

## **PhD Position in Generalizing Human-Demonstrated Robot Skills, KU Leuven, Belgium**

### **Job Description**

You will be embedded in the Robotics (ROB) group of the KU Leuven Department of Mechanical Engineering. ROB has pioneered robotics research in Europe since the mid-1970s. The group was among the first to develop active force feedback for assembly operations. It has covered virtually all aspects of sensor-based robotics, from the high-level task specification down to low-level sensor-based control, and applied the research results in a variety of industrial applications. In the last decade the group shifted its attention towards service robots (behaviour-based mobile manipulation, shared control, learning control), medical robotics (natural interfaces, haptic bilateral control), industrial robot assistants, and active sensing. ROB has created several spin-off companies that are active in robotics-related activities, has initiated several free and open-source software projects in robotics (Orocos, KDL, iTaSC, eTaSL ...), and has participated in dozens of robotics and control oriented EU projects.

### **Project**

The fundamental challenge addressed in this project is: how can a robot generalize a skill that has been demonstrated in a particular situation and apply it to new situations? This project focuses on skills involving rigid objects manipulated by a robot or a human and follows a model-based approach consisting of: (1) conversion of the demonstrated data to an innovative invariant representation of motion and interaction forces; (2) generalization of this representation to a new situation by solving an optimal control problem in which similarity with the invariant representation is maintained while complying with the constraints imposed by the new context.

Major breakthroughs of this new approach are that the required number of demonstrations and hence the training effort decrease drastically, similarity with the demonstration is maintained in view of preserving the human-like nature, and task knowledge is easily included.

We did preliminary work on the invariant representation of rigid-body motion trajectories and its use for recognition and generalization of motion. We designed numerical optimization algorithms to transform a recorded motion to its invariant representation and to generalize this representation to a new situation. We also performed initial human intent recognition experiments using the invariant representation of motion trajectories.

In the project there is room to do more conceptual work, numerical optimization work, robot programming and/or experimental work.

In particular, with a team of PhD students, postdoc researchers and senior staff, we want to do:

- extension of the conceptual work: extension of the invariant approach to the dual force/moment trajectories during contact (e.g. for force-controlled robot assembly applications);
- extension of the numerical optimization work (improving the algorithms in terms of accuracy, robustness and execution speed in view of real-time applications involving human/robot interaction);
- linking the model-based approach to machine learning methods;
- development of robot applications involving robot motions in free space (e.g. human/robot hand-over tasks or bimanual robot tasks);
- development of robot applications involving contact (e.g. assembly tasks);

- application to biomechanics (describing motion of human body segments with the invariant representation).

## **Profile**

We are searching for young, motivated and skilled PhD researchers with a strong background in one or more disciplines including robotics, programming, numerical optimization and machine learning to perform highly innovative research in a multi-disciplinary team in the framework of an ERC Advanced Grant (ROBOTGENSKILL, URL [kuleuven.be/english/research/EU/p/horizon2020/es/erc/robotgenskill](http://kuleuven.be/english/research/EU/p/horizon2020/es/erc/robotgenskill)).

Candidates must be fluent in spoken and written English and demonstrate this in their application (e.g., by means of a TOEFL test, by adding English papers written by the candidate, ...)

Candidates must hold a Master's degree in a relevant field of engineering (mechanical, systems and control, machine learning...). Successful candidates have typically ranked at or near the top of their classes.

An ideal candidate:

- is familiar with systems and control, and in particular with motion control; practical experience in motion control or robot control on a real set-up is appreciated;
- has knowledge of programming languages, numerical algorithms and signal processing;
- has some basic knowledge of robotics related disciplines such as vision, motion planning, ...;
- has experience with a Linux programming environment, ROS, C++, and Lua;
- is a problem solver;
- loves to work in a multidisciplinary team.

Please motivate clearly your experience with the above mentioned topics by listing concrete courses, thesis work, certificates, links to software, ...

## **Offer**

A fully funded PhD position in an international context for four years at the KU Leuven: a top European university and a hub for interdisciplinary research in the fields of robotics, systems, and control. You will be embedded in the ROB research team of the Department of Mechanical Engineering. The doctoral candidate will work in world-class facilities with highly qualified experts, on a highly innovative project.

KU Leuven offers to the selected candidate a stimulating and ambitious research environment in a nice place to live and work [1][2]. To assist in matters of visas, living, mobility, housing,... , KU Leuven has the International Admissions Office [3].

A start date in the course of 2018 is to be agreed upon.

[1] [kuleuven.be/english/living](http://kuleuven.be/english/living)

[2] [leuvenmindgate.be/en](http://leuvenmindgate.be/en)

[3] [kuleuven.be/welcome](http://kuleuven.be/welcome)

## **Interested?**

Please use the online application tool to submit your application and include: (i) an academic CV with photo, (ii) a Pdf of your diplomas and transcript of course work and grades, (iii) statement of research interests and career goals (max. 2 pages), (iv) a sample of technical writing (publication or thesis), (v) contact details of at least two referees, (vi) proof of English language proficiency test results for applicants whose mother tongue is neither Dutch nor English. For more information please contact Prof. dr. ir. Joris De Schutter, tel.: +32 16 32 24 79, mail: [joris.deschutter@kuleuven.be](mailto:joris.deschutter@kuleuven.be) or Dr. ir. Erwin Aertbeliën, tel.: +32 16 32 25 51, mail: [erwin.aertbelien@kuleuven.be](mailto:erwin.aertbelien@kuleuven.be).

You can apply for this job no later than September 30, 2018 via the online application tool

KU Leuven seeks to foster an environment where all talents can flourish, regardless of gender, age, cultural background, nationality or impairments. If you have any questions relating to accessibility or support, please contact us at [diversiteit.HR@kuleuven.be](mailto:diversiteit.HR@kuleuven.be).