POLITECNICO DI TORINO

Master's Degree in Mathematical Engineering

Master's Degree Thesis

Segmenting dynamic points in 3D scenarios

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Summary

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Acknowledgements

ACKNOWLEDGMENTS

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Goofy, Google by Google

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Acronyms

AI
: artificial intelligence

Chapter 1

Related Works

1. Epic Kitchens
2. Epic Fields
3. Photogrammetry
4. COLMAP
5. NeRF
6. NeuralDiff
7. Monocular Depth Estimation
8. (N3F)
9. (Gaussian Splatting)

1.1 Photogrammetry

Photogrammetry is the science and technology of obtaining reliable information about physical objects and the environment through the process of recording, measuring and interpreting photographic images and patterns of electromagnetic radiant imagery and other phenomena[1].

It comprises all techniques concerned with making measurements of real-world objects features from images. Its utility range from the measuring of coordinates, quantification of distances, heights, areas and volumes, preparation of topographic maps, to generation of digital elevation models and orthophotographs. The functioning rely mostly on optics and projective geometry rules.

As first assumption we have the modellization of the camera as a simplified version of itself: the *Pinhole Camera*. As in the first designed cameras(*camera obscura*), in the Pinhole Camera world's light is captured through a pinhole and then projected into the *focal plane*.

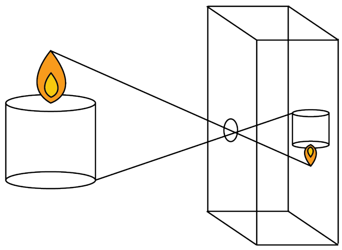

Figure 1.1: Pinhole Camera

A Pinhole camera is characterized by two collection of parameters:

- **Extrinsic** parameters: gives us information on location and rotation in the world.
- **Intrinscic** parameters: gives us internal property such as: focal length, field of view, resolution...

These parameters can be rewritten in their corresponding matrices:

$$Intrinsic = K = \begin{bmatrix} f_x & s & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix}$$

where:

- f_x, f_y are are the *focal lengths* of the camera in the x and y directions, they are needed to keep the image aspect ratio.
- c_x, c_y are the coordinates of the *principal point* (the point where the optical axis intersects the image plane).

$$Extrinsic = \begin{bmatrix} \mathbf{R}_{3x3} & \mathbf{t}_{3x1} \\ 0_{1x3} & \mathbf{1}_{1x1} \end{bmatrix}$$

where:

- $\mathbf{R}_{3x3}$ is a rotation matrix
- $\mathbf{t}_{3x1}$ is a translation vector

Extrinsic matrix is also known as the 4x4 transformation matrix that converts points from the world coordinate system to the camera coordinate system.

Exploting homogeneous coordinates we can rewrite the image capturing process as the following combination of matrices:

$$\begin{bmatrix} u \\ v \\ z \end{bmatrix} = \begin{bmatrix} f_x & s & c_x & 0 \\ 0 & f_y & c_y & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} \mathbf{R}_{3x3} & \mathbf{t}_{3x1} \\ 0_{1x3} & \mathbf{1}_{1x1} \end{bmatrix} \begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix}$$

Appendix A

Galileo

```python
import os
os.system("echo 1")
```

$\mathcal{O}(n \log n)$

`numpy`

Bibliography

[1] ASPRS online Archived May 20, 2015, at the Wayback Machine (cit. on p. 1).