Post-Doctoral Research Position:

"Learning Dynamical Models for Complex Robotic Systems"

Research Institute and University:

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Description for the Project and Position

The modelling of complex dynamic systems is a major societal and industrial challenge. In fact, most existing real-world robotic systems are becoming more complex and their dynamic modelling is often either inaccurate or the models obtained by using the traditional tools do not make it possible to design strategies of control or estimation of the state of the system with a desired accuracy. These effects notably happen in medical robotics and imaging, where the actuation system needs to handle poorly textured surfaces affected by deformations [1,2,3]. To mitigate these conditions, one recent strategy is to develop artificial models by learning on data to help estimate the dynamic information about the system [1, 4]. In this context, this postdoctoral research project focuses on two problems involving systems that can be considered complex for their modelling and control: the modelling and analysis of deformable objects and controlling an endoscopic/microrobotic capsule.

One central research aspect of these problems is the requirement of reliable non-rigid surface tracking and modelling of deformable objects, which is still a challenge [3, 5, 6, 7]. This problem poses a great challenge in the fields of computer vision and robotics, since current sensors cannot capture the complete 3D shape of an object from a single point of view, but also because the object can deform from one point of view to another. This research project aims to extend and improve the few fundamental existing computer vision frameworks as Shape-from-Template (SfT), and Non-Rigid Structure from Motion (NRSfM) [6, 7, 8] to better consider the conditions of the complex systems. The project will be carried

out in the context of European Project SYROCO, whose main goal is to provide solutions to system modelling using the design of observers (software artificial sensors).

Main Objectives and Activities

The main objective of the project includes the development of generic learning-based algorithms for modelling complex intelligent systems. This includes the development of learning strategies to estimate dynamic models and the refinement of these models with state observers. We also plan to validate the results in real-world experiments to demonstrate the relevance of the obtained algorithms for different robotic applications. In summary, the research activities can be divided into three main parts:

- Understanding and development of algorithms to obtain dynamic system models from data. One possible direction will be to explore Koopman operators for physical modelling.
- Representation and encoding of physical models subjected to non-rigid deformations, such as the ones found in medical imagery conditions as for chirurgical robotics with endoscopes.
- Validation of the results obtained on simulation and real robotic platforms. This activity will be carried out by the postdoctoral fellow in collaboration with other doctoral students whose subjects are related to the theme of this project.

Hosting Team

The VIBOT/ImViA team is one of the three constituent members of the ImViA laboratory (Imagery and Artificial Vision). It is located in the Creusot campus of the Université de Bourgogne, within two European Master programs (VIBOT and MAIA), as well as one campus of the ESIREM engineering school. The research activities of the team are focused on multimodal perception/control for robotics, with expertise in non-conventional imaging, scene reconstruction and analysis, and robotic manipulation. The project has two important applications in the ImViA laboratory which are the manipulation of objects (potentially deformable) based on multimodal information (multimodal vision, tactile, ...). The second application is endoscopy and microrobotics for targeted delivery of medical treatments.

Desirable Skills and Ideal Candidate Profile

The ideal candidate should be motivated to carry out world-class research and should hold a Ph.D. degree in the areas of Computer Science or Electrical Engineering along with solid skills in mathematics, and dynamic systems modelling, computer vision and robotics. We also expect the candidate to have strong programming experience in Python, OpenCV, Pytorch (or TensorFlow). Some practical experience with ROS is of added value.

Additional Information and Application

This postdoctoral research position has an initial duration of 12 months (with possible later renewal) in the context of the project SyRoCo funded by the European Union through the

FEDER program. The postdoctoral research will also have the opportunity to co-supervise Master and Ph.D students whose subjects are related to the theme of the project.

We ask interested candidates to please send a detailed CV, PhD thesis report, a document with a list of publications, motivation letter, one coding program sample, and the email coordinates of two referees to be contacted for recommendation. Please include these files into a single .zip or tar.gz file to be sent to Omar Tahri (omar.tahri@u-bourgogne.fr) and Renato Martins (renato.martins@u-bourgogne.fr).

Calendar

The position is to be started by the end of next fall, ideally in October/November or December 2022. We invite the candidates for applying to the position before 30 June 2022. Late applications might not be considered after this date if a suitable candidate has been found.

References

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