MA1 projects at SAAS – Academic year 2017-2018

1. Pitch control for mechanical load reduction upon grid disconnection

Supervisors: Sandra Paola Vasquez Rodriguez and Michel Kinnaert

Mitigating extreme mechanical loads in wind turbines is of paramount importance in order to reduce maintenance costs. Previous work has shown that pitch control may be useful to reduce extreme mechanical loads that are observed upon occurrence of faults in the network that induce abrupt turbine disconnection. However, the considered studies do not take into account the backlash in the gear. The aim of this project is to take into account this phenomenon in the controller design and to study how it affects control performance.

2. Control of a magnetic levitation process

Supervisors: Laurent Catoire and Michel Kinnaert

The student is asked to design (modeling, actuator and sensor selection), build and control a magnetic levitation process. A prototype has been built during a former project (see below) but it has to be optimized, notably concerning the actuator (winding of the coil and ball size), the sensor and the controller.

3. Smart knee pad measuring knee kinematic (1 or 2 students)

Supervisors: Robin Wilmart and Emanuele Garone

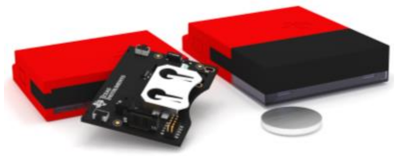
Context of the work

Nowadays, doctors still encounter difficulties to compare the efficiency of medical procedures especially between different methods linked to knee rehabilitation. There is indeed still no way to be sure that the patients follow the medical prescriptions and properly perform the exercises recommended by the doctor.

The objective of this project is to solve that issue by developing a kind of knee pad embedding two IMUs (one on the thigh and the other on the shin) to measure the kinetic and kinematic of the knee.

The sensors will communicate with a smartphone through Bluetooth and data will be therefore saved on a cloud to which the doctor will have access. Thanks to an App, the patient will follow his improvements and the doctor will be able to verify if the exercises will have been performed and if they will have been performed properly.

Sensors: 2 TI SimpleLink SensorTags featuring the CC2650 wireless MCU targeting Bluetooth.



Description of the work

1. Draw the bibliography up (sensors datasheets, Bluetooth protocols, sample products, signal processing, …)
2. Make the acquisition of the raw data through Bluetooth connection.
3. Transform raw data into angles using appropriate filters or algorithms (Kalman filter, Digital Motion Processing, …)
4. Cross the data from the thigh and the shin to visualize the kinematic and kinetic of the knee.
5. Save the data on a cloud and develop an interface that allows the doctor to easily access it.
6. Elaborate an App that gives feedback to the user in hopes of motivating him and sparing time on the rehabilitation.

4. Benchmarking of system identification methods

Supervisors: Emanuele Garone and Ivan Markovsky

The project has two objectives:

1. build a system identification benchmarks database and
2. compare existing identification methods on the benchmarks.

The benchmarks will be selected from practical stands, available at the laboratory of the Control Engineering and System Analysis Department of the ULB and the ELEC department of the VUB. The system identification methods to be compared are a range of subspace and prediction error methods (available in the System identification toolbox of MATLAB), the frequency domain identification toolbox, and a method based on structured low-rank approximation (available from http://slra.github.io).

5. UAV Navigation in Crowded Environments in the Potential Function Framework

Supervisors: Mehdi Hosseinzadeh (Mehdi.Hosseinzadeh@ulb.ac.be), Tam Nguyen (tanguyen@ulb.ac.be), and Emanuele Garone (egarone@ulb.ac.be).

Context of the work

In recent years, Unmanned Aerial Vehicles (UAVs) have received an increasing amount of attention from the scientific community. Their applications range from simple navigation missions to complex aerial robotic construction missions. However, UAVs are usually subject to constraints (e.g. input saturations, obstacles, crowds, etc.), which must be dealt with to maintain safety, reliability, and stability properties of the UAVs.

The objective of this project is to develop a path planner for a UAV to autonomously navigate an area crowded with moving obstacles (see figure below).

Description of the work

The student will be asked to:

1. Understand the potential field philosophy.
2. Design a potential field-based path planning algorithm for fixed obstacles; then, to extend it for the case of moving obstacles.
   Note: Only the kinematics will be considered in the design procedure.
3. Experimentally implement the proposed algorithm.
4. Develop a MATLAB toolbox to make the proposed method easy to use for a wider public.

Advanced works will be to:

1. Understand the concept of invariance level sets.
2. Incorporate the dynamics of the UAV in the design procedure.
3. Develop a general path planner (with considering both dynamics and kinematics) for UAVs in the presence of moving obstacles on the reference governor philosophy.

6. Towards systematic tuning of iterative learning control algorithms

Supervisor: Michel Kinnaert (Michel.Kinnaert@ulb.ac.be)

The aim of this project is to study different variants of the iterative learning (ILC) control algorithm, both in simulation and on a physical set-up (cart of an inverted pendulum). This method is used for the control of repeated tasks involving precise positioning notably. Issues like choice of the filter and the different tuning parameters will be studied and guidelines for systematic tuning will be determined.