Kinematic and dynamic model analysis for an improved design of home-based wearable lower limb rehabilitation robot

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ABSTRACT

This paper presents the analysis of kinematic and dynamic modeling of a wearable lower-limb robot (WLLR) for home-based applications. SOLIDWORKS software was utilized, and the concept of modular configuration was adopted into the design. The Denavit Hartenberg (DH) and geometric method were employed to obtain the theoretical of forward and inverse kinematics model respectively. The Lagrangian formulation on kinetic and potential energy method was selected to derive the joint torque equation. For validation, MATLAB Robotic ToolBox was utilized to simulate forward and inverse kinematic behaviour of the WLLR while MATLAB SimMechanics was used to investigate the maximum torque for the hip and knee joint in various ranges of motion (ROM) and walking condition. The results showed a strong agreement of the simulation and the theoretical model for forward and inverse kinematic of WLLR. The torque required for the hip and knee joint in walking conditions was less than the torque required in various ranges of motion. The maximum torque recorded at the hip and knee in ROM condition is 74.73 Nm and 15.05 Nm respectively while the maximum torque recorded for the hip and knee in the walking condition is 55.00 Nm and 11.01 Nm respectively. This analysis is essential as a basis for further actuator selection and control system development.