Applied Mathematics Analysis of the Multibody Systems

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Abstract

In this work, A methodology is developed for the analysis of the multibody systems that is applied on the vehicle as a case study. The previous study is emphasized on the derivation of the multibody dynamics equations of motion for bogie [see 2]. In this work, we have developed a guide-way for the analysis of the dynamics behavior of the multibody systems for mainly validation, verification of the realistic mathematical model and partly for the design of the alternative optimum vehicle parameters .

$$\frac{\partial}{\partial t}\left[\frac{\partial E_K}{\partial \dot{p}^i}\right] - \frac{\partial E_K}{\partial p^i} + \frac{\partial E_P}{\partial p^i} + \frac{\partial E_D}{\partial p^i} = Q_i \qquad (1)$$

Derivation of the DAEs

Lagrange method is used with trajectory coordinate system as seen by equation 1. to derive generalized equation of motion for the differential algebraic equations [see 4]. These generalized equations programmed in the Matlab's Symbolic Mathematics Toolbox. The size of the DAE's are 44 for the *bogie* and about 156 for the whole railway vehicle.

A methodology is developed for applied mathematics analysis of the multibody systems. This methodology can be used to compare with the symbolically derived DAEs of the motions with the previous studies for validation or the optimization of the vehicle dynamical parameters [see 1 and 3]. Case studies of the railway vehicle multibody mathematical model is tested for this methodology with a success. Although the most critical and influential symbolically varied parameter of the velocity is picked for the case study one can pick the rest of the other parameters such as mass, inertia or dimensions of the vehicle to design vehicle or mechatronic system for purposes such as stability (critical velocity for railway case) and comfort criteria.

Keywords: Computational differential-algebraic equations (CDAEs), Multibody dynamics (MBD), Eigenvalue analysis, Lagrange dynamics, Railway vehicles.

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