Point Cloud Occupancy with Dynamic Planes

Computer Vision Course Project

Master's Degree in Artificial Intelligence and Robotics

Eugenio Bugli (1934824)

Academic Year 2024/2025

SAPIENZA
UNIVERSITÀ DI ROMA

Table of Contents

What is the Addressed Problem

- We are interested in learning the occupancy values of points inside a bounding box
- With encode a noisy point cloud into features and project them onto dynamic planes
- During Inference we reconstruct meshes with Multiresolution IsoSurface Extraction

Table of Contents

2 Dataset

FAUST Dataset

2 Dataset

This Dataset is composed by high-resolution human scans of 10 different bodies in 30 different poses.

- Each of the samples inside the training set has a corresponded ground truth alignment (registration)
- The test set is composed by 200 scans, while the training has 100 scans.
- About 80 % fo the initial training set has been used for training, while the other 20 % has been used for validation

Data Processing

2 Dataset

I have followed the same strategy of the original paper:

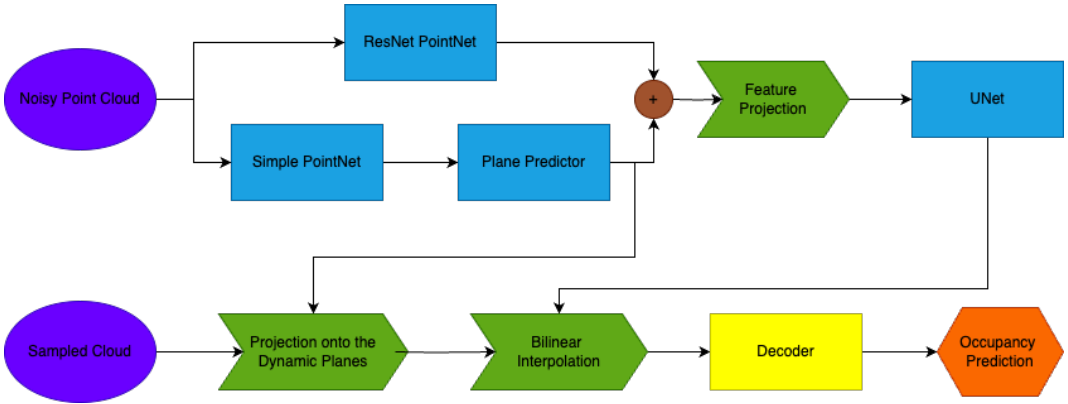
- We need to randomly sample 3000 points from the cloud's surface
- Then we inject Gaussian noise with zero mean and 0.05 standard deviation

These noisy clouds are then used to learn the features and the geometry of the object through the Encoder. The occupancy is then predicted over a set of 2048 points uniformly sampled over all the bounding box containing the original cloud/mesh.

Table of Contents

Architecture design

3 Architecture

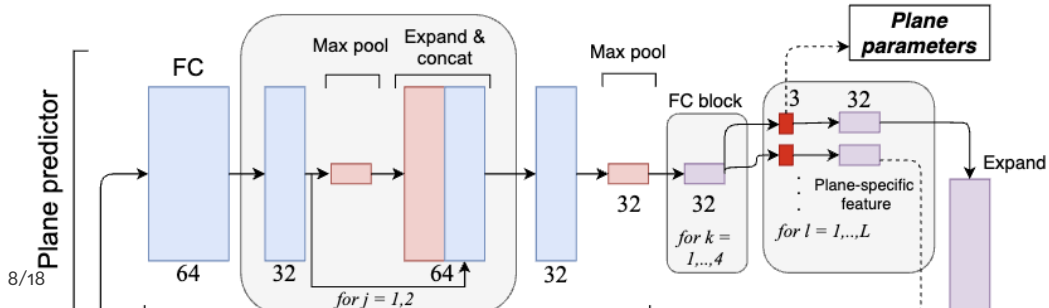


Encoder

3 Architecture

The Encoder takes in input the Noisy Cloud and is composed by the following steps:

- ResNet PointNet
- Simple PointNet + Plane Predictor
- Feature summation + projection
- UNet



Decoder

3 Architecture

The Dec is composed by:

- Feature Projection and Bilinear Interpolation
- Occupancy Network

Table of Contents

Multiresolution IsoSurface Extraction (MISE)

4 Reconstruction

- Create a grid over all the bounding box
- Evaluate the occupancy of each corner of the voxels
- Define the Active voxels as the one composed with at least one occupied corner and one not
- Subdivide each Active voxels into 8 subvoxels (2x2x2 grid) and evaluate the new points occupancy
- Repeat until the desired resolution is obtained

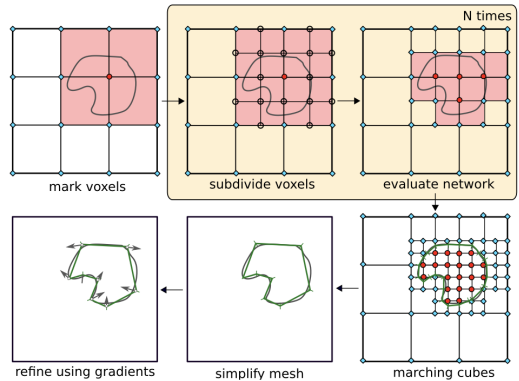


Table of Contents

Metrics

5 Results

In order to evaluate the performance of our model, the following metrics have been used:

- Chamfer Distance :
  $CD(A,B) = \frac{1}{|A|}\sum_{a\in A}\min_{b\in B}\|a-b\|_2^2 + \frac{1}{|B|}\sum_{b\in B}\min_{a\in A}\|b-a\|_2^2$
- IOU : $IoU(A',B') = \frac{|A'\cap B'|}{|A'\cup B'|}$
- F-Score:

Add each formula

Loss Performances

5 Results

Insert here plots

Metrics Performances

5 Results

Insert here just a table with metrics, gpu usage various types of sampling

Table of Contents

Possible Changes and Future Improvements

6 Improvements

Point Cloud Occupancy with Dynamic Planes

Eugenio Bugli

1934824