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THE FRENCH AEROSPACE LAB

PROPOSITION DE STAGE EN COURS D'ETUDES

Référence : **DTIS-2021-36**
(à rappeler dans toute correspondance)

Lieu : Palaiseau

Département/Dir./Serv. : DTIS/NGPA

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DESCRIPTION DU STAGE

Thématique(s) : Robotique et autonomie

Type de stage : ☒ Fin d'études bac+5 ☒ Master 2 ☐ Bac+2 à bac+4 ☐ Autres

Intitulé : Safe navigation toward a moving destination through a complex cluttered environment

Sujet : Navigation of an autonomous vehicle in cluttered environments has been a focus of research for decades. The common design approach to attain this objective is through a three-step procedure. First, a path planner generates a spatial curve that avoids static obstacles and connects the initial position of the vehicle to its final, fixed destination. Second, a trajectory generator provides a time parametrization of the path to satisfy certain constraints. Finally, a control law is designed so that the vehicle follows this reference trajectory. However, due to the particular assumptions in each step (e.g. path planning does not account for vehicle dynamics, control design does not account for the vehicle size), such an approach can be time-consuming and more importantly, might not guarantee the safe navigation for all initial positions/final destinations.

An approach that unified these steps and provided a constructive framework was the methodology of navigation functions [1,2]. Despite an increased number of important contributions through the years, the navigation-function approach has been applied to scenarios that assume spherical obstacles, Euclidean workspaces and fixed destinations. However, in a variety of missions such as target tracking and navigating through holes (windows, doors, tunnels …), labyrinth or bounded workspaces/environments, the previous assumptions do not hold.

In this internship, we will focus on the recent developments that extend the navigation-function approach to topologically complex environments and time-varying destinations [3,4]. The student will evaluate and test numerically (MATLAB/Simulink) the designed algorithms on scenarios of interest for robotic and aerospace applications. A publication in an international conference or journal is expected.

Bibliography

1. E. Rimon and D. E. Koditschek, "Exact robot navigation using artificial potential functions," IEEE Trans. Robot. Automat., vol. 8, no. 5, pp. 501– 518, 1992.

2. S.G. Loizou, "The navigation transformation," IEEE Transactions on Robotics, 33(6), pp.1516-1523, 2017.

3. S.G Loizou, "Navigation functions in topologically complex 3D workspaces," Proceedings of the American Control Conference (ACC), pp. 4861-4866, 2012.

4. C. Li, H.G. Tanner, "Navigation functions with time-varying destination manifolds in star worlds,", IEEE Trans. on Robotics, pp. 35-48, 2019.

Est-il possible d'envisager un travail en binôme ? **Non**

Méthodes à mettre en oeuvre :

☒ Recherche théorique ☐ Travail de synthèse

☒ Recherche appliquée	☐ Travail de documentation
☐ Recherche expérimentale	☐ Participation à une réalisation
Possibilité de prolongation en thèse :	**Non**
Durée du stage : Minimum : 5 Mois	Maximum : 6 Mois
Période souhaitée : A partir de Février 2021	

PROFIL DU STAGIAIRE

Connaissances et niveau requis : - Automatique, mathématiques appliquées, robotique - Bon niveau rédactionnel - Bon niveau d'anglais - Outils de CAO et/ou de simulation (Matlab/Simulink, C++, Python)	Ecoles ou établissements souhaités : Master 2 Recherche et/ou dernière année d'école d'ingénieur avec spécialisation en automatique, robotique, mathématiques appliquées