Offre n°2024-07513

PhD Position F/M 3D Computer Vision and geometry processing

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 Université Côte d'Azur includes 37 research teams and 8 support services. The centre's staff (about 500 people) is made up of scientists of different nationalities, engineers, technicians and administrative staff. The teams are mainly located on the university campuses of Sophia Antipolis and Nice as well as Montpellier, in close collaboration with research and higher education laboratories and establishments (Université Côte d'Azur, CNRS, INRAE, INSERM ...), but also with the regiona economic players.

With a presence in the fields of computational neuroscience and biology, data science and modeling, software engineering and certification, as well as collaborative robotics, the Inria Centre at Université Côte d'Azur is a major player in terms of scientific excellence through its results and collaborations at both European and international levels.

Mission confiée

Efficient data structures and algorithms for processing massive point clouds

Context
Analyzing 3D point clouds captured from real-world environments is a core component of Geometry. Processing and 3D Computer Vision. Processing tasks include, for instance, the estimation of local geometric properties, semantic segmentation, extraction of geometric primitives or reconstruction into surface meshes. Algorithms that perform these tasks are typically designed to handle up to a few million points efficiently [1,2]. With the technological advances on sensors and storage capacity, new acquisition protocols generate more and more massive point clouds that contain billions of points. The naive solution then consists in decomposing the space into blocks of reasonable number of points before performing parallel computing. This solution is however prone to border effect errors and does not allow the analyze of point clouds at global scales. Moreover, it requires high computing resources and storage capacity.
Scaling point cloud processing algorithms to billion points without naïve block decomposition is a challenging scientific problem. Among existing works, streaming methods that process data on the fly have been designed towards this goal. They however are tailored made for specific applications [3,4] and cannot be generalized easily to a generic toolbox. Other methods, e.g. [5], operate block decomposition by focusing on border effect reduction. Besides these strategies, the nature of the data structure that encodes input points is also a central question. For visualization applications for instance, octrees constitute a popular choice as levels of details for rendering points can be easily defined by this hierarchical structure [6,7].

Objectives
The goal of this PhD is to (i) investigate new data structures to read, compress and store the information contained in massive point clouds efficiently, and (ii) to rethink popular processing tasks so that they can operate at multiple scales directly from such data structures.
The candidate will study the potential of different space partitioning data structures that can be built efficiently in a hierarchical way and from which information can be stored and requested easily. He/she will also propose compression operations to convert clusters of input points into lightweight geometric objects, and clusters of these geometric objects into single one. The choice of geometric objects will have to account for representation genericity, compactness and efficiency to connect and aggregate them. Prior work shows, for example, that planar components (which are frequent in urban environments) can be turned into a hierarchy of floating polygons with a limited loss of information. Similarly, the notion of "superpoints" introduced in [9] could also be a solution for compressing non-planar components.
The candidate will also revisit some traditional point cloud processing tasks such as estimation of local geometric properties, surface reconstruction or primitive detection under the idea that the atomic geometric element is not a 3D point anymore, but geometric object living at a given scale of the data structure. Continuing on the previous example with polygons and superpoints, planar shape detection could be simply addressed by selecting polygons in the hierarchy of the data structure, and surface reconstruction, by assembling the geometric objects with a space partition.
The candidate will also investigate the potential of the proposed data structures in recent 3D deep

learning architectures which still largely suffer from scalability issues. In particular, the proposed data structures could be an effective alternative to the very coarse simplification of input point clouds [10].

Keywords
Geometry processing, 3D computer vision, massive point clouds, point set processing, geometric data structures

References
[1] The CGAL Project. CGAL User and Reference Manual. CGAL Editorial Board, 5.5.1 edition, 2022.
[2] CloudCompare, version 2.10.3, 2022.
[3] Pajarola. Stream-Processing Points. IEEE Visualization 2005
[4] Zhou and Neumann. A streaming framework for seamless building reconstruction from large-scale aerial lidar data. CVPR 2009
[5] Mostegel, Prettenthaler, Fraundorfer and Bischof. Scalable Surface Reconstruction from Point Clouds with Extreme Scale and Density Diversity. CVPR 2017
[6] Schütz, Ohrhallinger, Wimmer. Fast Out-of-Core Octree Generation for Massive Point Clouds. Computer Graphics
Forum, vol 39(7), 2020
[7] Elseberg, borrmann and Nuchter. One billion points in the cloud – an octree for efficient processing of 3D laser scans. ISPRS Journal of Photogrammetry and Remote Sensing, vol 76, 2013
[8] Fang, Lafarge, and Desbrun. Shape detection at structural scales. CVPR 2018
[9] Landrieu and Simonovsky. Large-scale Point Cloud Semantic Segmentation with Superpoint Graphs. CVPR 2018
[10] Potamias, Bouritsas and Zafeiriou. Revisiting Point Cloud Simplification : A Learnable Feature Preserving Approach. ECCV 2022

More information can be found athttps://team.inria.fr/titane/files/2024/03/sujet_Massive_PCP.pdf

Compétences

The ideal candidate should have good knowledge in 3D geometry and computer vision, be able to program in C/C++ and Python, be fluent in English, and be creative and rigorous.

Avantages

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of 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

Rémunération

Duration: 36 months
Location: Sophia Antipolis, France
Gross Salary per month: 2100€ brut per month (year 1 & 2) and 2190€ brut per month (year 3)

Informations générales

- **Thème/Domaine :** Interaction et visualisation
  Calcul Scientifique (BAP E)
- **Ville :** Sophia Antipolis
- **Centre Inria :** Centre Inria d'Université Côte d'Azur
- **Date de prise de fonction souhaitée :** 2024-10-01
- **Durée de contrat :** 3 ans
- **Date limite pour postuler :** 2024-05-19

Contacts

- **Équipe Inria :** TITANE
- **Directeur de thèse :**
  Lafarge Florent / Florent.Lafarge@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.

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

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.