

PROPOSITION DE SUJET POUR UN CONTRAT DOCTORAL

<p><u>Laboratoire</u> Laboratoire MIA</p>
<p><u>Titre de la thèse</u> Fuzzy Graph Representation Learning: Applications to Computer Vision for Environmental Preservation</p>
<p><u>Direction de la thèse</u> <i>directeur-trice-s (grade, HDR) et éventuels co-directeur-trice-s</i> T. Bouwmans (MCF HDR, MIA, LRUniv), A.Zakharova (MCF, MIA, LRUniv)</p>
<p><u>Adéquation scientifique avec les priorités de l'établissement</u> Préservation environnement maritime (LUDI)</p>
<p><u>Descriptif du sujet</u> <i>(enjeux scientifiques, applicatifs, sociétaux...)</i> Graph Signal Processing (GSP) techniques gained quite a popularity in the two decades. In this rise of GSP since 2017, different data processing tasks (such as inpainting, denoising, compression, etc) were adapted to graph irregular structure, accompanied by generalization of standard data techniques. In particular, Fourier transform, wavelets and Gabor frames were adapted in order to process signals on networks. This naturally leads us to an idea that GSP could also be a suitable tool for moving objects detection of interests in surface (ground, maritime) and underwater scenes in order to control human activities or to control the biodiversity, and image registration which consists in the alignment of images. For environmental preservation, image registration can be used to optimize road scene analysis for self-driving cars. In literature, the data representation used for moving objects detection and image registration are diverse. Supposing that the given data is organized in a form of graph, we aim to study the resulted problem. The main difficulty is that the space associated with a graph is non-euclidean. This could be overcome by introducing the notion of a translation on a graph in various ways. In addition, relations in the graph are crisp relations neglecting the presence of imprecision, uncertainty and incompleteness in the data as in moving objects detection. Thus, in this thesis we propose to focus on fuzzy graph representations as ones that can provide a good description of geometrical structures of data domains, where the connections and edge weights between two nodes are inspired by the particularity of the problem.</p>
<p><u>Contexte partenarial</u> <i>(cotutelle internationale, EU-CONEXUS, partenariat avec un autre laboratoire, une entreprise...)</i> UdeA (Colombia)</p>
<p><u>Impacts</u> <i>(scientifiques, technologiques, socio-économiques, environnementaux, sociétaux...)</i> Préservation environnement maritime</p>
<p><u>Programme de travail du doctorant</u> <i>(tâches confiées au doctorant)</i> The contributions of this PhD thesis will address the following points:</p> <ol style="list-style-type: none"> 1. An accurate problem formulation for a MOD method and an image registration method based 2. on fuzzy graphs using different notions of translation. 3. Efficient computational methods of MOD and image registration based on fuzzy graphs representation to address the challenges met in these fields. 4. Applications in environmental preservation in the context of LUDI research interests

Calendrier de réalisation

01 September 2025 – 01 September 2028: Bibliography + step 1 up to 4 + redaction

Accompagnement du doctorant / Fonctionnement de la thèse (*accompagnement humain, matériel, financier, en particulier pour la prise en charge du fonctionnement de la thèse et des dépenses associées*)

The applicant should have skills in machine learning and computer vision. For his PhD, he will benefit of the experience of the supervisors in the field of GSP and GNNs. The research will be conducted at the MIA Laboratory. In addition, the applicant will benefit of the European Label with a stay of 3 months in an european laboratory. Finally, he will be associated to a project with UdeA (Colombia) in a project ECOS-NORD