[1] Centre National d'Etudes Spatiales, Toulouse, France, [2] IGN, Paris, France, [3] ONERA, Paris, France, [4] CS-SI, Toulouse, France
[5] AIRBUS DS Intelligence, Toulouse, France, [6] GEOSAT, Bordeaux, France, [7] QuantCube, Paris, France, [8] CLS, Toulouse, France
http://ai4geo.eu

AI4GEO : A DATA INTELLIGENCE PLATFORM FOR 3D GEOSPATIAL MAPPING

Overview

The availability of 3D Geospatial information is a key issue for many expanding sectors such as autonomous vehicles, business intelligence and urban planning. The AI4GEO[1] is a consortium between institutional partners (CNES, IGN, ONERA) and industrial groups (CS Group, AIRBUS Defense and Space, CLS, GEOSAT, QUANTCUBE) that aims at providing automatically land cover map and 3D urban reconstruction from very high resolution and temporal satellite multi-view images at large scale. Over the last few decades, manual fastidious interventions have been needed for providing these products. Within AI4GEO project new artificial intelligence and big data technologies are studied to solve this issue by developing full automatic pipeline.

Project Initiative

The project is structured around 2 axes :

Axe 1 (CNES, IGN, ONERA)

Developing a set of building blocks allowing the automated production of qualified 3D maps using artificial intelligence approaches.

Axe 2 (CS Group, AIRBUS Defense and Space, CLS, GEOSAT, QWANT, QUANTCUBE)

Deriving from these technological bricks a variety of new services : Environment, economic intelligence, smart cities, autonomous vehicles, etc.

Introduction

Context

- Massive volumes of satellite imagery (High temporal/spatial resolution)

Objectives

- High spatial resolution land cover classification
- Change detection
- 3D urban mapping

Challenges

- Maintaining IA performance over different areas of the world
- Development of full automatic End-to-End pipeline
- Handling limited amount of ground truth / Lack of quality data

Post-doctoral project

The objective of this post-doctoral work is based on two main axes: semantic segmentation for the production of land use maps and the production of 3D information. Indeed, we focus on the extraction of georeferenced building in order to propose a 3D representation with different levels of detail (Lod0-1-2).

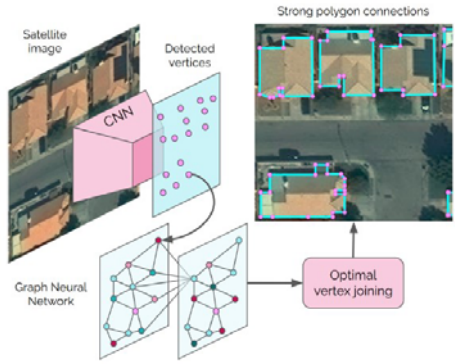
This poster focuses on an existing end-to-end method of extracting buildings from a very high resolution optical satellite image and adjusting their contours to provide their LOD0 representation. This method relies on a complex chain of neural networks to produce regularized polygons of buildings. It is based on innovative AI architectures such as GNNs and attention mechanisms. In the first part of this post-doc, my research focuses on the adaptation and improvement of this methods to process Pleiades images.

Methodology and Results

Polyworld

Polygonal object extraction with **PolyWorld**. The method uses a CNN backbone to detect vertex candidates from an image, and aggregates the information of the visual descriptors exploiting a graph neural network. The connections between vertices are generated solving a differentiable optimal transport problem.

Pipeline



Results

Inference are carried out on Pleiades images where the model is learned on CrowdIA dataset.

✓ *Preliminary results are encouraging*

× *Problem of under-detection*

↓

Need to retrain the model on Pleiades images

Training dataset

The data were sourced from Pléiades satellites. The satellite provide high spatial resolution images, ortho-rectified and resampled at 0.5 m.

- Construction of a ground truth dataset
  - Mask of building vertex positions:

Extraction of building vertices and decimating the polygons to fewer points using Douglas-Peucker algorithm.

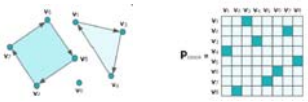
  - Buildings semantic GT

Digitanie database providing precise labelisation. Here the a binary mask of buildings polygons is generated.

- Angles of building vertices

After creating the ground truth of building vertices, the angle $\bar{p}_{u,v,w}$ between each 3 consecutive points u, v and w is computed and stored on structure.

- Permutation matrix **P**: describes the connection between polygon vertices



Perspectives

To enrich the PolyWorld model, the use of physical sensor expertise can be considered for semantic extraction and 3D reconstruction of buildings. In particular, image acquisition angles and solar angle can be fed to the AI models. It will also be interesting to be able to detect shadows in the image and use this information to improve predictions of buildings.

References:
[1] P. M. Brunet, P. Lassalle, S. Baillarin, B. Vallet, A. Le Bris, et al.. AI4GEO: A data intelligence platform for 3D geospatial mapping. 2021 24th ISPRS Commission II: Imaging Today, Foreseeing Tomorrow, Jul 2021, Virtuel, France. pp.817-823