World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:12, No:03, 2018

Identification of Vehicle Dynamic Parameters by Using Optimized Exciting Trajectory on 3- DOF Parallel Manipulator

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Abstract : Dynamic parameters, including the center of gravity, mass and inertia moments of vehicle, play an essential role in vehicle simulation, collision test and real-time control of vehicle active systems. To identify the important vehicle dynamic parameters, a systematic parameter identification procedure is studied in this work. In the first step of the procedure, a conceptual parallel manipulator (virtual test rig), which possesses three rotational degrees-of-freedom, is firstly proposed. To realize kinematic characteristics of the conceptual parallel manipulator, the kinematic analysis consists of inverse kinematic and singularity architecture is carried out. Based on the Euler's rotation equations for rigid body dynamics, the dynamic model of parallel manipulator and derivation of measurement matrix for parameter identification are presented subsequently. In order to reduce the sensitivity of parameter identification to measurement noise and other unexpected disturbances, a parameter optimization process of searching for optimal exciting trajectory of parallel manipulator is conducted in the following section. For this purpose, the 321-Euler-angles defined by parameterized finite-Fourier-series are primarily used to describe the general exciting trajectory of parallel manipulator. To minimize the condition number of measurement matrix for achieving better parameter identification accuracy, the unknown coefficients of parameterized finite-Fourier-series are estimated by employing an iterative algorithm based on MATLAB®. Meanwhile, the iterative algorithm will ensure the parallel manipulator still keeps in an achievable working status during the execution of optimal exciting trajectory. It is showed that the proposed procedure and methods in this work can effectively identify the vehicle dynamic parameters and could be an important application of parallel manipulator in the fields of parameter identification and test rig development.

Keywords : parameter identification, parallel manipulator, singularity architecture, dynamic modelling, exciting trajectory
Conference Title : ICMEAM 2018 : International Conference on Mechanical Engineering and Applied Mechanics
Conference Location : Paris, France
Conference Dates : March 15-16, 2018