2019-01391 - PhD Position F/M PhD position on Computer Vision and Computer Graphics: Remeshing urban-specific CAD formats

Type de contrat : CDD de la fonction publique
Niveau de diplôme exigé : Bac + 5 ou équivalent
Fonction : Doctorant

A propos du centre ou de la direction fonctionnelle

The Inria Sophia Antipolis - Méditerranée center counts 37 research teams and 9 support departments. The center's staff (about 600 people including 400 Inria employees) is composed of scientists of different nationalities (250 foreigners of 50 nationalities), engineers, technicians and administrators. 1/3 of the staff are civil servants, the others are contractual. The majority of the research teams at the center are located in Sophia Antipolis and Nice in the Alpes-Maritimes. Six teams are based in Montpellier and a team is hosted by the computer science department of the University of Bologna in Italy. The Center is a member of the University and Institution Community (ComUE) "Université Côte d'Azur (UCA)".

Mission confiée

Context

3D models of buildings are deeply used for imagining new constructions, analyzing existing sites as well as operating physical simulations to optimize, for instance, the energetic properties of a building. Practitioners use different formalisms as CityGML [1] developed for Geographical Information System (GIS) applications or IFC [2] devoted to Building Information Modeling (BIM). Because the geometry, the topology and the semantics related to these representations significantly differ, there is a dire need for as-automatic-as-possible tools able to transpose a formalism into another. Moreover, the 3D models exploited by practitioners frequently contains topological errors and geometric imprecisions. The correction of these imprecisions is also a crucial problem for operating simulation tasks, and globally speaking, for democratizing BIM models.

Existing works for converting urban-specific formalisms and repairing CAD models usually relies on heuristics-based mechanisms in which decisions for snapping and labeling surface or volume elements are made locally by thresholding operations [3,4,5]. These methods are usually poorly robust to the diversity and complexity of buildings. At least, they require fastidious trial-and-error tuning of the numerous parameters that control the quality of the output models.

Objectives

The main objective of this PhD thesis is to design as-automatic-as-possible algorithms for repairing and converting BIM models of buildings in different urban-specific CAD formats. Contrary to existing works, we want to develop a methodology without local snapping operations and heuristic-based decisions in order to robustly correct geometry and identify semantics. The key idea we plan to explore consists in creating an intermediate representation that partitions the 3D space into surface and volume elements. These elements will later be regrouped to constitute semantic objects and reintroduced into BIM models. Such an idea has been exploited by [3] with combinatorial maps. However, the construction of these geometric data-structures is a complex and usually unstable process based on local heuristics. To the contrary, we want to exploit a kinetic framework in which input polygonal facets expands in a natural and global way until forming a partitioning of the 3D space into polyhedra. Recent works [6] in the Titane team has demonstrated the efficiency of such a framework for computer vision problems and for reconstructing polygonal surface meshes from 3D data measurements.

Several research directions will be investigated during the project:

Extend the kinetic framework developed in the Titane research team to operate on different urban-specific CAD formats. The input CAD model will be decomposed into a soup of polygonal facets. Each polygonal facet will inherit from the semantic information given by the original format. Redundant facets will be detected and removed before operating the kinetic propagation from remaining facets.

Identify semantics in the kinetic partition. We will regroup volume and/or surface components of the kinetic partition by semantic similarity. Inspired by recent works [7], we will exploit knowledge inherited from the input data combined with supervised strategies that are able to learn urban-specific formalisms. In particular, we will investigate deep learning architectures operating on graphs to identify the semantics on the components of the kinetic partition. BIM models created interactively by design software will be a precious source of knowledge to create training datasets.

Remeshing the input CAD model. After associating a semantic label with each volume and surface component of the kinetic partition, we will propose a strategy to remesh each semantic object of the scene individually while guaranteeing a spatially-coherent connection in between objects.

Keywords

geometry processing, BIM, remeshing, semantic segmentation, deep learning, buildings, CAD models, IFC, CityGML

References

[1] G. Groger and L. Plumer. CityGML – Interoperable semantic 3D city models. *Journal of Photogrammetry and Remote Sensing (JPRS)*, Vol. 71, 2012

[2] Sharing your model with IFC: an introduction. In VectorWorks architech, 2018

[3] A. Diakite. Application des cartes combinatoires à la modélisation géométrique et sémantique des bâtiments. Phd thesis, Université of Lyon, 2015

[4] T. Kang and C. Hong. IFC-CityGML LOD Mapping Automation based on Multi-Processing. Proc. of

Informations générales

- **Thème/Domaine :** Interaction et visualisation
  Calcul Scientifique (BAP E)
- **Ville :** Sophia Antipolis
- **Centre Inria :** CRI Sophia Antipolis - Méditerranée
- **Date de prise de fonction souhaitée :** 2019-09-01
- **Durée de contrat :** 3 ans
- **Date limite pour postuler :** 2019-05-31

Contacts

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A propos d'Inria

Inria, l'institut national de recherche dédié aux sciences du numérique, promeut l'excellence scientifique et le transfert pour avoir le plus grand impact. Il emploie 2400 personnes. Ses 200 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3000 scientifiques pour relever les défis des sciences informatiques et mathématiques, souvent à l'interface d'autres disciplines. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 160 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.

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 :
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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.

ISARC, 2015

[5] J. Cheng, Y. Deng and Q. Du. Mapping between BIM models and 3D GIS city models of different levels of detail. International conference on construction applications of virtual reality, 2013

[6] J.-P. Bauchet and F. Lafarge. KIPPI: Kinetic Polygonal Partitionning of Images. In CVPR, 2018

[7] H. Fang, F. Lafarge and M. Desbrun. Planar shape detection at structural scales. In CVPR, 2018

More details can be found at https://team.inria.fr/titane/files/2019/03/Phd_CAD_remeshing.pdf

Compétences

The ideal candidate should have good knowledge in geometry processing, computer vision and applied mathematics. He/she should be able to program in C/C++, be fluent in English, and be creative, rigorous and highly motivated.

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: 1982€brut per month (year 1 & 2) and 2085€ brut/month (year 3)