# VEHICLE PERFOMANCE ANALYSIS

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## LITERATURE SURVEY

### 1. INTRODUCTION:

Literature survey is mainly carried out in order to analyse the background of the current project which helps to find out flaws in the existing system and guides on which unsolved problems we can work out. So, the following topics not only illustrate the background of the project but also uncover the problems and flaws which motivated to propose solutions and work on this project.

### 1.1 LITERATURE SURVEY:

Literature survey is the documentation of a comprehensive review of the published and unpublished work from secondary sources data in the areas of specific interest to the researcher. The library is a rich storage base for secondary data and researchers used to spend several weeks and sometimes months going through books, journals, newspapers, magazines, conference proceedings, doctoral

dissertations, master theses, government publications and financial reports to find information on their research topic. Reviewing the literature on the topic area at this time helps the researcher to focus further interviews more meaningfully on certain aspects found to be important is the published studies even if these had not surfaced during the earlier questioning, so the literature survey is important for gathering the secondary data for the research which might be proved very helpful in the research. The literature survey can be conducted for several reasons. The literature review can be in any area of the business

## PAPER 1:

# Vehicle Planar Motion Stability Study for Tyres Working in Extremely Nonlinear Region

## ABSTRACT:

Many researches on vehicle planar motion stability focus on two degrees of freedom(2DOF) vehicle model, and only the lateral velocity (or side slip angle) and yaw rate are considered as the state variables. The stability analysis methods, such as phase plane analysis, equilibriums analysis and bifurcation analysis, are all used to draw many classical conclusions. It is concluded from these researches that unbounded growth of the vehicle motion during unstable operation is untrue in reality thus one limitation of the 2DOF model. The fundamental assumption of the 2DOF model is that the longitudinal velocity is treated as a constant, but this is intrinsically incorrect. When tyres work in extremely nonlinear region, the coupling between the vehicle longitudinal and lateral motion becomes significant. For the purpose of solving the above problem, the effect of vehicle longitudinal velocity on the stability of the vehicle planar motion when tyres work in extremely nonlinear region is investigated.

To this end, a 3DOF model which introducing the vehicular longitudinal dynamics is proposed and the 3D phase space portrait method is employed for visualization of vehicle dynamics. Through the comparisons of the 2DOF and 3DOF models, it is discovered that the vehicle longitudinal velocity greatly affects the vehicle planar motion, and the vehicle dynamics represented in phase space portrait are fundamentally different from that of the 2DOF model. The vehicle planar motion with different front wheel steering angles is further represented by the corresponding vehicle route, yaw rate and yaw angle. These research results enhance the understanding of the stability of the vehicle system particularly during nonlinear region, and provide the insight into analysing the attractive region and designing the vehicle stability controller, which will be the topics of future works.

## PAPER 2:

# Modelling and performance analysis of a vehicle with kinetic dynamic suspension system

## ABSTRACT:

This paper presents a kinetic dynamic suspension (KDS) system to achieve enhanced cooperative control of the roll and warp motion modes for on-road and off-road sports utility vehicles (SUV). The proposed KDS system consists of two hydraulic circuits acting on two pairs of torsional rods and levers, which can be treated as novel anti-roll bars. Hence, these anti-roll bars do not work independently, but are coupled to merely respond to particular motion modes. To verify the handling and ride performance of the system, a 14-DOF model of a SUV and a “magic formula” tire model are

developed. The dynamic responses of the vehicle model with KDS suspension are obtained through half-sine bump, asynchronous sine road, and fishhook manual simulations. The responses of the KDS equipped vehicle are compared to those of one with anti-roll bars to demonstrate its improved performance and also illustrate the side-effects. The results show that the KDS system considerably improves the vehicle's anti-roll ability. Furthermore, the vehicle's warp stiffness is significantly reduced by the KDS system, which enhances the vertical load distribution of each wheel when driving off-road.

**PAPER 3:**

## Battery Performance Analysis for Working Vehicle Applications

**ABSTRACT:**

The attention is focused on a specific battery testing methodology for high-power hybrid electric working vehicle applications. Due to the power demand, a deep knowledge of the battery behaviour is necessary and requires specific testing procedures, different from the standard activities available in the literature for the automotive field. In this article, the attention focused on the power demand that an energy storage system must satisfy to achieve a certain performance, considering this testing approach closer to the real application. A numerical model of a full electric telescopic handler developed in previous works was used to test a LiFePO4 cell

in a hardware-in-the-loop bench test configuration. The output voltage–current characteristic was compared with the same output generated by the numerical model of the considered battery. The same model was then tested according to a handling working cycle proposed by the authors for a telescopic handler derived from the experience of the research group in the field of this type of vehicles. This mission profile was then used to evaluate the performance of the proposed battery pack configuration in a real working scenario and at different SoC levels.

**PAPER 4:**

## Improved vehicle performance using combined suspension and braking forces

**ABSTRACT:**

This paper investigates the integration of various subsystems of an automobile's chassis. The specific focus of this research is the integration of active suspension components with anti-lock braking (ABS) mechanisms. The performance objective for the integrated approach is defined as a reduction in braking distance over just anti-lock brakes. A two degree of freedom half car vehicle model is developed along with models for a hydraulic active suspension and an ABS system. For both subsystems, actuator dynamics are included. Individual controllers are developed for the subsystems and a governing algorithm is constructed to coordinate the two controllers. Simulations of the integrated controller and an

ABS system demonstrate a significant increase in performance.

The nonlinear "sliding" control law is applied to an electro-hydraulic suspension system. The controller relies on an accurate model of the suspension system. To reduce the error in the model, a standard parameter adaptation scheme, based on Lyapunov analysis, is introduced. A modified adaptation scheme, which enables the identification of parameters whose values change with regions of the state space, is then presented. These

parameters are not restricted to being slowly time-varying as in the standard adaptation scheme; however, they are restricted to being constant or slowly time varying within regions of the state space. The adaptation algorithms are coupled with the control algorithm and the resulting system performance is analysed experimentally. The performance is determined by the ability of the actuator output to track a specified force. The performance of the active system, with and without the adaptation, is analysed. Simulation and experimental results show that the active system is better than a passive system in terms of improving the ride quality of the vehicle. Furthermore, both of the adaptive schemes improve performance, with the modified scheme giving the greater improvement in performance.

**PAPER 5:**

## Physical modelling of tire wear for the analysis of the influence of thermal and frictional effects on vehicle performance

**ABSTRACT:**

The tire and vehicle setup definition, able to optimise grip performance and thermal working conditions, can make the real difference as for motorsport racing teams, used to deal with relevant wear and degradation phenomena, as for tire makers, requesting for design solutions aimed to obtain enduring and stable tread characteristics, as finally for the development of safety systems, conceived in order to maximise road friction, both for worn and unworn tires. The activity discussed in the paper deals with the analysis of the effects that tire wear induces in vehicle performance, in particular as concerns the consequences that tread removal has on thermal and frictional tire behaviour. The physical modelling of complex tire–road interaction phenomena and the employment of specific simulation tools developed by the Vehicle Dynamics Uni Na research group allow to predict the tire temperature local distribution by means of TRT model and the adhesive and hysteretic components of friction, thanks to Gr ETA model. The cooperation between the cited instruments enables the user to study the modifications that a reduced tread thickness, and consequently a decreased SEL (Strain Energy Loss) and dissipative tread volume, cause on the overall vehicle dynamic performance.

Based on tyre brush theory, a tyre wear model has been developed which includes a thermal model, a pressure model and a friction model. Simulations and analysis of different cases has been performed. From the results, one can conclude the following:

The tyre temperature and inflation pressure change with the distance the vehicle travels at the beginning and later become steady;

higher external temperature will decrease tyre wear rate since the inflation pressure increases with the external temperature and the sliding friction decreases;

higher vehicle speed leads to a higher tyre wear rate;

the tyre temperature increases with increasing vehicle speed; the amount of tyre wear increases linearly with the normal load on the tyre;

the tyre wear increases with the slip ratio exponentially due to both the siding distance and the sliding friction increasing with the slip ratio;

the tyre wear increases exponentially with the slip angle. The complete model can estimate the tyre wear with different vehicle settings and external factors.

**PAPER 6:**

## The effect of driving style on electric vehicle performance, economy and perception

**ABSTRACT:**

It has long been known that driving style has a major impact on the efficiency of conventional combustion engine powered vehicles. Particular aspects of conventional driving such as harsh acceleration and deceleration and

poor anticipation have been demonstrated to be unfavourable for clear technical reasons relating to the efficiency of the internal combustion engine at particular
speeds and loads. Furthermore, definite trends have been identified in terms of the relationship between age and driving style for conventional vehicles. Little work has been done in this area using electric vehicles. This paper addresses
this by presenting a detailed study of the performance of a number of drivers around a standard route in an electric vehicle. In addition to highlighting how particular aspects of driving style influence power consumption and regeneration. We also look at how the drivers perceived the electric vehicle compared to conventional vehicles of the same class.

**PAPER 7:**

## The Effect of Spot Weld Failure on Dynamic Vehicle Performance

**ABSTRACT:**

Spot welds are the dominant joining method in the automotive assembly process. As the automated assembly process is
not perfect, some spot welds may be absent when the vehicle leaves the assembly line. Furthermore, spot welds are highly susceptible to fatigue, so that a substantial number may fail during the vehicle lifetime. The scope of this article is two-fold. First, the impact of spot weld quality and design on a vehicle's functional performance is reviewed, addressing strength and stiffness, NVH and durability. The overview

briefly covers both experimental tests and predictive finite element (FE) modeling approaches, explains the complexity of a spot weld design problem and discusses optimization strategies. Second, an industrial robustness study is presented, that assesses the effect of spot weld failure on dynamic vehicle characteristics. Damaged models are generated automatically, by breaking a subset of the vehicle's spot welds, using a weighted-uniform selection probability. Monte Carlo simulations are then used to assess the scatter on dynamic vehicle characteristics.

**PAPER 8:**

## Modelling community-scale renewable energy and electric vehicle management for cold-climate regions

**ABSTRACT:**

With increasing environmental problems of fossil fuel-based devices and systems in societies, diffusion and adoption of sustainability solutions such as renewable energy technologies and hybrid/electric vehicles have increased in the residential and commercial sectors. However, energy demand in the buildings and energy supply from renewables are complex, dynamic, and non-linear. This complexity shows itself in cold-climate regions that the supply of required energy from renewables is along with uncertainties and even sometimes stochastic. This paper assesses the energy supply/demand performance of a group of residential buildings in a community in a cold-climate region, St. Albert, Canada. First,

all the buildings of the community are modelled and the required energy to respond to the demand and electric vehicles are calculated. Then, the potential of each building for electricity supply via photovoltaic panels is calculated. Finally, the energy supply/demand management of the community is assessed using a machine learning tool. The results show that the community peak heating and cooling loads are 420 kW and 121 kW, respectively and the total annual energy production from photovoltaic system is 14,203 kWh for a single house. Regarding the electric vehicle load, the photovoltaic system can provide 29.23% of the community's total load, annually, finally by comparing the modelled pattern and the predicted pattern, an accuracy of 88.6% is obtained for the prediction.

**PAPER 9:**

## Performance of Motor Vehicle based on Driving and Vehicle Data

**ABSTRACT:**

With the increasing population demographics and the dependency of man on motor vehicles as the primary source of transportation, the number of motor vehicles being registered for commercial as well as non-commercial activities on a daily basis is massive and yet continues to increase at an alarming rate. This has a direct and an unambiguous effect on the amount of fossil fuels being utilized globally and its subsequent environmental effects,

which is of great concern in the present situation. Several attempts from various research sectors are ongoing in order to overcome this global issue and promising results are expected. This project is one such attempt at identifying the performance of small passenger cars in terms of fuel efficiency and map them with factors affecting it using machine learning techniques. The commencing activity while carrying out any such research activity will be the identification of the problem and all its possible sources. In this case, two potential sources can be identified and they are; the vehicle characteristics and the driver/driving behaviour. The relevant data for this analysis was taken from the public source, Kaggle which is the data collected from the OBD of the car and models are built using techniques like Multiple Linear Regression, XG Boost, Support Vector Machine and Artificial Neural Network and their performance is compared to discover the rate technique in predicting the fuel efficiency and to propose the optimum driving behaviour in terms of throttle position to achieve better fuel efficiency. The results reveal that XG Boost model outperforms all other models developed in predicting the fuel efficiency for the different split ratios evaluated and comparing the throttle position with the predicted fuel efficiency explains that to achieve better fuel efficiency the throttle position must be around 70 to 80 on a scale of 100, referred to as full throttle position. The knowledge discovered from the research could be used by car manufacturers to design cars in future to mitigate the fuel consumption.

**PAPER 10:**

# Effects of Electric Vehicle Fast Charging on Battery Life and Vehicle Performance


## ABSTRACT:

As part of the U.S. Department of Energy's Advanced Vehicle Testing Activity, four new 2012 Nissan Leaf battery electric vehicles were instrumented with data loggers and operated over a fixed on-road test cycle. Each vehicle was operated over the test route, and charged twice daily. Two vehicles were charged exclusively by AC level two electric vehicle supply equipment, while two were exclusively DC fast charged with a 50 KW fast charger. The vehicles were performance tested on a closed test track when new, and after accumulation of 50,000 miles. The traction battery packs were removed and laboratory tested when the vehicles were new, and at 10,000-mile intervals throughout on-road mile accumulation. Battery tests performed include constant-current discharge capacity, electric vehicle pulse power characterization test, and low peak power tests.
The data collected over 50,000 miles of driving, charging, and rest are analysed, including the resulting thermal conditions and power and cycle demands placed upon the battery. Battery performance metrics including capacity, internal resistance, and power capability obtained from laboratory testing throughout the test program are analysed. Results are compared within and between the two groups of vehicles over the test period. Specifically, the impacts on battery performance, as measured by laboratory and track testing, are explored as they relate to battery usage and variations in conditions encountered, with a primary focus on effects due to the differences between AC level two and DC fast charging.

The contrast between battery performance degradation and the effect on vehicle performance is also explored.