Progress Toward the Shared Control of a Prosthetic Arm

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Abstract

State-of-the-art myoelectric hands and arms typically have a greater number of functions than the possible number of control signals, requiring amputees to manually switch through a fixed list to select the desired function. For this reason, the control of powered prosthetic arms is often considered complex and non-intuitive. Previous studies have demonstrated that techniques from reinforcement learning, and in particular General Value Functions (GVFs), can be applied to develop temporally extended predictions about signals related to prosthetic arm movement. In particular, we have shown that it is possible to learn and maintain predictions about which joint of a robotic arm a user intends to use next, and use this information to create and update an adaptive switching list. In this work, we extend previous studies by demonstrating the real-time use of adaptive switching by an amputee in a simple control task with a myoelectric arm. We also present results from a non-amputee subject controlling a myoelectric arm in a more complex task, providing evidence for the scalability of the learning system. Our results suggest that, compared with a fixed-list switching method, adaptive switching can significantly decrease the amount of time and the number of switches required for the control of a robotic arm and potentially reduce the cognitive burden on myoelectric arm users. Furthermore, we anticipate the future blending of human and machine decision making for the shared control of a robotic arm. Given high enough prediction certainty, a robotic arm could begin to switch autonomously between joints, further reducing the time and effort required by amputees.

Keywords: upper limb prosthetics, shared decision making, rehabilitation robotics, reinforcement learning

Acknowledgements

This work was supported by grants from the Alberta Innovates Centre for Machine Learning (AICML), Alberta Innovates – Technology Futures (AITF), the National Science and Engineering Research Council (NSERC), and the Glenrose Rehabilitation Hospital Foundation.