PhD thesis summary
Doctoral Program in Mechanical Engineering (35th Cycle)

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Electric kick scooter assessment from vehicle dynamics to rider perspective

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Summary

In the last years, urban mobility has been globally forced towards the reduction of vehicles powered by fossil fuels. The target pursued by governments through driving restrictions is to limit pollutants, greenhouse-gas emission and traffic congestion. Incentive programmes and sharing mobility services have meanwhile encouraged the quick spread of a new category of urban vehicle, i.e., the electric micro-vehicles. This segment, which is extremely suitable for short urban travels of single road users, is undoubtedly driven in popularity by electric kick scooters. The main peculiarities which distinguish electric kick scooters from other motorized two-wheeled vehicles stand in the small weight and the standing position of the driver. Since the advent of these vehicles on the market is quite recent, scientific research aiming at assessing their dynamics and targeting safety and comfort improvements is still in development. The purpose of this PhD project is to enhance the knowledge of electric kick scooters focusing on the longitudinal and the vertical dynamics, with a special emphasis on comfort and vehicle-rider interaction. Two commercial vehicles characterised by different design solutions (motor, braking system, suspensions, tyres) are considered. Their main technical specifications are collected and the unknown parameters related to vehicle inertias and tyre characteristics are evaluated, adapting well known methodologies. On-road tests are carried out to assess the performance in longitudinal manoeuvres such as standing start, braking and coasting. Operating parameters such as the tyre pressure and the motor settings are varied during the tests. Lumped parameter models are developed and validated on the basis of the experimental evidence in order to highlight the rider influence during the standing start and the braking manoeuvres.
A comparison between the two vehicles focused on comfort analysis is carried out in a second experimental campaign driving on artificial bumps and homogeneous surfaces (asphalt and pavé) at several constant velocities. Tests on the bumps are repeated by a sample of fourteen riders, monitoring the kinematics of the main human body segments and statistically evaluating the vibration transmissibility from vehicle to driver. A detailed multibody model is finally developed to analyse the human body response in heavy braking and driving on uneven roads.