Offre n°2023-06731

PhD Position F/M Aerial Robots with the sense of touch

Le descriptif de l'offre ci-dessous est en Anglais

Type de contrat : CDD

Niveau de diplôme exigé : Bac + 5 ou équivalent

Fonction : Doctorant

A propos du centre ou de la direction fonctionnelle

The Inria Centre at Rennes University is one of Inria's eight centres and has more than thirty research teams. The Inria Centre 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.

Contexte et atouts du poste

Conditions:

- The work will be carried in English in the Rainbow team at the Inria Rennes Bretagne Atlantique research center.
- The Ph.D. position is full-time for 3 years (standard duration in France). The position will be paid according to the French salary regulations for PhD students.
- We do high quality and impactful research in robotics, publishing on the major journals and conferences.
- We often collaborate with other top researchers in europe and worldwide.
- You will have access to a well established laboratory including:
- two flying arenas equipped with motion tracking system, several quadrotors, and a few fully-actuated manipulators,
- one robotic manipulation lab equipped with several robotic arms, like the Franka Emika Panda.
- You will be part of an international and friendly team. We organize several events, from after works, to multi-day lab retreat.
- Regular visits and talks by internationally known researchers from top research labs.

Supervisors : M. Tognon, P. Robuffo Giordano

Mission confiée

Short Abstract: Researchers are trying to make **aerial robots perform physical work**. Current methodologies show promising results, but they fail in real scenarios, mostly because of inaccurate visual perception. Inspired by nature, this project investigates **how to also provide aerial robots with the sense of touch** and how to use it for improving their manipulation capabilities.

Description: Aerial robots (commonly called "drones") are nowadays extensively used to perceive the environment for surveillance and monitoring in applications like agriculture, mapping, etc. But if aerial robots were also able to effectively manipulate the environment, the application domains could be further extended toward new areas like contact-based inspection, assembly and construction, and so on. But contact is today synonymous for crash, and thus avoided. The unstable nature of aerial robots, their non-linear dynamics, and limited vision-based perception, make the manipulation problem in real environments extremely difficult and delicate.

To show the feasibility of Aerial Physical Interaction (APhI), the research community has previously focused on the design and control of aerial manipulators [1]. This opened

the door to new applications, e.g., contact-based inspection [2,3]. However, current methodologies are still limited to very simple interaction tasks, involving limited contact behaviors with static and rigid surfaces (e.g., touching a flat wall with a stick rigidly attached to the robot [4]).

Inspired by nature, we want to tackle the problem by considering a novel aspect : the sense of touch. We hypothesize that the sense of touch (as for humans) can give a new improved understanding of the environment and the physical interaction between the aerial robot and its surrounding. In AEROTouch, we aim at giving the missing sense of touch to aerial robots and design new haptic- based control methods that would make these robots eventually capable of performing real physical work in real environments.

Related references:

1. A. Ollero, M. Tognon, A. Suarez, D. J. Lee, and A. Franchi, "Past, present, and future of aerial robotic manipulators," IEEE Trans. on Robotics, 2021.
2. G. Nava, Q. Sablé, M. Tognon, D. Pucci, and A. Franchi, "Direct force feedback control and online multi-task optimization for aerial manipula- tors," IEEE Robotics and Automation Letters, vol. 5, no. 2, pp. 331–338, 2020.
3. M. Tognon, Tello-Chavez, H. A., Gasparin, E., Sablé, Q., Bicego, D., Mallet, A., Lany, M., Santi, G., Revaz, B., Cortés, J., and Franchi, A., "A Truly-Redundant Aerial Manipulator System With Application to Push-and-Slide Inspection in Industrial Plants", IEEE Robotics and Automation Letters, vol. 4, no. 2, pp. 1846-1851, 2019.
4. W. Zhang, Ott, L., Tognon, M., and Siegwart, R., "Learning Variable Impedance Control for Aerial Sliding on Uneven Heterogeneous Surfaces by Proprioceptive and Tactile Sensing", IEEE Robotics and Automation Letters, pp. 1-8, 2022.
5. M. Brunner, G. Rizzi, M. Studiger, R. Siegwart, and Tognon, Marco, "A planning-and-control framework for aerial manipulation of articula- ted objects," IEEE Robotics and Automation Letters, vol. 7, no. 4, pp. 10 689–10 696, 2022.

Principales activités

Envisaged Activities:

So far, to the best of our knowledge, no one has attempted to extend touch capabilities to aerial robots, and even less to exploit tactile sensors as direct feedback to perform manipulation. We will address these challenges in the following points:

- **Tactile sensor:** On one side we have to answer the question if and which tactile sensors are feasible for flying robots. We will review and evaluate different tactile sensors mounted on the end-effector of an aerial manipulator (e.g., Digit from Meta, and uSkin from Xela).
- **Haptic-based control:** On the other side, we have to understand how to use those measurements at best. We will take inspiration from visual-servoing and reinforcement-learning control methods to define a new haptic-servoing paradigm, where the robot actions are defined to reproduced a desired haptic feeling, e.g., the one to open a door.
- **Experimental evaluation:** The proposed methodologies will be validated on real aerial manipulators. Their effectiveness will be demonstrated through complex interaction tasks in real-world scenarios, like opening a door with only onboard sensors (both visual and haptic) and minimal knowledge of the environment.

Avantages

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    - 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

Rémunération

Monthly gross salary amounting to 2082 euros for the first and second years and 2190 euros for the third year

Informations générales

- **Thème/Domaine :** Robotique et environnements intelligents
- **Ville :** Rennes
- **Centre Inria :** Centre Inria de l'Université de Rennes
- **Date de prise de fonction souhaitée :** 2024-01-01
- **Durée de contrat :** 3 ans
- **Date limite pour postuler :** 2024-05-21

Contacts

- **Équipe Inria :** RAINBOW
- **Directeur de thèse :**
  Tognon Marco / marco.tognon@inria.fr

A propos d'Inria

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie

2600 personnes. Ses 215 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3900 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 200 start-up. L'institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

L'essentiel pour réussir

Requirements:

- M.Sc. degree in mechatronics, robotics, engineering, computer science (or related fields)
- Excellent written and spoken English skills
- Good experience in C/C++ , ROS, Matlab/Simulink, CAD
- Good experience with numerical trajectory optimization tools for robotics (e.g., use of CaSaDi, Acado, Autodiff, Crocoddyl, etc.)
- Scientific curiosity, large autonomy and ability to work independently
- Experience with visual sensors and visual perception for robotics is a plus
- Experience with robotic systems and/or aerial robots is a plus

Attention: Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.

Consignes pour postuler

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

Sécurité défense :
Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

Politique de recrutement :
Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.