Abstract

Rehabilitation robotics is the field of research dedicated to understanding and augmenting rehabilitation through the application of robotic devices. For those who suffer from mobility impairment, electrically powered wheelchairs (PWC) are becoming the common solution, which assist users when they require help. But at the same time users of PWC often struggle to drive safely and effectively, resulting in the loss of their residual skills. Because human is the ultimate user of these systems, PWC must interact with human as a team mate. For effective Human-Robot-Interaction (HRI), fair participation of the user is required; and the wheelchair cognitively enhanced. Work reported in this dissertation is a step towards that direction. We implement a cognitively enhanced control architecture for PWC. Our proposed cognitive collaborative architecture (CCA) provide better human participation to achieve effective human-Robot interaction.

In realistic simulation of our proposed architecture, we have considered to use a 3D robotic simulator called USARSim (Unified System for Automation and Robot Simulation) and a control framework ROS (Robot Operating System). Implementation embodies the principle of learning by doing" — to learn about the system we must first build a model of some sort and then operate the model. Within the overall task of implementation, there are three primary sub-fields: model design, model execution and model analysis. We have implemented CCA as a ROS-Node. ROS has a rich set of software libraries and tools that has eased our implementation of CCA. CCA as ROS-Node is designed to give support for cognitive and mobility impairs. Implementation detects the flaws in robotic algorithms and behavior so that robotic architecture and algorithm can be re-modeled to abolish flaws. CCA reported here is the end result of such an iterative process of design and implementation.

Pioneer-3AT (P3AT) robot is adopted to mimic the wheelchair. This agent is cognitively enhanced through incorporation of CCA as a ROS node. The agent is tested in a maze environment that has been constructed in USARSim. Performance of P3AT (which imbibes our architecture) in the simulated environment evaluate the effectiveness of the proposed cognitive collaborative control.

Keywords: rehabilitation robotics, HRI, cognitive architecture.