

Study Case - Roof & Wall Plane Detection

Goal:

The internship project objective is to improve the 3D models obtained from Kestrix 3D engine using AI & Computer Vision. Our goal is to obtain 3D models of buildings which preserve the properties of man-made scenes: parallelism, rectangularity, sharp angles...

The first step of the project will be to extract the primary shapes (building primitives) that represent the building, as they will be the input for the AI model. Therefore, the aim of this study case is to make the candidate familiar with the data input it will face and the kind of libraries it will be working with.

Objective:

Your task is to write a program in Python or C++ that performs the following tasks:

- Convert a given mesh file into a point cloud.
- Preprocess the point cloud (e.g., remove noise, downsample, recompute normals).
- Detect valid roof and wall planes within the point cloud based on specific criteria.
- Save the detected valid roof planes as separate PLY files.

Tools and Libraries:

Feel free to use any commonly available libraries or built-in functions for input/output operations, mathematical computations, mesh/point cloud processing, and visualisation. Recommended libraries include Open3d, Trimesh, PDAL for Python users, and PCL for C++ users. For visualisation, you can use Meshlab, CloudCompare, or built-in viewer classes provided by libraries like Trimesh or Open3d.

Instructions:

Your program should perform the following steps:

Read the input mesh file named **property.ply**, which includes vertex locations, normals, colours, and face indices. All dimensions in the file are in metres.

1. Convert the mesh into a point cloud representation.
2. Perform **preprocessing on the point cloud**, such as noise removal or downsampling.
3. Detect valid **roof planes** within the point cloud based on the following criteria:
 - a. Area of the roof planes should be **greater than 10 square metres and less than 25 square metres**.

- b. The centroid height of the roof plane should be more than **2 metres** above the centroid of the mesh.
4. Exclude the ground plane and vertical planes (walls of the building).
5. Save all valid planes as separate PLY files in a folder. Each file should be named **roof_plane_x.ply**, where x represents the plane number. The order of the planes doesn't matter.

3D model



Please see the image below for an illustration of valid planes. Note that the ground plane is filtered out as are all the vertical planes (walls of the building). Here is how all the planes loaded should look like:



Output:

The output should be a folder containing all valid roof planes saved as PLY files.

Bonus

After successfully detecting the roof planes:

6. Detect valid **facade planes** within the point cloud based on the following criteria:
 - a. Area of the wall planes should be **greater than 10 square metres and less than 30 square metres**.
7. Save all valid planes as separate PLY files in a folder. Each file should be named **wall_plane_x.ply**, where x represents the plane number. The order of the planes doesn't matter.

Now that you have the primitive shapes for facades and walls, how would you extract the outline of the planes?

Explain your reasoning for your answer and provide code if possible.



Contact

For any questions, or to send completed exercise, contact ismael@kestrix.io