IRI-UPC Internship Programme 2019

The Institut de Robòtica i Informàtica Industrial, CSIC-UPC, offers **3 grants** addressed to UPC Master or undergraduate students to carry out a research internship in our centre. This programme is under the María de Maeztu Unit of Excellence Seal.

1. Requirements of the applicants

The students must meet the requirements to apply for an INIREC grant at UPC (to be enrolled as *Grau* or Master student at the UPC and not having another grant or contract).

2. Duration of the internship

Each internship will be funded for a maximum of 4 months under this Programme. The dedication of the student will be 20 hours per week.

3. Funding support:

Each student will receive 525 Euros per month.

4. How to apply

The candidates must submit their applications by sending an e-mail to mdm@iri.upc.edu with this information:

- Name of the student
- Contact information
- A selection of a maximum of three research projects from the list of available proposals. The applicant must indicate a preference order.

The next documentation must be attached: Academic records and CV

The deadline for receiving applications from the students will be **31st January 2019**.

5. List of proposals

(1) Data-driven modelling and control approach for discrete-time descriptor systems
(2) Animated characters based on textual descriptions
(3) 3D Human Pose Estimation from EgoPose Camera
(4) Human Motion Dataset in the Wild
(5) Learning robotic cloth manipulation through human motion capture
(6) Human-robot collaboration in outdoors
(7) Support in the development of a novel mobile robotic platform
(8) A remotely-driven hoverboard with platform leaning control
(9) Planning and control of energy-efficient motions for an omnidirectional four-wheeled vehicle

A description of each proposal can be consulted below:

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- Proposal 1:

Data-driven modelling and control approach for discrete-time descriptor systems

Supervisor: Congcong Sun

Description:

Water/energy networks, aircraft, robot manipulators and unmanned aerial vehicles among others should be represented by differential/algebraic equations that can be formalized using the descriptor systems approach. On the other hand, thanks to the development of sensing and communication techniques, large amounts of data are available which lead the development of advanced data-based systems identification and automatic control approaches. This work is aimed to propose advanced modelling and real-time control approaches to improve performance of descriptor systems based on the most successful methodologies in the field of data science. The following specific tasks are expected to be fulfilled:

1. Data-driven methodologies based on regularization approaches, pattern recognition and kernel methods will be studied to enable precise state estimation and dynamic prediction algorithms.
2. New real-time optimization methods and tools to take advantage of data information will be developed to ensure efficiency, stability and security of descriptor systems.
3. Real pilots will be used as case studies to demonstrate the proposed approaches.

Student profile:

UPC students from Automatic Control, Applied Mathematics or similar fields. The student should be fluent in English (both writing and speaking)

- Proposal 2:

Animated characters based on textual descriptions

Supervisor: Jordi Sánchez Riera

Description:

The idea of the project is to generate realistic models based on textual descriptions of body and face. Many times we can find in books or cartoons a description of several characters that appears on its story. If we could generate a models for those descriptions, this could be a first step towards create an automated animation film based on text descriptions.

Also, another kind of funny application could be to create a textual description of yourself or a public figure and then find if the models created correspond to the reality. Using a software to render images [1] and a 3D human model [2] we can generate several human shapes and faces. For example, work of [3] collect information from users with body in different configuration parameters to obtain a correlation between the text description and the body parameters. In a similar way, we can obtain from a text essay description [4], the information necessary to find human body parameters that match a certain description. As for the faces, we could explore the algorithms suggested in [5].

Student profile:

The ideal candidate should have knowledge of computer languages such as C/C++ and Python. It will be positively appreciated if the candidate has worked already with Blender or Similar and it's familiarized with text parsing tools and natural language processing

[1] https://www.blender.org/
[2] http://www.makehuman.org/
[3] https://deeva.mmci.uni-saarland.de/
[4] https://essayforum.com/writing/best-friend-lenka-description-person-16612/
[5] Bhatia N, Kumar R, Menon S (2007) FIDA: face recognition using descriptive input semantics, December 14.

- Proposal 3:

3D Human Pose Estimation from EgoPose Camera

Supervisor: Jordi Sánchez Riera

Description:

With the advances in robotics, human-robot interaction has become a very hot topic. A natural communication with a robot could help human in many fields like household tasks among others. For a successful interaction, it is important for the robot to know the position of the person.

Many algorithms have been proposed to infer the human 3D pose from a single camera [1][2]. However, these algorithms expect a camera located in some corner of a room, providing images from a 3rd person point of view. In our case, we want to focus on 1st point of view cameras assuming the camera is mounted on the head of the robot.

To this end, we will create a custom dataset with ego camera views with Blender and model the persons with Makehuman software. Once the dataset is ready we will create a new deep learning network able to infer the 3D positions of the person under challenging points of view provided by the images taken by the robot.

Student profile:

The ideal candidate should have knowledge of computer languages such as C/C++ and Python. It will be positively appreciated if the candidate has worked already with Blender or Similar and it's familiarized with deep learning.

[1] Julieta Marinez, Rayat Hossain, Javier Romero, James J. Little. "A simple yet effective baseline for 3d human pose estimation". ICCV 2017.
[2] Xingyi Zhou, Qixing Huang, Xiao Sun, Xiangyang Xue, Yichen Wei. "Towards 3D Human Pose Estimation in the Wild: a Weakly-supervised Approach". ICCV 2017.

- Proposal 4:

Human Motion Dataset in the Wild

Supervisors: Francesc Moreno, Antonio Agudo, Albert Pumarola

Description:

Recent advances in 3D human pose estimation have shown impressive results in retrieving the 3D location of the body joints from a single image. Most these approaches are based on Deep Neural Network architectures trained with pairs of images and skeleton poses captured in indoor and controlled settings.

In this project, we aim to build a human motion dataset acquired in the wild, that is, outdoors, at home and any non-constrained environment. For this purpose, we will use our recently acquired motion capture solution [1], which is based on inertial sensors collocated onto the person and that allows tracking precisely the 3D motion of the person any setting.

The student will need to get familiar with the sensor and then prepare the protocol for the acquisition of the dataset and perform the actual acquisition. The whole dataset is expected to be made of 2-3 million frames, with 10-15 different persons, each performing 10-15 actions in 5-10 scenarios. The outcome of this project is expected to be submitted to a journal/conference.

Student profile:

For creating such dataset, we seek for a student of any of the following disciplines: computer science, industrial engineering, telecommunications or mathematics.

[1] https://www.xsens.com/products/xsens-mvn-analyze/

- Proposal 5:

Learning robotic cloth manipulation through human motion capture

Supervisors: Adrià Colomé and Joan Lobo

Description:

This internship aims at developing a general framework for robots to learn how to manipulate garments from human demonstrations. The framework will encompass: non-expert teaching of a task, robot perception and skill learning, task-oriented cloth representation, probabilistic planning, robot task execution in varying initial conditions, failure diagnosis and informed requests for human help. This internship project will focus on robot skill learning. The student will use an IMU-based motion capture system to analyze arm kinematics/dynamics during cloth manipulation. Using the information from this motion analysis the student will develop a man-machine skill transfer method using Movement Primitives (MPs) that will be implemented and tested on a robotic arm.

Student profile:

We are looking for a UPC MSc student with a strong background in robotics and previous experience on motion capture, control and programming.

- Proposal 6:

Human-robot collaboration in outdoors

Supervisors: Alberto Sanfeliu

Description:

Robots have to help humans to do tasks in diverse environments, as urban areas. In order that robots cooperate with humans, they have to develop skills to anticipate and adapt to human's actions, based on the human preferences. We want to learn these human preferences in a specific task and apply them to extend the Social Force Model.

Student profile:

We are looking for a student who has an engineering bachelor or master degree, with preference in robotics or artificial intelligence

- Proposal 7:

Support in the development of a novel mobile robotic platform

Supervisors: Attila Husar, Sergi Hernández and Jose Agustín Aguilar

Description:

IRI is upgrading an existing mobile robotic platform to implement: a sustainable energy plant (a PEM Fuel Cell) as its energy source and novel navigation algorithms. A position for an undergraduate student that can be proposed as a TFG is currently available in this project. The student will perform works related to the development of the robotic platform, specifically in the area of electronics.

Some of the tasks to be done include decode the communication protocol between the current power plant of the platform (a battery bank) and the control unit, the development of an Arduino module to monitor current /voltage and other parameters of the system, propose a scheme of modules (from the electronics viewpoint) in order to substitute the battery bank and connect the new power plant, taking into consideration the electrical and communication aspects, and its final development and integration.

Student profile:

We are looking for an Industrial/Electronics undergraduate student, with these required knowledge/skills:
- Ability to read and write PCB schematic lay-outs, making use of common PCB design tools.
- Familiar with the use of laboratory equipment and tools and communication protocols (CAN, SPI, I2C).
- Able to read technical literature (specification sheets, manuals, etc) in English.
- Some knowledge in industrial electronics.

These skills are a plus:
- Deep knowledge in industrial electronics.
- Knowledge in battery charging circuitry.
- Experience in design of industrial electronics / communication PCBs

- Proposal 8:

A remotely-driven hoverboard with platform leaning control

Supervisors: Lluís Ros and Enric Celaya

Description:

The purpose of this work is the design and construction of a self-balancing platform driven by two wheels, similar to the nowadays widespread hoverboard. The distinctive feature of the platform will be that, instead of being ridden by a human, it will be remotely controlled or autonomously driven towards a user-defined state. To keep the platform balanced, a mechanism to compensate the torques applied to the wheels will be required. Moreover, the angle of the platform with respect to the horizontal plane will be controllable at will at any time.

Student profile:

Master's student with a degree in Industrial, Mechanical, or Computer Science Engineering. We will appreciate specific knowledge or interest in: robotics, control, mechanical design, and mathematical methods in system dynamics.

- Proposal 9:

Planning and control of energy-efficient motions for an omnidirectional four-wheeled vehicle

Supervisors: Enric Celaya and Lluís Ros

Description:

The purpose of this project is twofold. A first objective will be to develop a trajectory planner for a four-wheel omnidirectional vehicle moving in a plane with known obstacles. The trajectory will have to be smooth, collision-free, and compatible with the dynamical constraints of the robot. It will also minimize an appropriate functional modelling the energy consumption of the motors. A second objective is to develop an appropriate motion controller to execute the previous trajectory in the presence of unmodelled force disturbances or dynamic model inaccuracies. Both the planner and the controller will be validated empirically in an omnidirectional vehicle of the Kinematics and Robot Design lab at IRI

Student profile:

Master's student with a degree in Industrial, Mechanical, or Computer Science Engineering. We will appreciate specific knowledge or interest in: robotics, control, mechanical design, and mathematical methods in system dynamics.