

Task for a Master Thesis

“Real-time Estimation the Position of Vehicle Center of Gravity based on IMU”

for Ms. / Mr. First name Surname, Registration No.: XXXXXX

The position of a vehicle’s center of gravity (CoG) are used as an important parameter for vehicle safety control systems for improving handling stability, while it can be changed considerably according to various driving conditions. Therefore, in order to make vehicle safety control systems to have the better performance, it is essential to obtain the accurate CoG position. However, it is generally difficult to acquire the value of this parameter directly through sensors due to cost reasons. In this task, a practical algorithm for estimating vehicle’s CoG position in real time will be proposed.

This algorithm is derived only based on pitch and roll movements of the vehicle. Figure 1, Vehicle dynamics model with roll and pitch movements. Moreover, the main differences in the proposed algorithm compared to previous studies is that it does not require information such as vehicle mass, vehicle moments of inertia, road grade or tire-road surface friction, which are difficult to acquire.

In the proposed algorithm, the relationship between the tire vertical force and the corresponding Pitch&Roll angles are used to determine the CoG position. To demonstrate a practical use of the proposed algorithm, the tire vertical force distribution will be tested under variable loading position and payloads. The proposed CoG estimation algorithm and its practical use will be verified via simulations and experiments with using a test vehicle equipped with Inertial Measurement Unit (IMU).

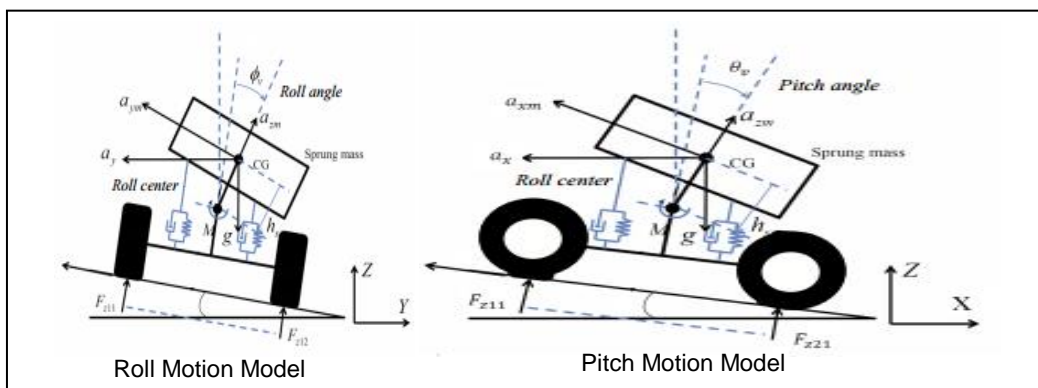


Figure 1: Vehicle dynamics model with roll and pitch movements

Major Responsibilities:

- Literature research on the vehicle inertial parameters - the CoG position.
- Mathematical model of road-vehicle kinematics system based on Pitch&Roll motions in forms of differential equation and state space equation.

- Simulink model of the sprung mass kinematic model system based on different road profile, then the pitch and roll angle rates, longitudinal and lateral accelerations from IMU of the sprung mass body were collected, processed and filtered respectively, and these measurements which as the input of the estimator.
- Simulation based on Simulink model with estimators which will be developed.
- Evaluation for the simulation results.
- Validation about the estimation algorithm in HiL system based on Vertical Test Bench.

We are looking for:

- Basic knowledge of vehicle vertical dynamics and Roll&Pitch kinematics.
- Familiar with control algorithms.
- Ability of mechanic analyzing and mathematical modelling.
- Theory of matrix analysis for converting differential equations to state space.
- Use Matlab/Simulink to make simulation models for simulation.
- Ability of doing experiment in HiL system.

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Berlin, 20.06.2020

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