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Development and Experimental Validation of a Dynamic Model for Electric Vehicle with In Hub Motors

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Abstract

This paper presents the development of a dynamic model of an electric vehicle with motors in all four wheels. The detailed model, is been developed in ADAMS® platform. It has 14 degrees of freedom and in it are included all elements of the actual vehicle such as coil springs, telescopic shock absorbers and pneumatic wheels. The model has been validated experimentally in the actual vehicle, showing the goodness of fit. This dynamic simulator will serve as a test bed for improving vehicle and driver pretesting traction and stability.

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1. INTRODUTION

Since the invention of the automobile, vehicles with internal combustion (IC) engines have so far dominated the market. Although there have been alternatives, they have never been comparable in quality, performance and price.

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However, in recent years a number of factors such as rising fuel prices and greater environmental awareness are leading to a new consumer mindset, and consequently there is a growing interest in Electric vehicles (EVs).

Major limitation of EVs is autonomy, it has been overcome by the advancement in battery technology (Li-Po, Li-ion,etc.) and their ability to combine with other sources such as super capacitors or fuel cells (C. Bordons, et al., 2010; D. Marcos, C. Bordons, M.A. Ridao, 2010).

Therefore, the power source and its management has become the main line of research for EVs, be they pure electric or hybrid. Also the use of electric motors instead of IC engines opens a series of possibilities in controlling the vehicle so far unpublished. Among other advantages, unlike IC engines, electric motors do not need to run at a minimum speed, i.e., idling. Therefore, better speed control can be achieved and also it power is consumed under stop and go road conditions.

IC engines, have a single motor, which, through a series of mechanical devices, applies the torque to either the front or rear or shared by all the four wheels, depending on the type of the drive (P. Luque, D.A. Mántaras, C. Vera, 2004). On the other hand, the simplicity of the electric motors, allows the designer to use several of them on one vehicle, using one for each wheel. In this way one can control the torque transferred by each axis, thereby, achieving better dynamic performance of the vehicle, both in normal driving when it is acting as a differential and under emergency situations for traction control device, vehicle stability, etc. (H. Qian, et al., 2010; J. Gutiérrez, et al., 2011). This torque control strategy can also be combined with other actuators that optimize other parameters such as the camber angle, suspension stiffness (J. Edrén, 2011).

In this paper we present the FOX vehicle, manufactured specifically as a test platform for analyzing drive power management along with torque control at each wheel. In turn, we present a dynamic model of the vehicle, essential for the development of various controllers.

2. DESCRIPTION OF THE VEHICLE

2.1. Vehicle

FOX vehicle is mounted on the chassis of a racing car Silver Car S2. The chassis is been slightly modified for the placement of the new devices (batteries, etc.). In addition, we have installed a second seat, and traditional suspension components have been replaced with custom-made in order to accommodate wheel motors.

The fairing mounts is same as original model. The modified FOX vehicle is shown in Figure 1. The vehicle is powered by four brushless DC wheel motors of 7 kW each (Figure 2). Feeding thereof is from 6 battery modules LiFeMnPO4 of 12.8 V-100 Ah connected in series. Among the set of batteries and four engines are two separate power converters.

Fig. 1. FOX vehicle

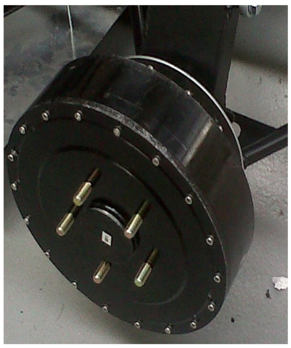

Fig. 2. In-wheel Motor

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