

Mechanical Grip Interface for Upper Arm End-Effector Base Robot Rehabilitation

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Introduction

In order to perform an end-effector based robot therapy for upper limb, it is necessary to specify the way the patient will be attached to the End-Effector Based Robot. Patients who have difficulties to actively hold or grip with their own hand, require a mechanical interface which will link both the patient's arm and the robot's last actuator. It must be guaranteed as well that the hand has no movement restrictions on the manipulation capabilities. The patient's arm needs to be distant to the robot's body when they are attached to each other.

It is important to consider stroke patients with upper limb paresis, which has an absence on the motor control and mechanical stability at the wrist. As well, spastic patients present a contraction movement on the arm when the palm detects certain pressure. Physiotherapists compensate this through assistance on the hand, taking the distal region of the palm and hand in order to have a stable wrist.

Methods

A mechanical interface was developed, which binds together the patient's forearm to the robot's last actuator. Two interfaces were made in order to be able to grip either left or right hand.

One part of the interface is a cylinder, which is mounted on a base plate.

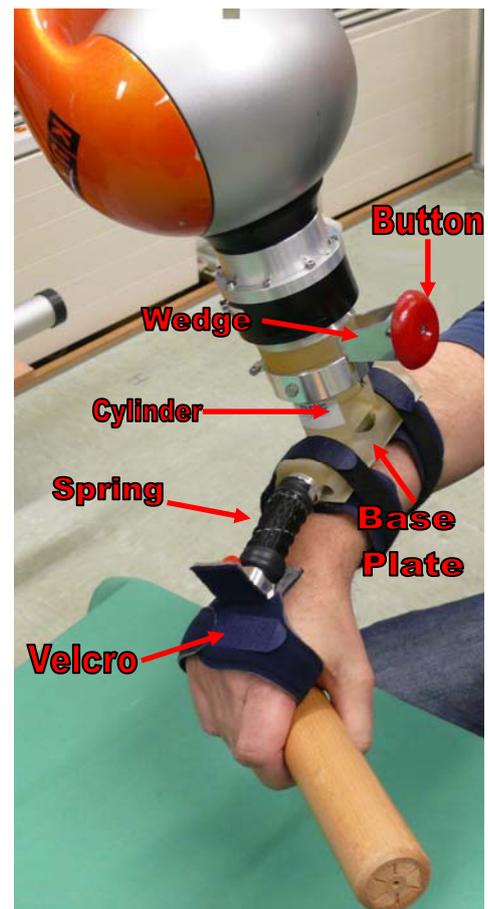
At the base plate a comfortable and ergonomic section is attached which will hold the patient's forearm. Hence, the interface offers high comfort, and minimizes the influences of the applied forces during the performance.

The interface has a Velcro part which supports the hand. It reaches and grips the distal part of the patient's hand as it is done by the physiotherapist assistance. This avoids the presence of pressure on the palm that could trigger a contraction on spastic patients. An individual part from the interface is a mechanical spring. It is coupled to the base plate and it can be adjustable depending on the required spring stiffness which will allow free hand movements. Therefore, the hand will stay at the correct position and the manipulation possibilities will not be disturbed.

Additionally for security reasons, it is necessary to define a breaking point, which will detach as fast as possible the mechanical connections between the interface and the robot in case a wrong movement is performed or a mishap occurs.

The interface has a permanent magnet which is located in the middle point of the cylinder which faces the robot's last actuator. The magnet has a load capacity of approximately seven kilograms. This load is nearly the weight of an average human arm, thus, when the patient's forearm is self-active or it executes an extra force, the mechanical connection between the interface and the robot will be lost. The magnet can be changed as well in case more or less attraction force is required.

Similarly, a manual break was developed. It is composed with a mechanical button and a metal wedge which will separate immediately the connection between the interface and the robot's last actuator whenever the button is pressed.



Results

The Human - Robot interface was tested on five healthy volunteers. Both left and right hand interfaces were verified. Therefore, the correct functionality of the interface could be proved by the subjects. As well, the used safety methods were proved, showing a quick response which offers protection to the patient during therapy.

Conclusion

The interface makes a correct and good connection between the patient's forearm and the robot's last actuator. It is suitable for stroke and spastic patients. It stabilizes the wrist with the help of the spring, making possible the anatomical alignment of the forearm and the hand. It was verified that the interface can be ergonomically adapted to the upper arm and the palm, so the restriction of the arm natural motion is decreased and the pressure on the palm from spastic patients is reduced.