2018-00658 - [CORDIS2018- HEPHAISTOS] Rehabilitation: robotics for accessibility, reduction of fatigue and patient follow-up

Level of qualifications required: Bachelor's degree or equivalent
Fonction: PhD Position

About the research centre or Inria department

The Inria Sophia Antipolis - Méditerranée center counts 37 research teams and 9 support departments. The center's staff (about 600 people including 400 Inria employees) is composed of scientists of different nationalities (250 foreigners of 50 nationalities), engineers, technicians and administrators. 1/3 of the staff are civil servants, the others are contractual. The majority of the research teams at the center are located in Sophia Antipolis and Nice in the Alpes-Maritimes. Six teams are based in Montpellier and a team is hosted by the computer science department of the University of Bologna in Italy. The Center is a member of the University and Institution Community (ComUE) "Université Côte d'Azur (UCA)".

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)
**General Information**

- **Theme/Domain**: Robotics and Smart environments
- **Town/city**: Sophia Antipolis
- **Inria Center**: CRI Sophia Antipolis - Méditerranée
- **Starting date**: 2018-09-03
- **Duration of contract**: 3 years
- **Deadline to apply**: 2018-05-06

**Contacts**

- **Inria Team**: HEPHAISTOS
- **Recruiter**: Merlet Jean-pierre / jean-pierre.merlet@inria.fr

**The keys to success**

- good programming skills, solid mathematical knowledge
- ability to work in a team, curiosity and openness

**Conditions for application**

**Defence Security**:

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

**Recruitment Policy**:

As part of its diversity policy, all Inria positions are accessible to people with disabilities.

**Warning**: you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.