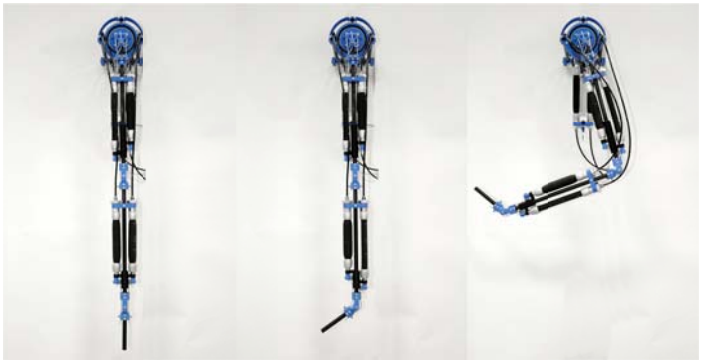
Torque and Stiffness Control of a Robotic Manipulator for Safe Human-Robot Interaction

Master Thesis Proposal in Automatic Control



The robotic manipulator while activating its joints via pneumatic artificial muscles **[1]**

The use of inherently compliant materials, characterized by flexibility and biomimetic attributes has been the recent interest of researchers and manufacturers. There has been a large research attempt in improving the design of humanoid robots and produce setups with motion capabilities inspired by the smoothness, accuracy and compliance that characterize the human motion.

The robotic manipulator **[1]**, developed in the Field Robotics Laboratory, consists of two revolute joints actuated via Pneumatic Artificial Muscles (PAMs) and possesses the mechanical ability of enabling its 2 Degrees of Freedom (DoF) to resemble the movements of the human wrist and elbow. PAMs are tube–like pneumatic actuator that are characterized by a decrease in the actuating length when pressurized, while possessing similar properties with those of the organic muscle, combined with several advantages as the ability to provide high power outputs, with relatively light weights and inherent compliance.

This master thesis will address the need for safe human–robot interaction, via the development and evaluation of a theoretical structure for the control of the manipulator's 2 DOF joint stiffness and generated torques. In this way, the setup will be able to support predefined reference signals for safe manipulation of objects or interaction with the human user.

The stiffness control of the robotic manipulator will enable further research on the development and advanced control of an upper limp humanoid robot.

Measurements regarding the angles and generated torques of the manipulator's joints will be acquired via the incorporation of various sensors (IMUs, VICON, Strain Gages, Pressure/Force Sensors etc.).

- No. of Participants: 1 Student
- The development of the torque and stiffness controlled setup will require the handling of various mechanical and electronic components (pressure regulators, I/O Cards, microprocessors, sensors etc.)
- The programming of the torque and stiffness controlled setup will require the use of various software packages (Matlab, ROS, LabVIEW) and various of operating systems (Windows, Linux, Arduino etc.)
- Knowledge in computer-aided-design (CAD) and Rapid Prototyping (3D Printing) will be considered a plus.
- Guidance will be provided by the supervisors on a weekly discussion basis.

Proposal from Georgios Andrikopoulos and George Nikolakopoulos, Control Engineering Group, SRT

Georgios Andrikopoulos, Room A2574, geoand@ltu.se

George Nikolakopoulos, Room A2556, geonik@ltu.se

References

[1] G. Andrikopoulos, G. Nikolakopoulos, D. Kominiak and A. Unander-Scharin, "Towards the Development of a Novel Upper-Body Pneumatic Humanoid: Design and Implementation", in *15th European Control Conference* (ECC), 29 June – 1 July 2016, Aalborg, Denmark.