CLASSIFICATION AND INTEGRATION OF MASSIVE 3D POINTS CLOUDS IN A VIRTUAL REALITY (VR) ENVIRONMENT

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LowCost 3D - Sensors, Algorithms, Applications

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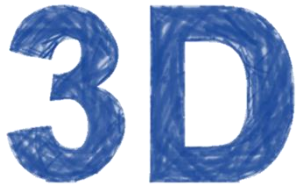
SUMMARY

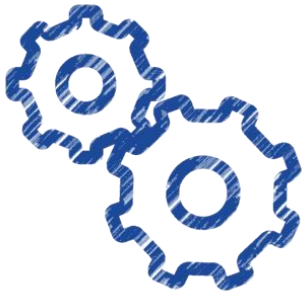
1. CONTEXT AND PROBLEMATIC
2. WORKFLOW
3. POINT CLOUD PROCESSING
    1. Segmentation
    2. Classification
    3. Structuration
4. VR APPLICATION & PERFORMANCES
5. DISCUSSION & PERSPECTIVE

CONTEXT

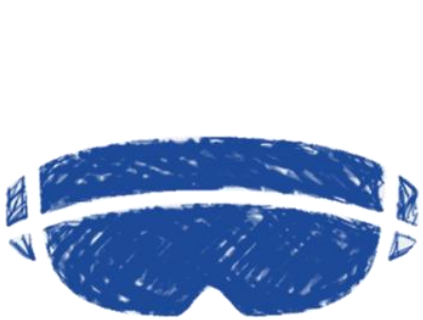
Acquisition tools



Massive point cloud



Processing algorithms
Computing power



New visualisation modes

PROBLEMATIC

1 Discrete sets of spatial data

2 Requirement for storage and processing capacities

3 Non-realistic aspect of point in VR

STEPS

Acquisition & preprocessing

Segmentation

Classification

Structuration in Potree's format

Implementation with Unity

Interface development

VR application with Oculus

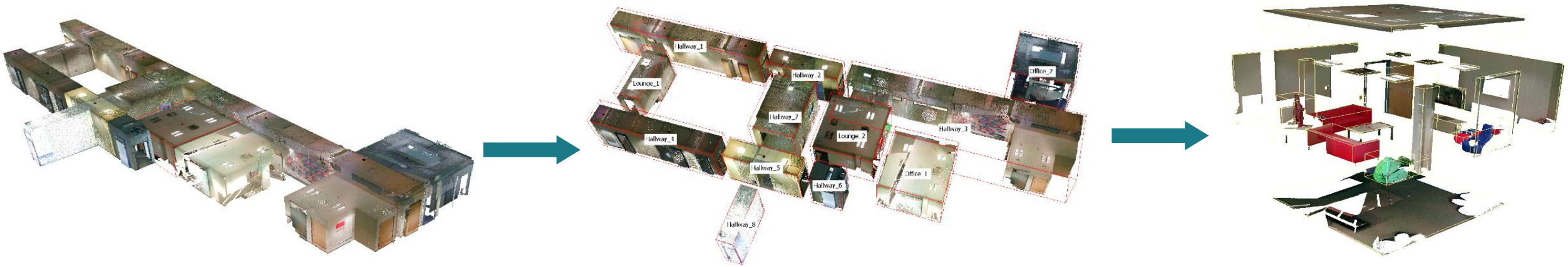
Performance test

Validation

POINT CLOUDS PRPCESSING

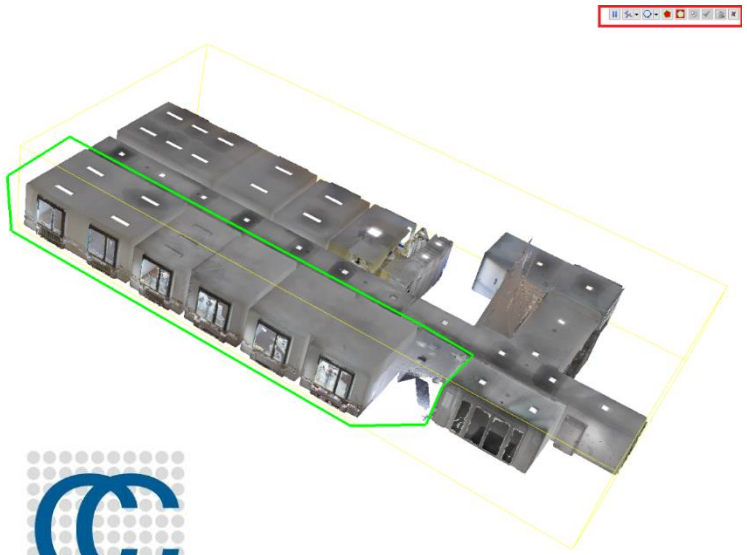
SEGMENTATION

Name	Number of points	Attribute	Sensor	Size Go
CHÂTEAU_JEHAY	2.300.247.428	RGB, intensity	Leica P30	69.636
PCID10_RTWH_Exterior	312.710.687	RGB, intensity	TLS	4,907
PCID11_RTWH_CHAIR	259.101.028	RGB, intensity	TLS	4,807
PCID2_ULG_B5a	115.190.236	RGB, intensity	TLS	3,824
PCID8_NAAVIS_1	44.847.540	RGB	NavVIS	0,657
PCID6_REVO	53.800.194	Without	REVO	0,630
PCID9_NAAVIS_2	4.244.416	RGB	NavVIS	0,062

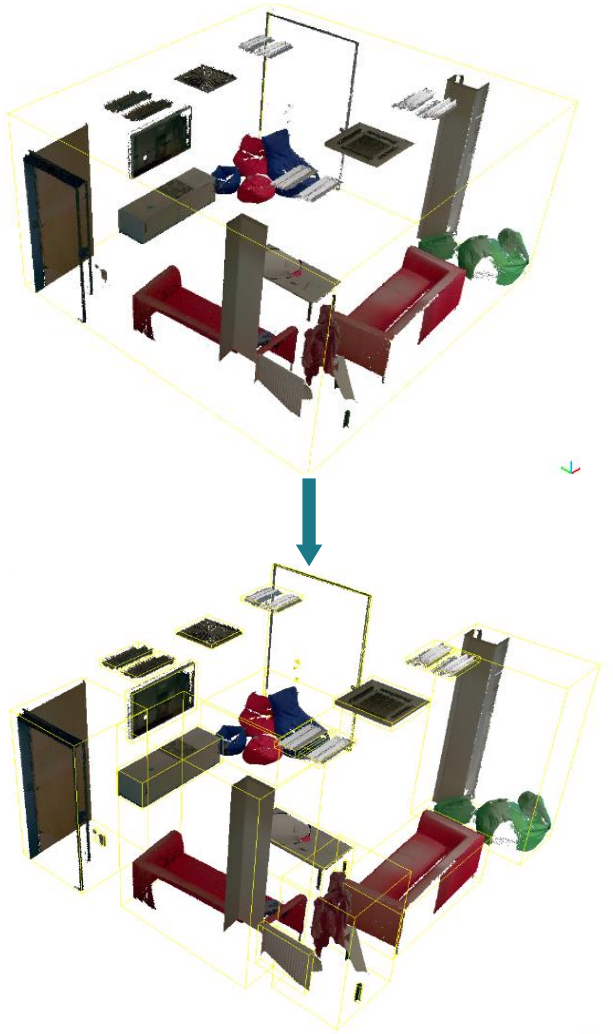


SEGMENTATION

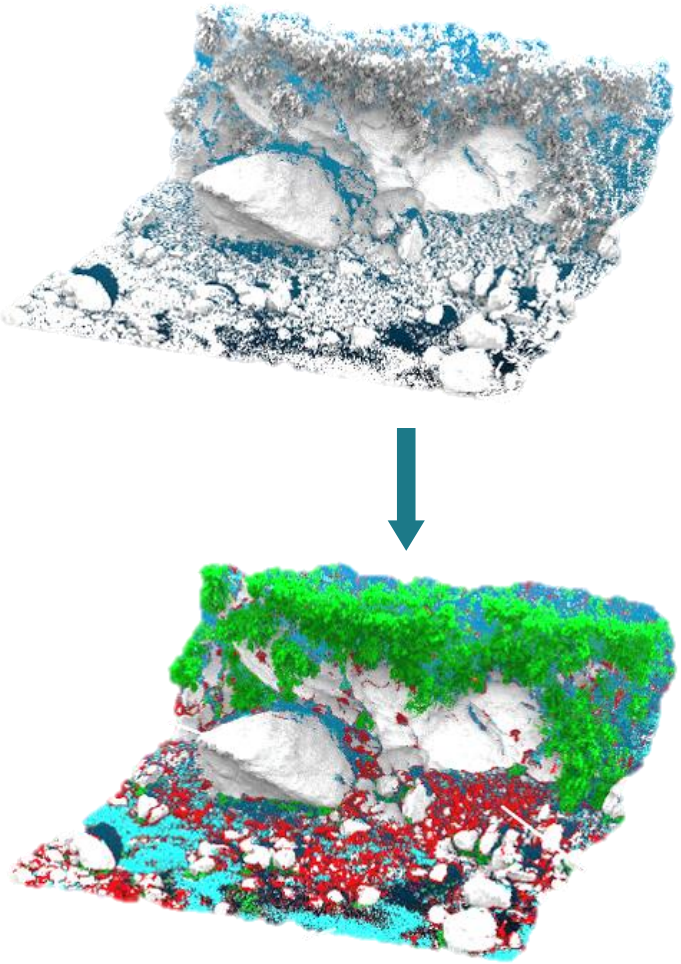
1. Manual segmentation



2. Label connected components

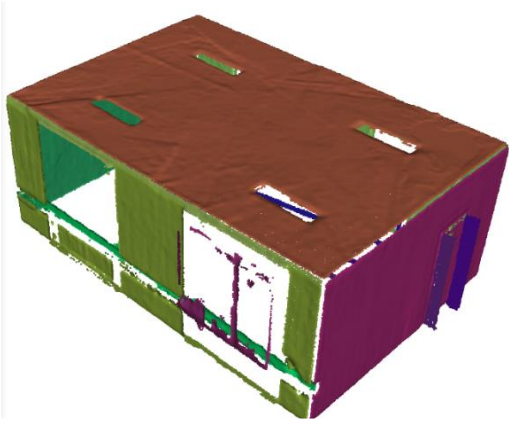


3. CANUPO

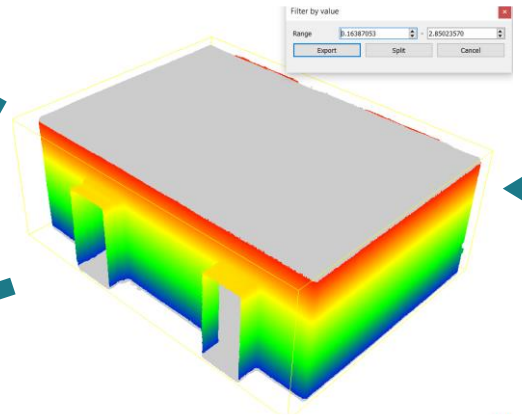


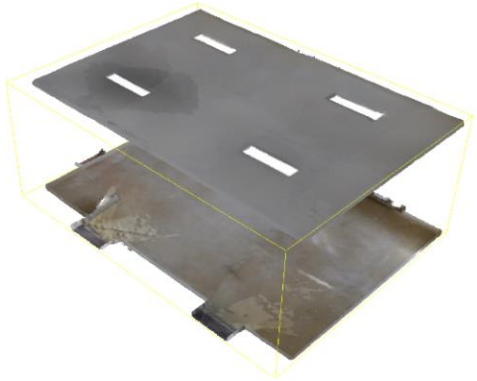
SEGMENTATION

6. RANSAC

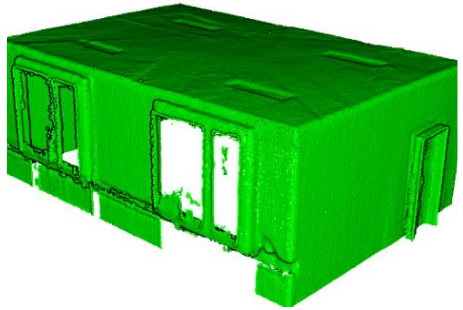


4. Histogram filtering





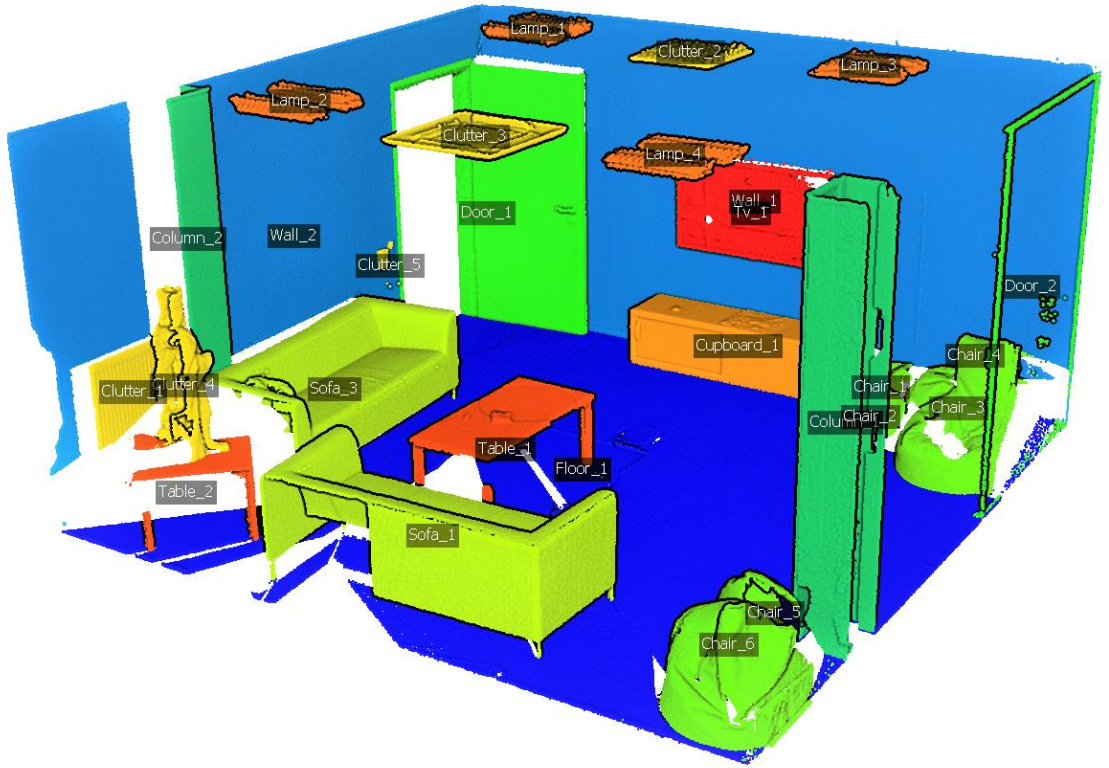
5. Cloth Simulation Filter



CLASSIFICATION

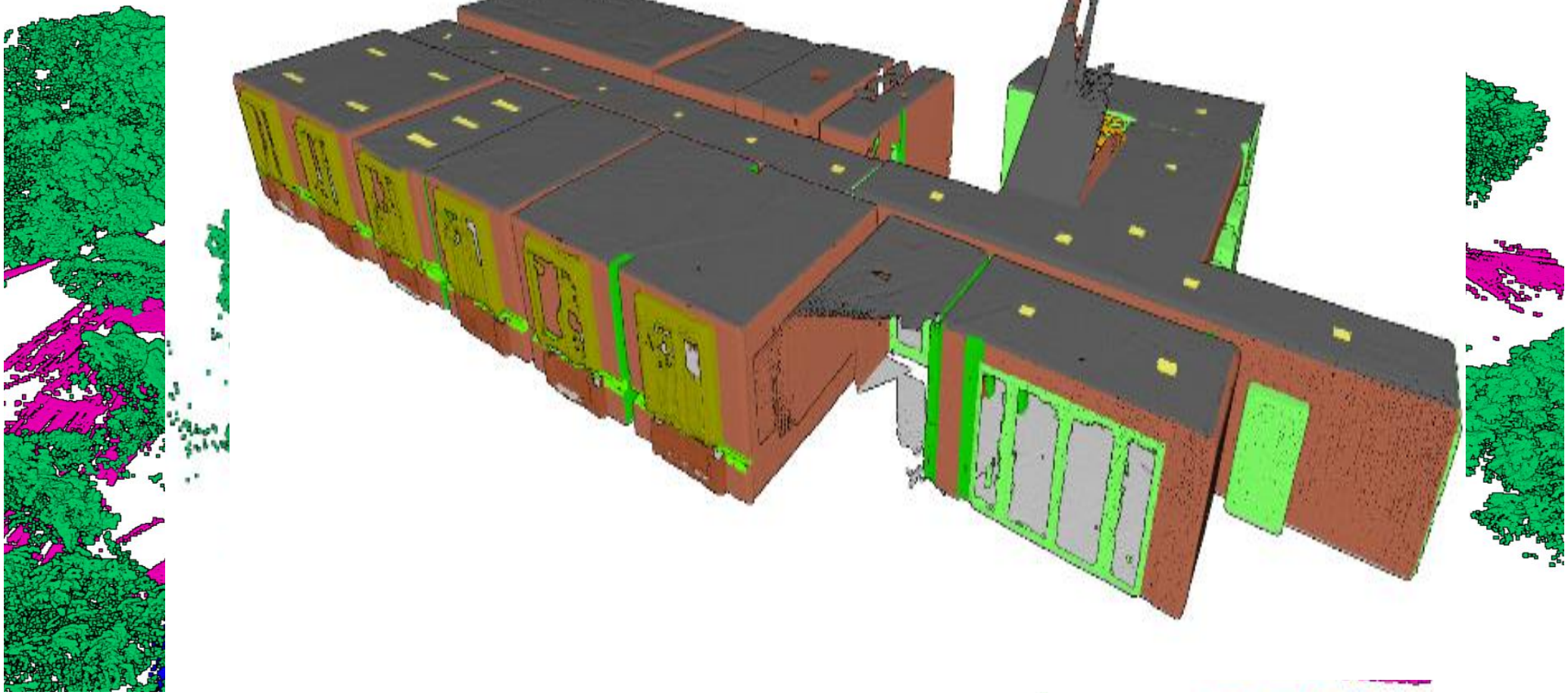
Indoor		Outdoor	
0	Floor	30	road_Sign
1	Ceiling	31	advertisingBoard
2	Wall	32	banc
3	Beam	33	bicycle
4	Column	34	bicycleStation
5	Window	35	Building_facades
6	Door	36	busStation
7	Table	37	car
11	Board	41	Humains
…	…	…	…

Format .LAS, ou bien .LAZ
Format specification .LAS version 1.2



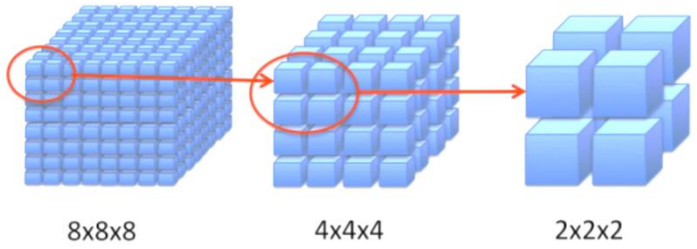
Example after classification

CLASSIFICATION

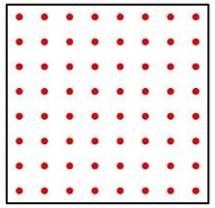


STRUCTURATION

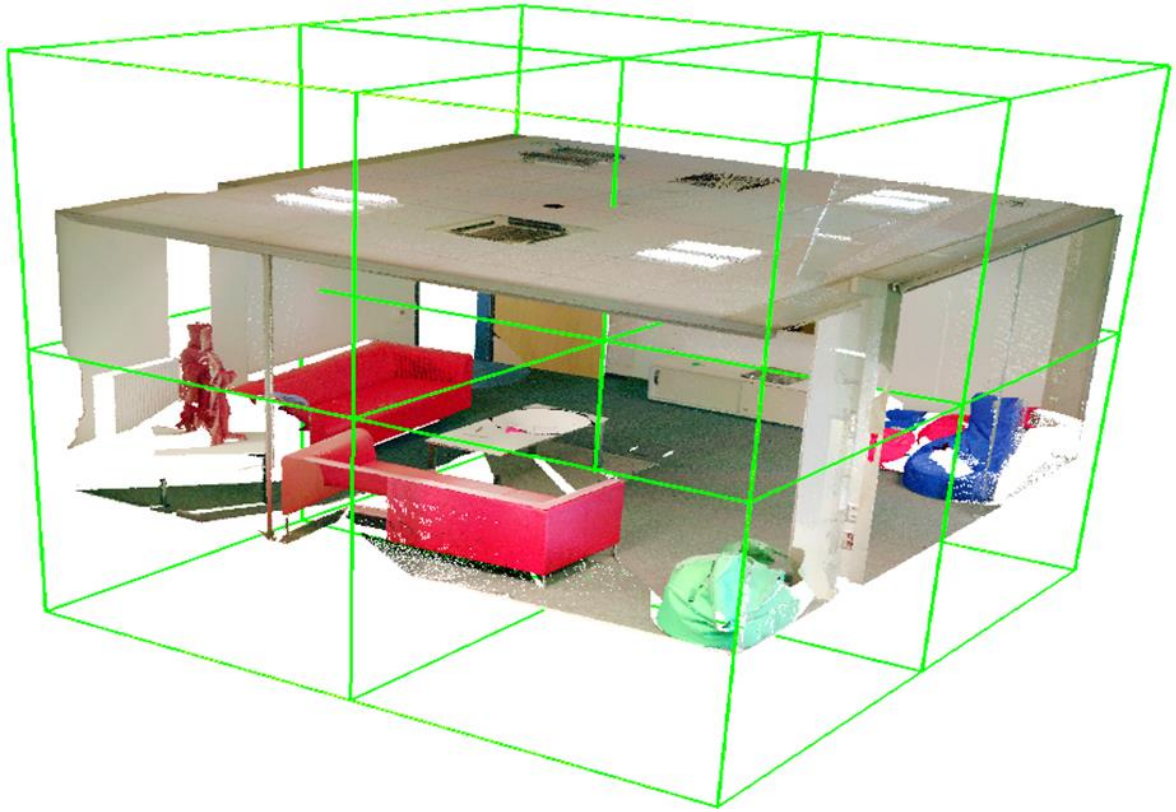
- Hierarchical multi-resolution structure
- Input-format .txt, .ply, .las, .laz
- Output-format .bin, .las, .laz



Potree.org
WebGL point cloud visualization

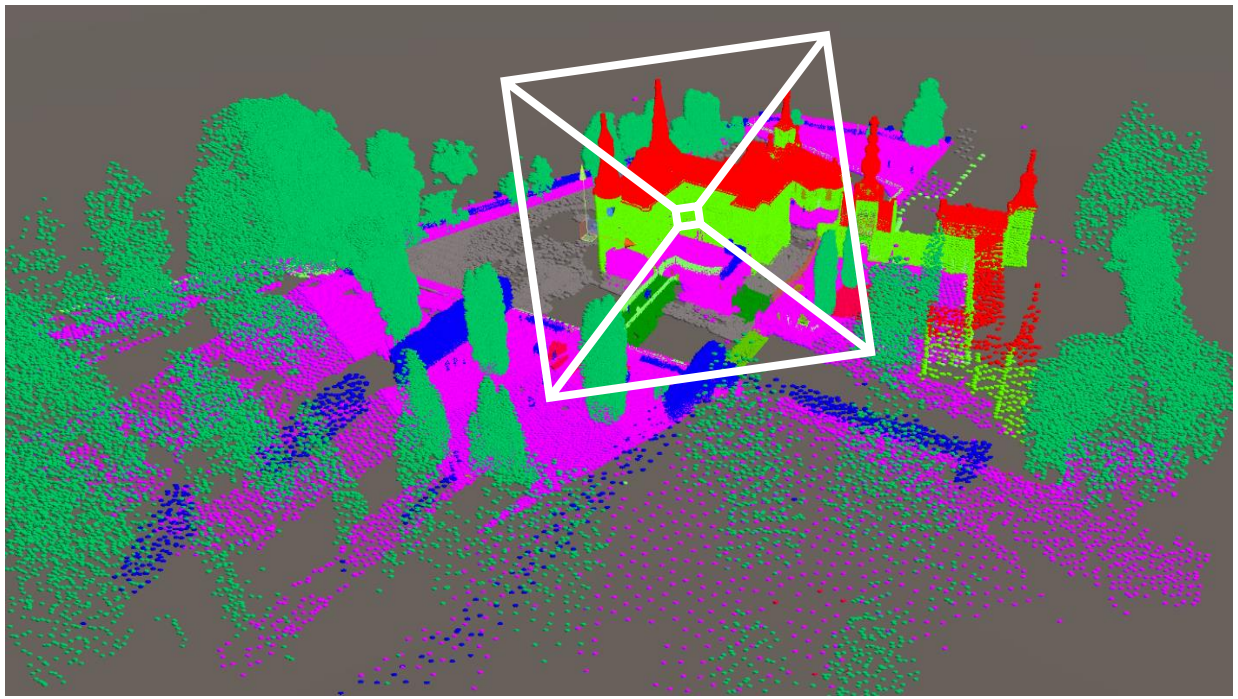


Raw point cloud data



VR APPILCATION

The loading process uses three threads: the Unity main thread, a traversing thread, and a loading thread. In the main thread, visible GameObjects are updated once per image if any necessary changes have been detected in the traversing thread.



Game objects are created for Octree nodes that should be visible and do not yet have game objects, nodes that should no longer be visible have their game objects removed.

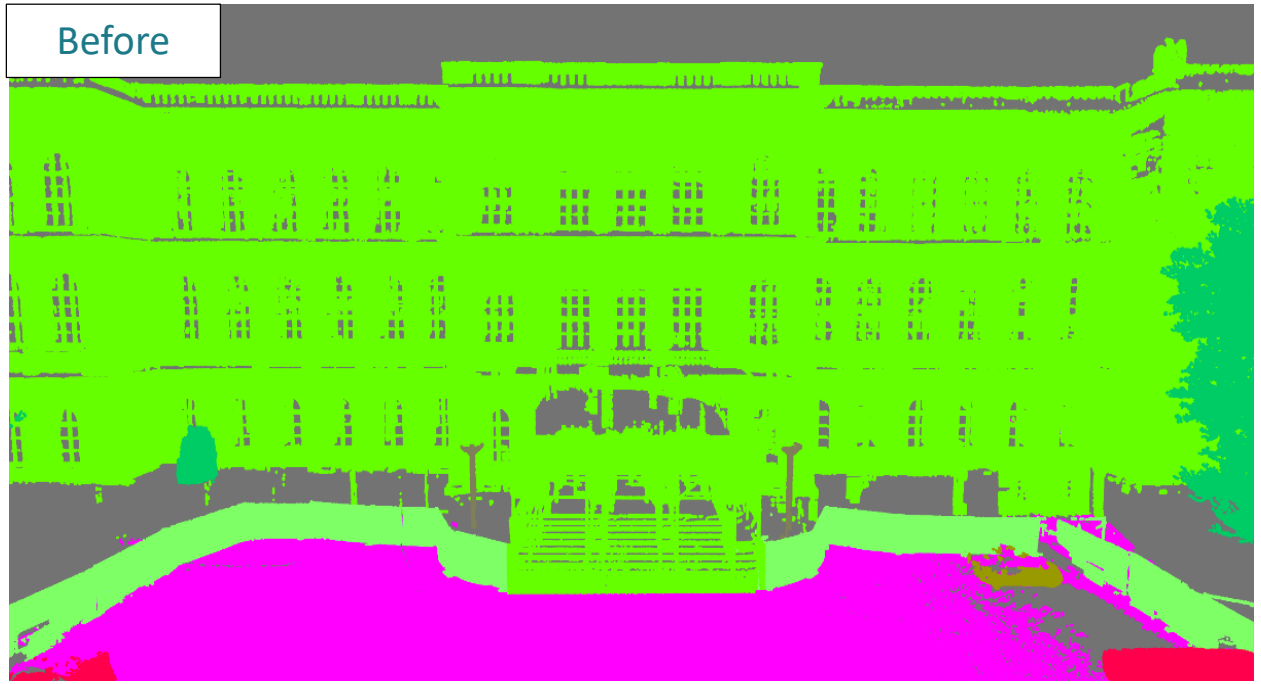
Determining which node the game objects should be created or deleted is the job of the traversing thread.

The loading thread is used to load point data from files,

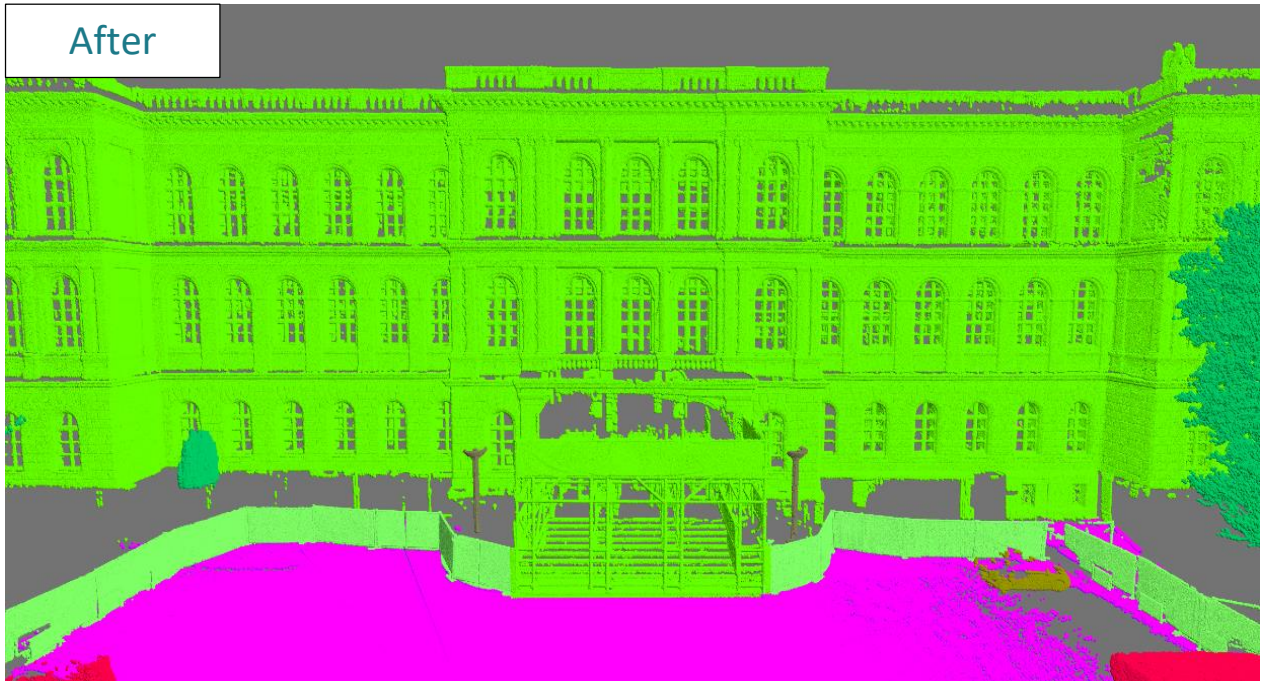
VR APPILCATION

Improved visual quality

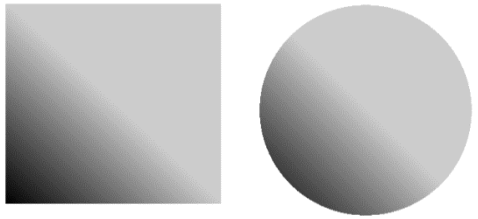
Before



After

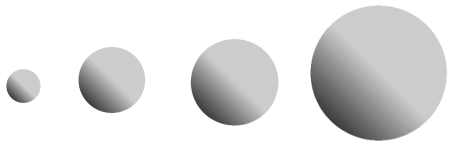


Shaders en Cg

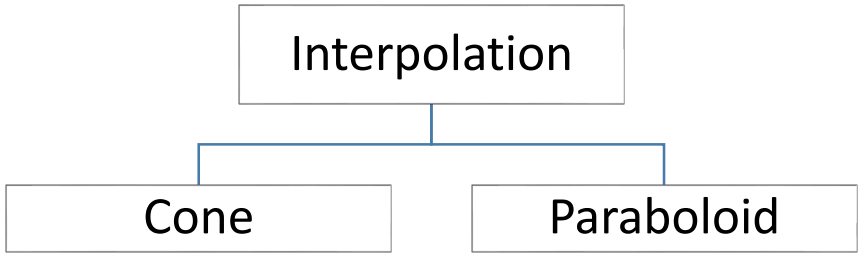


Square

Circle



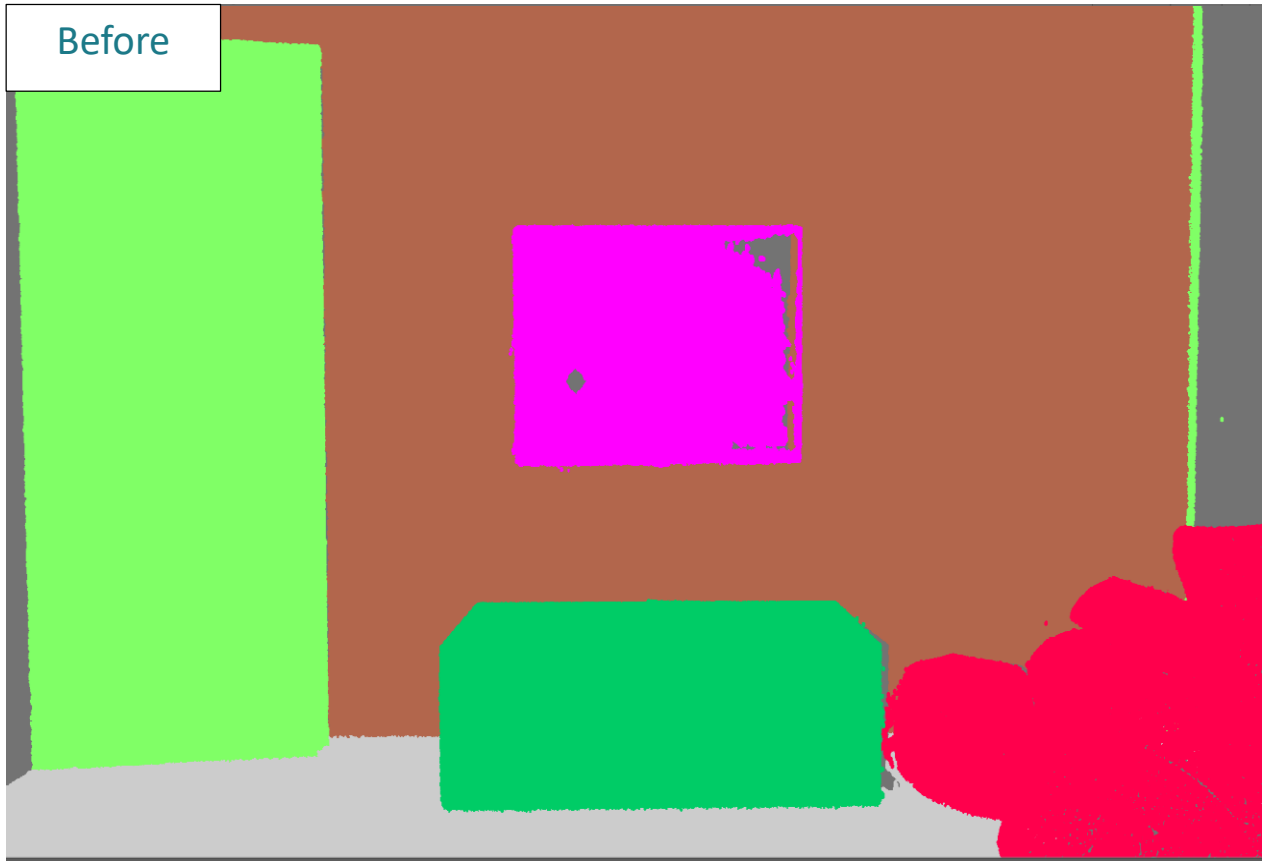
Variable size



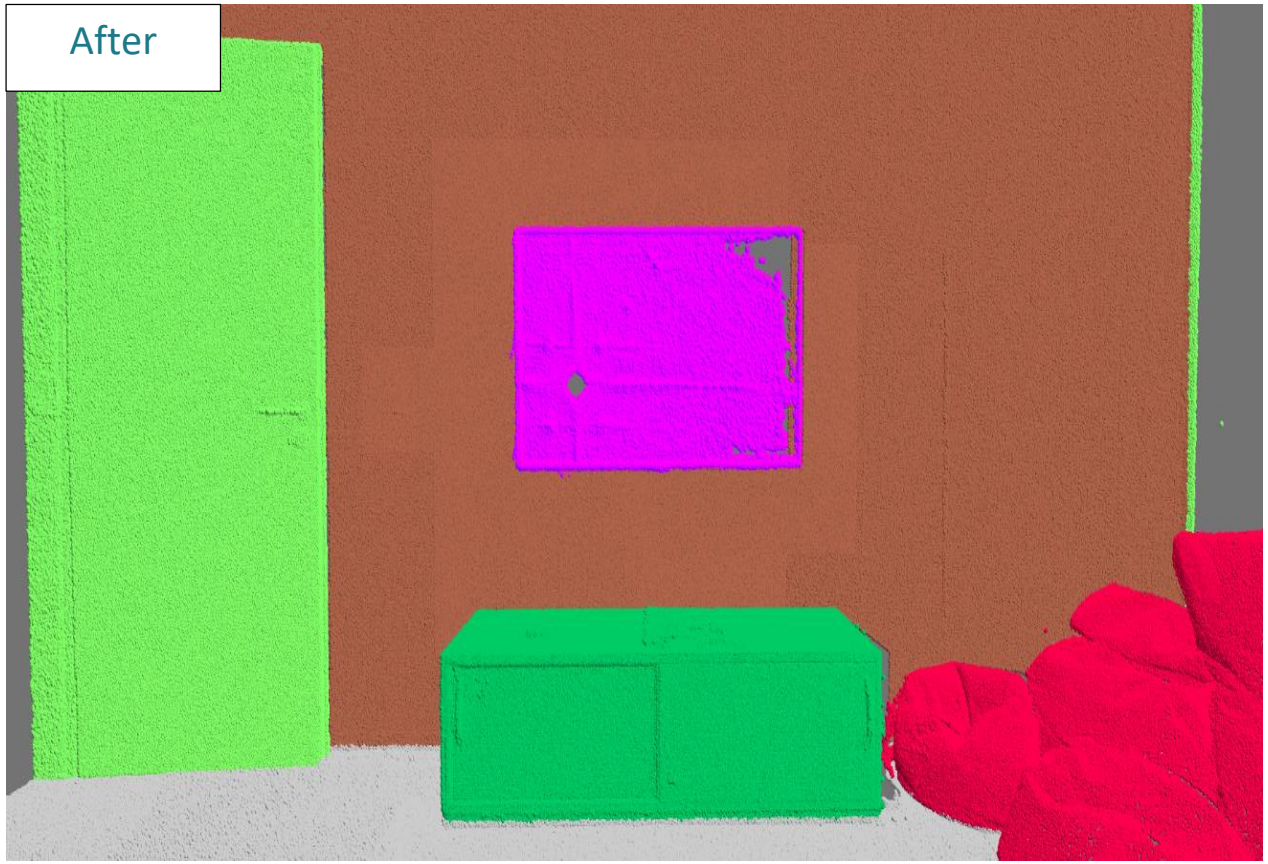
VR APPILCATION

Improved visual quality

Before

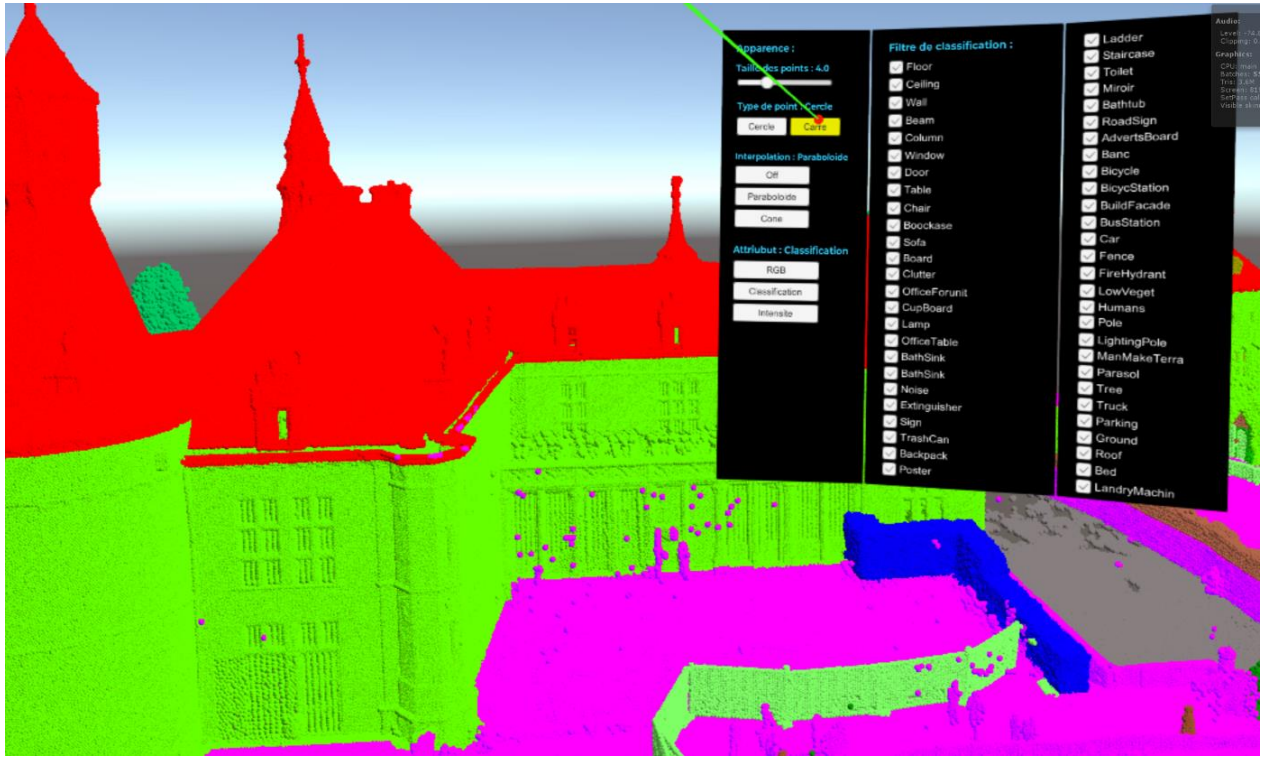


After



VR APPILCATION

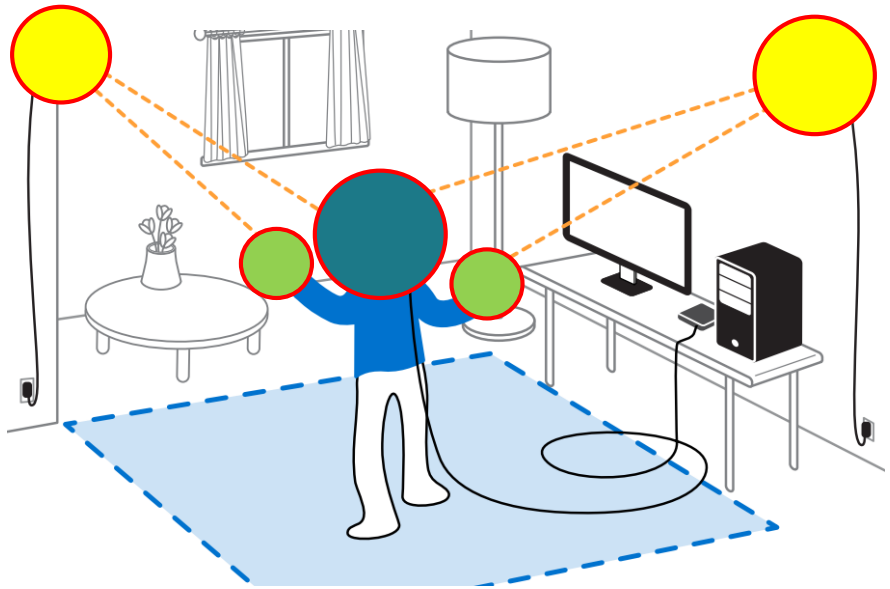
Easy interaction



1. Point size 2. Point type 3. Type of interpolation

4. Attribute type 5. The classes to visualize

3D immersion in VR

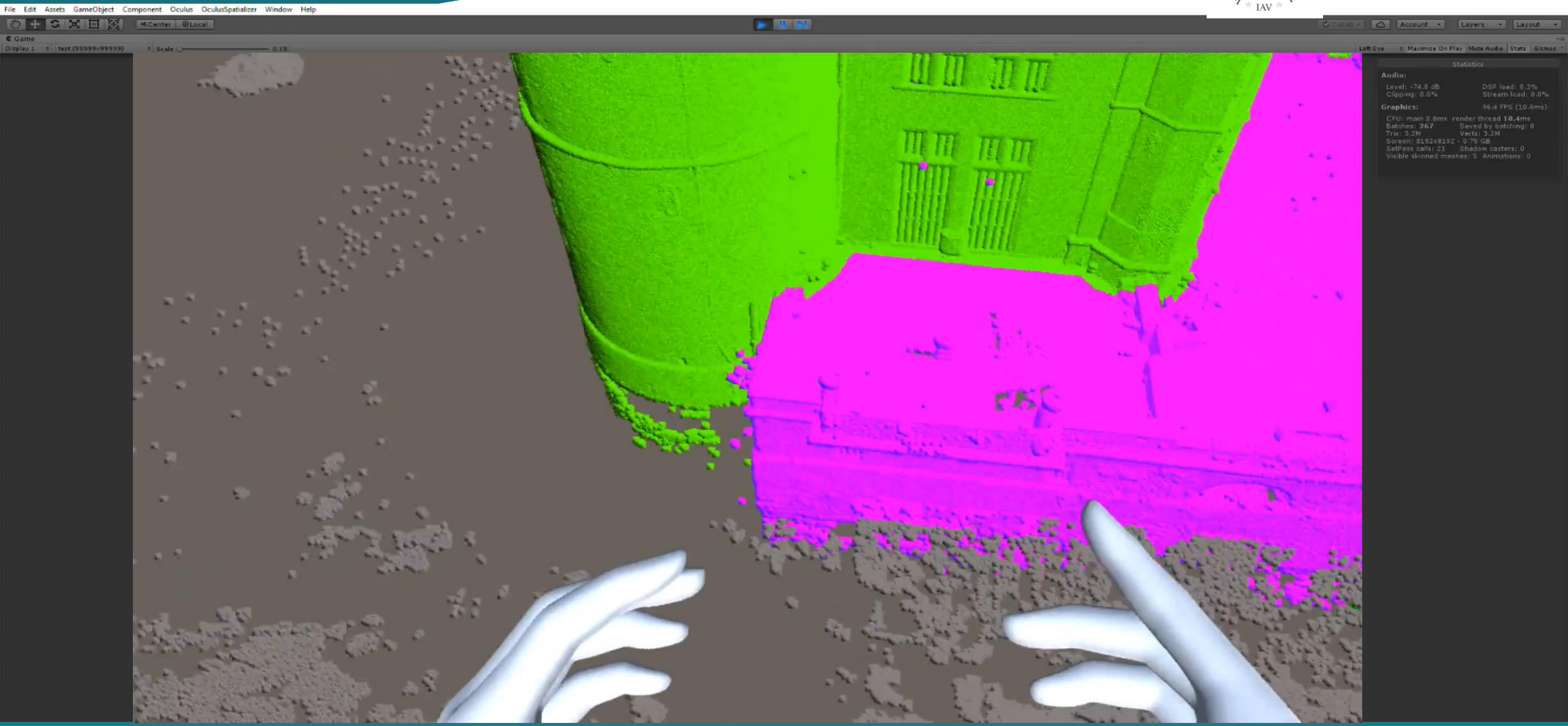


Oculus Headset

2 touch

2 Capteurs

VR APPILCATION



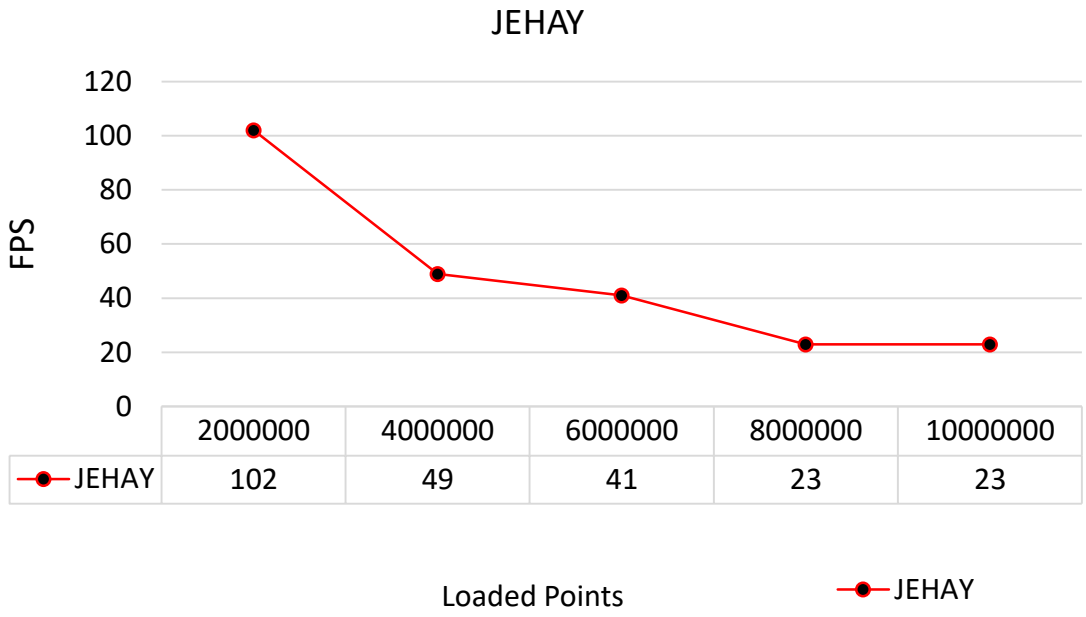
PERFORMANCES

Environnement et tests

Processor	Intel® Core™ i6-6800K CPU @ 3.40GHz 3.40 GHz
Graphic card	NVIDIA GeForce GTX 1080
RAM	48.0 Go
Operating system	Windows 10 Pro, 64 bits

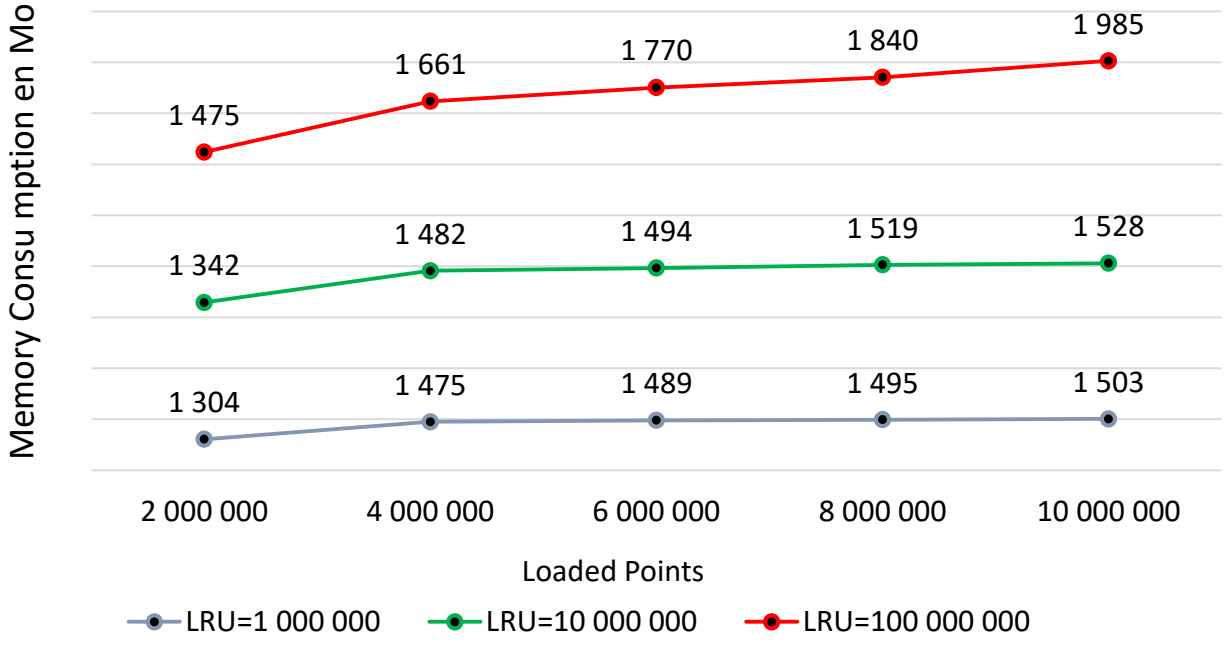
Settings to test	FPS
	Consumption in memory

Settings that influence	Point size
	Number of loaded points
	Number of points cached
	Type of interpolation

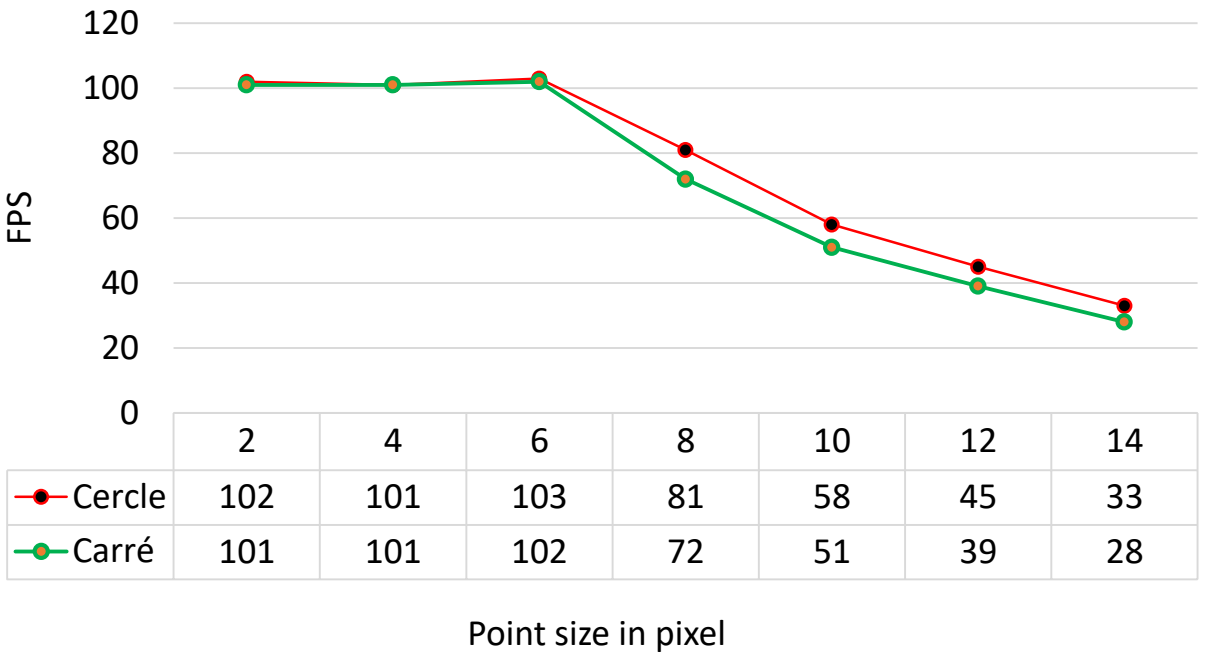


The variation of the FPS number according to the number of points loaded, JEHAY with 2.3 billion.

PERFORMANCES



Variation of the memory consumption (in Mo) according to the size of the point cloud loaded and the LRU cache.



	2	4	6	8	10	12	14
Cercle	102	101	103	81	58	45	33
Carré	101	101	102	72	51	39	28

Influence of the variation of the point size on the FPS, JEHAY with a budget of 2Million, interpolation = paraboloid, LRU = 2M

Discussion and perspective

Development of semantic segmentation process to automate the enhancement of point cloud with class information.

Creation of a dual spatial and classification indexing to make possible querying and direct interaction with the point cloud in the VR environment.

Implementation of the Continuous Level of Detail (Schütz et al., 2019) rendering method.

Thank you for your attention

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