Context

As part of a long-term collaboration between the HEPHAISTOS team, Nice hospital and the center heliomarin of Vallauris we are working on the application of robotics in rehabilitation.

Among the major problems in rehabilitation we can mention that:
1. most standardized exercises require the patient to have a sufficient mobility
2. exercises can create significant muscle fatigue even on non-injured members, which imposes to reduce the exercise duration
3. patient’s assessment is based on subjective ratings of clinicians with a summary follow-up

The purpose of this thesis is to finalize a robotic system for propose an economically viable solution to these three problems. The purpose of this system is to provide flexible assistance, to be easy to implement, who will allow to perform exercises even for very frail patients, may contribute to reduce selectively musculoskeletal fatigue while allowing the establishment of synthetic indicators that are relevant to the state of health from objective physical measures. The system has to be mechanically powerful, since it may have to be able to support the full weight of a patient, but secured for reducing the risk of accidents, while being perceived as being non intrusive by the patient and easy to install in various places. Regarding patient assessment the internal state of the robot (forces, displacements, etc.) will be part of the measures that will be used to establish the synthetic indicators.

To achieve these goals we have developed a 6 degrees of freedom cable-driven parallel robots that is able to carry a patient (or one of his limb) while being acceptable to the patient, flexible in term of installation and with a limited cost compared to existing devices.

Assignment

The purpose of this thesis is to finalize the prototype and its control, using theoretical elements and software that have been developed in the HEPHAISTOS team and to integrate them in a rehabilitation environment that may use different exercise devices (treadmill, rower, etc.). First it will be necessary to develop a software framework allowing for quick configuration changes of the rehabilitation environment to adapt it to the exercises, to the patients and, with their collaboration, to the needs of clinicians. Second it will be necessary to examine how the measurements from the robot could allow the establishment of indicators, possibly in combination with other external sensing modalities. Finally these indicators will have to be presented in an appropriate manner both to the patient and to the clinicians for long-term follow-up.

Therefore it will be necessary to merge a huge amount of physical data into a reduced number of indicators with medical purposes. Of course this type of research work requires to be involved in experiments that will be carried out with the support of our clinician partners.

Note that the theoretical developments and software around this robot could also be used in the context of other applications.
Main activities
- theoretical, software and experimental development for cable-driven parallel robots
- implementation of modularity solution within the framework of a rehabilitation environment
- establishment of health indicators deduced from the robot measurements, that will be validated by experiments

Skills
Technical skills and level required:
- good level of programming in C / C++, knowledge of the Linux world, fundamental in robotics, knowledge in signal processing
- bonus: Arduino / Phidgets, biomechanics, Maple skills, big data
- super bonus: knowledge in interval analysis

Languages: some knowledge in French will be appreciated mostly for working with clinicians

Relational skills: ability to work in a team, curiosity

Other valued appreciated: familiarity with the medical world

Benefits package
- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration
Duration: 36 months
Location: Sophia Antipolis, France
Gross Salary per month: 1982€ brut per month (year 1 & 2) and 2085€ brut/month (year 3)