday life. Use a mobile phone while drivingis one of the driving distractions problem to drivers. The chance is 23 times higher than that of safe driving according to the US transition DEPT when driving texting. There are also other threatsto drivers, such as talking on the phone- right side, Texting through right hand, Smoking, talking on the phone -Left side, operating radio, doing makeup and set the hair, talking to passengers, reaching behind etc.

Aim of this paper is organized as follows: Section 2 discusses the Related work for driving distraction and existing techniques of driving distraction. Section 3 discusses the comparativeanalysis of Existing techniques and concludes in section 4.

2. RELATED WORK

This section we give a detailed description of different types of driver distraction and applicationsof driver distraction classification.

2.1 Types of Driver Distraction

There are mainly three types of driver distraction such as Visual, Manual and Cognitive [6].

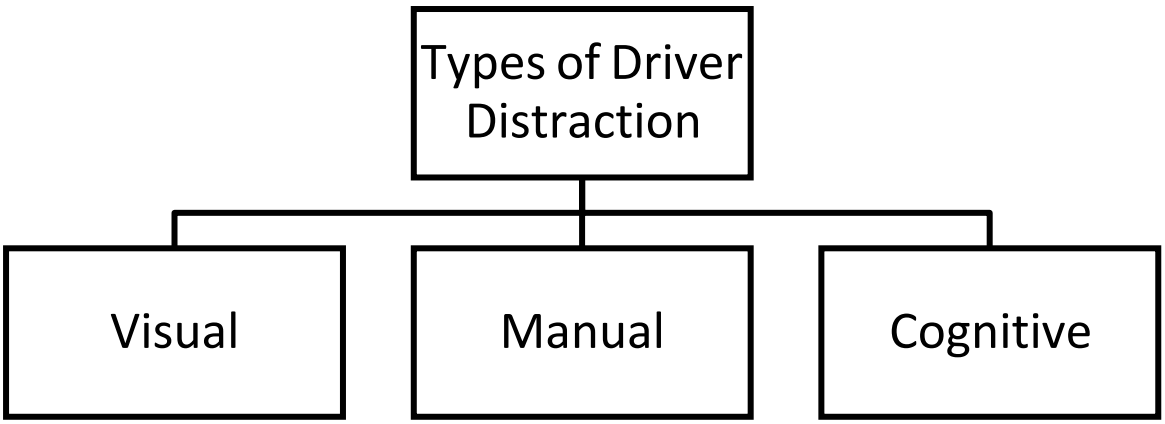

Fig 1. Types of Driver Distraction [6]

Visual Distraction:

Visual distraction is the first form of distraction, and one of the drivers that is most common. Theseare things which take the driver's road off the focus and the eyes. Running the radio is a one kindof visual distraction [5].

Fig 2. Visual Distraction [9]

Manual Distraction:

Manual distraction, driver takes one or both hands of their steering wheel for a number of reasons.It can be a text message, or a call answer [5].

Fig 3. Manual Distraction [9]

Cognitive Distraction:

The last type of distraction is cognitive distraction. There are obstacles when driving and do not focus the mind. This can be due to emotional stress, family or earnings issues, talking to someoneelse in the car or using the mobile [5].

Fig 4. Cognitive Distraction [9]

2.2 Applications

There is various application of classification of driver distraction such as Insurance Company, Warning System and Advance assistance system.

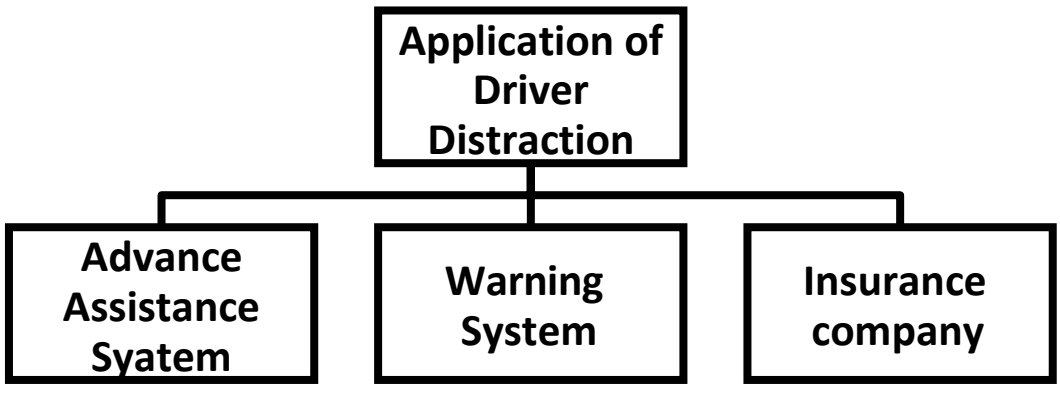

Fig 5. Applications of Driver Distraction

Insurance company [5]:

Many insurance providers use the driver distraction model classification to reduce the incident. One of them is State Farm Insurance company. State Farm aims to boost these alarming statistics, and better inform their customers by checking weather dashboard cameras can automatically identified distracted behaviors [7].

Warning System [10]:

Currently, driver distraction causes many incidents. We can create a distracted driving alert system using deep learning approaches and classification techniques, which identifies and alerts drivers to distract themselves.

Advance Assistance System (ADAS) [8]

Mostly the road accidents are caused by human mistake which is very bad for all drivers. Advanced technology in driver distraction is save the people's lives. The automated Advance Driver Assistance System (ADAS) system provided to the vehicle has been shown to minimize road deaths by reducing human error.

2.3 Driver Distraction Classification

Driver Distraction classification is a method of assessing whether or not the driver is distracted from driving so identified driver is also distracted from different groups like texting-right, telephone-left, safe driving, texting-left, telephone-right, smoking, operating the radio, hair and make-up, reach behind, talking to passengers [8].

Figure 2.6 Safe Driving [9]

Figure 2.7 Distracted Driving [9]

In above Fig. describe driver is doing Safe-Driving and driver is distracted from driving. Computer vision, machine learning and Deep learning is one of Driver distraction's possible solutions. Using computer vision, machine learning and Deep learning techniques to identify distracted driving behaviour.

Safe Driving

Texting Right

Talking on Phone Right

Texting Left

Talking on Phone Left

Operating Radio

Drinking

Hair and Makeup

Talking to Passenger

Reaching Behind

Figure 2.8: Different Classification of Target Classes [8] [9]

2.3 Different Classification Methods

In this section, we had reviewed both machine learning based techniques and deep learning based techniques for image classification. So, we discuss Multi-class SVM [29] and K-NN [30] are based on machine learning Algorithm. Whereas, Artificial Neural network (ANN) [31] and Convolutional Neural Network (CNN) [32] are based on a deep learning algorithm. Image classification is a part of supervised learning. Some classification methods explain below.

2.3.1 Machine learning Algorithms

Machine Learning is a type of artificial intelligence that used automated data processing algorithms that help to identifies new pattern in data and make decision more natural and enhance the performance based on the results. Artificial intelligence is a computer science aspect that focuses on systems that are capable of solving problems and performing tasks that involve human intelligence. There are four major machine learning models namely supervised, semi-supervised, unsupervised and reinforcement.

K-nearest neighbor (KNN) [12] [27]

KNN is a supervised machine learning algorithm that used for solving both problem classification and regression but mostly it used for the classification problem. KNN algorithm use data and classify new data points based on similarity measurement between the new data and available data and classify new data into the category based on the similarity. In the training process, the KNN algorithm only stores the dataset and, when it gets new data, classifies the data into a categorythat is similar like the new data.

Support Vector Machine (SVM) [13] [14] [16] [28]

SVM is a supervised machine learning algorithm that is used for binary classification. SVM is discriminative classifier that used for two-group classification problems. The main goal of SVM is to create a best line that can separate the data into two class. This best separating line is called hyperplane. There are two types of SVM linear SVM and Non-linear SVM. Linear SVM is used for separating the data by linearly, that means data can be separated into two classes using single line and classifier is called Linear SVM classifier. Non-linear SVM is used for separating the data by non-linearly, that means data cannot be separated by single line and classifier is called Non- linear classifier.

Laplacian Support Vector Machine (LapSVMs) [16] [29]

Laplacian support vector machine (LapSVMs) is a semi-supervised machine leaning algorithm. LapSVMs used for to develop better understanding and improve the quality of classifiers exploiting unlabeled data.

Semi-supervised extreme learning machine (SS-ELM) [16][30]

SS-ELM is an expanded form of extreme learning machine (ELM). ELM is a single hidden layer feed forward neural network. SS-ELM is deal with unlabeled data problem. SS-ELM has good performance of generalization. It is discernible the unbalanced data issue imposes obstacles in real-world applications including medical diagnostics and fraud detection of credit card.

2.3.2 Deep learning Algorithms

Deep learning is a branch of machine learning that has a huge network of neurons. A neural network is consisting input layer, hidden layer and output layer. In neural network number of hidden layers are presents. All layers are connected with neuron. Neuron is also called as a node. Input layers represents data into the numerical, Output layer predict answer and hidden layer correlated with the computation. Deep learning is the only method which can overcome feature extraction problems. Deep learning models are capable to learn huge amount of labeled data and archived very good accuracy because it focusses on the right features automatically. Basically, deep learning is the way just like human brain therefor it learns from

experience. It is the reason why deep learning is receiving a lot of coverage. There are different types of neural network such as Artificial Neural Network (ANN), Convolutional Neural Network (CNN) which are explained below.

Artificial Neural Network (ANN) [31]:

ANN is a type of deep learning. ANN consist mainly three layers such as Input layer, Hidden layer and Output layer. There might be more than two hidden layers in architecture. All neurons in the input layer are connected to hidden layer and all neurons of hidden layers are connected to the output layers. All connections have weight and initially it takes weight randomly and after a certain process it will produce output. If output would be different than actual output then it generates an error and after that, weight will be updated accordingly. This is called back propagation and this process will continue till the error will be null. It is fully connected network so it takes more time consuming than CNN.

Convolutional Neural Network (CNN) [15] [16]

Convolutional neural network is like neural networks with learning parameters and biases by neurons. Each neuron receives multiple inputs, assumes a weighted sum, passes it through an activation function, and gives output response. Convolutional neural network on deep learning thatperform task to recognize images and classify images. CNN has wide applications in the field of image and video recognition recommendation system and processing of natural language. CNN consist of layers of input layers, number of hidden layers, and output layers. This hidden layer performs the task of extracting features [15]. To extract the features from the image, there are threelayers in the hidden layer and the activation function. Convolutional neural network dived into twoparts namely, Feature Extraction and classification

In feature extraction, extract the lower and higher-level features of an image. Features of a lower level means the extraction of lines, edges and brightness, etc. and the feature of a higher level means the extraction of whole objects. This phase is included Convolution layers, Rectified linearunit (ReLU) and Pooling layer. Convolutional layer is the first layer to extract the feature from aninput image in convolutional layer [15]. Filters are used to extract the image features. This filter has different sizes like 3*3,5*5,7*7, etc. these filters or kernels and the matrix of image are two convolution inputs [4]. Then the image matrix convolution multiples with the filter matrix that is called the output feature map. These filters pass through the image from left to right and from top to bottom and extract the features from the image. Ever layer extracts a picture's different features. Initial CNN layers extract the lower level characteristics and the higher-level characteristics are extracted by half of the remaining layers. ReLU is an activation function. ReLU transform functionactivates node only if the value of the input is above a certain quantity, while the value of the inputis below zero, the output is zero, but if the input is above a certain threshold, it has a linear relationship with the dependent. The main purpose of this function is to introduce non-linearity inthe convolution. All positive values remain the same, but they change all negative values to zero [14]. The number of parameters of an image is reduces by pooling layers. This reduces the imagematrix to a smaller size. There are various types of pooling such as max pooling, average pooling,

and pooling of sums [14]. Max pooling layer is taken from rectified matrix by the larger element. The average pooling could also take the feature matrix's larger element. Summary of all feature matrix elements called sum pooling.

Classification has done by fully connected layer. Fully connected layer is the CNN network's last layer. It is used to convert output vectors into a number of classes, and the classifier finds each output's probability [12]. There are many pretrained models of CNN such as VggNet [21], AlexNet [18], ResNet [20], InceptionNet [19], Xception[22], MobileNet[23] etc. we can used that models directly for classification.

Transfer Learning Architecture of CNN [12]

Transfer learning is a method to reuse the knowledge that has already been acquired. The idea is to use a state-of-the-art model that has been trained for a long time on a larger dataset and has proven to function well in related tasks. There are a lot of such models for us to use. Transfer learning provides a major boost in terms of speed and performance [12].

In transfer learning, first train a base dataset and task, then repurpose or transfer the learned features to a second target network for training on a target dataset and task [12]. This process will tend to work if the feature is general, meaning suitable to both base and target tasks, rather than the base task specific.

2.4 Existing techniques of driver distracted

There are various techniques available for image classification. In this section we discuss all techniques for classification of driver distracted. Our main focus on deep learning based classification of driver distraction.

2.4.1 Discussion of all the techniques proposed

Thomas K. Ferris et al. presents driver distracted using deep learning approaches. They have useddata augmentation technique for increase the data for training. After that they have used pre-trainedCNN model for feature extraction such as VGG and GoogleNet. Besides these models, there are two top performing solution used for this model: K-nearest neighbours, assemble. First, creating an ensemble of the model can reduce variance and alleviate the problem of overfitting, because ofthe testing size is larger than training set. Secondly, if images are taken from the video clip in thatcase many images are similar and identical. So, that images should be classified in the same class.

Raimondo Schettini et al. presents classified driver distraction using deep learning from 2D cameras. In this paper, they have focused on video-based classification. Firstly, they have extractedand classified the feature through ResNet-101.

Helen J. A. Fuller et al. presents two specific purposes in this paper: first, to show that a model predictive framework, in which the driver's nominal (i.e ., no secondary task) behaviour is captured in a model and the model predictions are used as baseline for conducting secondary task,can provide useful information on the individual effects of secondary tasks, and secondly, to showthat model predictions are used. It means that this knowledge will not only be available offline, which is also useful in and of itself for the design of in-vehicle systems, but also online, which would be a vital piece of information for active safety systems.

Manjula Kumari et al. introduces an algorithm based on the CNN which would distinguish a driver's distracted face from non-distracted ones. The CNN would estimate driver's head pose angle. The amount of distraction is related to face pose angle and is given as the CNN's class outcome. There are several layers in a CNN and 22 layers was utilized in this paper. A series network is a neural network that is commonly used in the sense of deep learning, in which the layers are organized in series fashion. This has a single layer for input and a single later for output.

Yong Kiang Yeo et al. discusses a subject-dependent model using SS-ELM and LapSVM. Furthermore, statistical Bayesian network with supervised clustering, SVM, ELM, Transudative SVM have been implemented to compare the proposed model. Then model partitioned each datasetinto three sub-sets, which is labeled, unlabeled, and test data. Supervised learning models were constructed using only labeled training data and SSL models, using both labeled and unlabeled data. And then tested all models output on test data collection.

3. COMPARATIVE ANALYSIS OF DRIVER DISTRACTED TECHNIQUES

In this section, we discuss comparison that depicts the analysis of previously discussed driver distracted classification techniques. Table-1 shows comparison of driver distraction classificationmethods, that method results, limitation of that methods and scope of improvement of driver distraction classification method.

TABLE-I: COMPARATIVE ANALYSIS OF DRIVER DISTRACTION CLASSIFICATION TECHNIQUES.

Author's name	**Approaches**	**Accuracy**	**Limitation**	**Scope of improvement**
Thomas Ferris K. et[8] al.	CNN KNN VGG-16 GoogleNet	86%	Overfitting is a major problem because testing set is larger than the training set	Data Augmentation ResNet-152
Raimondo Schettini et al.[6]	CNN LSTM SVM	96.67%	Misclassification Identification problem	Introduce moreaction classes
Helen J. A. Fuller et al. [5]	Radial Based NN (model creation) SVM	100%		Improve the Framework for different secondary tasks and different age groups and explore alternative models and classification

				techniques
Manjula Kumari et al.[7]	CNN	93.63%	For a small Size kernel able to Capture minute detail. But Bigger size kernels could not able to Capture Minute detail.	
Yong Kiang Yeo et al. [10]	Laplacian Support vector machine SS ELM	97.2%	Output of driver distraction detection will be less accurate if eye movement behaviour is changed.	Improve the Framework for different secondary tasks and different age groups and explore alternative models and classification techniques

4. CONCLUSION

In this paper, we have studied about driver distraction, it is a major problem that leading to a significant number of accidents around the world. Because of distracted driving in the world many people are death and many people are majorly injured. Thus, we studied different method for implementing the classification of driver distraction. Then, we also discussed the application of driver distraction in real life. We also discussed driver distraction dataset such as state farm and Realtime dataset are used for classify the distracted driver behaviour. We also discussed different techniques for classify distracted driver behaviour. By review of different methods, we had identified various issues in existing driver distraction classification. These all methods are based on machine learning and deep learning. But our mainly focus on deep learning based classification. Driver distraction classification are useful in many applications it very helpful in real life transportation.

REFERENCE

[1] Anbarjafari, G., 2020. 1. Introduction To Image Processing. [online] Sisu.ut.ee. Available at: <https://sisu.ut.ee/imageprocessing/book/1> [Accessed 7 June 2020]. Drkmm.com. 2020. [online] Available at:

[2] <http://www.drkmm.com/resources/INTRODUCTION_TO_IMAGE_PROCESSING_29aug06. pdf> [Accessed 7 June 2020].

[3] En.wikipedia.org. 2020. Computer Vision. [online] Available at: <https://en.wikipedia.org/wiki/Computer_vision#:~:text=Computer%20vision%20is%20an%20interdisciplinary,human%20visual%20system%20can%20do.> [Accessed 7 June 2020].

[4] Tryolabs.com. 2020. An Introductory Guide To Computer Vision. [online] Available at: <https://tryolabs.com/resources/introductory-guide-computer-vision/> [Accessed 7 June 2020].

[5] T. Ersal, H. J. A. Fuller, O. Tsimhoni, J. L. Stein, and H. K. Fathy, "Model-Based Analysis and Classification of Driver Distraction Under Secondary Tasks," IEEE Transactions on Intelligent Transportation Systems, vol. 11, no. 3, pp. 692–701, 2010.

[6] L. C. Valeriano, P. Napoletano, and R. Schettini, “Recognition of driver distractions using deep learning,” 2018 IEEE 8th International Conference on Consumer Electronics - Berlin (ICCE- Berlin), 2018.

[7] M. Kumari, C. Hari, and P. Sankaran, “Driver Distraction Analysis Using Convolutional Neural Networks,” 2018 International Conference on Data Science and Engineering (ICDSE), 2018.

[8] Cs229.stanford.edu, 2019. [Online]. Available: http://cs229.stanford.edu/proj2016/report/SamCenLuo-ClassificationOfDriverDistraction- report.pdf. [Accessed: 13- Dec- 2019].

[9] Kaggle.com. 2020. State Farm Distracted Driver Detection | Kaggle. [online] Available at: <https://www.kaggle.com/c/state-farm-distracted-driver-detection/data> [Accessed 23 May 2020].

[10] T. Liu, Y. Yang, G.-B. Huang, Y. K. Yeo, and Z. Lin, “Driver Distraction Detection Using Semi-Supervised Machine Learning,” IEEE Transactions on Intelligent Transportation Systems, vol. 17, no. 4, pp. 1108–1120, 2016.

[11] M. Belkin, "Laplacian Support Vector Machines Trained in the Primal", Jmlr.org, 2020. [Online]. Available: http://www.jmlr.org/papers/volume12/melacci11a/melacci11a.pdf. [Accessed: 07- Jun- 2020].

[12] Abuassba, Z. Dezheng and Z. Mahmood, "Semi-supervised Multi-kernel Extreme Learning Machine", Procedia Computer Science, vol. 129, pp. 305-311, 2018. Available: 10.1016/j.procs.2018.03.080.

[13] "An Introduction to Deep Learning", Medium, 2020. [Online]. Available: https://towardsdatascience.com/an-introduction-to-deep-learning-af63448c122c. [Accessed: 07-Jun- 2020].

[14] F. Chollet, "Xception: Deep Learning with Depthwise Separable Convolutions", Openaccess.thecvf.com, 2020. [Online]. Available: http://openaccess.thecvf.com/content_cvpr_2017/papers/Chollet_Xception_Deep_Learning_CV PR_2017_paper.pdf. [Accessed: 07- Jun- 2020].

[15] "K-Nearest Neighbor(KNN) Algorithm for Machine Learning - Javatpoint", www.javatpoint.com, 2020. [Online]. Available: https://www.javatpoint.com/k-nearest-neighbor- algorithm-for-machine-learning. [Accessed: 07- Jun- 2020].

[16] "Support Vector Machine (SVM) Algorithm - Javatpoint", www.javatpoint.com, 2020. [Online]. Available: https://www.javatpoint.com/machine-learning-support-vector-machine- algorithm. [Accessed: 07- Jun- 2020].

[17] "An Introduction to Deep Learning", Medium, 2020. [Online]. Available: https://towardsdatascience.com/an-introduction-to-deep-learning-af63448c122c. [Accessed: 07-Jun- 2020].

[18] Krizhevsky, I. Sutskever and Geoffrey E. Hinton-“ImageNet Classification with Deep Convolutional Neural Networks”, ACM Digital Library, 2012.

[19] C. Szegedy, V.Vanhoucke, S. Ioffe, J. Shlens and Z. Wojna-“Rethinking the Inception Architecture for Computer Vision”, Computer Vision and Pattern Recognition (cs.CV), 2015.

[20] K.He, Xi.Zhang, S. Ren and J. Sun -“Deep Residual Learning for Image Recognition”, Computer Vision and Pattern Recognition (cs.CV), 2015.

[21] K. Simonyan and A. Zisserman–“Very Deep Convolutional Networks for Large-Scale Image Recognition”, Computer Vision and Pattern Recognition (cs.CV), 2014.

[22] F. Chollet, "Xception: Deep Learning with Depthwise Separable Convolutions", Openaccess.thecvf.com, 2020. [Online]. Available: http://openaccess.thecvf.com/content_cvpr_2017/papers/Chollet_Xception_Deep_Learning_CV PR_2017_paper.pdf. [Accessed: 07- Jun- 2020].

[23] G. Howard, M. Zhu, B. Chen, D. Kalenichenko, W. Wang, T. Weyand, M. Andreetto, and H. Adam, “MobileNets: Efficient Convolutional Neural Networks for Mobile Vision Applications,” arXiv.org, 17- Apr-2017. [Online]. Available: https://arxiv.org/abs/1704.04861. [Accessed: 13-Jul-2020].