Mechanical Engineering Doctoral Defense

Advanced Prosthetics and Joint Mechanisms

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abstract

Robotic joints can be either powered or passive. This work will discuss the creation of a passive and a powered joint system as well as the combination system being both powered and passive along with its benefits. A novel approach of analysis and control of the combination system is presented.

A passive and a powered ankle joint system is developed and fit to the field of prosthetics, specifically ankle joint replacement for able bodied gait. The general 1 DOF robotic joint designs are examined and the results from testing are discussed. Achievements in this area include the able bodied gait like behavior of passive systems for slow walking speeds. For higher walking speeds the powered ankle system is capable of adding the necessary energy to propel the user forward and remain similar to able bodied gait, effectively replacing the calf muscle. While running has not fully been achieved through past powered ankle devices the full power necessary is reached in this work for running and sprinting while achieving 4x's power amplification through the powered ankle mechanism.

A theoretical approach to robotic joints is then analyzed in order to combine the advantages of both passive and powered systems. Energy methods are shown to provide a correct behavioral analysis of any robotic joint system. Manipulation of the energy curves and mechanism coupler curves allows real time joint behavioral adjustment. Such a powered joint can be adjusted to passively achieve desired behavior for different speeds and environmental needs. The effects on joint movement and stiffness from adjusting one type of mechanism is presented.

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