

# Space Visualizations

Jonah Schwartzman

April 21, 2025

## 1 Introduction

This document is not real.

## 2 Camera3D

A Camera3D represents a viewer in 3D space, with a focal length to the view plane. The main function of a Camera3D is to convert from a point in 3D world view to a 2D point on the view plane. The camer3D has seven parameters:

- $x$ : camera x-coordinate
- $y$ : camera y-coordinate
- $z$ : camera z-coordinate
- $\theta$ : pitch (angle 1)
- $\phi$ : roll (angle 2)
- $\gamma$ : yaw (angle 3)
- $f$ : focal length

## 3 Transform Idea

Keep track of how the camera moves with user input, and use this to convert world points to view plane points. `StdDraw.point(xClip, yClip)`

$$worldPoint = \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

$$T(worldPoint) = \begin{pmatrix} xClip \\ yClip \end{pmatrix}$$

Find  $T$  that converts from world coordinates to clipping coordinates.

$$T : WorldSpace \rightarrow_W CameraSpace \rightarrow_C ClipSpace$$

$C : \mathbb{R}^3 \rightarrow \mathbb{R}^2$  uses the focal length to divide out the  $z$  coordinate. So, in CameraSpace the  $z$ -axis is perpendicular to the view plane.

$W = [T]_c^w : \mathbb{R}^3 \rightarrow \mathbb{R}^3$  transforms a vector written in world coordinates to the same vector in camera coordinates.



