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Prediction of Vehicle Clutch Breakdown Based On Multiple Linear Regression

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Abstract

The clutch plays a significant role in all automobile vehicle operations. Breakdown of clutch for any vehicle directly affects the vehicle in operation and could impact on human safety. Many reasons could be the identity for clutch breakdown, for example, a vehicle carrying excessive weight, continuously engage of the clutch in the city traffic, and malpractices with the gear operations. Predicting the breakdown of the clutch is a high priority requirement which is currently not achieved through vehicle diagnosis. In this paper, the author is discussing multiple regression analysis to predict the clutch life with the help of numerous vehicle parameters such as transmission oil temp, vehicle speed, vehicle torque, vehicle engine speed, transmission oil level, accelerometer pedal position, parking brake status, contamination of oil. Consideration of multiple parameters contributes to increasing the accuracy of the prediction output. The detailed mathematical model and resultant graphs of the machine learning model has discussed in this paper. The predicted variable with the different status is defined, which can be easily inputted to any of the monitor display tools to convey the information in the Lehman language.

Keywords: *Vehicle clutch, Multiple Linear Regression.*

1. INTRODUCTION:

Vehicle electronics design is maturing day by day with various sensors intelligent systems like vehicle ECU, actuators which contribute to building many primary vehicle smart components like ABS, EMS, IC, Airbag, Transmission System.

Advancement of vehicle network now, it is straightforward to fetch various sensor data from the vehicle. This Data can be preprocessed and can be utilized for multiple statistical analyses.

To strengthen the statistical analysis based on historical data and use this Data for future prediction is the crucial concept of the machine learning model, this model can be trained with the available historical information and will be used for the next forecast.

We used multiple linear regression machine learning supervised models which help to predict the clutch life based on the various input parameter information. The author considers the earlier work happen with machine learning models. Accuracy of prediction can be increased with the number of growing parameters, and this can be handled with multiple regression analysis. Regression analysis is mainly used for predicting the data.

2. LITERATURE SURVEY

For this research article, we have referred to several research papers. All these are explained further. In

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paper [1] presents the prognostic diagnostic approach for the vehicle Transmission clutch system using the Bayesian algorithm and fuzzy logic. Paper[2] Explains the different machine learning techniques used in the vehicle prognostics. Paper [3] explain about remaining life prediction of sensors using deep learning and neural network. In Paper[4] author discussed operational data on automatic transmission from on-board diagnostics. The purpose of this paper is to show a proactive maintain name that can be performed. In this paper, [5] relative comparative study of advantages and disadvantages of regression versus classification models presented. The focus of this paper is predicting remaining useful life using the machine learning model. Paper[6] explains how to predict the remaining useful life of the battery. The author also proposes the prognostic based on the GPR combined with the imperial model to realize lithium-ion battery RUL prediction. In paper[7] with regression and classification model based on machine learning are used to test the correlation between the interfacial tension values of the transformer oil. Paper[8] covers the concept of machine learning and its theory

3. SYSTEM DESIGN AND METHODOLOGY

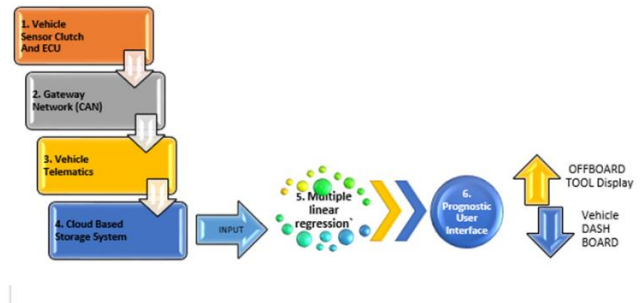

Figure 1*. System Design*

Concerning the above diagram first, blocks have a different parameter in the vehicle can be accessed by vehicle fitted sensors. These sensor's value can be manipulated with an intelligent system. With the second block that is gateway network as CAN. The data of the ECU (Intelligent system) can be fetched from the vehicle. The third block, which is vehicle telematics, used this fetch data and transfer it to the forth block that is clutch storage to store this vehicle information. This completes the extraction and storage of vehicle data. Now with the fifth block is multiple regression model here, we can use the stored data, which can be further preprocessed on to Device data into training and testing part. With the help of training data, we can train the model .with the testing data, and we can test the model. We can divide the train and test data by 70 -30. The output of this model then feeds to the block six that is the display user interface for the prognostic out. These can be utilized in the vehicle dashboard or offline prognostic tool.

4.SYSTEM MATHEMATICAL MODEL

4.1 Multiple Linear Regression

Multiple linear regression support model with the relationship between two or more variables. Every independent variable X is associated with dependent variable Y. The population regression line for P explanatory variables X1, X2, ..., Xp is given with the following equation

$$M_{y=}\ B_0+B_1\ x_1+B_2\ x_2+\ldots+\ B_p\ _xP$$

Regression line describes meaning response M_y changes with the explanatory variables. The observed values for y changes concerning their means M_y. These values have the same standard deviation σ. The given fitted values estimate the parameters $BB_0+B_1+B_2+\ldots+\ B_p$ of the population regression line.

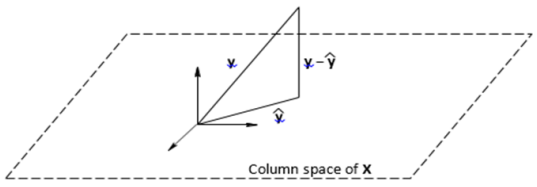

Figure 2: *Multiple Regression Model*

Figure 2 is a prediction of the *n*-dimensional data vector **Y** onto the hyperplane Crossed by **X**. this

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specifies column space of X accessed by Y on to hyperplane through X and Y-axis. This diagram shows the mathematical X –Y space covered by multiple regression lines as like the equation of the line.

4. RESULT ANALYSIS

Forgiven system different parameters are considered in the dataset as a parking brake, envTemp, vehicle speed, engine Torque, Transmission Oil, and clutch Life. Whereas clutch life is as Dependent parameter and all other are independent parameters. The subset of dataset fetched and shown below as in Table 1

Table 1: *Clutch Life Status and Other Parameters*

Parking brake	EnvTemp	Vehicle Speed	Engine Torque	Transmission Oil	Clutch Life
0	35	40	1500	49	1
0	39	25	1000	44	1
0	35	65	3000	105	2
1	30	35	2000	88	2
0	45	80	2000	67	2
0	50	80	2500	77	2
0	35	65	3000	105	2
1	30	35	2000	88	2
0	25	46	3500	121	3
0	55	42	4500	140	4

After applying multiple regression model on this dataset by considering two combinational parameters, it gives different regression lines as an output as shown in the following figures for Graph 1, Graph 2 and Graph3 respectively. Graph1 provides regression estimation of the parking brake and EnvTemp concerning clutch life status. Graph 2 gives the regression estimation of vehicle speed and engine speed concerning clutch life status. Similarly, Graph 3 provides regression estimation of transmission oil and vehicle speed for clutch life status.

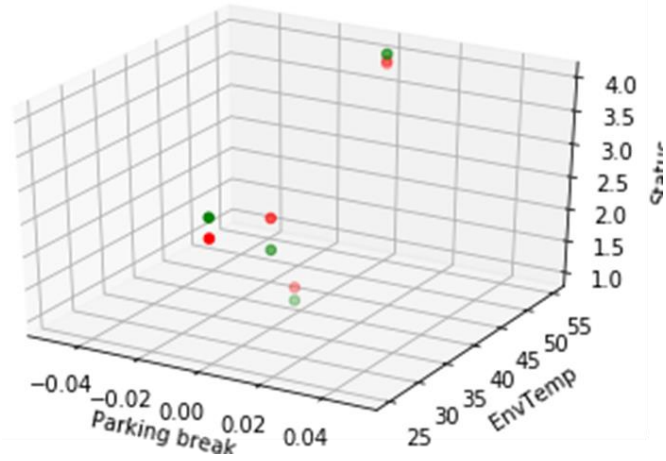

Figure 3. *Graph 1 For Clutch Life Status Vs Envtemp And Parking Brake*

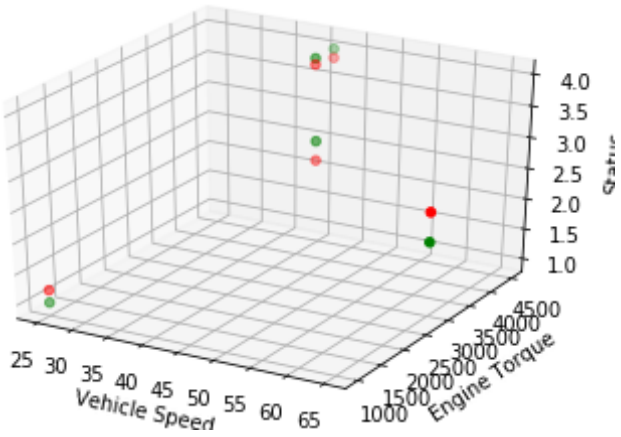

Figure 4. *Graph 2. For Clutch Life Status Vs Vehicle Speed and Engine Torque*

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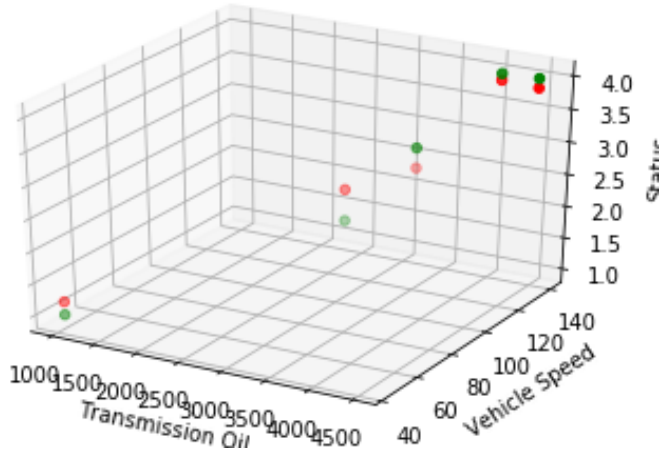

***Figure 5**. Graph 3. For Clutch Life Status Vs Transmission Oil And Vehicle speed*

With the analysis of the above three graphs, it shows the multiple regression for vehicle clutch prognostic gives 94 % accuracy for the system. The coding line to get the efficiency of the system is r2_score (testing_y, Pred_y) which leads to accuracy as 94.11879

5.CONCLUSION

Multiple regression analysis carried out for the prediction of the status of the clutch. In this, different parameters like engine Torque, parking brake, environmental Temp, Engine speed, Transmission oil temp are used as an independent variable and clutch status parameter is used as a dependent parameter. Based on the multiple regression analysis, we have calculated the intercept and coefficient values to predict the output value. As we considered here various setting, we discussed here multiple regression analysis. With the current dataset sample, we can achieve 94% of accuracy for the prediction.

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