# A picture containing shape Description automatically generated***Introduction:***

(TARZAN : THE WONDER CAR)

REPORT

INTERM

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* Businesses aiming to increase efficiency, safety, and cost-effectiveness in their transportation operations may find an autonomous following car to be an appealing option. Businesses may minimize the need for human drivers, save fuel costs, and improve the speed and accuracy of their deliveries by automating the process of following a lead vehicle.
* Autonomous following cars can be especially advantageous in areas where time and cost efficiency are crucial, such as logistics, shipping, and delivery services. An autonomous following car, for example, may be deployed to follow a delivery truck, allowing it to make several stops and drop-offs without the need for a separate driver for each vehicle.
* Aside from possible cost savings and efficiency improvements, self-driving automobiles have the potential to increase safety on the road. These cars can lessen the risk of accidents caused by human error or exhaustion by using powerful sensors and algorithms that identify and respond to impediments in real-time.
* However, considerable technical and regulatory difficulties must still be overcome before autonomous following cars can become a common economic reality. These include developing dependable and safe technology, addressing legal and liability concerns, and assuring public faith in the safety and usefulness of self-driving vehicles.

# ***Project Objectives:***

The project goal for constructing an autonomous following automobile can vary depending on the project's individual goals and constraints. However, some shared goals may include:

* Improving safety: The fundamental goal of many self-driving car programs is to improve road safety by lowering the chance of accidents caused by human error, exhaustion, or distraction.
* Improving efficiency: Self-driving cars can improve efficiency by automating the process of following a lead vehicle, decreasing the need for human drivers, and enabling faster and more precise deliveries.
* Cost savings: By eliminating the need for human drivers, businesses can save money on labor, gasoline, and insurance rates, among other things.
* Creating sophisticated technology: Creating an autonomous following car necessitates the integration of several technologies, including Sensors, cameras, machine learning algorithms, and control systems are just a few examples. As a result, numerous programs seek to create and test innovative technologies that can be applied in other areas.
* Addressing societal difficulties: By lowering the number of vehicles on the road and enabling safe and efficient transportation for all, autonomous following cars can help address societal challenges including as traffic congestion, pollution, and the ageing workforce.

# ***PROBLEM STATEMENT***:

* Autonomous vehicle distance prediction techniques now in use depend on modal smart sensors like radar, lidar, and cameras. Although these technologies offer useful information, their cost, accuracy, and dependability can be limitations. In some situations, environmental conditions like fog or sun glare can also affect these technologies, which can significantly reduce their accuracy.
* Very few data-driven models can reliably predict acceleration and we will find Why?
* The trajectories do not match or are not even presented, despite having an excellent RMSE score.

# ***SOLUTION STATEMENT:***

* Using the NGSIM dataset, create and contrast a data-driven car-following model.
* Along with trajectories, R-squared, and RMSE are displayed and compared.
* To overcome the shortcomings of modal sensing technologies and improve the precision of vehicle distance prediction in autonomous vehicles, convolutional neural networks (CNNs) and recurrent neural networks are integrated. (RNNs). By processing visual input from cameras with a CNN, we can recognise and locate other vehicles on the road. The RNN may use this data to forecast where these cars will be in the future based on their past behaviour.
* Our next inquiry will be focused on three aspects of this topic. Road traffic efficiency will be considered first to keep the inter-vehicle distance within a more reasonable range. Our second objective is to classify driving behaviours more thoroughly to provide users additional options. Lastly, to improve the proposed model's acceptability and we plan to develop the driver model in conjunction with the executive capabilities of the lower controller.

# ***IMPACT ON STAKEHOLDER***:

Several stakeholders, including the following, will presumably be significantly impacted by the creation and use of autonomous following cars:

* Car Manufactures : As autonomous vehicles would require them to create new technology and software to provide self-driving capabilities, they could disrupt the conventional automotive sector. Additionally, manufacturers would have to deal with worries about liability, cybersecurity, and safety, all of which might influence their bottom line.
* Drivers: The introduction of self-driving follow vehicles may have a big influence on drivers, especially those who depend on driving as a source of income. Self-driving vehicles are becoming more sophisticated, which may lead to employment losses for drivers like truckers and cabbies. Additionally, it might lessen the necessity for car ownership, which might influence vehicle sales and the auto finance sector.
* Pedestrians and cyclists may be safer thanks to autonomous following cars because they may be able to interact with other vehicles and predict their movements. Self-driving cars may not be able to recognise all barriers or react quickly enough to avoid collisions, which might raise worries about how they interact with pedestrians and cyclists.

# ***DATA SOURCE:***

There are two ways to obtain the data: either manually by taking images or through web-scraping for the dataset.

* The autonomous car alone has sensors and cameras that can collect data about its surroundings, such as other vehicles, pedestrians, and road conditions. The location, route, and traffic conditions of the car can be determined using GPS and mapping data.
* The NGSIM dataset can be used to evaluate our accuracy. Accurate datasets are difficult to find several data online. We did, however, locate some.

<https://datahub.transportation.gov/stories/s/Next-Generation-Simulation-NGSIM-Open-Data/i5zb-xe34/>

# ***ETHICAL CONCERN:***

Based on the NGSIM open data, the following five ethical issues with autonomous following cars are related to permission, clarity, consequences, control, and consistency:

* Consent: It's critical to gain informed consent from passengers before autonomous following cars collect and use any of their data. The types of information being gathered, how they will be utilized, and who will have access to them must all be adequately disclosed to passengers. This enables people to decide how to handle their privacy and personal data with knowledge.
* Clarity: Making sure that passengers are aware of the capabilities and restrictions of autonomous following cars requires clear communication. It is important to make sure that passengers understand how the technology functions, how it makes judgments, and what they can and cannot do while inside the car. This guarantees that the technology is safe and used by passengers.
* Consequences: It is crucial to consider the ethical issues raised by autonomous following vehicles. It is critical to consider the potential effects of these cars on society, including job displacement, modifications to the transportation sector, and environmental effects.
* Control: The technology must be under the passengers' control, and they must be able to step in when the vehicle's judgements may not be in line with their preferences. This guarantees that users of autonomous following cars can keep their safety and autonomy.
* Consistency: Regardless of the circumstance or the people involved, autonomous following cars must make decisions consistently. This makes sure that everyone is treated equally and impartially by the technology.

# ***Tools/Technology Required:***

* Numpy
* Pandas
* AI tools like Microsoft Azure
* Data Cleaning/Smoothing
* CNN , RNN
* Neural Network
* Pandas
* Tableau and Dashboard for Visualization
* Few Ski learn packages.
* ML model using python in Jupyter Notebook.
* Tensor flow
* Matplotlib
* Streamlit and Seaborn

# ***RELATED WORK:***

* For this project , we choose the NGISM dataset for our model . It is a very complex data . So , our first step was Exploratory Dataset of Analysis(EDA). In EDA , I will discuss everything what we have done till now .
* I performed several data manipulation tasks on a pandas DataFrame that contained data on the behavior of vehicles in highway traffic. Firstly, I removed duplicate rows using the **remove\_duplicates** function and converted certain columns from feet to meters using the **convert\_feet\_to\_metre** function.
* I also created new columns with NaN values using the assign method and mapped values in the v\_Class column to new values using the map method. Finally, I used the **Filter\_highways** function to filter the original DataFrame into two separate DataFrames based on the location of the highways. These actions helped me prepare the data for further analysis and gain insights into the behavior of vehicles on highways.
* several functions have been defined to process and filter a pandas DataFrame containing data on traffic flow. The **filter\_vehicle\_classes()** function takes the DataFrame and returns sets of vehicle IDs for each vehicle class. The **preceding\_vehicle()** function maps each vehicle's preceding vehicle to its class and creates a new column with the vehicle combination.
* The **preced\_vehicle\_length()** function calculates the average length of each motor vehicle and assigns it to its preceding vehicle. Finally, the **change\_front\_to\_back()** function calculates the rear-to-front space headway and front-to-rear time headway for each vehicle. The functions are applied to separate DataFrames created by filtering the original DataFrame based on the highways US-101 and I-80.
* The first function, called "**transforming\_map\_lead\_Vehicle",** seems to perform a series of operations to identify the lead vehicle for each vehicle, calculate relevant attributes of the lead vehicle, and merge this information with the original DataFrame. To accomplish this, the function first creates a new DataFrame called **"Lane\_check"** that contains each vehicle's ID and the lane it is in. It then drops any duplicate rows and groups the DataFrame by vehicle ID to count the number of lanes each vehicle traverses.
* We took only 4 lane , and we are assuming the 5,6,7,8 lane as exit road from highway or ramps road . After this we made two functions **find\_following\_lane\_change\_pairs** and **find\_preceding\_lane\_change\_pairs**, are designed to identify pairs of vehicles that have changed lanes. The **find\_following\_lane\_change\_pairs** function identifies pairs based on the following vehicle, whereas the **find\_preceding\_lane\_change\_**pairs function identifies pairs based on the preceding vehicle. Both functions return a list of lane change pairs. The input data for these functions is a dataframe that contains information about each vehicle's lane changes, including their preceding and following vehicles, and their vehicle ID. These functions are useful for analyzing lane-changing behavior on highways or other roadways.
* The **filter\_records\_for\_model** function takes a pandas DataFrame and filters out rows based on certain criteria. First, it removes vehicles with multiple lengths and classes for the same vehicle ID. Next, it removes vehicles with a total car following time less than 30 seconds, time headway less than 5 seconds, and those on ramps. It also removes vehicles that change lanes within the first and last 5 seconds. The function prints a summary of the removed rows for each lane and returns the filtered DataFrame.
* After the EDA of our dataset , we made a random forest regressor model for just checking our initial model if it is working fine or not . A dataframe df, a split ratio split, a boolean neural indicating whether or not the split is for neural network training, and a random seed seed are all inputs for the **train\_test\_pair** function. Based on the split ratio and the neural flag, it divides the dataframe into three segments: **train, validation, and test**. A portion of the test set is used for validation if neural is True. The three **dataframes train\_df, val\_df, and test\_df** are then returned by the function. The **lead-Front\_Pair** column's unique values are used to split the data, and the split is then randomised using the seed option.

• After deploying our initial model, we received an overfitting rf.score of 0.9999967. We are aware that overfitting can teach us how to create the optimal model. We examined where we were falling short. We discovered that there was an excessive amount of correlation between the columns, so we created a heat map to show which columns have the highest correlation.

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* This heat map makes it very evident that there was an excessive amount of correlation between the columns. Therefore, we made the decision to only use important variables in our model, and we selected the following columns: **Lead\_v\_Class, Diff\_Vel\_follow\_Lead, v\_Vel, v\_Acc, v\_Class, and Rear-to-Front-Space-Headway.**
* After our selected columns , we got good rf.score = 0.876 , Feature selection worked pretty well for us .

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* After Feature Selection , we were planning to use a hyperparameter for better r2.score ,however we failed to make it more better and we will look into it deeply in next semester .

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# ***FUTURE PLAN:***

* We will create three model : CNN , RNN and KNN
* After that we will compare all the model and choose the best one .
* Planning to predict all models .
* Final step : Deployment of model

# *REFERENCES*:

* Carey, N., & Lienert, P. (2022, September 19). *Truly autonomous cars may be impossible without helpful human touch*. Reuters.

<https://www.reuters.com/technology/truly-autonomous-cars-may-be-impossible-without-helpful-human-touch-2022-09-12/>

* *Autonomous and Electric Vehicles: The Future of Mobility*. (55083, May 23). Wevolver. <https://www.wevolver.com/article/autonomous-and-electric-vehicles-the-future-of-mobility>
* *Gerard Gibbs & Huamin Jia (2021 , November 21) . Obstacle Detection with Ultrasonic Sensors and Signal Analysis Metrics*

<https://www.sciencedirect.com/science/article/pii/S2352146517311031?via%3Dihub>

* Yeruva, V. (2022, February 14). *Autonomous Vehicles And Their Impact On The Economy*. Forbes.

<https://www.forbes.com/sites/forbestechcouncil/2022/02/14/autonomous-vehicles-and-their-impact-on-the-economy/?sh=7f2f8ac060de>

* *Takens, F. (1981) Detecting Strange Attractors in Turbulence. In Rand, D.A. and Young, L.-S., Eds., Dynamical Systems and Turbulence, Lecture Notes in Mathematics, Vol. 898, 366-381. - References - Scientific Research Publishing*. (n.d.).

<https://www.scirp.org/(S(lz5mqp453edsnp55rrgjct55))/reference/ReferencesPapers.aspx?ReferenceID=2173085>