Offer #2022-04675

PhD Position F/M Markerless 3D localization of surgical tool in a per-operative context

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

About the research centre or Inria department

The Inria Rennes - Bretagne Atlantique Centre is one of Inria's eight centres and has more than thirty research teams. The Inria Center is a major and recognized player in the field of digital sciences. It is at the heart of a rich R&D and innovation ecosystem: highly innovative PMEs, large industrial groups, competitiveness clusters, research and higher education players, laboratories of excellence, technological research institute, etc.

Context

Today, according to Global Market Insights, the orthopedic medical device (MD) market is growing rapidly and will be worth more than $22.4 billion by 2025. Joint replacement (hip, knee, extremities) represents nearly 37% of the market share. These devices include conventional ancillary instruments, custom-made guides, navigation systems, and robotic systems. More recently, augmented reality (AR) navigation systems have been developed. They are recognized for their accuracy, low cost, ease of use, as well as clinical added value. It is in this context that the ANR MARSurg project [2021-2025] aims to implement an innovative surgical navigation solution with high scientific, technological and clinical potentials.

Assignment

This thesis will be done at Inria and Irisa in Rennes in collaboration with ISIR (Sorbonne Université) in the scope of this ANR MARSurg project. The goal will be to improve the state-of-the-art regarding accurate and robust localization, pose estimation and visual tracking of markerless 3D objects using RGB-D images. These topics are very relevant in various applications, including industry (e.g., objects handling and grasping) and automotive vehicles (e.g., localization, navigation, ...) but also in computer-assisted medical interventions (CAMI).

Tracking and pose estimation are very important research subjects in a real-time augmented reality context. The main requirements for trackers suitable for AR systems are high accuracy, robustness and little latency. The tracking of objects in the scene amounts to calculating the 3D pose between the camera and the objects. Virtual objects can then be projected into the scene using the pose.

Main activities

The objective of this thesis is to develop robust methods for detection, localization and tracking of objects (without markers) in RGB-D image sequences. Using deep neural network-based approaches, we aim to detect, classify and initialize a pose computation process for surgical instruments present in the images (eg, [Rad 2017]). Then, model-based tracking and localization approaches using both contours and depth maps provided by the RGB-D camera will be proposed [Marchand, 2016, Trinh, 2018]. The complexity of the surgical instruments under consideration requires the development of GPU (Graphics Processing Unit) based approaches to ensure a fast and complete projection of the model into the images [Petit 2014]. As the camera is itself mobile, the position of the objects in a fixed reference frame (in which the anatomical landmarks will also be expressed) requires the localization of the camera w.r.t. the environment that will be done using Visual Inertial SLAM methods assisted by an IMU (Inertial Measurement Unit). Moreover, to deal with fast movements, the prediction of object position, integrating inertial data, will be managed thanks to particle filters on SE(3). To validate the system, an estimation of the measurement error will be performed by an external system giving the ground truth (either by mounting the camera on a robot or by using a Vicon 3D measurement system).

Skills

- Knowledge in computer vision and image processing, vSLAM, machine learning
- Mathematics, optimization, linear algebra
- Excellent programming skills in C ++

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Possibility of teleworking (90 days per year) and flexible organization of working hours
- partial payment of insurance costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours)
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Remuneration

Monthly gross salary amounting to :

- 1982 euros for the first and second years and
- 2085 euros for the third year

General Information

- **Theme/Domain :** Robotics and Smart environments
  System & Networks (BAP E)
- **Town/city :** Rennes
- **Inria Center :** Centre Inria de l'Université de Rennes
- **Starting date :** 2022-10-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2023-06-30

Contacts

- **Inria Team :** RAINBOW
- **PhD Supervisor :**
  Marchand Éric / Eric.Marchand@irisa.fr

About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

The keys to success

- Methodological developments will be carried out using the C ++ ViSP software library (https://visp.inria.fr) and will be validated via experiments on real image sequences and mockup.

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.

Instruction to apply

Please submit online : your resume, cover letter and letters of recommendation eventually

For more information, please contact claudio.pacchierotti@irisa.fr

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.