EFFECTIVE RADICAL DRIVER SUPPORT SYSTEM USING MACHINE LEARNING METHODS FOR CONNECTED VEHICLES

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ABSTRACT:
In recent days, connected vehicle technology is most dominating field in automotive industries and it is the most greatly researched area. The benefits of connected vehicles are realized in many aspects like crash elimination, improved energy efficiency, improved safety etc. Machine learning (ML) a subset of Artificial Intelligence that yields systems learning capability and progress from experience without the intervention of humans and without the explicit programming model. Applying machine learning algorithms in connected vehicles technology is need of an hour these days to effectively perform tasks in critical situations without human interventions. In this article, a machine learning framework model is proposed for the head pose estimation in connected vehicles. A comprehensive analysis on various machine learning algorithms is performed by using Advanced Driver Assistance System (ADAS) database. Experimental results show that decision tree algorithm outperforms the other learning algorithms well when compared to other supervised learning algorithms.

Keywords: Automotive industry, Connected Vehicles, Driving Performance, Machine Learning, Supervised learning

I. INTRODUCTION
Connected vehicle technology is likely to play a vital role in minimizing the occurrences of traffic accidents. The utilization of such association in reducing such happenings of accidents is by providing precise information regarding the current status of the road such as friction level to those who drive or to the smart intellectual system that devious the car. Algorithms meant for learning and searching endowed with the performance of various procedures, frameworks, nature and finally the people who opens the door to new possibilities of fundamental world based on the results of analyzing huge volume of data.

In today’s fast changing world, it is a high demand in the need of high efficiency in transport industry as the traffic is keep increasing which may have a drastic effect on low margin business with a high turnover. Astonishing changes in exterior conditions like increase in fuel rates, economic down trends or vehicle failures may affect the profit or loss in businesses. This results in high need of continuous monitoring over the efficiency
of transport facilities. This monitoring indirectly affects the companies that increases the competitiveness and stay profitable.

In the context of recent past, the analysis over these huge data driven by these vehicles can predict the early failure of the component. For vehicles which uses electricity as their fuel undergoes far less failures and repairs than the traditional old internal combustion engines but in-turn increases only the reliability. Connectedness makes it possible the spirit of autonomous vehicles. Some people might disbelieve in these autonomous driverless cars, in spite of that the United States National Highway Traffic Safety Administration (NHTSA) proved with a latest report that these driverless vehicles are safer than the self-driven sort of vehicles. Reinforcement machine learning algorithms is yet another learning technique that works together and communicates with the surroundings by fabricating actions. Brute force search which incorporates trial and error mechanism and deferred reward are the major significant characteristics of reinforcement learning. This framework provides a way for the machines and the software agents to interact with each other to put forth the best possible behavior in a unique situation or context that automatically raise its performance. A reinforcement signal is used to learn about the finest type of action required for the agent known by the simple reward feedback. The ultimate motto of the machine learning in these connected autonomous vehicles is to let the vehicles to be trained and learn automatically without the intervention of the humans and take necessary actions accordingly and inevitably.

The remaining sections of this manuscript are organized as follows. In part 2 we briefly illustrate the notion behind connected vehicles. Section 3 presents state of the art approach relating to the connected vehicles. The algorithms used to perform comparative analysis of machine learning are explained in section 4. Section 5 depicts the experimental evaluation that is well presented. Section 6 finally narrates the conclusion of the paper.

II. CONNECTED VEHICLES

In 1996, Eldorado, Serville and Deville, an automaker that was initiated first is to introduce the primary allied vehicle to global arcade was general motors with on star. General Motors fashioned OnStar with Motorola Automotive. The ultimate purpose was safety when there was an accident. OnStar worked with voice but when the cellular systems raise it introduce various data to the system. By 2001, remote diagnostics were introduced.

By the year 2003, connected vehicles included the services such as turn-by-turn directions, vehicle health reports and a device that offers network access. In 2007, vehicle telematics a technology for transmitting and receiving data using communication hardware devices to control objects remotely. It blends the ideology of telecommunication system and informatics to control the devices during mobility. In 2014, Wi-Fi Hotspots using fourth generation LTE was initially introduced by the automaker company Audi and the General Motors basic initial mass employment is LTE with 4G. The associated vehicles can be subdivided into 8 categories. They are mobility management, commerce, vehicle administration breakdown prevention, safety, entertainment, driver assistance and finally well-being. In 2014, 3rd March a novel structure to fix iPhone version 5/5C/5S to car information assessed units utilizing for the cars IOS 7 through a lightning connect aid was announced by Apple called CarPlay. During June 2014, Android Auto releases a smart way to connect the smart phones with the car infotainment systems. For electrification and access to vehicle data, most of the devices used are integrated into the on-board diagnostics port (OBD). It can be further categorized into two types of connection. They are hardware creating the proprietary internet connection via GSM module and Hardware relying on customer’s smart phone for the internet connection. In Europe, the regulation meant for safety regulations for an automated Emergency Call (eCall) were mostly driven by built-in solutions. One specific use case and one customer segment were usually focused by brought-in devices.

The challenges and drawbacks are the ability to hack, which is a major problem with the connected vehicles. It becomes more exposed to penetrate from the outside when it is connected to the system and to the internet. The car-makers can provide the service and help from any distance, with the help of that channel and the hackers could intrude and gain control power over the car. Countries such as Brazil and Germany, fifty-nine percent of
drivers of the car fear that if the car is connected to the internet, it is to be hacked. There are 43% in U.S and 53% in China and the average comes to 54 percent of all. Yet another major concern is towards the reliability.

There may be a possibility of malfunction in the integrated hardware devices in the autonomous vehicles, Cars and the sensors. The entire framework has to agree with unintentional error communications including denial of service attacks and as well as incorrect data. Privacy is also the problem in connected vehicles with both hacking and other uses. From the car, the most sensitive data such as the driver's routine route, his or her locations, type of application used etc., are hacked for unauthorized attempts. For example, 51% in Germany, the car drivers do not want to rely on any of the car oriented connected services as there was a threat towards their privacy. Worldwide the car drivers thought of the same scenario. For example, about 45%, 37% and 21% in U.S, Brazil and China respectively worried about the privacy issues whose average comes to thirty-seven percent. A sudden and unexpected small crash in the entire system in the connected network enabled car or anywhere else in the system while on the automatic drive primes to deadly consequences.

All the above said drawbacks are recovered by 1) changing the design of product—the main role is played by the product in “maintenance-respond-architecture”. The organizations have to put attention on the long term solutions as it is more advantageous over short term in terms of cost and deployment. 2) There must be an in-house cooperation between the departments such as corporate IT security and product security teams in order to avoid hacking of their secured devices. The organizations must narrate the guidelines to minimize the probability of occurrences of bugs, and security gaps. 3) A new technology termed over-the-air abbreviated to OTA over comes the security issues existing in the current scenario and it becomes essential to OEMs. This technological enhancement allows the organizations and industries to perceive security problems momentarily and protects from outbreak. This is a very costly approach and not to lose money on inefficiency, the companies should be aware of the knowledge of complete road map structure of their systems to devastate from disputes. Value Chain Security is one where all companies are the final integrators of security systems and they should have to control security. In addition, the service providers have to ensure, for the mobile device the security plays the vital role. The entire security issue starts at first over the value chain. Addressed approach can be involved to shape and outline the standards of forthcoming security in the industry and every worker in the industry has to know about the importance of safety.

### III. LITERATURE REVIEW

Ghazaleh et al. [1] proposed a framework for predicting the road friction level using past friction data. This framework uses three ML algorithms such as neural networks SVM support vector machine, logistic and regression to forecast the friction class. This work uses friction values for prediction and along with that they used additional parameters such as moisture, temperature, and rainfall. Experimental results mentioned in this work shows that the neural networks out perform well when compared to other machine learning methods. Martin et al. [2] says that Machine learning and data science are the major technologies meanwhile instinctive learning further optimization to be incorporated in the locomotive industries in forthcoming years. Optimization analytics speaks about the spontaneous optimization as a major technological enhancement in collaboration with the data analytics. This article reveals that the above technologies could make the automotive engineering more proficient throughout all their activities and operations, encompassing from the artefact and its enlargement progression to the consumers and their link to the product.

Matan et al. [3] proposed that to save connected vehicles against the cyber-attacks. A system that screens diverse interfaces of vehicle’s and excerpts related information based on configurable rules and deviations from normal behavior was detected by trained generative model by receiving the information. Data abstraction of higher level is provided by using configurable data collector and accomplished centered on proceedings instead of rough unprocessed data that eradicates the essential to rehabilitate the framework whenever a decorum changes and contains a noise filtering effect. A latest tacticis assigned to the time-based environment process of the domain and to detect anomalies. The preeminence of adaptive cutoffs over to non-dynamic ones is demonstrated. The viable benefit of framework through promising pragmatic outcomes is also demonstrated. Simon & Mattias [4]
investigated the algorithms in machine learning which can automatically learn how to control the vehicles grounded on its own knowledge gained with experience. Two Reinforcement Learning (RL) algorithms are employed and they are Actor-Critic with Experience Replay (ACER) and Deterministic Policy Gradient (DDPG). In a synthetic environment the algorithms were evaluated and trained. To authenticate the usability of frameworks trained on generated data the evaluation of data taken from the real world realm is still required.

Mehdi et al. [5] explained that Machine learning plays a major role in complicated pattern recognition and Tailgating Detection. The automated vehicles use machine learning for the decision making. This could be a challenge for cars which generates large amount of data. Fast processing is important in connected cars. Security and policy compliance needs to be checked frequently. Some of the applications are correlating driving patterns with fuel consumption and providing feedback to driver for efficient driving. Rune [6] investigated supervised and unsupervised methodologies for envisaging maintenance of vehicle. The methods that are driven based on the rough unprocessed information and widespread quantity of data streamed or on and off board databases to aggregated data are used. The method enables with a back-office system for communication of vehicles. Data illustrations by these given models or aggregations are transferred over the air without any support of the medium to analyses the data for deviations in an off-board system. It also investigates the diverse behaviors of doing deviation detection and data proliferations and visualizations. A classification model generated used for foreseeing the available patterns to be learned in the convention data that lead to precise repairs. The vehicle maintenance can be evaluated with the intervention of the classifier model. This scheme is experimented for the letdowns of the transportation vehicles air compressor which is based on AB Volvo’s datamarts of utilization statistics of vehicles.

Lex et al. [7] governed that to undertake the driving data collection from the enormous corpus real world that incorporates the video description to deep learning fuel growth based external and internal discernment systems and to observe a huge acceptance of how humans are interacting with automating the vehicle technology by assimilating driver characteristics with the usage of video based, mental models, vehicle state data and technology with self-reported experiences and to ascertain in what way other features and technologies related to acceptance of automation. The documented streams of data include GPS, CAN messages, IMU, quality video streams of the gestures made by the driver face, the instrument cluster, the roadway in-front and the driver cabin. Silviu [8][14][15] offerings a classification of the responsibilities which occurs while the drive drives the vehicle and its demonstrating from the viewpoint of artificial intelligence and standard control engineering. The problem of self-directed vehicles administration is addressed based on 4-level strategies that includes dynamic vehicle control, movement control, and traffic at a time and finally effective maneuver respectively. It talks about unambiguous routines such as: identification of pathway for travel, traffic signals and sign acknowledgement and feedback to signals and traffic related tasks, planning and reconfiguration, speed control, long distances and its direction. Jeffrey [9][16] says that the automated vehicles control a significant challenge for control theory and artificial intelligence. Reinforcement learning is a technology where the mediator enhances the policies for controlling systems feedback and experience. These methodologies at times fall in situations needing continual operation and action spaces, like standing in the signal and driving. The results of this learning algorithm evaluated on enormous control domains as well as control the automobile tasks.

IV. PROPOSED METHODOLOGY

In this part, a machine learning based approach for head pose estimation in a connected vehicle. Figure 1 demonstrates the block diagram of the machine learning approaches for head pose estimation. Every component of this diagram is explained below.
Raw data is collected and it is preprocessed in a data preprocessing step which tries to eliminate the noises in the original data and effectively handle the missing values. Machine Learning algorithms are employed to form intelligent system that will estimate human head pose which analyze driving performance in connected vehicles. In this work, we make use of various supervised machine learning algorithms for estimating human head pose in a connected vehicle. The detailed descriptions of these algorithms are listed below.

A. DECISION TREE:
A decision tree is a help tool which utilizes a tree-like graph of choices and their potential results. It is one of the best approach or an algorithm that allows only the presence of conditional statements containing yes/no responses as result. They are regularly utilized in explicitly in choice investigations, tasks research to help and distinguish a technique destined to arrive at an objective, yet they are likewise utilized in AI. A decision tree is the flowchart-like model in which each non-leaf node signifies to a test in an attribute, and every out coming branch representing a possible outcome and each leaf node speaks to a class label it belongs. Each and every path from the root to leaf forms a classification rules.

B. MULTILAYER PERCEPTRON:
A Multilayer perceptron (MLP) fits to a varied class labels of feed forward artificial neuro system. MLP uses three layers of nodes for its processing. Every node in it is termed as a neuron that exploits a non-linear initiation work, aside from the node input. For training, it utilizes the regulated supervised learning strategy called back propagation. It can isolate information that can't be linearly distinguishable. They are some of the time informally alluded to as "vanilla" neural systems, particularly when they have a single concealed layer. In MLP's, small set of neuron particles consume a non-linear activation exertion that was formed to reveal the recurrence of actionpromises, or terminating of organic biological neuron things.

C. RADIAL BASIS FUNCTION NETWORK:
RBFN is utilized in the field of scientific and mathematical modeling, a radial base function is an ANN artificial neural network that utilizes radial functions as activation functions. The outcome of the network is a
direct mix of the contributions of radial basis functions. Radial base function networks have numerous uses, time arrangement prediction, including capacity function approximation, classification. There are three layers in Radial base function (RBF) systems and they are (i) input layer, (ii) hidden layer with a non-straight its activation function and (iii) a linear outcome layer.

D. SUPPORT VECTOR MACHINES:

In machine learning techniques, a supervised learning model support vector machines with its associated learning algorithms which are utilized for classification and regression analysis. Taking into consideration of sample set of training data, where every training set is noticeable as fitting to many such dissimilar categories a SVM procedure meant for training develops a model that allocates fresh trials to certain category or another one making it into a binary linear non-probabilistic model classifier. In accumulation to accomplishment of linear classification, SVMs can professionally accomplish a non-linear classification using which is named the kernel trick, internally plotting their inputs into high dimensional feature spaces.

E. EXPERIMENTAL EVALUATION

A detailed experimentation was performed on a machine with Intel Core i5-4460@3.20 GHz and 24GB RAM, running on Ubuntu 14.04 LTS. The experiments in Figure 2 were carried out on Advanced Driver Assistance System (ADAS) dataset from [10]. The dataset consists following information shown in the table 1 given below.

<table>
<thead>
<tr>
<th>Sno</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Topic</td>
<td>[1:4]</td>
</tr>
<tr>
<td>2</td>
<td>imgENum</td>
<td>Integer</td>
</tr>
<tr>
<td>3</td>
<td>Labels</td>
<td>Takes the value from 1/2/3 (head pose conforming to lr/l/lf)</td>
</tr>
<tr>
<td>4</td>
<td>Angles</td>
<td>Angles used for head pose [0,15,30,-15,-30,-45]</td>
</tr>
<tr>
<td>5</td>
<td>[wF hF xF yF]</td>
<td>Position of the face</td>
</tr>
<tr>
<td>6</td>
<td>[xRE yRE]</td>
<td>Position of the right eye</td>
</tr>
<tr>
<td>7</td>
<td>[xLE yL]</td>
<td>Position of the left eye</td>
</tr>
<tr>
<td>8</td>
<td>[xN yN]</td>
<td>Position of the Nose</td>
</tr>
<tr>
<td>9</td>
<td>[xRM yRM]</td>
<td>Position of the right bend of mouth</td>
</tr>
<tr>
<td>10</td>
<td>[xLM yLM]</td>
<td>Position of left corner facing of mouth</td>
</tr>
</tbody>
</table>

Table 1. Parameters used in dataset

In this database, subject is considered to be a target variable. The experiments are conducted by using various machine learning algorithms such as decision trees, multilayer perceptron, radial basis function networks and support vector machine. Algorithms performance is evaluated by using classifier accuracy. Using the below formula Classifier accuracy is calculated.

\[
\text{Classifier accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}}
\]

TP - True Positive Value
TN - True Negative
FP - False Positive
FN - False Negative

The detailed explanation of above formula is available in [11][12][13]. It is observed that decision tree approach outperforms well when compared to the other approaches. The record of Machine Learning algorithm performance in terms of Accuracy for Head Post estimation in a connected vehicle is mentioned in Table 2.
<table>
<thead>
<tr>
<th>S.No</th>
<th>Algorithm</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Decision Tree</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Naive Bayes</td>
<td>62.55</td>
</tr>
<tr>
<td>3</td>
<td>Support Vector Machine</td>
<td>95.47</td>
</tr>
<tr>
<td>4</td>
<td>Multilayer Perceptron</td>
<td>90.12</td>
</tr>
</tbody>
</table>

Table 2: Record of Machine Learning Algorithm Performance in terms of Accuracy for Head Post estimation in a connected vehicle

![Figure 2. Plot of Machine Learning Algorithm Performance in terms of Accuracy for Head Post estimation in a connected vehicle](image)

**CONCLUSION**

Thus, the head post estimation was done by using many supervised learning algorithms in Machine learning techniques, in that our experimental evaluations shows that of all the supervised algorithms, Decision tree algorithm give more accurate result which implies that the Decision tree algorithm can be used in connected vehicles to perform head post analysis and this algorithm has the capable of taking right decision at the right time in an effective manner. This can reduce the chances of road accidents and save their life’s.

**REFERENCES**