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Analysis of Stress and Strain in Head Based Control of Cooperative Robots through Tetraplegics

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Abstract : Industrial robots as part of highly automated manufacturing are recently developed to cooperative (light-weight) robots. This offers the opportunity of using them as assistance robots and to improve the participation in professional life of disabled or handicapped people such as tetraplegics. Robots under development are located within a cooperation area together with the working person at the same workplace. This cooperation area is an area where the robot and the working person can perform tasks at the same time. Thus, working people and robots are operating in the immediate proximity. Considering the physical restrictions and the limited mobility of tetraplegics, a hands-free robot control could be an appropriate approach for a cooperative assistance robot. To meet these requirements, the research project MeRoSy (human-robot synergy) develops methods for cooperative assistance robots based on the measurement of head movements of the working person. One research objective is to improve the participation in professional life of people with disabilities and, in particular, mobility impaired persons (e.g. wheelchair users or tetraplegics), whose participation in a self-determined working life is denied. This raises the research question, how a human-robot cooperation workplace can be designed for hands-free robot control. Here, the example of a library scenario is demonstrated. In this paper, an empirical study that focuses on the impact of head movement related stress is presented. 12 test subjects with tetraplegia participated in the study. Tetraplegia also known as quadriplegia is the worst type of spinal cord injury. In the experiment, three various basic head movements were examined. Data of the head posture were collected by a motion capture system; muscle activity was measured via surface electromyography and the subjective mental stress was assessed via a mental effort questionnaire. The muscle activity was measured for the sternocleidomastoid (SCM), the upper trapezius (UT) or trapezius pars descendens, and the splenius capitis (SPL) muscle. For this purpose, six non-invasive surface electromyography sensors were mounted on the head and neck area. An analysis of variance shows differentiated muscular strains depending on the type of head movement. Systematically investigating the influence of different basic head movements on the resulting strain is an important issue to relate the research results to other scenarios. At the end of this paper, a conclusion will be drawn and an outlook of future work will be presented.

Keywords : assistance robot, human-robot interaction, motion capture, stress-strain-concept, surface electromyography, tetraplegia
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