9-4-2014

Electronic Control Optimization of a Regenerative Leg Prosthesis

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Abstract

Until recently, leg prostheses (artificial legs) operated similarly to a leg without muscles. With recent advances in electronic technology, motorized prostheses have become possible. However, these prostheses require large batteries and have a limited operation time. Our research focuses on using supercapacitors in prostheses to exploit the braking portion of human walking to regenerate energy, thus reducing the dependence on batteries. To use supercapacitors with the knee motor, electronic control circuitry is required. We are using a circuit that is similar to a standard motor controller to manage the flow of energy between the supercapacitor and the knee motor. This circuit can operate in two primary modes: one mode during motoring, and another mode during braking. Two additional, secondary modes arise depending on the direction the knee is rotating. Real-time switching between these four modes allows the prosthesis to correctly power the motor, and to maximize energy storage during braking. The prosthesis characteristics are optimized with artificial intelligence algorithms. Due to the large amount of computational effort required, the optimization algorithm is performed with parallel computing.