ELECTRIC KICK SCOOTER DRIVING SIMULATION - RISKS AND SAFETY

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Micro-mobility is currently a significant global trend in city transport innovation, with introduction of electric kick scooters representing a major breakthrough. However, these mobility systems have resulted in numerous accidents, primarily due to incorrect usage and insufficient safety measures (Lee *et al.*, 2021). Given that kick e-scooters are a relatively new type of vehicle, established mathematical models are still in development. Developing a model could be beneficial in comprehending the dynamic properties of these micro-mobility vehicles, which could ultimately enhance their design and reduce the incidence of riding accidents. The computer simulations are speed up design and reduce the risks and costs associated withexperimental testing is a widely accepted technique in the transport industry. The simulation process in motorcycles, scooters etc. (two wheels vehicle) is more challenging compared to cars (four wheels vehicle) due to the instability of two wheels vehicle, making it impossible to simulate open loop manoeuvres.

This paper introduces a model designed for simulating the vertical dynamic behaviour of electric kick scooters. The model takes into consideration the mechanical impedance of the driver, allowing for an estimation of the overall driver's comfort and road holding capabilities. The simulation model consists from three main part: main vehicle model, the tire and its interaction with road and human body modelling. In vehicle dynamic simulation, the tire model is the first and most crucial aspect to consider. This is because the tire is the only component that comes into contact with the road pavement and is responsible for providing a force required for movement (Karpenko *et al.*, 2023). In current simulation for driver a simple multibody models reproduce by the biomechanics in dynamic simulations is used.

The obtained results present a planar model that enables simulation of the driving electrical kick scooter in vertical dynamics. This model takes into account the mechanical impedance of driver, which significantly impacts the dynamics of the entire system. To adaptthe approach to this new context, simplifications were made while utilizing conventional methods used for modelling the mechanical impedance of the human body for structure excitation. Furthermore, the paper shows simulation result envelope curves for lumped different obstacles by driving the electrical kick scooter for established drive safety and risk factors ofuse electrical kick scooter in urban area. The obtained results allow to define the critical risk of driving electrical kick scooter in urban area through different type of obstacles.

References

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