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In-socket sensory system with an adaptive neuro-based fuzzy inference system for active transfemoral prosthetic legs

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Abstract

An in-socket sensory system enables the monitoring of transfemoral amputee movement for a microprocessor-controlled prosthetic leg. User movement recognition from an in-socket sensor allows a powered prosthetic leg to actively mimic healthy ambulation, thereby reducing an amputee's metabolic energy consumption. This study established an adaptive neurofuzzy inference system (ANFIS)-based control input framework from an in-socket sensor signal for gait phase classification to derive user intention as read by in-socket sensor arrays. Particular gait phase recognition was mapped with the cadence and torque control output of a knee joint actuator. The control input framework was validated with 30 experimental gait samples of the in-socket sensory signal of a transfemoral amputee walking at fluctuating speeds of 0 to 2 $km \cdot h^{-1}$. The physical simulation of the controller presented a realistic simulation of the actuated knee joint in terms of a knee mechanism with 95% to 99% accuracy of knee cadence and 80% to 90% accuracy of torque compared with those of normal gait. The ANFIS system successfully detected the seven gait phases based on the amputee's in-socket sensor signals and assigned accurate knee joint torque and cadence values as output.

Citation

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