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Zurich, 30/10/2020

Upper Limb Soft Wearable Exosuits: towards a symbolic assistive technology

The seminar was about exosuits for upper and lower limb. Over the years the assumption of rigid robotics left the stage to soft robotics, less robust, but more symbiotic. Wearable assistive devices are employed in assisting people recovering from walking and for human augmentation. The talk highlighted three main pillars for exosuits design: ergonomics, actuation, and control. Exosuit design is mostly an artisanal approach: ergonomics is primarily concerned with understanding the anatomical districts to model, the biomechanics and to produce a prototype. Some of the challenges of ergonomic design are how to distribute softness and hardness. The hardness in the point to which the actuation is attached (anchor point) must be optimized in order not to have dissipation. Finally, pressure distribution: a high force transmitted to a point results in pressure applied on the skin that causes the device to be uncomfortable. Trying to avoid that engineers have long studied pressure distribution curves: some materials are more incline to have pressure peaks while some others more evenly distribute the pressure. Concerning actuation there are two broad categories: Tensile Functional Units (electric motor tendon units/pneumatic artificial muscles) and Expansive Functional Units (pneumatic interference actuators). For electric motor tendon unit, the lecturer showed a portable exosuit aiming at reducing the metabolic rate of walking and running, augmenting human performance for military applications. While for Pneumatic Actuation a glove made of different materials that once inflated deforms according to a certain shape: the aim is to mimic the functional posture of the hand to grasp. Trying to combine both advantages we have Clutch-able actuation: one to many different sets of clutches that engage or disengage for more degrees of freedom. Finally, we have Control design: how to detect in a soft domain the motion of an arm? There are two different approaches: Dynamic based control force sensing and Model-based myoelectric. The first is problematic in the delay of motion: in order to make the system move the system needs to be initiated. The second is much more responsive in terms of delay thanks to biosignal detection, but needs calibration.