OUT-OF-CORE RESAMPLING OF GIGANTIC POINT CLOUDS

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Abstract

Nowadays, LiDAR scanners are able to capture complex scenes of real life, leading to extremely detailed point clouds. However, the amount of points acquired (several billions) and their distribution raise the problem of sampling a surface optimally. Indeed, these point clouds finely describe the acquired scene, but also exhibit numerous defects in terms of sampling quality, and sometimes contain too many samples to be processed as they are. In this work, we introduce a local graph-based structure that enables to manipulate gigantic point clouds, by taking advantage of their inherent structure. In particular, we show how this structure allows to resample gigantic point clouds efficiently, with good blue-noise properties, whatever their size in a reasonable time.

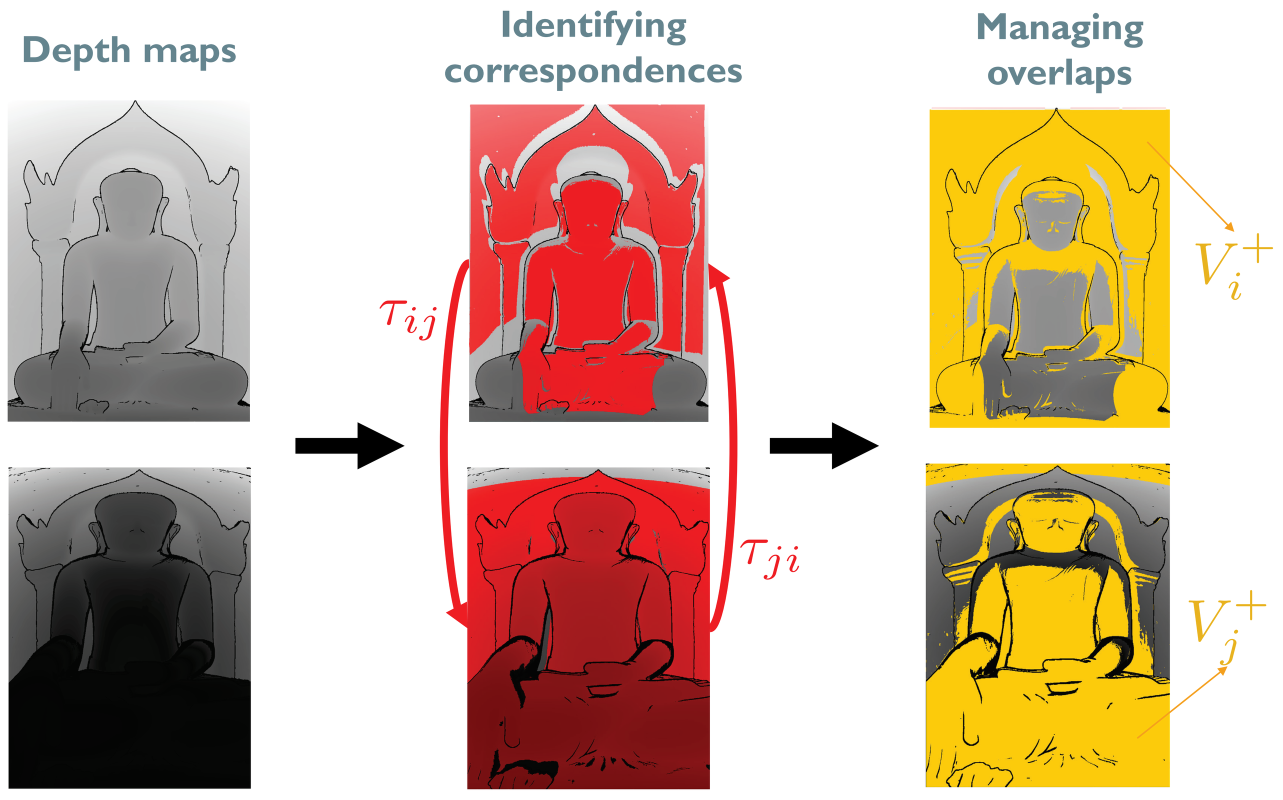
Problem statement

- It became quite easy to digitize large and complex 3D scenes via a set of terrestrial LiDAR acquisitions.
- Gigantic point clouds are then generated, exhibiting numerous defects in terms of sampling quality (overlapping regions, highly non-uniform distributions, etc.).
- Typical solution : constructing space partitioning trees to subdivide the 3D space containing a point cloud.
  - Those methods are unable to consider the local behavior of the surface described by the point cloud.
- Recently, [1] proposed to consider a graph to provide a discrete representation of the captured surface.
  - But this representation is hardly scalable (space complexity of the graph).
- We propose two contributions :
  - A local graph-based structure to represent a set of acquisitions of a digitization campaign
  - A resampling algorithm based on the proposed structure

The site *Wat Phra Si Sanphet, Ayutthaya (Thailand)* resampled with our graph-based approach. Only 2.8% of the original 5 billions points (156 acquisitions) have been kept.

Local graph-based structure

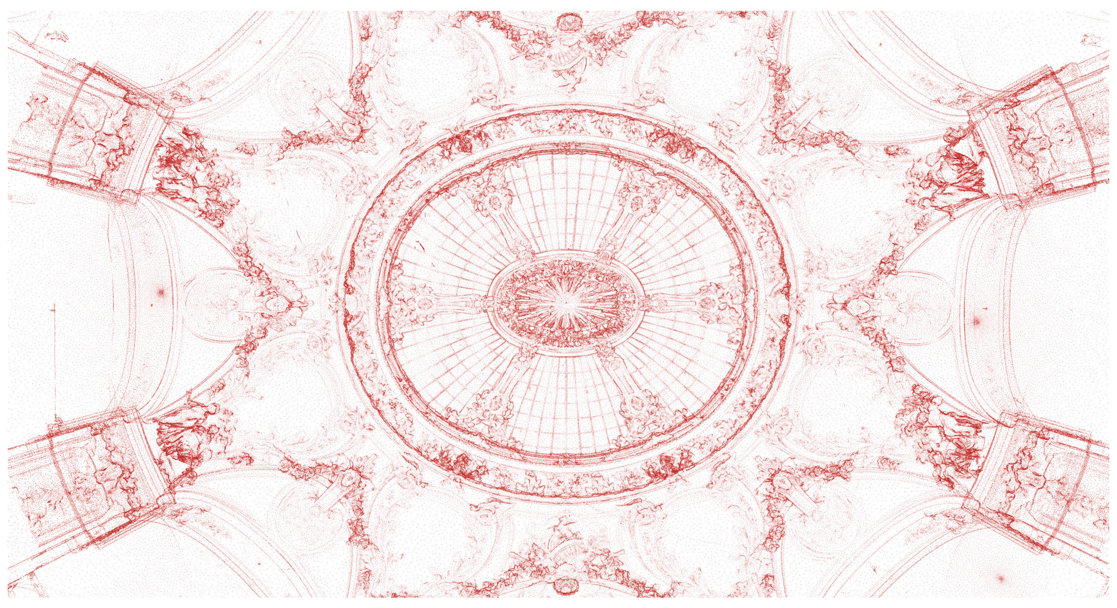
- Constructing a graph $G_i(V_i, E_i)$ from each acquisition
- Identifying correspondences between the different graphs using **transition functions** τ.
- A single acquisition can capture **up to hundreds of millions of points**.
  - Splitting a depth map into a set of **overlapping tiles**
  - Determining their respective transition functions τ (translations of the transition function of the original depth map)
  - Processing sets of tiles similarly to sets of acquisitions.
- Identification of the vertices with the highest sampling density
- In each graph G_i the set of identified vertices $V_i^+ \subseteq V_i$ is used for the computations, and the others fetch the results from other graphs.



Resampling gigantic point clouds

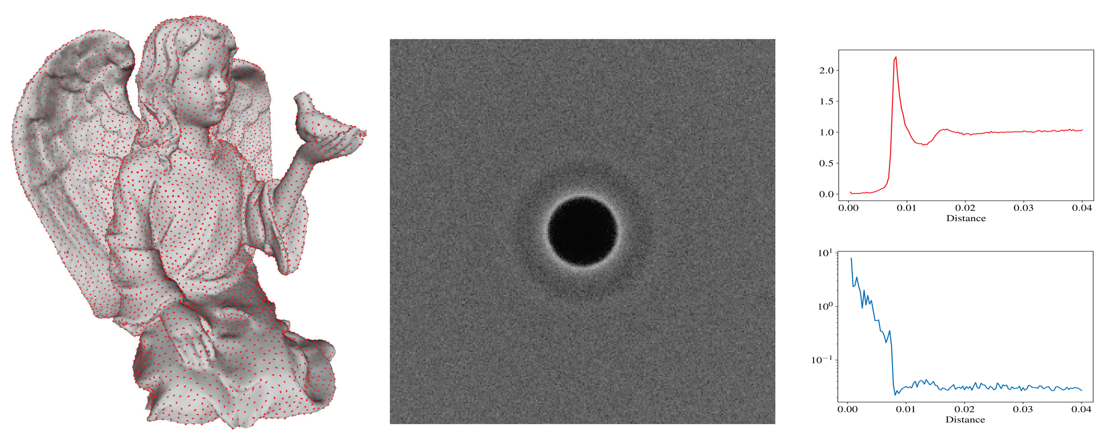
- **Maximal Poisson disk sampling** of a set of local graphs using a dart-throwing algorithm
- For each graph $G_i \in G = \{G_1, G_2, ...G_n\}$:
  - Maximally sample G_i by considering the vertices V_i^+ as the candidate samples;
  - For each other graph $G_j \in G, i \neq j$, the vertices V_j fetch the information of inclusion (or not) in a specific disk from their corresponding vertex in V_i.

Results



Resampling using a curvature-aware metric of the interior of *the Palais de la Découverte, Paris (France)*.

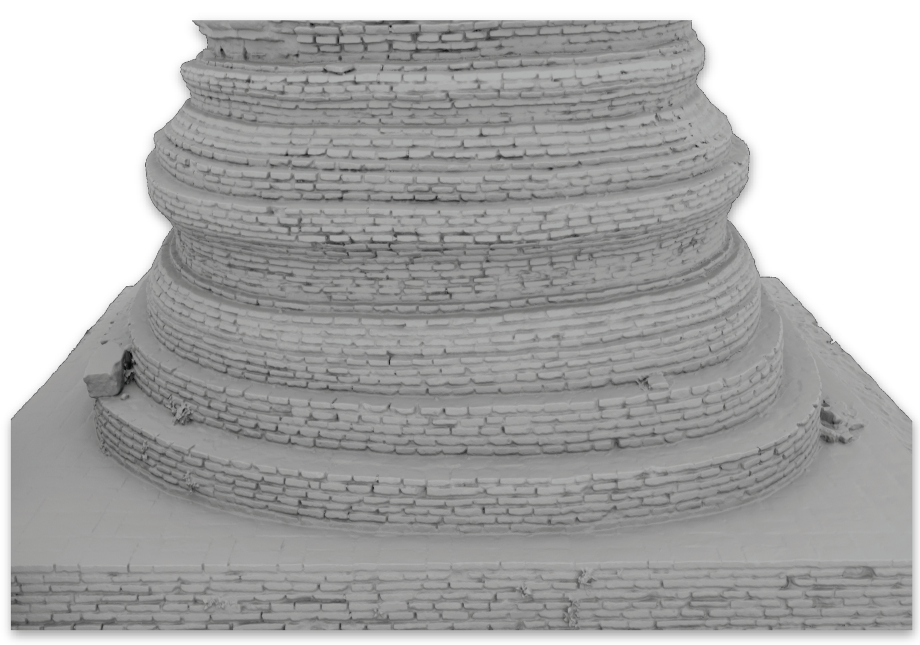
		Time (h:m) / Peak mem. (GB)	
Model	**#pts. (#acq.)**	**8192x8192**	**4096x4096**
Facade	977M (19)	00:59 / 6.1	01:36 / 2.1
Interior	2.0B (35)	02:38 / 7.5	06:55 / 2.0



Example of the quality of the resulting distributions (using [2]). RAPS in red and Anisotropy in blue.

Application to surface reconstruction

- Our resampling algorithm enables the use of surface reconstruction algorithms like [3].



Wat Phra Si Sanphet, Ayutthaya (Thailand).

Eim Ya Kyaung, Bagan (Myanmar).

Palais de la Découverte, Paris (France).

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