

User Interfaces for Automated Knee Rehabilitation

Supervisors: Prof. Dr. Agathe Koller, Prof. Dr. Kenneth Hunt

Institutions: Institute for Laboratory Technology ILT, University of Applied Sciences Rapperswil

Examiners: Prof. Dr. Kenneth Hunt, Prof. Dr. Agathe Koller

The University of Applied Sciences Rapperswil, Switzerland developed a robotic device to mobilize the patella (kneecap) called the Knee Rehabilitation Device (KRD). The most critical part of the KRD is the patella gripper which is in direct contact with the patient. A measurement system has not been implemented. As part of this thesis new patella grippers and a measurement system to measure patella deflection and the force to mobilize the patella was developed.

Introduction

The knee is the biggest and most complex joint in the body. Due to its complexity it is vulnerable to injuries and diseases. Knee surgery and knee injury cause tissue injuries within and around the joint. These can lead to scar tissue formation and tissue adhesions. This is why the rehabilitation of the knee is a crucial part in maintaining joint movement. The patella (kneecap) is the small sesamoid bone in the front of the knee articulating with the femur (thigh bone). Tissue adhesions usually occur around the patella. Therefore patellar mobilization as part of the rehabilitation process of the knee is essential.

The University of Applied Sciences Rapperswil, Switzerland developed a robotic device to mobilize the patella called the Knee Rehabilitation Device (KRD). The most critical part of the KRD is the patella gripper which is in direct contact with the patient. A measurement system has not been implemented yet.

The aim of this thesis was to develop new patella grippers and a measurement system to measure patella deflection and the force to mobilize the patella during therapy sessions.

Materials and Methods

The new patella grippers consist of a metal base gripper connected by a screw joint to the KRD and a soft material fixed on the metal gripper. The soft material ensures a comfortable interface to the patient's patella.

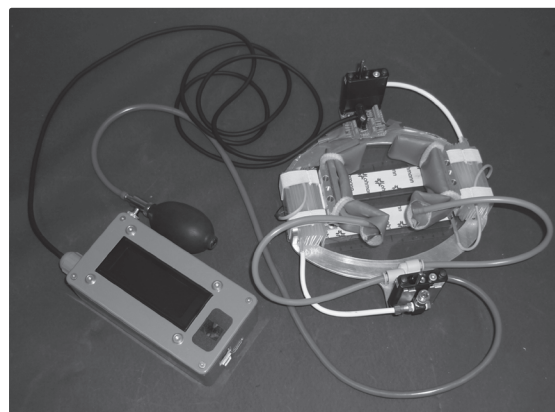
The measurement system consists of two foil potentiometers which measure the distance, two force sensitive resistors as force sensors, a microcontroller board, a display and a switch to start the measurement. The sensor values are displayed on the display and the data is written to a text file which can be selected for analysis if connected to a PC.

Results

The patella grippers and the measurement system were integrated into the existing prototype and tested. The force transmission of the new patella grippers was superior to the previous grippers. The new patella grippers were reported as very comfortable and they could adapt easily to different sized and shaped patellas. Initial tests could be performed at the Medical Center Bad Ragaz. But the measurement system could not be tested with adequate methods to prove its precision. The realized 9V battery supply is not sufficient as it lasts only for a few hours.



Constanze Hofmann



Newly developed patella grippers and newly developed measurement system installed on the KRD

Discussion

The patella grippers need to be tested with more patients to ensure that the new design is suitable for many patella sizes and shapes.

The measurement system needs to be revised as the power supply is not secured. The circuit chosen for the force sensor allows a current that is too high for the force sensors. This must be changed before the measurement system can be used for force measurement. Another concept to transmit force on the sensor has to be considered as well.