

Formula varsity race car - Roll dynamic analysis

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ABSTRACT - This paper presents the roll dynamic analysis of a Formula Varsity (FV) race car. The analysis is performed to study the stability and the dynamics of the race car including roll moment. The data for the dynamic analysis is recorded using Lego Mindstorms gyro sensor and analyzed using Matlab/SIMULINK software. Side drop test and cornering experiment at low speed are performed. The data recorded is analyzed. Based on the results, the dynamic performance of the race car can be demonstrated. The responses from cornering experiments can be used to identify the parameters of stiffness and damping of the car. The parameters of the car can be tuned to produce better dynamic performance for racing.

1. INTRODUCTION

The dynamic performance of vehicles is important to control the stability and the drivability of the vehicle [1]. One of the engineers made research about dynamic automotive which observing a car that driven in a sharp corner if the centrifugal force in the hands of drivers will lead to crash [2]. Driving method is the main problem in that time. The performance of a vehicle can be observed during acceleration, braking and cornering. The sharp cornering is important to determine the stability and the ability of the vehicle to balance. The balance is depending on the vehicle dynamics and the driver behaviors [3]. Operation of the vehicle depends on the road and type of driving. Current research of vehicle dynamic performance uses computational approach [4]. This research method is acceptable for the theoretical validation. The vehicle and road conditions are modeled and the simulation performed using engineering software on computer. Some of the road conditions are neglected to reduce the time of simulation of the vehicle. Universiti Teknikal Malaysia Melaka (UTeM) has already finished the construction of the Formula Varsity Race Car that is designed and completed by the UTeM Racing Team (URT) [5]. Finite Element Analysis (FEA) of the car is already completed.

In this research, the roll dynamic analysis of the race car is performed experimentally to get the data. The main issues of the race car are controlling the movement direction and controlling the stability if there is problem occurs on the road such as hole and the cornering.

2. METHODOLOGY

The FV Race Car is shown in Figure 1. This car is used to for the roll dynamic analysis. The car is equipped with sensor at the center of gravity (COG). Two experiments are performed; side drop test (Figure 2) and cornering test at 20 km/h (Figure 3). The roll data will be analyzed using Matlab/SIMULINK software. The sensor used on the car is LEGO NXT Mindstorms gyro. The data will be taken using the sensor and will be transfer to the computer to. Figure 4 shows the sensor used for the data acquisition (DAQ).



Figure 1 URT FV race car



Figure 2 Side drop test



Figure 3 Cornering test

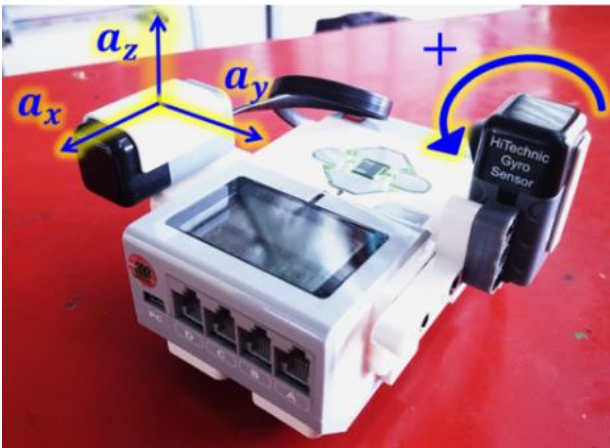


Figure 4 Lego Mindstorm EV3 DAQ

3. RESULTS AND DISCUSSION

Figure 5 and 6 show the roll moment of the car during side drop test and cornering test at 20 km/h. During side drop test, the roll moment is fluctuating obviously. The roll moment is also significantly recorded during cornering. This is due to motion rotating the vehicle to the right and left about horizontal axis.

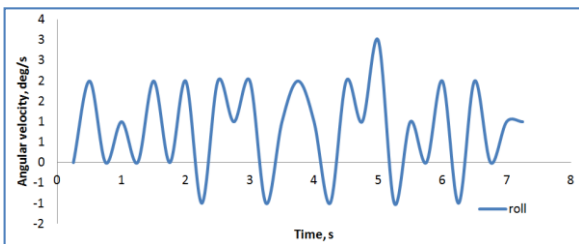


Figure 5: Roll moment for side drop test.

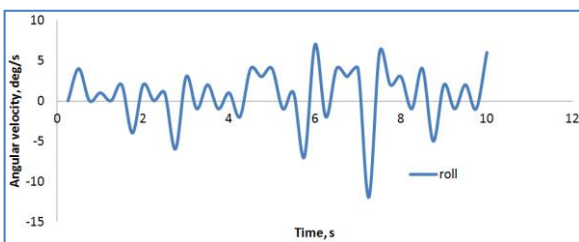


Figure 6: Roll moment for cornering test

4. CONCLUSIONS

The simple vehicle dynamics experiments of the URT FV race car are performed. The data is analyzed and studied. The data is important to predict the race car performance during racing. Few changes on the stiffness of suspension and tire are also can be carried out to tune the dynamics behaviors of the race car. URT FV race car is one of the best achievements by the Universiti Teknikal Malaysia Melaka. The aerodynamic condition and the design of the car is one of the glories for the car. The roll and accelerations are important for the vehicle because they affect the peak levels and the safety of the vehicle itself.

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