PINCH AND GRIP CONTROL BY A NEURAL NETWORK
MODELING THE CEREBRO-CEREBELLAR SYSTEM

SORAYA BENSMAÏL¹, MICHEL DUFOSSE², ALEXANDER FROLOV³,
ARTHUR KALADJIAN⁴, AND FÉTHI BEN OUEZDOU¹
¹Lab. d'Instrumentation et de Relations Individu-Système
CNRS FRE-2508, Vélizy, France
²UMR S Inserm U742 – UPMC
Université Pierre et Marie Curie- Paris6
F-75005 France
³Lab. Mathematical Neurobiology of Learning
Institute of Higher Nervous Activities and Neurophysiology
Russian Academy of Sciences
Moscow, Russia
⁴Institut des Neurosciences Cognitives de la Méditerranée
UMR 6193 CNRS,
Université de la Méditerranée
Marseille, France

ABSTRACT—Many recent motor control studies such as the synthesis of robotic controllers have been inspired from biological systems. In this paper, a new neural network approach, inspired from neurophysiological theories, is proposed to control multidimensional redundant systems. The main goal of this approach is to perform pinch or grip movement by modeling the cerebro-cerebellar learning of visuomotor transformation. The approach is based on two theories of motor control, the Equilibrium Point theory of motor control and the differential neurocontroller theory, and two models of brain structures, the columnar organization of the cerebral cortex and the Marr-Albus-Ito theory of cerebellar learning. The convergence of the learning procedure was proved for human arm reaching movement. The novel approach is extended to model the human pinch movement, by including biomechanics and muscle properties of the human thumb and index.

Key Words: pinch, motor learning, neural network, cerebro-cerebellar interaction, plasticity.