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Biography

Vivek Bafna, has completed his B.Tech in Mechanical Engineering from National Institute of Technology Bhopal. He is currently pursuing MS in Mechanical Engineering from Indian Institute of Technology Madras and conducting research in the field of Assistive Health Technologies. His areas of research interest include Biomechanics, Design Optimisation, Dynamics and Control of mechanical systems.

Design Optimisation Of MR Fluid Based Damper For Transfemoral Prosthesis

Abstract:

For transfemoral amputees to mimic the natural swing kinematics of the human knee joint, especially at different walking speeds, various types of damping elements are used in the prosthetic knee. Among these are Magneto-Rheological(MR) fluid based dampers which can modulate the damping level in real time during walking as per the user requirement. MR fluid exhibits its dynamic viscosity characteristics and yield stress depending on the magnetic field applied to impede the flow. Existing work optimised the design of the damper with an objective to improve damper performance without considering the overall prosthesis and end user behavior. We propose a methodology to capture the behavior of the prosthesis user at the initial design stage and optimize the damper with an objective to enhance the user experience. We consider an MR damper with single-coil annular structure. The MR fluid behavior is modelled using Bingham model and magnetic circuit is analysed using Ampere circuital law. The Prosthetic limb is modelled as double pendulum wherein the ankle joint is assumed to be fixed. The optimization problem was formulated with multiple objectives and non-dominated sorting genetic algorithm - II (NSGA-II) was applied to optimize the design of the damper. When damper is optimised using conventional technique, the RMS (root mean square) error value of the actual knee angle trajectory with respect to desired trajectory is 5.44^0. Whereas by using proposed methodology of damper optimization, obtained RMS error is 0.57^0 and there is comparatively 13% reduction in power consumed per gait cycle.