KINETIC AND BUILDING LOD2

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Introduction

Context

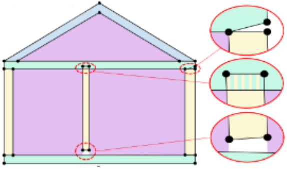


Figure: Mesh with issues

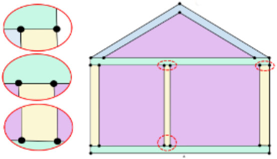


Figure: Mesh without issues

Issue with orientation

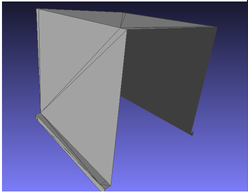


Figure: Cube not oriented

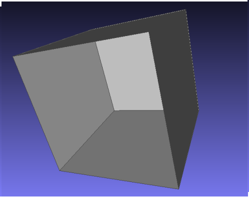


Figure: Cube badly oriented

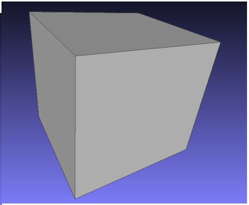


Figure: Cube oriented by CGAL

Self Intersection issue

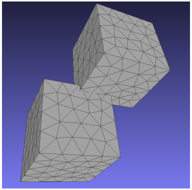


Figure: Two cube self intercting

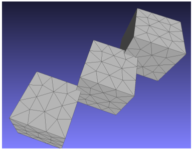


Figure: Two cubes intersecting a third one

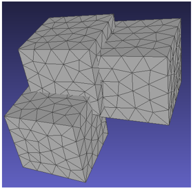


Figure: Three cubes self intersecting

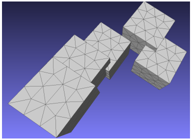


Figure: Five cubes intercting randomly

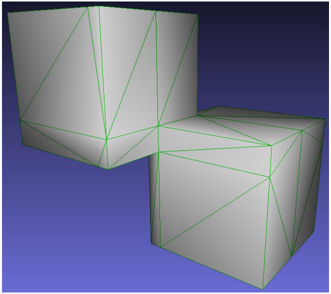


Figure: Two Cubes fixed

All other result in a execution error

Objectives

- Check the validity of the Mesh
- Create a workflow for automatic generation using KSR Algorithm
- Keep the correspondence of surfaces between both meshes
- Run some simulations using the Feel++ library

CGAL

- C++ library for geometric calculations, providing data structures for mesh generation and manipulation.

The main packages utilized are:

- `CGAL::Polygon_mesh_processing`
- `CGAL::Surface_mesh`
- `CGAL::Point_set_processing`
- `CGAL::IO_streams`
- `CGAL::AABB_tree`

File Format

- IFC : Standart for builllding data modeling,similar to class oriented code
- CityGML : 3D format for city modeling with representation of geographic details
- STL : 3D Modeling format
- OBJ :A standard file format for 3D models
- OFF : A file format for 3D mesh data
- PLY : A file format for 3D mesh data,stocking the cloud point of the mesh
- MSH : A file format for mesh data use by GMSH software

Software

- Github : Platforme for collaborating work on a project
- Visual Studio Code : Versatil tools for coding with various extensions
- Paraview : Open-source data analysis and visualisation
- Meshlab : A tool for processing,editing,visualisation of 3D mesh
- GMSH : a 3D finite element mesh generator

Data

The following Data were given by Vincent Chabannes

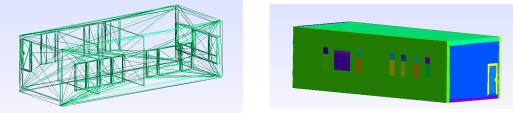


Figure: Three zones mesh

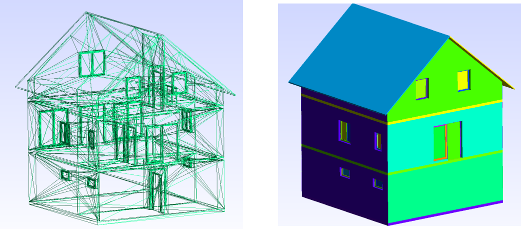


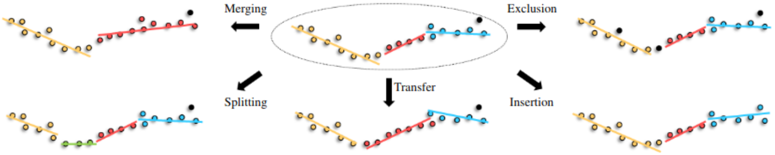
Figure: ACJasmin mesh

Kinetic

We get information from a INRIA report (citer le rapport) Kinetic algorithm is an geometric algorithm generate 3D mesh from a point clouds,it uses geometric primitive with an energy based model to fit the primitives to the model.
Energy formule:

$$U(x) = w_f U_f(x) + w_s U_s(x) + w_c U_c(x)$$

to calculate the best primitive
to fit the mesh. then we have a list of geometric operation on each primitive



preprocessing

To improve Kinetic outcome we pre-process the mesh :

- Isotropic remeshing of the mesh
- Unified and regularize the mesh with grid simplify
- Fix self Intersection
- Calcul normals

Labelling

Issue: Inria developed a method to preserve the semantic information of IFC elements, but it has not yet been implemented in CGAL.
Two potential solutions:

- Modify the Kinetic Solver to recognize and utilize markers on each point used to form a shape.
- Compare the input and output meshes to apply the same markers to the closest faces.

Labelling

Exemple of result of second solutions:

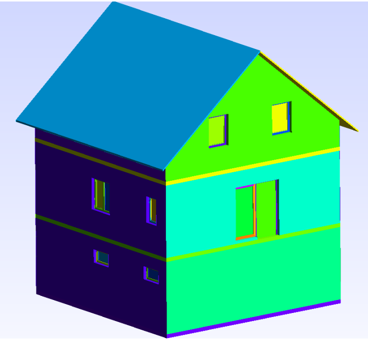


Figure: Input Mesh

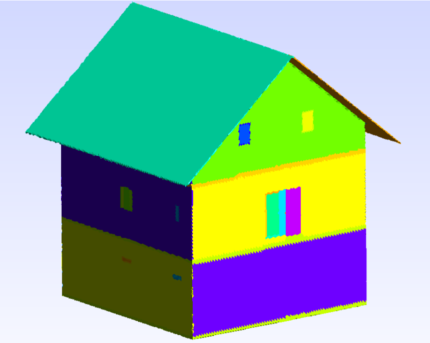


Figure: Output Mesh

Metric

We also want to add method to check the quality off the output mesh

- Properties Check (closed,connected,triangulated...)
- Correspondance between input and output

To check the Correspondance between mesh, we can compare bounding box of each labelled elements.

Table: Bounding Box value

% of marker correct	Three Zones	ACJasmin
<5%	22/57	3/82
between 5 and 10 %	11/57	7/82
between 10 and 20 %	13/57	9/82

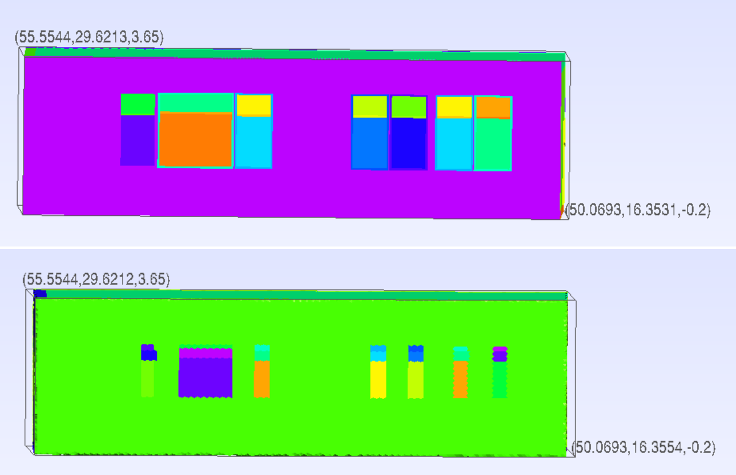


Figure: Three zones Bounding Boxe comparaison

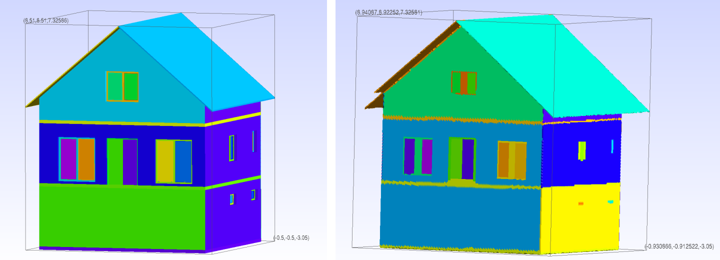


Figure: ACJasmin Bounding Boxe comparaison

Function implemented

- checkProperties
- gridSimplify
- remesh
- KSR

test

- test on Surface Mesh Check
- test on Kinetic algorithm
- test on Point set class and manipulation function

Point cloud

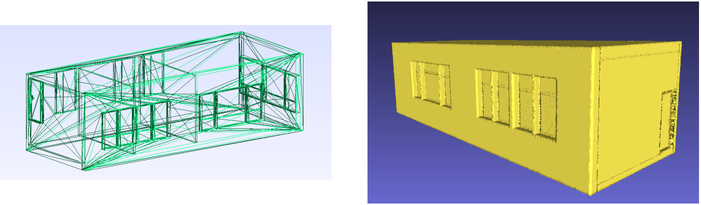
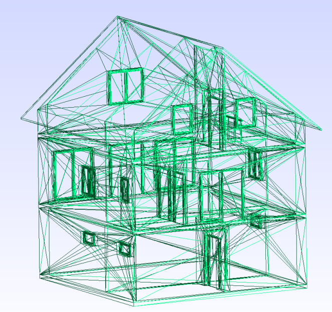


Figure: Three zones mesh point cloud



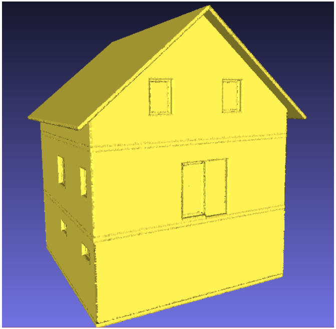


Figure: ACJasmin mesh point cloud

Comparison of Kinetic Outcome

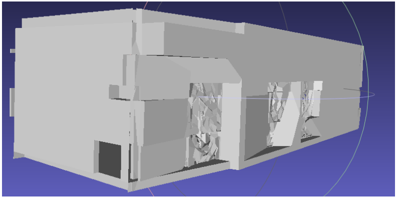


Figure: Old KSR outcome

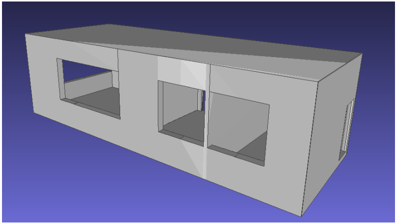


Figure: New KSR outcome

Comparison of 3 Zone Results

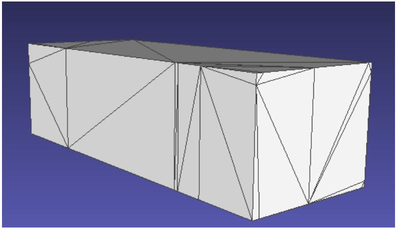


Figure: 3 Zone 500

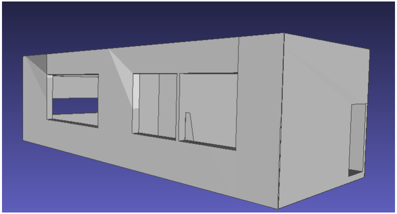


Figure: 3 Zones 45

Comparison of Jasmin Images

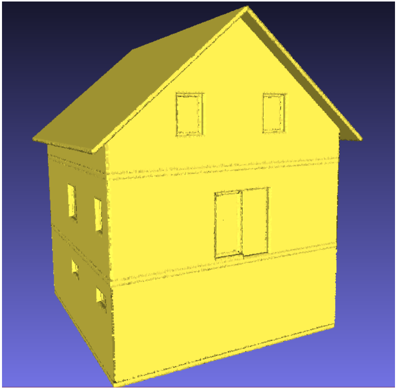


Figure: Jasmin Ply

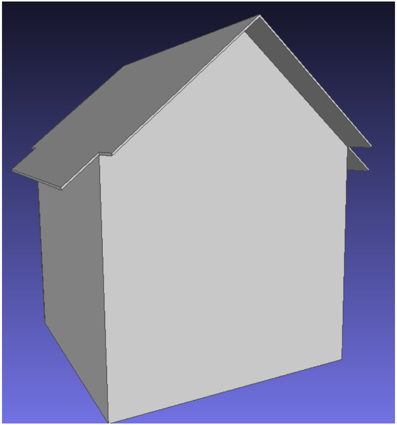


Figure: Jasmin Image

Self Intersection fixing

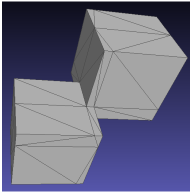


Figure: Same result as intro

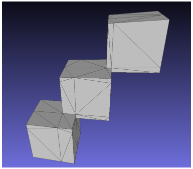


Figure: Worked

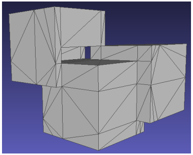


Figure: Worked

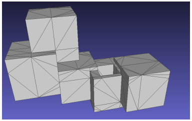


Figure: Worked

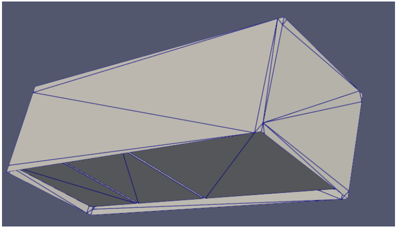


Figure: Refined Zones

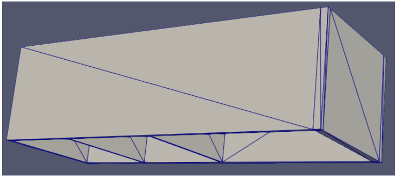


Figure: Not Refined Zones

Comparison of Refined and Not Refined Zones

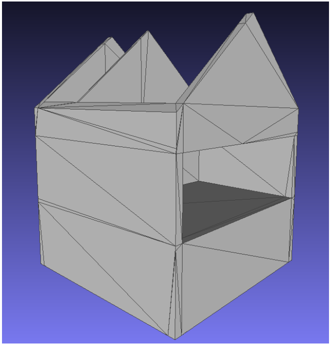


Figure: ACJAsmin Refined

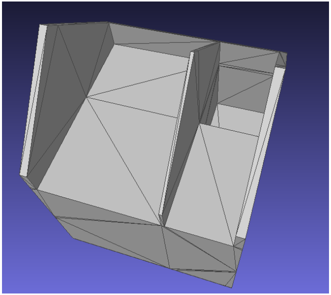


Figure: Jasmin Hole

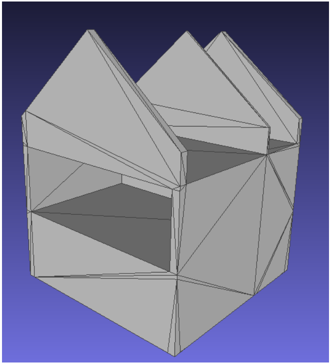


Figure: ACJAsmin Not Refined

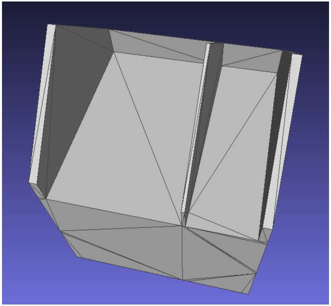


Figure: Jasmin Not Refined Roof

Comparison of ACJASMIN Results

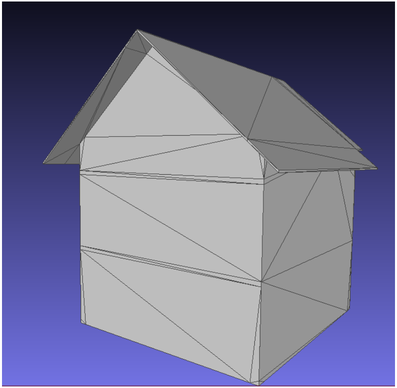


Figure: ACJASMIN Refined

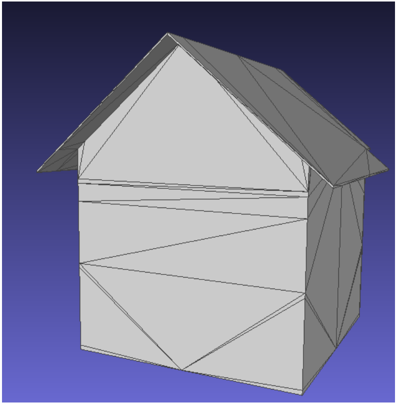


Figure: ACJASMIN Not Refined

Results from the Start of Internship and After Grid Simplify

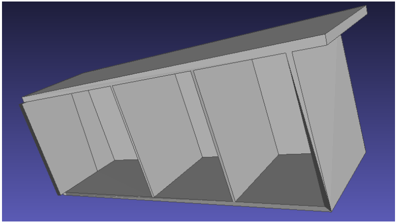
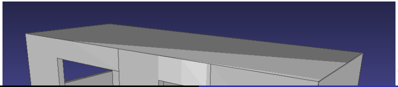


Figure: Result from the start of internship. Shape detection took 124s and the kinetic space partition 0.2s. When compared to the size and the complexity of the meeting room mesh, it was kind of disappointing.



Execution Time with Our Workflow on Three Zones

Parameters	Default	min.region.size=2000	min.region.size=50
Shape detection	7.97s	8.18s	5.76s
Kinetic space partition	0.22s	0.22s	0.36s
Total execution	8.2s	8.41s	6.13s

Table: Execution time with our workflow on Three Zones

Conclusion

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