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Intelligent Feedback Model for Healthy Driving Style: A Review

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ABSTRACT
Automating safe driving in vehicles and intelligent transportation systems require enhanced understanding of the human driver behaviour. This is not only necessary to guarantee safe and adequate performance, but also to adjust to the drivers' needs, potentiate their acceptability and ultimately meet drivers' preferences in a safe environment. This paper reviewed the various safe driving style systems with different driving characteristics and dataset locations. This work was able to highlight various machine learning techniques that can be applied to safe driving system showing the best ML technique to apply in different driving characteristics and the relevance of deployment of appropriate system using the relevant dataset to help improve the efficiency of the system when applied in different locations.

KEYWORDS: Machine Learning, Localized dataset, safe driving, Driving events, cognitive processing

I. INTRODUCTION

Machine learning is a branch of artificial intelligence that aims at enabling machines to perform their jobs skillfully by using intelligent software [9]. It also involves the ability of machines to learn by themselves and improve their own performance. This system does not rely on rule-based programming, but on algorithms that identify patterns in data and then predict similar patterns in new data. Driving is one of the major form of transportation. The ability to drive is one of the most important activities of daily living. Hence, [7] have pointed out that models that capture both high-level cognitive processing and low-level operational control are needed. For practical applications, these models must capture the behavior of the overall population but also have facilities to adapt to a particular person or driver.

Industries have taken a further step to influence driver driving style through active and passive corrective feedback towards safer and eco-friendly practices [6]. The firsts can intervene into the driving task directly by generating haptic inputs, whilst the second is only advisory and targets to improve drivers' awareness through visual or audio advice [8].These systems are being embedded in the recent vehicles to assist in one form or the other in cautioning and assisting the driver as the case maybe. However, these set of vehicles are very expensive that transportation companies and most individuals in Africa and Nigeria in particular might not be able to afford them. Nevertheless, better understanding of driving style is required to ensure appropriate and consistent recognition and to effectively promote safe driving. Lots of vehicle dynamic systems and vehicle control systems are designed by engineers, and they generally put their emphasis and interest on the vehicle itself. Recently, high-performance vehicle cannot meet the needs of customers who require more human-friendly vehicle that can be easily managed and also maintained. Thus, human driving skill and characteristics is needed to be encouraged and add into the vehicle dynamic systems to improve the vehicle's drivability, maneuverability, and safe driving.

II. OVERVIEW OF HEALTHY DRIVING IN NIGERIA

Healthy driving style involves applying all cautions and regulations available for road safety. It is the duty of the Federal Road Safety Corps to ensure the appropriate use of roads and implementation of the cautions and regulations by the road users. Some road machines have enhanced features for healthy driving while some transportation industries use safe driving mobile sensor applications for driving assistance and monitoring. Some of these drivers assistance are data driven.The road data are collected from road cameras, mobile sensors among other devices and these data when trainable can be used to develop mobile applications to encourage and enhance safe driving.

The level of implementation of the government initiatives and the performance of the National Road Safety Strategy in meeting the set targets of 2018 National Economic Council Roadmap for safer road culture have not been accomplished. Curtailing the rate of road accidents in Nigeria is a difficult task as many factors have to be put in place, including managing the drivers who are human beings with different characters and behaviours. Modern cars are often equipped with many driving assistance systems that detect and resolve dangerous situations, but these systems are not available in cheaper and older cars, as most of the individuals and transportation companies within the country cannot afford such vehicles.

Unavailability of domain centric data is one of the challenges that affect healthy driving styles in Nigeria because when those systems developed outside these area are applied in these environment, their efficiency dropped. This is as a result of several factors ranging from socio-economic factors to regional factors.

Drivers behaviour monitoring has undergone the development process from unified driving assessment and management to personalized driving assessment and management. At the very beginning, the driving behaviour is evaluated according to the fixed information, such as the type of vehicles model etc. However, under this mechanism, quality drivers are not rewarded while non-quality drivers are not penalized. The unified driving assessments have so much to do with the type and model of vehicle acquired by the road users (transportation companies, private drivers etc). Considering the high cost of the vehicles which is as a result of improved unified sophiscated accessories and models in managing driving styles and the socio economic situation of Africa, this model of vehicles becomes nearly impossible for some road users to acquire in this part of the world.

Therefore, some researchers and practitioners have begun to develop a non-fixed way in which driving behaviour management is more dependent on human factors. There are some existing non-fixed systems by which driver'sbehaviour is being assessed as used by some commercial vendors already in managing their drivers. The system include speed limit notifiers that alert the management or the driver when the speed is above the normal recommended speed limit is above directed by their management. In table 1, we are presenting a comparison of some work done with regards to dataset location and corresponding machine learning technique results in different parts of the world.

Table 1. Comparison of different works done with respect to their dataset location and Machine Learning technique results.

Author and Date	**ML Technique**	**Data set/Location**	**Research objective**
Xue et al. (2019)	Random Forest, K-Nearest Neighbour and Neural Network (Multi-Layer Perceptron) was compared with Support Vector Machine. Their results showed that Support Vector Machine out performed others	Trajectory data from surveillance video on the road side, was collected by U.S. (FHWA) in 2005.	Recognize driving style (collision approaches) based on the labelled data
Delveno et al. (2019)	Compared Neural Network (Multi-Layer Perceptron), to Linear Regression, K-Nearest Neighbour, Classification and Regression Tree, Support Vector Regression (SVR), Adaptive Boasting (AB), Gradient Boasting (GB) and	Simulated and real world data. Bologna avenues and Rome cycle urban	Prediction of the activation friction brake to cluster eco- driving behaviors thereby avoiding wasting style and optimizing battery change

	Random Forest (RF). MLP has a better performance than the others except for AB and GB which are slightly more accurate on average, but MLP proved to be the right choice, since it worked better than the others as it suits the research.		
Qingwen et al. (2019)	Random Forest, Multi-Layer Perceptron, K-Nearest Neighbour, and Support Vector Machine.	surveillance video data in Emeryville, California	Driving style recognition method based on vehicle data
Bian et al. (2019)	Deep Neural Network, Support Vector Machine and Random Forest. Deep Neural Network performed better than Support Vector Machineand Random Forest in the research.	Real driving behavior data (OBD device)from Mainland China and Hong Kong.	A multilayer model for assessing driving risk
Iranzamini and Jakob, (2018)	Deep learning and the driver norms method	Sensor data from smartphones collected from drivers all over the world.	Investigated the ML methods that can be used to estimate driver behavior pattern.
Jair et al. (2017)	Compared the performance of Artificial Neural Network, Support Vector Machine, Random Forest and Bayesian Network. Random Forest proved to be the best in performance in their research.	Smartphone sensors, accelerometer, linear acceleration, magnetometer and gyroscope.	To identify the best combination of ML algorithms to detect individual event types.
Wang et al. (2017)	Support Vector Machine, Random Forest and Neural Network where Neural Network was proven as the most suitable prediction algorithm	Real world data (infantry's data records & trajectory data records).	A model to predict the possibility of vehicle violations.
Hu et al. (2017)	Neural Network	the real-world Vehicle Test Data	Personalized premium calculation for driving behavior detection.
Yu et al. (2017)	Support Vector Machine and Neural Network	Smart phone sensors data from China.	Detected real-time high-accurate abnormal driving behavior
Naiwala et al. (2016)	K-Nearest Neighbor and Support Vector Machine	Data from driving simulator	Driving skill classification in curve driving scenes
Nai et al. (2016)	Fuzzy Logic	Raw data collected from GPS	Driving style to assess risk level of insured vehicle

Shi et al. (2015)	K-means clustering and neural network algorithms.	Simulated data	Normalizing driving behavior based on personalized driver model
Paefgen et al. (2013)	Logistic Regression, Neural Network and Decision Tree. Neural Network outperformed the other two Machine Learning methods in terms of accuracy.	Real world data from USA	A system that predicted accident risk.
Tran et al. (2011)	Hidden Markov Model	Vehicle sensor data	Prediction of driver behavior by foot gesture analysis
Johnson and Trivedi (2010)	K-Nearest Neighbor	Smartphone sensor data from United State	Driving Style Recognition using smartphone
Zhang et al. (2010)	Multi-Layer Perceptron (Artificial Neural Network), Decision Tree, and Support Vector Machines (SVMs),	Driving simulator data	Pattern-recognition approach for driving skill characterization

III. MACHINE LEARNING ALGORITHM

The table 1 featured the machine learning algorithm that can be used to obtain good results (show good accuracy, precision, and recall rates) for safe driving researches. Deep learning and non-deep learning methods were used by some researchers and were also compared at different point by some researchers. The result of the comparisons were as presented in table 1. The overall result implied that both deep learning and non-deep learning can be used for safe driving systems in monitoring driver's behaviour's. The driving characteristics, behaviour'sand the kind of dataset have proven to also be parameters for choosing the kind of machine learning methods to apply as the case maybe. And from table 1, some of the machine learning method that have been used by researchers that yielded good accuracy in safe driving include, Multi-layer perceptron (neural network), support vector machine, Random forest, K- nearest neigbour, Decision tree, Hidden markov model, K-means clustering, Adaptive Boasting (AB), Gradient Boasting (GB) and fuzzy logic.

IV. DATASET

Review of the researches done has also proven that most dataset that were used for safe driving system are mainly collected from road cameras, On-Board Diagnostic devices and smartphone sensors. It is important to note that many of the countries in Africa have poor data management and policies such that they do not have repository of road data. Some of these countries barely have road cameras and those that have the road cameras, they may are not even be functional. These equipment's when acquired, tested and deployedmay not be durable because there was no plan for sustainability hence managing these equipments(road cameras and the database management systems) become a difficult issue. Furthermore, smart phone sensors seem to be another most adopted means of collecting safe driving data as many of the researchers from the review above used it to collect their data. And from the review abovein table1 these data were collected in form of pictures, images and sound depending on the drivingevent that the researcher applied while gathering the dataset, Therefore dataset can be provided by the commercial drivers, individual drivers and travelers since the exploration of the data set can be location based. Hence throughout the trip, the driver can provide the video/image data from their smartphone sensors as the case maybe. The video/image data can then be used to derive different driving events. Again data is provided in the form of driving events with information on the type of event and the total time of occurrences.
Table 2 provides us with the description and features of the different driving events.

Table 2: The description and features of the different events

Events	**Description**
Safe driving	Whenever a driver is within the safety driving regulation, this event occurs.
Speeding	Whenever a driver exceeds a speed limit for a certain road type. The speeding event will also contain a notification sound whenever the driver speeds above the required speed limit on the road. The unit of measurement is kilometers per hour (kmph).
Distractions	Occur when a stop or noise is detected over time. There will also be distraction notification sound.
Braking	This occurs whenever a driver brakes irresponsibly overtime while driving.
Acceleration	Whenever the driver accelerates and brakes irresponsibly overtime. The value of an acceleration event is the total change of speed during the event. The sign of this value decides if the event was a deceleration or an acceleration.
Tailgating	This event occur when driving too closely behind another.

V. SUMMARY AND CONCLUSION

Our main goal in this paper wasto review on how to improve the driving behaviour of human beings with special reference to Nigeria. Unavailability of data in most of the African countries including Nigeria made it difficult for researchers and even industries to get a first-hand system that could be specific to this part of the world. Many of the systems available in handling safe driving usually drops its efficiency when applied in developing countries of the world like in Africa because of unavailability of trainable data or application of generic data collected that may not suite some specific areas within the continent. Therefore, the need for collection of local data cannot be overemphasized. And this data when trained and implemented will take a further step to influence drivers driving style through active and passive corrective feedback towards safer and friendly practices, the local data will also provide an enhanced feature for car manufacturers when such data are deployed in an embedded systemdesigned in vehicles that are used in this part of the world.Hence prospective researchers having gone through this work can understand what has been done in safe driving and that they are provided choices to take with respect to machine learning method, data collection methods and the form of data to be applied in their own research. This review, further exposed the need for researchers to delve into working in African environment since not much has been done in terms of data capturing as they relate to intelligent transport system in the continent and when these work are done, Nigerian in particular and Africa as a continent will be closer to curtailing the disturbing effect of road accidents in this part of the world.

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