Development of a Real Time Drowsy Driver Detection System

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Abstract: **This paper presents the development of real time drowsy driver detection system. The study reviewed literature and identified that drowsy has remained a major cause of most road accidents. To address this problem a real time drowsy driver was developed using convolutional neural network and implemented as an accident prevention and control system using Mathlab. The result when tested showed that the system was able to detect drowsiness in real time which is very good.**

Key words**: Drowsy Driver, Real Time, Accident, Convolutional Neural Network**

I. INTODUCTION

According to Kayode (2018), an estimated 90% of passengers depend on road network for transportation. This implies that the passengers reach out to their respective commercial service based, habitat or domain via vehicles. Some of the commercial driver's piloting these vehicles spend most of their times on the steering wheel driving, since their pay checks depend on the number of passengers they convey to various destinations daily. This alone accumulates enough mental stress and fatigue on the driver's brain and induces drowsiness while still on high way after some hours. This is the reason why some drivers take precautionary measures like eating bitter kola, drinking coffee, drinking alcohol, taking few minute refreshment breaks, eating chewing gums and even smoking sometimes with hope of countering this effect of drowsiness. However one cannot manipulate nature as these traditional techniques are not good enough or reliable. The use of alcohol for instance induces more fatigue to the brain cells and increases the rate of drowsiness contrary to the drivers aim and as a result can have a devastating effect on the driver concentration, thus endangering the lives of the passengers on board and most time leading to series of road accidents.

For instance in the final quarter of 2015 according to a report released by the federal road safety corp (FRSC) of Nigeria, over 12,077 road crashes were recorded with 75400 fatalities within the year. A more recent annual report by the same agency recorded 3,947 road crashes involving 6448 vehicles which results to 1758 deaths and 11250 injuries between the first quarter of the year 2020, with all investigations pointing to drowsy drowsiness and reckless driving. Therefore there is need for intelligent based drowsy driver monitoring and detection systems which is cost effective so as to affordable and monitor driver's action when driving with précised result.

To solve these problems, various assignment works have been developed on drowsy driving detection system over the past decades, employing different methods such as physiological, behavioral and vehicle-based methods respectively Mardi et al. (2011). However they all have their prons and cons. This assignment proposes to solve this problem of drowsiness using real time approach which intelligently monitor the driver behavior and detect drowsiness instantly.

II. LITERATURE REVIEW

Author	Technique	Work done	Research gap/Limitation
Charlotte et al. (2018)	Artificial neural network (ANN)	The study used adaptive neural network to develop drowsy driver algorithm	The system achieved accuracy of 80% and detection time of 1 minute
Nikita and Bryan (2014)	K- mean clustering	The study developed a clustering based drowsy driver algorithm using ECG signal and wavelet transform and classified with K-mean clustering	The system achieved 89% accuracy but can be improved
Manoram and Aril (2018)	Artificial Neural Network (ANN)	The study used neural network to develop a drowsy driver algorithm	Accuracy of 94% was achieved and training time of 19s
Varun and Kartikeyan et al. (2021)	Convolutional neural network	The study used computer vision and CNN to develop an algorithm to detect drowsiness	The accuracy achieved is 92% and 1mint delay time
Chin et al. (2005)	Independent component Analysis (ICA)	The paper used ECG signal and ICA to develop a drowsy driver detection	The study can be improved with computer vision
Peter et al. (2001)	Mathematical method	The used differentiation to estimate the performance of drowsy drivers using ECG signs	The study can be improved with artificial intelligence

III. THE PROPOSED SYSTEM

The proposed system was developed using a training dataset of video clips made up of various driving attributes characterized as critical, minor and perfect driving behaviors. These data were processed to have the same specifications such as length, weight and then used to train the deep learning technique to develop the proposed system. The video acquisition device was made intelligent and used for the data collection; this intelligence was possible using computer vision to detect drivers face (since the face is the main part of the body where drowsiness can be sensed) and automatically search for facial points with drowsy features. The data collected is set to the same size as those in the training dataset. The data collected were extracted feed forward for training using deep learning technique. After the training the result was classified to detect driver behavior in three outputs as follows; if critical drowsy symptoms like sleep for instance are detected, then a warning sign indicating danger is displayed, else if classified as perfect driving condition, then it is displayed, else if any minor drowsy behavior is classified such as yawning for instance, then sensing drowsy behavior is displayed. The activity diagram of the proposed system is presented as shown below which further explained the process flow of the system and the interactions within each step.

IV. METHODS AND SYSTEM MODELLING

This section presented the step by step processed used to design and implement the proposed drowsy driver detection system as shown below;

Video Acquisition sensor: this is a process of collecting real time driving behavior from the driver in a video format. The process was facilitated using a hardware device (video camera) whose operation was made intelligent via computer vision. The computer vision was developed using viola jones algorithm in (Ituma and Asogwa, 2018) and then incorporated into the camera to have object detection intelligence with main focus on human face for data collection. The camera collects 30 frames of pictures per seconds in the size of 200 x 200 resolutions. This implies that the quality of each frame is 200 pixels in height and 200 pixels in weight; hence the total number of pixels for each image quality is 40000.

Face detection and tracking: this is a process of detecting a human face from other objects. This process was made possible using computer vision algorithm as also disclosed. The algorithm equipped the camera with facial detection and tracking capabilities and then collects information in series of frames for processing. Data flow diagram (DFD) was used to model the video acquisition and intelligent data collection process as shown in figure 1;

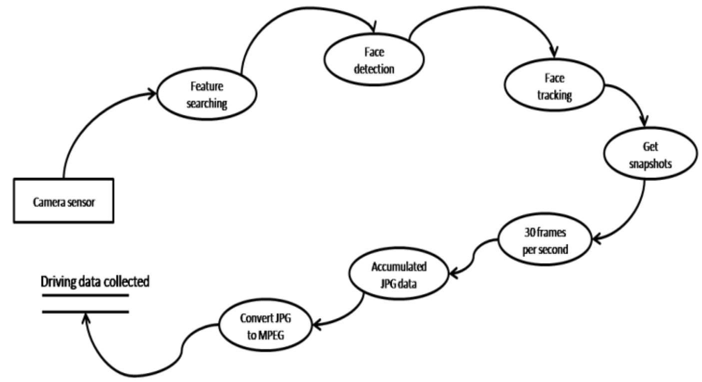

Figure 1: model of the intelligent video acquisition system

Training dataset

Dataset which contains information of driving behaviors were collected from self volunteered drivers using video camera. The sample size of data collected is 900 videos of 3secs each. The video was classified into three classes which are minor drowsy, major drowsy and critical drowsy signs as inspired and the data model in presented in figure 2;

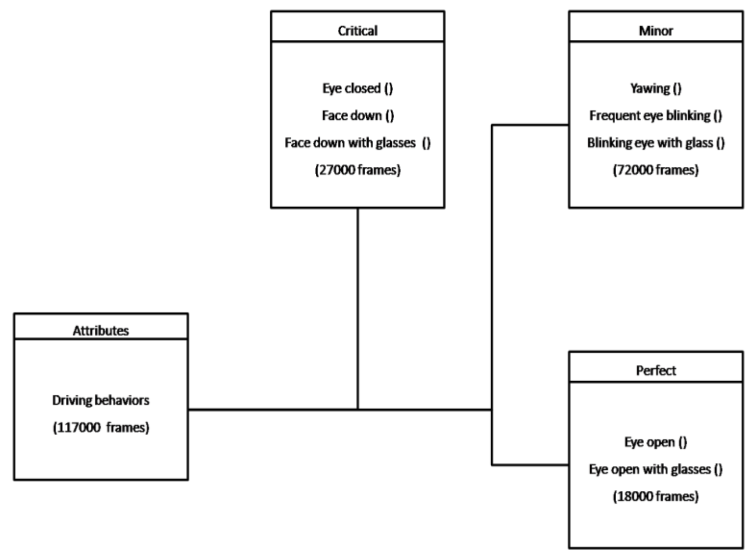

Figure 2: model of the training dataset

Feature Extraction

This is a process of extracting images frame from the video clips collected by camera and then feed forward to the deep learning technique for training. These images were set to be compatible with the training images in terms of size as (200 x 200) before feeding forward for training.

Deep learning algorithm used: Deep learning is a branch of machine learning techniques used for image classifications. It is employed for training the dataset in figure 3 and also new features extracted from the testing dataset. The deep learning algorithm used is called convolutional neural network (CNN). CNN is a deep neural network class structured with neurons of learnable weights and biases which intelligently process large sets of data and make correct predictions.

The Convolutional Neural Network Design Architecture

The convolutional neural network employed in this work was adopted from Kekong et al. (2021) whose architecture was used to train the data model in figure 2 and the used to new drowsy driver CNN architecture in figure 3

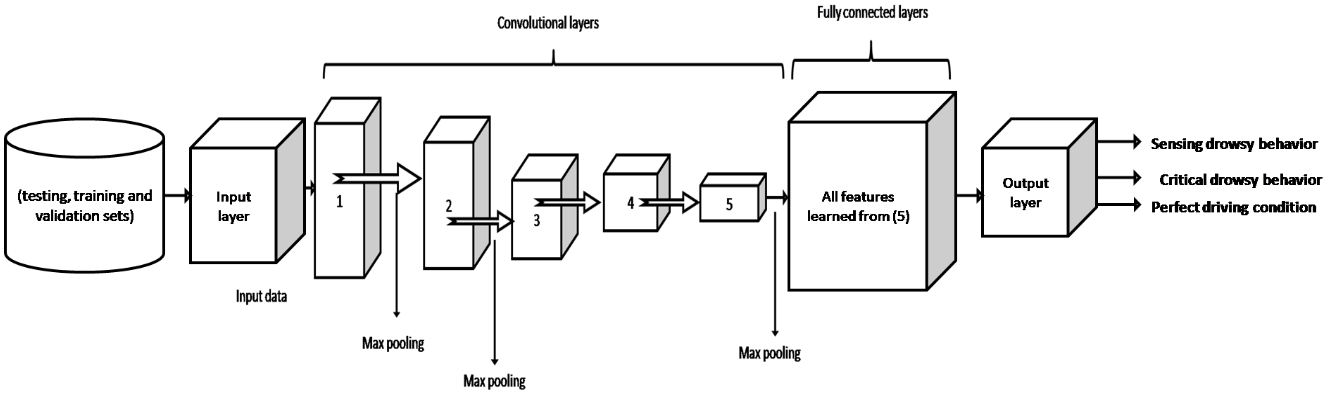

Figure 3: Architectural model of the convolutional neural network

The model in figure 3 presents how the CNN collects and train data to classify driving behavior. The architecture in figure 3 was developed with the training data model of drowsy drivers, the input layers which configure the size of data input from the driver and then the convolutional layer used filter and pooling function to extract the interesting drowsy features for training using the fully connected layer. The five convolution layer used was adopted to improve the efficiency of the feature extraction process before training in the fully connected layer. The output layer used softmax function to classify and detect drowsy driving.

System Flow

The data flow model in figure 4 presented the developed system for real time monitoring of drowsy behaviors using data collection from the driver and then the train to detect the driving behavior and notify on danger such as sleep, continuous eye blinking, head down while driving etc.

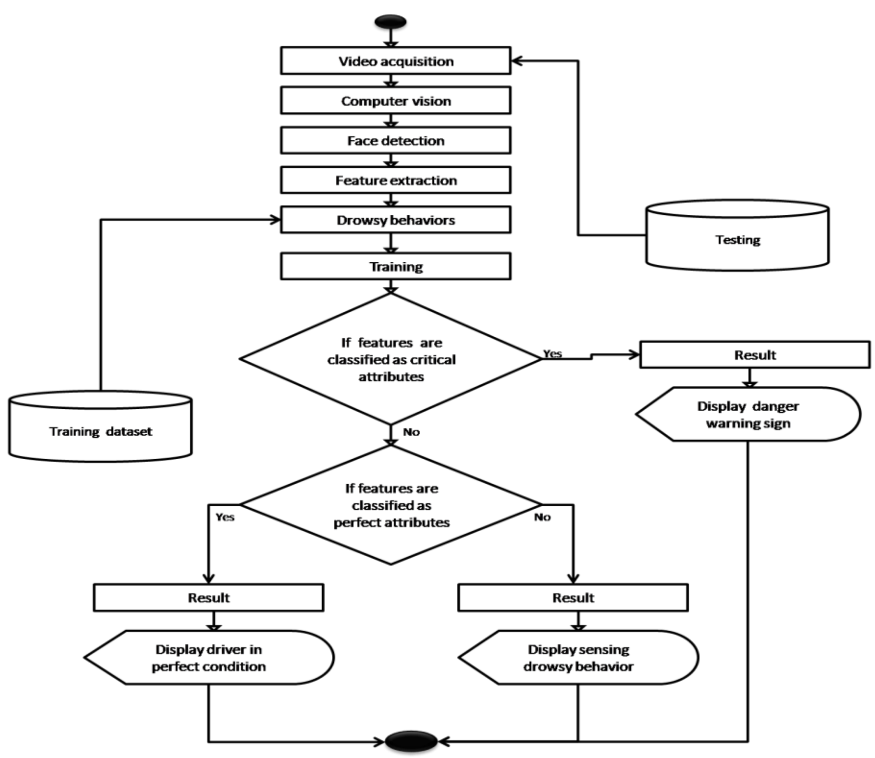

Figure 4: the Real time drowsy driver activity model

The figure 4 shows the model of the real time drowsy driver system, showing the various logical flow of the modules which sequentially interact with each other to achieve the new system.

V. IMPLEMENTATION AND REAL-TIME EVALUATION

The system was implemented with Mathlab using deep learning toolbox, computer vision toolbox, optimization toolbox and image acquisition toolbox. The result of the system implementation, training step response time and testing was presented in the figure 5 and 6 showing the performance of the system when tested with driver active and driver displaying drowsy signs.

In the system model in figure 4, the computer vision toolbox used to model the camera in figure 1 detects and read the driver behavior by extracting facial features and track the drivers face. The data extracted was feed to the CNN algorithm in figure 2 to train and classify driver behavior as drowsiness or not drowsy sign as shown in figure 5 and 6. The step response behavior is presented in figure 7;

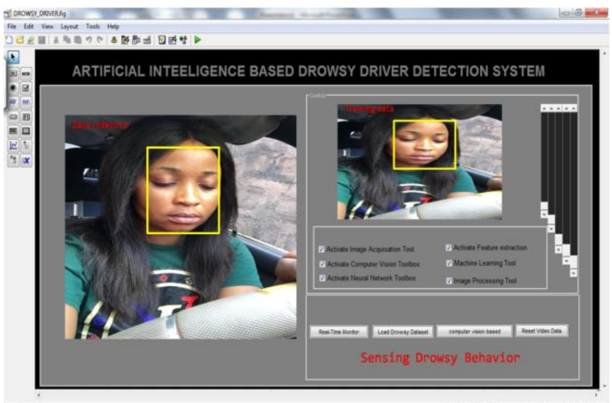

Figure 5: System performance at drowsy behavior

The figure 5 presented the drowsy driver detection system performance when deployed for driver behavior monitoring. In the result the system was able to capture the driver behavior, train and detect sleep which a drowsy behavior as indicated in the figure.

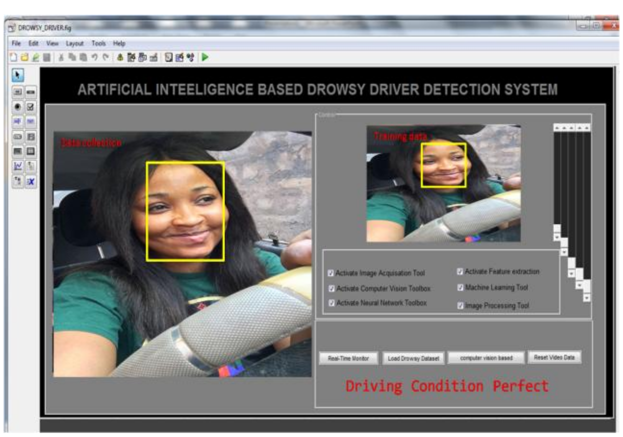

Figure 6: System performance at Perfect driving scenario

The figure 5 and 6 shows the behavior of the drowsy driver detection and monitoring system developed. To determine the step response time to detect these behaviors, the step response graph in figure 7 was used.

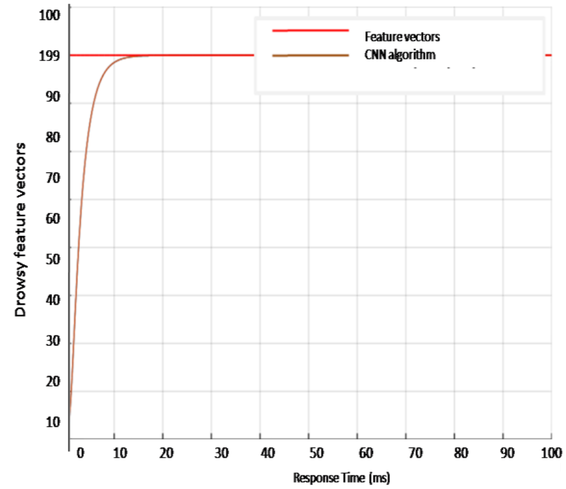

Figure 7: Response time result

The figure 7 shows the response time behavior of the system, showing the time it took to collected drowsy features and train to detect driver's behavior. The response time is 12ms which is very good and is classified as real time based on (Kopetz, 1997; Kuo and Lee, 2006) which presented time less then 20ms as real time.

VI. CONCLUSION

This assignment has successfully presented the application of real time embedded system as an accident prevention and control instrument for the monitoring and detection of drowsiness from drivers. This was achieved using camera as the sensor which collected drowsy data and feedback to the artificial intelligence system for processing and notification of any drowsy signs. This will go a long way to prevent accident and ensure safety of lives and properties.

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