E. Cattin, S. Roccella, N. Vitiello, F. Vecchi, M.C. Carrozza. Neuroexos elbow module: a novel exoskeleton for elbow rehabilitation. Gerontechnology 2008; 7(2):86. Different research groups have developed a number of robotic solutions for supporting the motor activities of the upper limb focusing on different aspects of the system. For example, D.A. Caldwell and H. Kobayashi use McKibben actuators for their prototypes. Caldwell et al. proposed an upper limb rehabilitation exoskeleton with a rigid link structure[1] while Kobayashi et al. integrate McKibben actuators into a power suit in a configuration similar to the natural muscles[2]. Other research groups are focusing on the control strategy. Kiguchi et al. propose a cable-driven exoskeleton actuated by DC motors and use a neuro-fuzzy logic to control and to predict the arm movements[3,4]. Genetic algorithm based on the Hill-type muscle model has been developed by Cavallaro et al. and implemented on a new 7 DoF arm exoskeleton; EMG, position and force interface information are used by the control system to predict the motions and the torques of the shoulder and of the elbow[5]. The Maryland-Georgetown Army (MGA) Exoskeleton addresses the problem of kinematics coupling between the exoskeleton structure and the human shoulder[6]. NEUROExos upper limb exoskeleton aims to provide an effective kinematic coupling with the upper limb implementing an agonist-antagonist bio-inspired scheme for actuation of the system. **Methods** The NEUROExos system has been designed as a wearable robotic system able to self-adapt its kinematic to the variable kinematic of the human upper limb joints. This solution allows a correct and automatic coupling between the human and the robotic system. The first design has been focused on elbow joint to verify the working principle of this new type of joint (*Figure 1*). The elbow anatomical axes move during flexion-extension movement changing orientation respect to the humerus and ulna-radio bones. The novel mechanism comprises two universal joint, a rocker arm mechanism and circular slider assembled in order to passively follow the anatomical axis of the elbow. The kinematic analysis and the working principle will be presented. In order to obtain a comfortable coupling of the system with the upper limb a double shell structure has been provided. The external shell is responsible for supporting the entire joint and actuation system, while the inner shell provides the support of the limbs, the comfort and size compatibility. Sensors are integrated in the structure in order to measure angular position, applied torque and force at interface. Innovative bio-inspired control schemes have been defined in order to implement user-friendly human-machine interface. **Results and discussion** The results of analysis and simulation of this novel system will be presented. They show the ability of the system of transmitting to the elbow a torque always aligned with anatomical axis of the user's elbow without any additional force or torque that can annoy the user. The final prototype, under fabrication, will be shown. Applications of NEUROExos elbow module for elbow rehabilitation protocols will be introduce focusing on possible rehabilitation and or assistive scenarios.

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Figure 1 First prototype of the NEURO-Exos elbow module