VRIM: Vehicle Road Interaction Modelling for Estimation of Contact Forces

Nacer K. M'SIRDI, Abdelhamid RABHI, Nabila ZBIRI and Yves DELANNE
LRV: Laboratoire de Robotique de Versailles
FRE 2659 CNRS, Université de Versailles St Quentin
10, avenue de l'Europe 78140 Vélizy, FRANCE
msirdi@lrv.uvsq.fr, rabhi@lrv.uvsq.fr

Abstract

The main objective of this paper deals with appropriate modelling (of a vehicle and the tires contact with road) for estimation of wheels contact forces. This model will be helpful for trajectory monitoring by means of steering control and also for diagnosis to avoid accidents situations and detection of over steering or under steering situations. A robust observer is also developed for adaptive estimation of the contact forces.

Key Words: Vehicle- Road Interaction Models (VRIM), Vehicle dynamics, Robust Observers, Variable Structure Systems, Default Detection and diagnosis, Adaptive Estimation and Identification.

Recently, many analytical and experimental studies been has performed on estimation of the frictions and contact forces between tires and road. The tire forces affect the vehicle dynamic performance and behavior properties. Thus for vehicles and road safety analysis, it is necessary to take into account the contact force characteristics.

However, tire forces and road friction are difficult to measure directly an complex to precisely represent by some deterministic model equations. In literature, their values are often deduced by some experimentally approximated models. The knowledge of tire forces is essential for advanced vehicle control systems such as anti-lock braking systems (ABS), traction control systems (TCS) and electronic stability program (ESP). Vehicle dynamics depends largely on the tire forces which are represented by nonlinear functions of wheel slip. The tire models encountered are complex and depend on several factors (like load, tire pressure, environmental characteristics, etc.). This make the forces and parameters difficult to estimate on line for vehicle control applications and detection and diagnosis for driving monitoring and surveillance.

In this paper, modelling of the contact forces and interactions between a vehicle and road is revisited in the objective of on line force estimation by means of robust observers coupled with a robust and adaptive estimation for contact forces. We propose an adaptive observer to estimate the vehicle state and an adaptive estimator for tire forces identification. The designed observer is based on the sliding mode approach. The main contribution is the on-line estimation of the tire force needed for control.

In this work we deal with a simple vehicle model well coupled with an appropriate wheel road contact model in order to estimate contact forces. Then we develop a method to observe tire forces. This paper is organized as follows : section 2 deals with the vehicle description and modelling. The design of the observer is presented in section 3. Some results about the states observation are presented, with some remarks and perspectives given in conclusion.