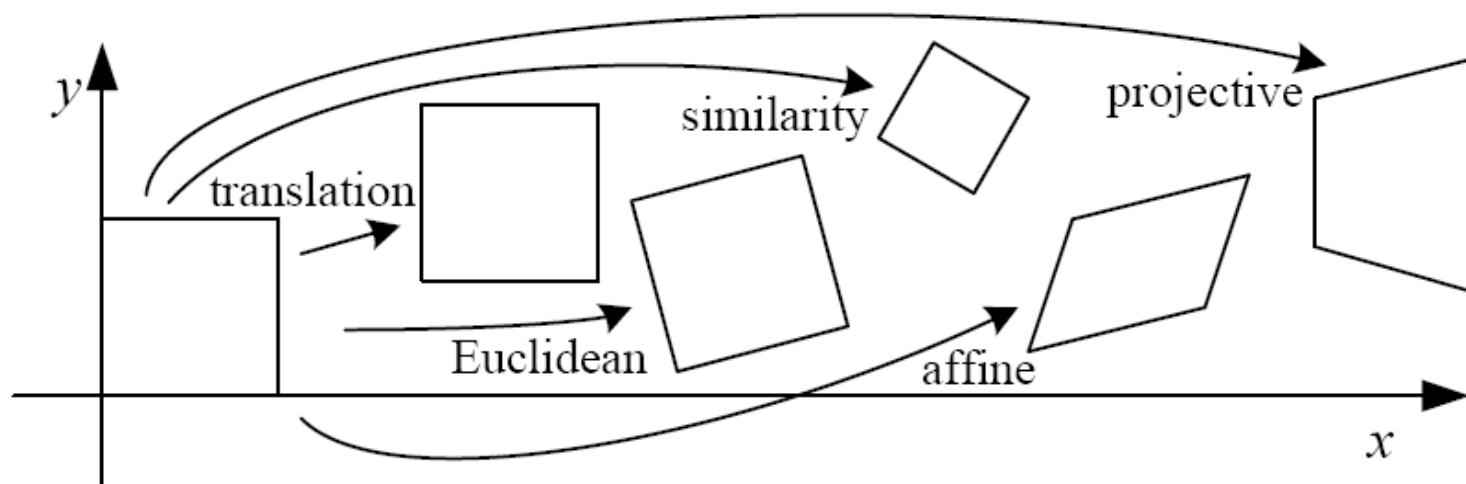


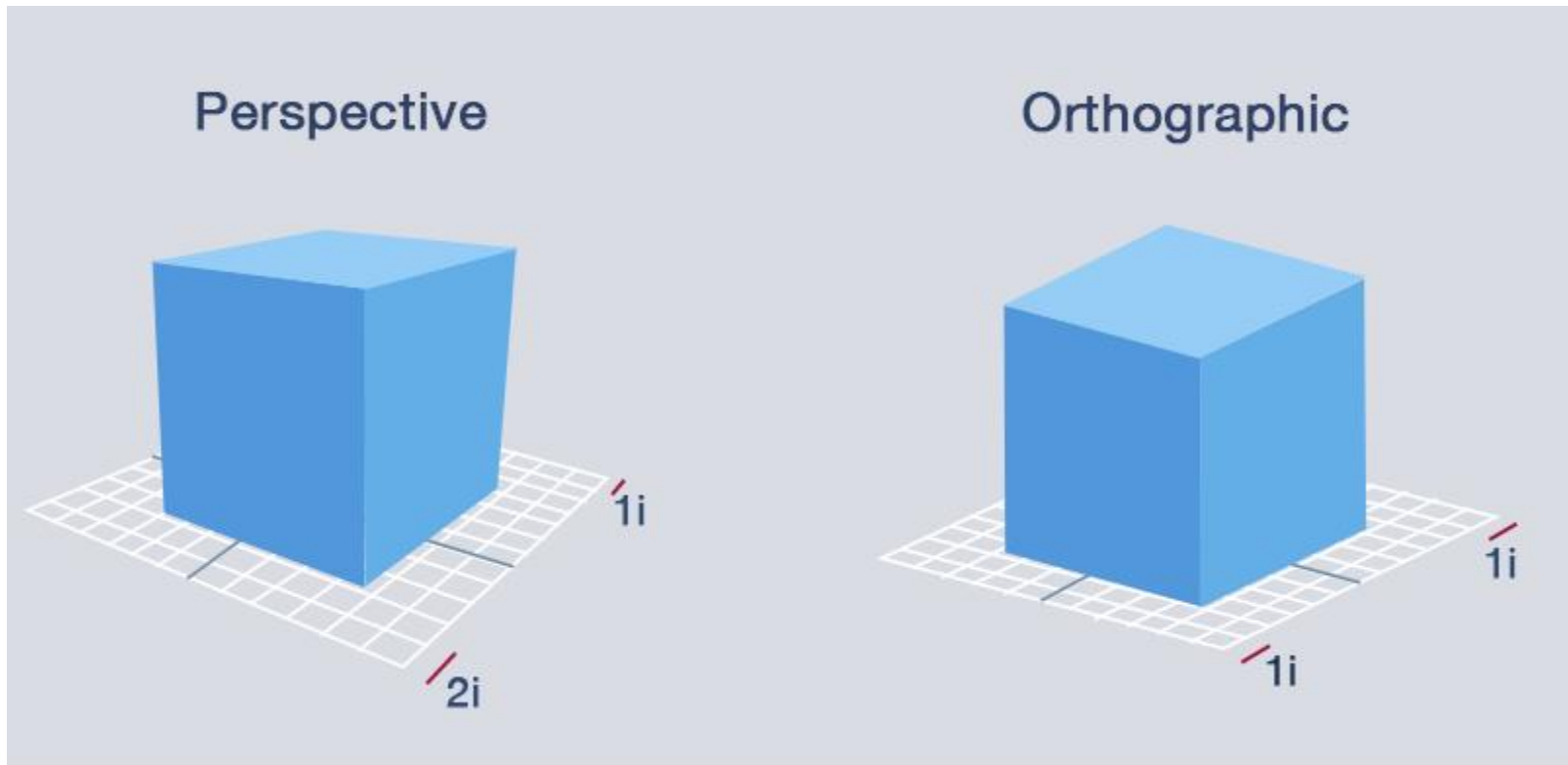
Image transformation



- 3d->2d trans
 - Perspective, orthographic, weak perspective, perspective distortion/warping
<https://fstoppers.com/architecture/how-lens-compression-and-perspective-distortion-work-251737>
- Camera intrinsics
- Camera extrinsics
- Radial distortion

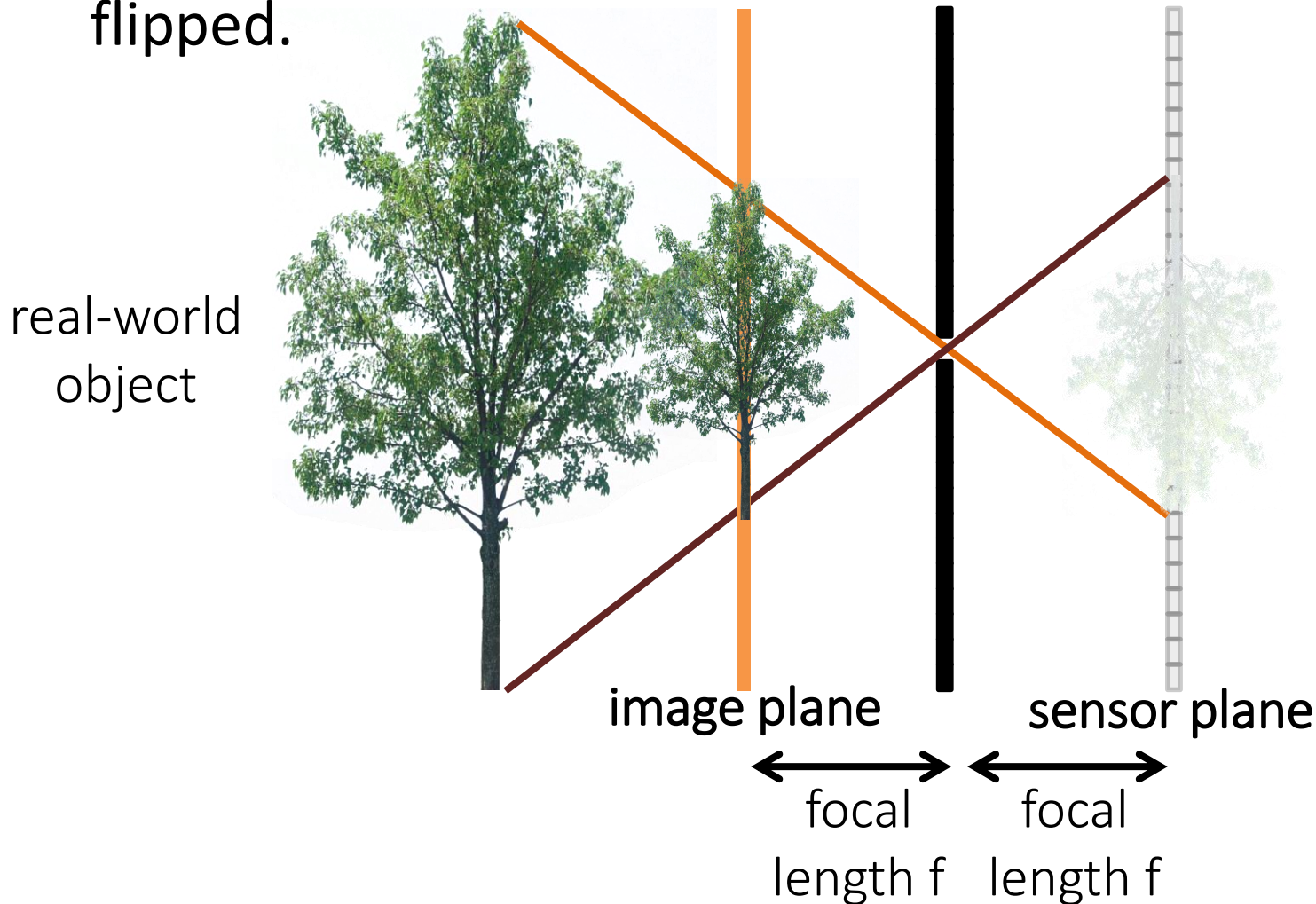
3D projection

- **3D projection** is any method of mapping three-dimensional points to a two-dimensional plane.
- Two types of projections are **orthographic** and **perspective**.



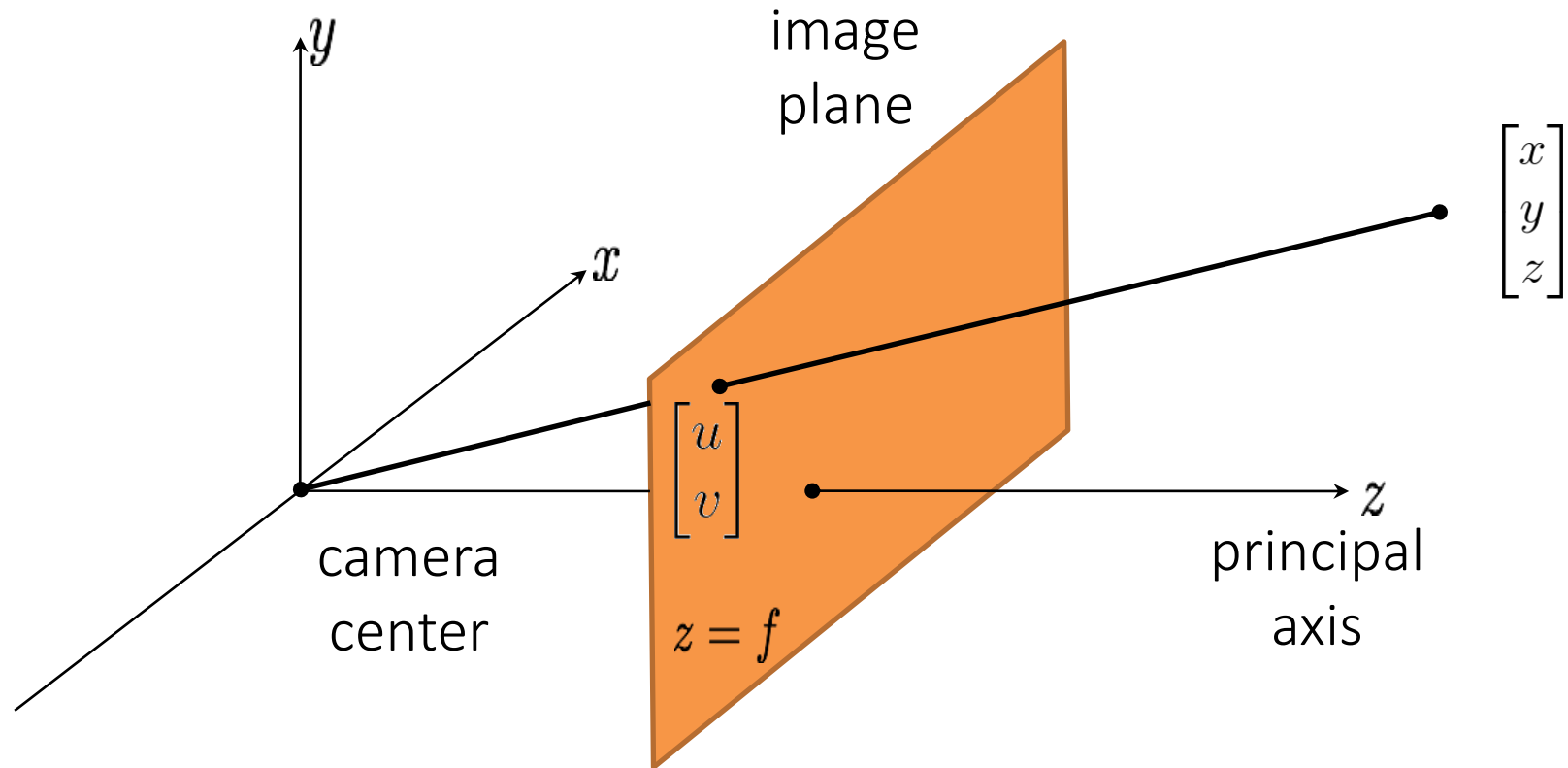
Perspective transformation

- When dealing with imaged 3D scenes, we tend to use the **image plane** rather than the sensor plane which is flipped.



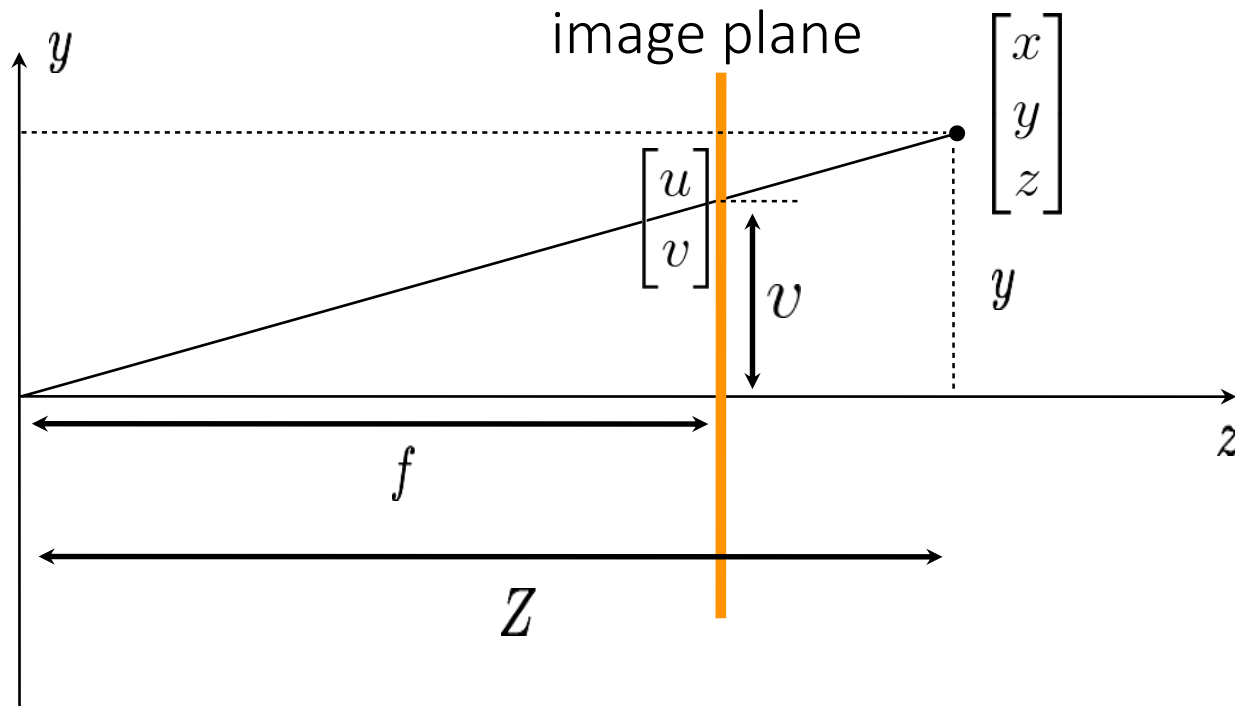
Perspective transformation

- **Perspective projection** is a linear projection where three dimensional objects are projected on the image plane.



Perspective transformation

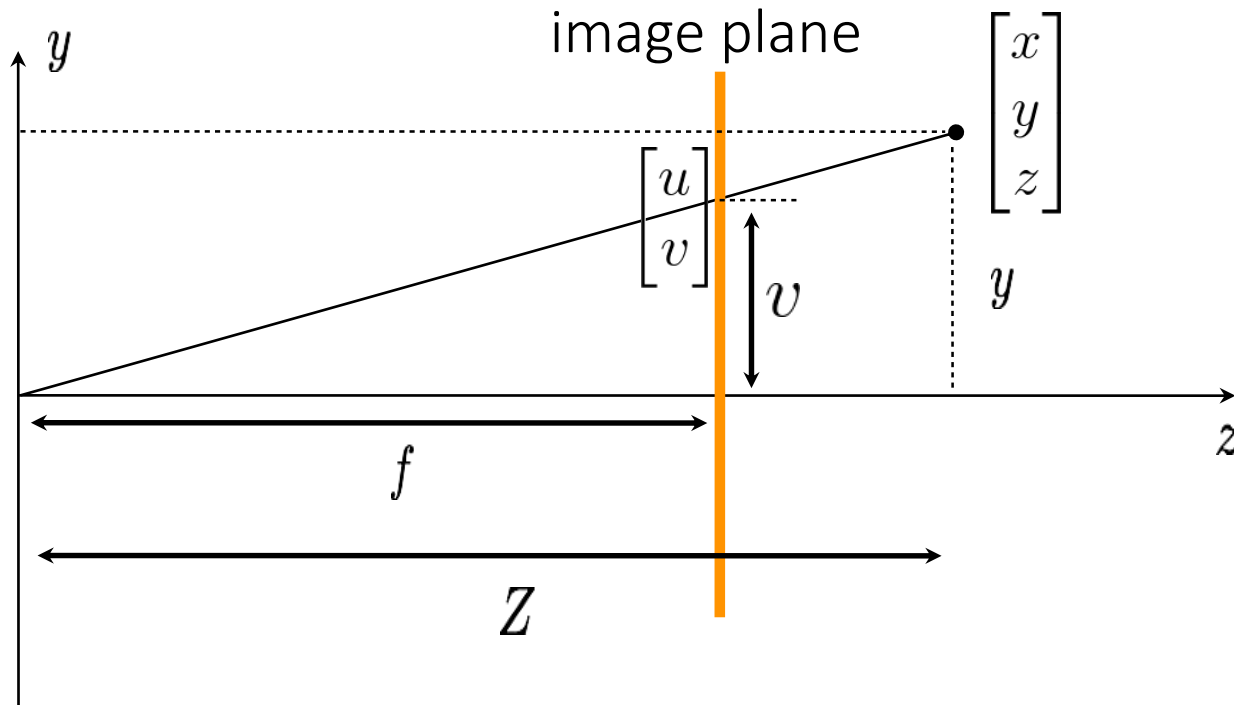
- What is the relationship between y & v ?



Perspective transformation

- Using triangle proportions (Thales' theorem) we can easily conclude that:

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} \mapsto \begin{bmatrix} u \\ v \end{bmatrix} = \begin{bmatrix} f \frac{x}{z} \\ f \frac{y}{z} \end{bmatrix}$$



Perspective transformation

- Let's use the homogeneous coordinates:

$$\begin{bmatrix} f & 0 & 0 \\ 0 & f & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} fx \\ fy \\ z \end{bmatrix} \stackrel{\text{hom. coo.}}{=} \begin{bmatrix} f \frac{x}{z} \\ f \frac{y}{z} \\ 1 \end{bmatrix}$$

– Units of $[m]$

Perspective transformation

- Transforming to units of pixels in image space:
 - Pixel size in x dimension is m_x and the same for m_y .

$$f_x = \frac{f}{m_x} \text{ \& } f_y = \frac{f}{m_y}$$

$$\begin{bmatrix} f_x & 0 & 0 \\ 0 & f_y & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} f_x x \\ f_y y \\ z \end{bmatrix} \stackrel{hom. \text{ } coo.}{=} \begin{bmatrix} f_x \frac{x}{z} \\ f_y \frac{y}{z} \\ 1 \end{bmatrix} = \begin{bmatrix} u \\ v \\ 1 \end{bmatrix}$$

Street art- perspective manipulation



Ames Room

