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Design & Modelling of Vehicle based on Vibration Measurement Study

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Abstract: ***Vibration qualification tests are currently more important for vehicle makers & suppliers. Vehicle manufacturers specifications are therefore conceived to challenge the vehicle fatigue damage, shocks, accidents. Vibration has become an important consideration in engineering. Development of industries and vehicles make the subject even more important. In today's world every family has a car. Therefore it becomes essential to study the phenomenon of vehicle vibration and its effects on humans as well as on vehicle body due to various road conditions. The study of vehicular traffic is essential for modern cities to determine the efficiency of their current roads and to plan new infrastructure that keeps the mobility of its inhabitants. Technologies that provide detailed data of the current situation on the roads are needed to reduce journey times and pollution emissions and consequently improve the quality of life of the people. We develop a vibration measuring device which help to determine the various road condition and also gives the indication of vibration act on vehicle in form of HIGH,LOW and MEDIUM .This will help us testing various road condition and vehicle vibration test.***

Keywords: Vibration Device, Vibration Test Vehicle, Battery Operated Vehicle, Various Road Profile.

I. INTRODUCTION

Vibration testing is the process of applying a controlled amount of vibration to a vehicle model, usually for the purpose of establishing reliability or testing to destruction. The importance of this paper is measuring the reliability and service time of the vehicle on the various road conditions by using vibration measuring device. The intension is to reliably identify the vibration characteristics associated with different road conditions and use of vibration device to identify better road conditions. Our vehicle is battery operated. The testing model is design for the purpose of testing various road profiles. This vehicle contain suspension system which activate when vehicle suffering from bump. When vehicle suffering from any bump the rolling effect observed in vehicle. It vibrates in two degrees of freedom. It is fully battery operated vehicle gives the concept of electric car which is most demanded in future. It saves the fuel and economical as well as good for environmental factor. We have to determine easy road profile for the safety purpose, which further helps for increasing the durability and reliability of vehicles. For the study of vibration on vehicle we had considered the Half body concept (or Quarter body for detail study).The vibration device consist of micro controller, LCD screen, motor IC(control the wheel of vehicle by varying the speed of motor which is attached to the rear wheel) .The vibration device is attached on the testing vehicle which gives the indication of vibration in terms of HIGH, LOW & MEDIUM on LCD screen. It also states the angle of rolling in vehicle. The vehicle is remote operated for easily handling. The main purpose of our project is to determine the reliability and service time of vehicle on various road conditions with the help of vibration measuring device. As we observed by testing on our vehicle model, there were different results obtained on different road conditions. Thus the result obtained from this, we know the road condition of different region which help to select the road profile while driving the vehicle. The recorded data is helpful to send road contractor for reconstruct the road. The durability test is known as the life cycle test and is essential for testing the reliability of vehicle. This test offer important data to determine the life cycle and service time of vehicle. This test data is used for determining defect of the main part of the vehicle during the life cycle and service time. The environment affects the reliability of vehicles owing to fatigue therefore the measurement of road profile and the evaluation of profile characteristics are important points to get reliable endurance test results. Road surface conditions are same for all kinds of vehicles and components, only the vehicle responses vary. The longitudinal profile provides the pitching effect to the vehicle and the lateral profile is responsible for the rolling effect. Numerous factors influence the fuel or battery economy of a vehicle from its aerodynamic properties, tyre wear however, just three basic forces impact fuel or battery economy are vehicle internal friction, air drag, and rolling resistance. While these three forces always affect fuel or battery economy, they vary in importance based on the vehicle speed. The rolling resistance forces a vehicle must overcome to maintain speed are linked to its suspension system, bearings and in part, the properties of the road. The road properties are commonly understood to affect rolling resistance: Surface texture - how rough the mixture is, Smoothness - how rough the road feels to a driver. Rough road surface affects fuel economy through the

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interaction of the tyre and the contacted area of the road. As a tyre deforms, energy is converted into heat, which is lost to the rest of the tyre and the atmosphere. Higher roughness of road leads to additional fuel or battery consumption. While it is important to consider the relationship between roughness of road and fuel or battery consumption, one must remember that road surface is key to ensuring safe driving conditions, particularly on wet roadways. The best way to provide the driving with the greatest possible fuel or battery economy from the road infrastructure is to design and maintain smooth road surface. In addition to aiding the driving, smoother road surface increase vehicle reliability and service time and thus require less maintenance.

A. *Objectives*

1) To determine vibration of vehicle for reducing breakdown or failure occurs in vehicle.
2) To determine vibration on different road condition.
3) To reduce noise and vibration experienced by the occupants of the cabin.
4) To determine vibration for preventing the chassis structure from resonance.
5) Vibration measurement is an important factor for preventing regular maintenance.

II. VEHICLE FABRICATION/STRUCTURE

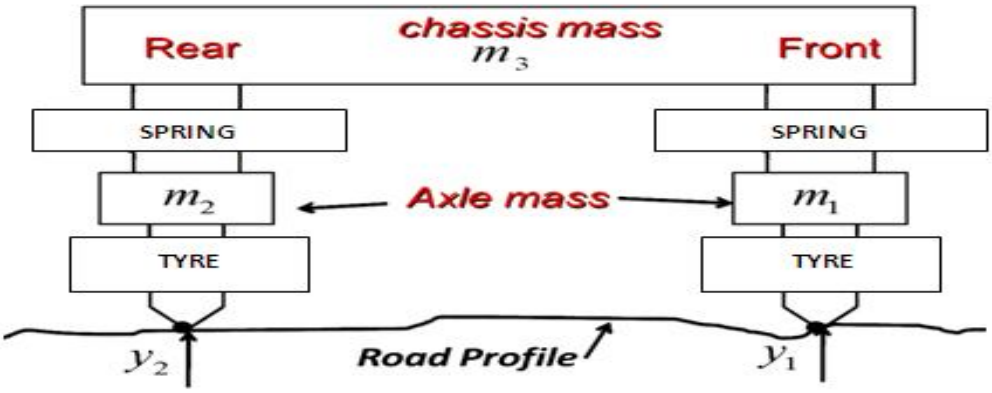
A. *Components*

Following are the important components in our testing model:-

1) *Springs:* The springs provides suspension is the system of tyres, tyre air, springs, shock absorber and linkages that connects a vehicle to its wheels and allows relative motion between the two. The spring has a free length of 8cm, outer diameter of 2.7cm and internal diameter 2.2cm
2) *Chassis*: A chassis consist of an internal vehicle frame that supports an artificial objects in its construction and use, can also provide protection for some internal parts.
3) *Battery Electric Vehicle:* A battery electric vehicle in which battery only uses chemical energy stored in rechargeable battery packs .It uses electric motor and motor controls instead of internal combustion engine for propulsion.
4) *Bearings:* Bearing is a machine part in which another part (such as joints or pins) turns or slides. The bearing has a external diameter of 5cm and internal diameter of 4.6cm.
5) *Axle:* Axle is defined as bar or shaft on which a wheel, pairs of wheel or other rotating members revolves.
6) *Tyre:* Tyre is a thick piece of rubber which is fitted onto the wheels of vehicles such as cars, busses and bicycles.
7) *Hub:* It is an automotive part used in most cars, passenger vehicles, light and heavy trucks.It is located between the brake drums or discs and the drive axle. It has an external diameter of 3.2cm and internal diameter of 2cm.

B. *Half Body Diagram*

The life cycle test or durability test is used for testing the reliability and service time of various vehicles. This test provides necessary data to determine the durability of various vehicles, by the testing on various road profiles. This result obtained on vibration measuring device is used for finding and predicting errors of the main parts of thevarious vehicles during the service time. One of the factor in the endurance test is the vibration environments in which the vehicles are operated. The environment affects the durability of vehicles going to failure. Therefore, the measurement of road profile and profile characteristics are essential points to determine service time of vehicles.



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These obtained results from vibration measuring device are used in the design process to make sure that the vehicle components are sufficiently strong. A model for measuring an accurate road profile can be achieved, however by using a half car model that contains three masses, four springs. In our half car model, it represents the whole front and rear wheel of the vehicle, but reduces it to two wheel masses and the body mass. The objective of the half car model is to determine the vehicle defects or errors by the input road profile and by comparing the input road profile with the measuring profile at various speeds. If both input and measured profile have the same nature and output at various speeds, then the measured profile can be used for Multi Body Dynamics simulation. However, in actual practice both input and measured profile cannot be the same nature wise. Because each measuring device has its own error, and hence input and measured profile is not possible practically. The measured profile is compared with the input profile to determine the various road profile.

C. Various Road Surface Conditions

The influence of the type of road surface on the tested vehicle model is determined by means of tests carried out with the use of vibration measuring device and on selected sections of road surface with rough surface which are presented in following figures. Due to the surfaced efects, the selected sections of the road surface is defined as road (**a)**no visible surface defects, road (**b)** with visible surface defects and road **(c)**with rough surface defects, transverse cracks and deformed surface (folds).

D. Vibration Measuring Device

The device is used for measuring vibrations on various road conditions with the help of electronic circuits. The circuit consists of LCD, sensor, microcontroller, motor driver IC, voltage regulator and battery. As soon as vehicle propelled on various road surface, the sensor senses vibration and sends the information to microcontroller and the result or output is displayed on LCD in terms of low, medium and high. The vehicle is operated with the help of battery through motor driver IC. The block diagram is shown below.

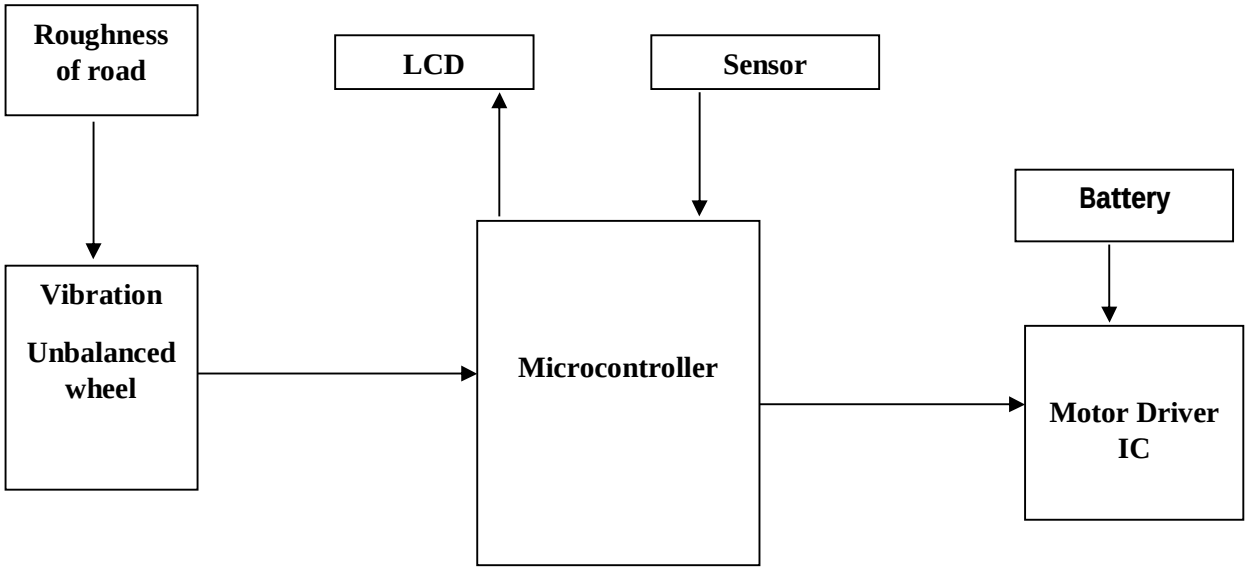

Fig. Block diagram of vibration measuring device

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E. Microcontroller (Atmega16)

All output signals generated from flex sensors are in analoge form and these signals need to be digitized before they can be transmitted to encoder. Therefore microcontroller ATMEGA 16 is used as the main controller in this project. It has inbuilt ADC module, which digitizes all analoge signals from the sensors and inbuilt multiplexer for sensor signal selection. It supports both serial and parallel communication facilities. ATmega16 is an 8-bit high performance microcontroller of Atmel's Mega AVR family with low power consumption. Atmega16 is based on enhanced RISC (Reduced Instruction Set Computing) architecture with 131 powerful instructions. Most of the instructions execute in one machine cycle. Atmega16 can work on a maximum frequency of 16MHz.

F. Motor Driver Ic

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

III. CONCLUSION

A complete half car model has been discussed for a road profile measuring system. After the simulation of a complete half car road profile measuring system, the outcome was a good agreement between input and output road profile. The static, strain and vibration has been discussed on the chassis design to develop the chassis structure according to specifications. The static and dynamic analysis is done todetermine whether the natural frequency of the chassis is in the suitable range.Vibration of the chassis of the vehicle can be reduced byinstalling suitable suspension to the chassis structure which could absorb the shock fromexternal factor such as bumpy road. As a result of the analysis, test-stand measurements and road tests, it was stated that interferences caused by road surface irregularities have a significant influence on vibrations of the sprung mass of the car body. Therefore, an early detection of unbalanced wheel by means of the measurement of the sprung mass of the car body may be subject to interferences caused by road surface irregularities. Moreover, it was found that road surface irregularities lead to accelerations both in the vertical direction as well as in the longitudinal direction.

We had successfully find out the vibration acting on the vehicle due to road irregularities . We distributed some value of vibration and termed it into HIGH,MEDIUM and LOW categories.We fulfil our requirement and need to find out road surface.

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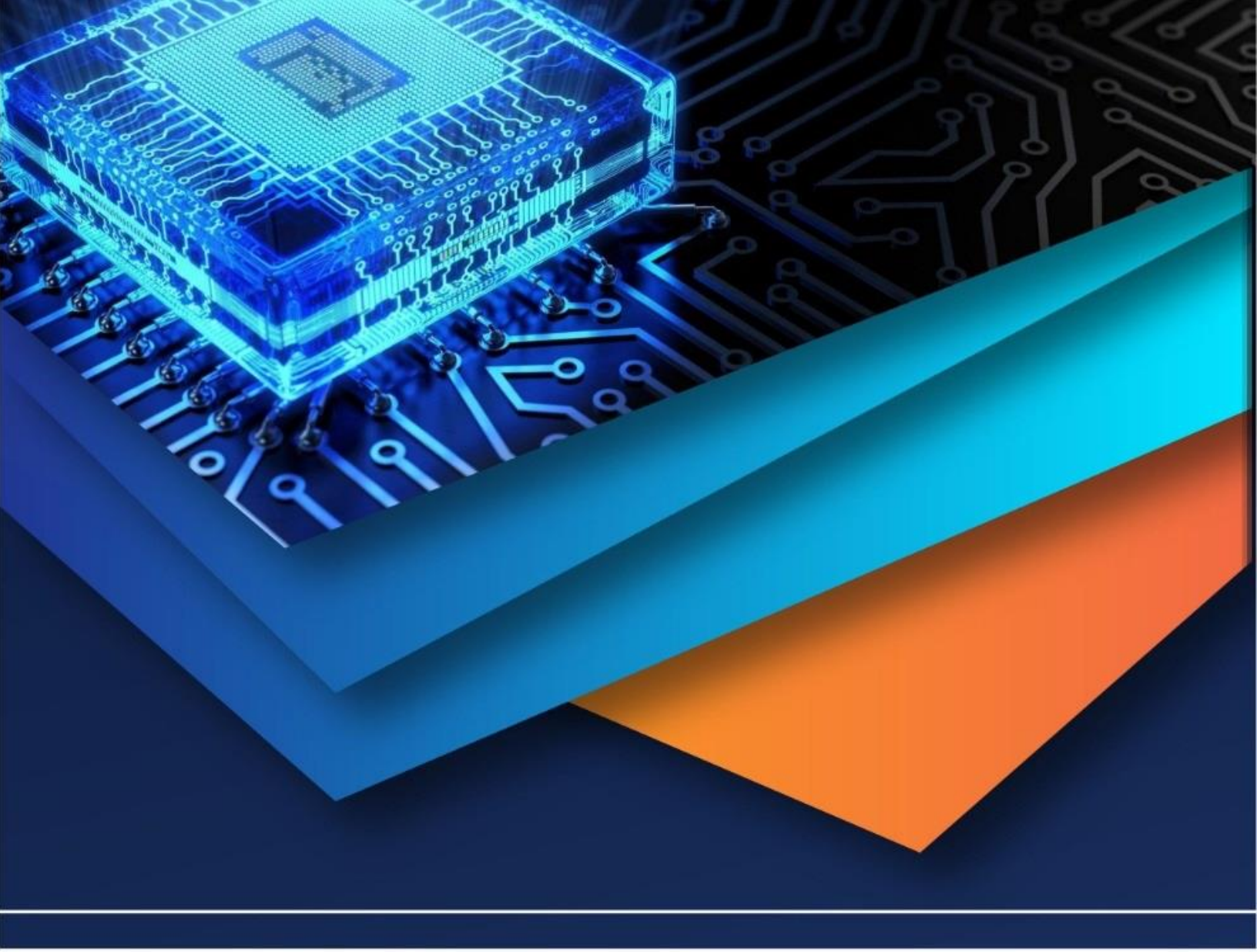

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