VIT-AP UNIVERSITY

Computer Vision

(Course Code: 4047)

Module-5:Lecture-2: Lines and Vanishing Points

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Perspective Projection of a Line

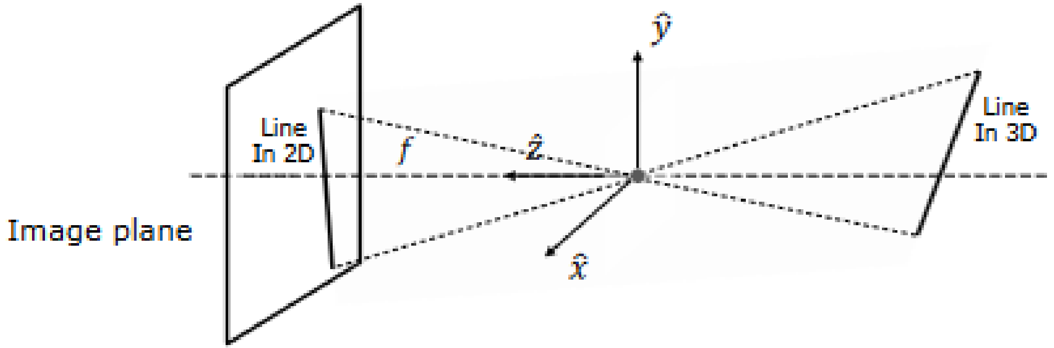
let us discuss the perspective projection of a line in 3D space on to the image plane.
We know that a line in 3D and the pinhole (a point) define a plane.

All the rays of light that emanate from the line and pass through the pinhole also lie on that same plane.

Thus, the image of the 3D line lies on the intersection of this plane and the image plane.

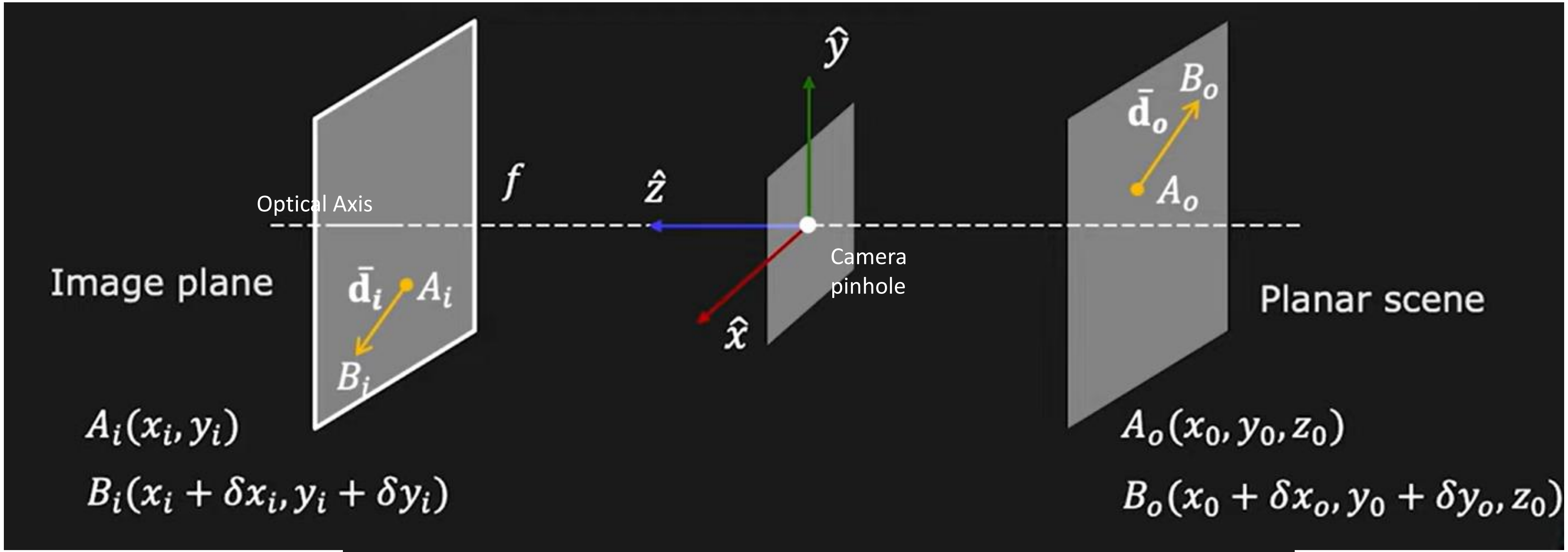
In other words, the image of a line in the 3D scene has to be a line on the 2D image plane.

That is why, as you may have noticed, straight lines in scenes map to straight lines in photographs.



Straight line in scene remains straight in image

Image Magnification



Magnification:

$$|m| = \frac{\|\bar{\mathbf{d}}_i\|}{\|\bar{\mathbf{d}}_o\|} = \sqrt{\delta x_i{}^2 + \delta y_i{}^2} \Big/ \sqrt{\delta x_o{}^2 + \delta y_o{}^2} = \left|\frac{f}{z_o}\right|$$

$$\boxed{m = \frac{f}{z_o}}$$

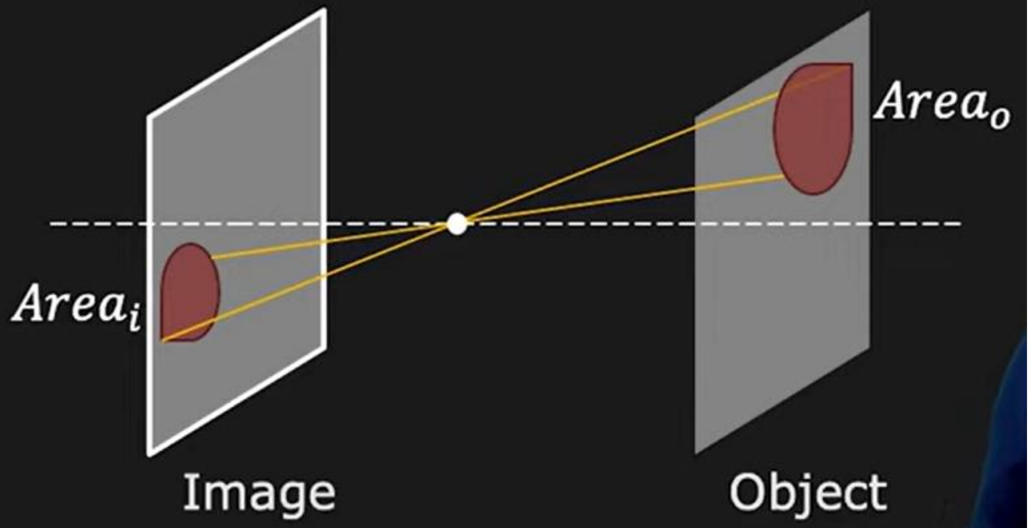
m is negative when image is inverted

Image Magnification

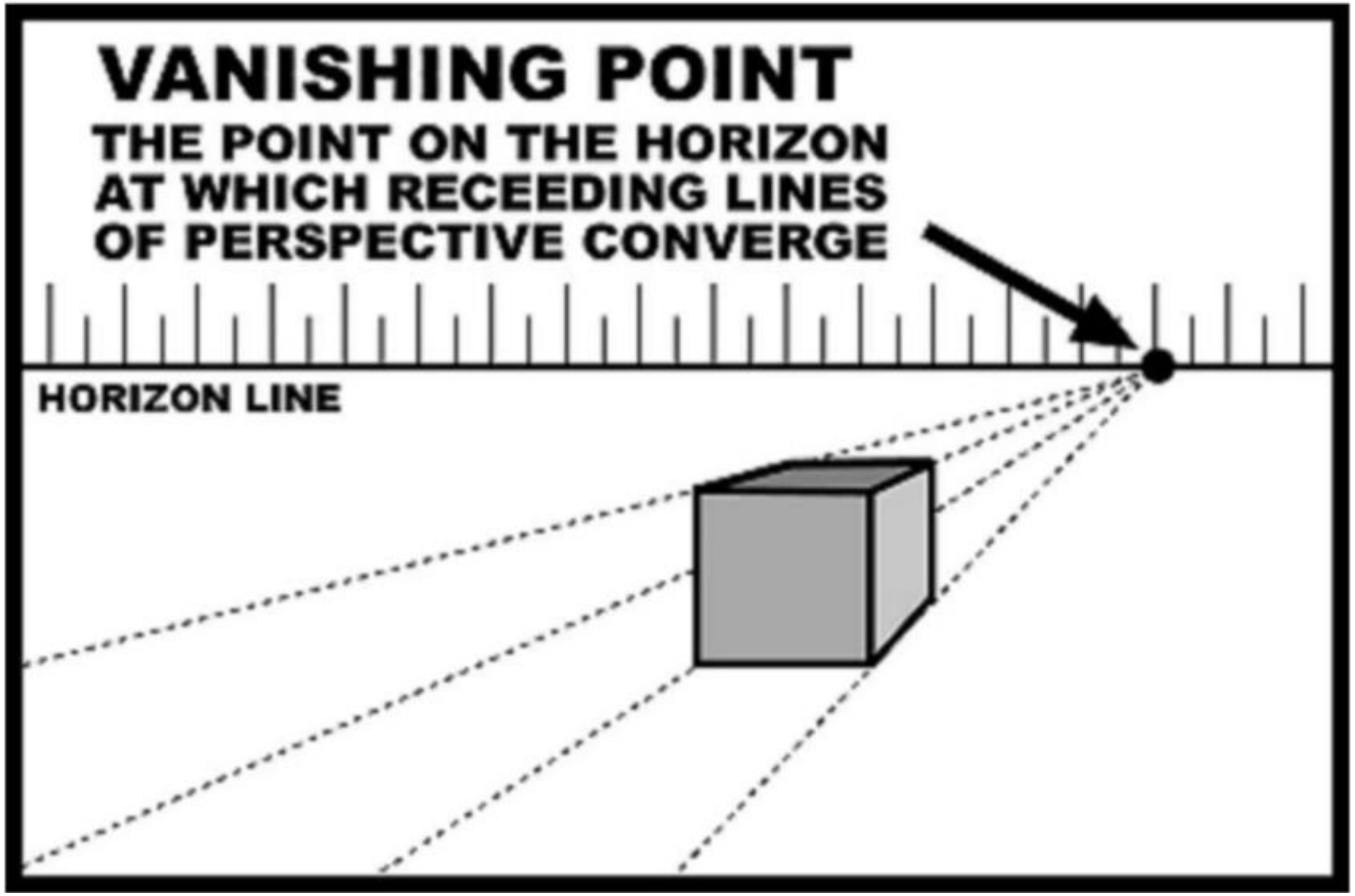
Image Magnification

Remarks:

- m can be assumed to be constant if the range of scene depth Δz is much smaller than the average scene depth $\tilde{z}$
- $\dfrac{Area_i}{Area_o} = m^2$



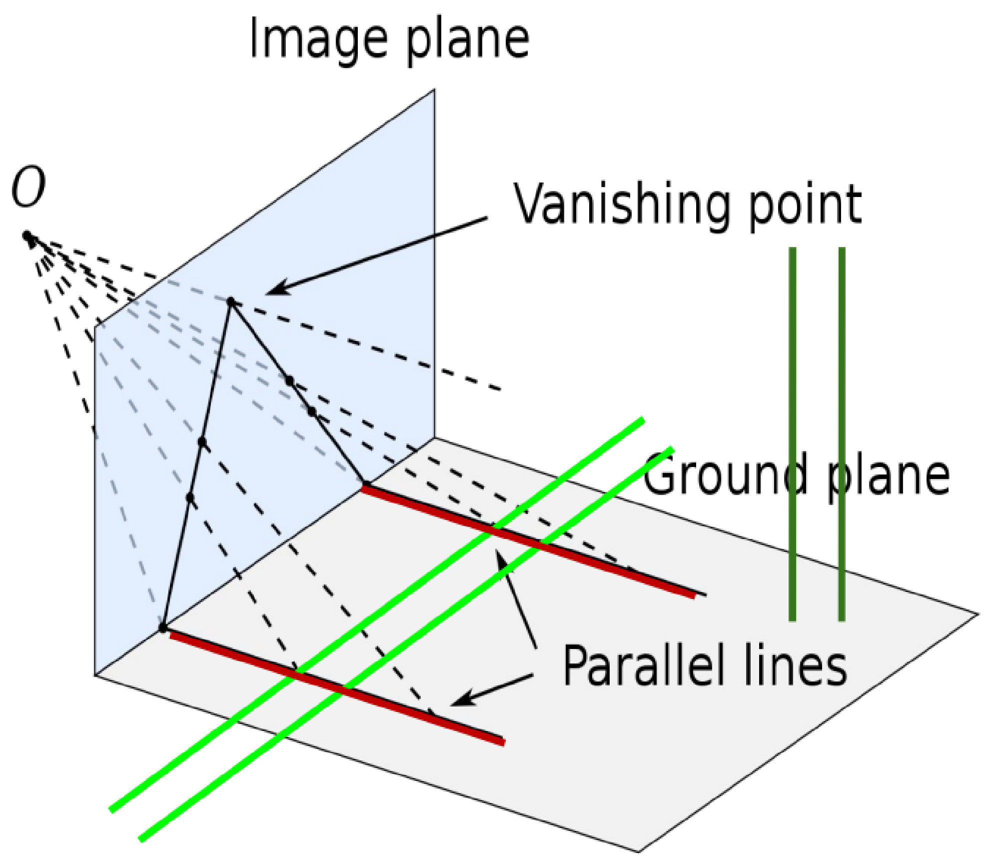
Vanishing Point



Vanishing Point

One-point Perspective: Only 1 Vanishing Point

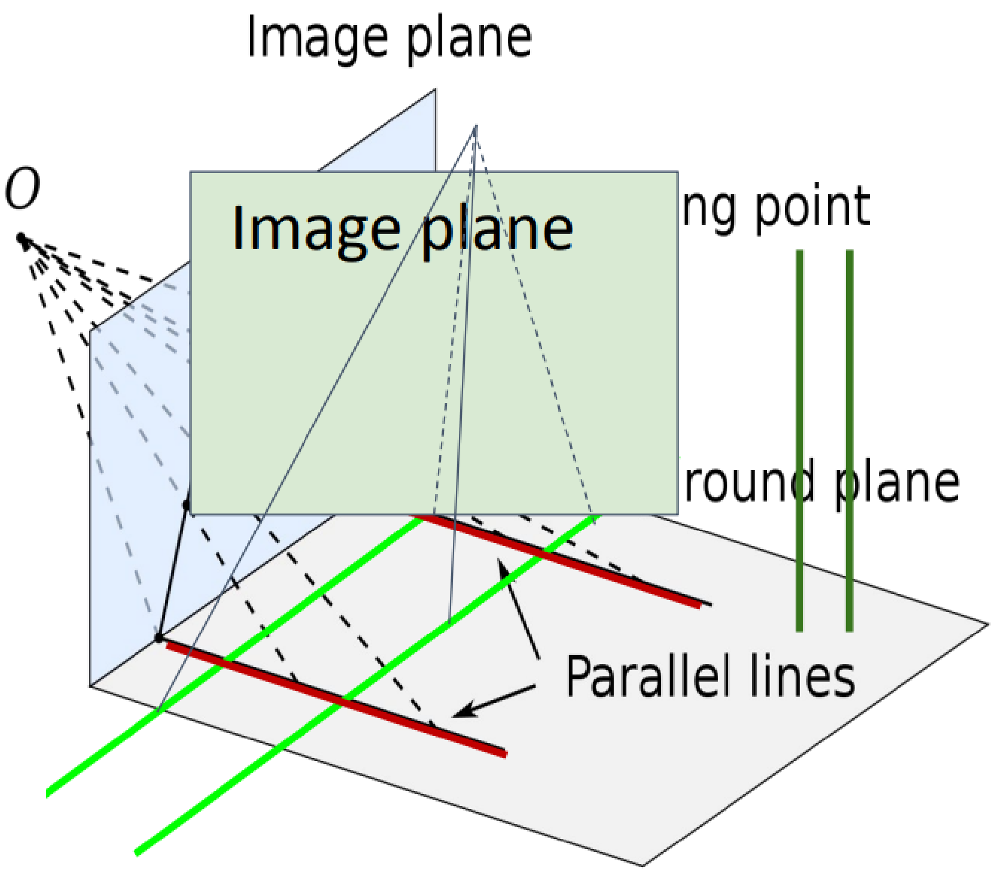
One-point Perspective: When the image plane is parallel to two world-coordinate axes, lines parallel to the axis that is cut by this image plane will have images that meet at a single vanishing point. Lines parallel to the other two axes will not form vanishing points as they a parallel to the image plane.



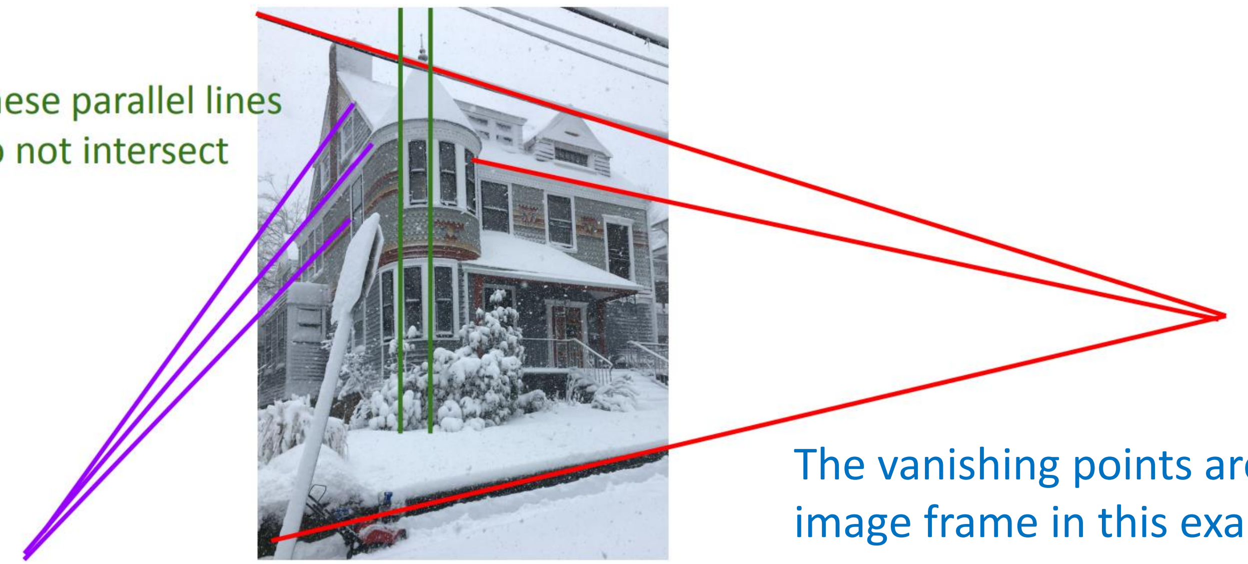
Two-point Perspective: 2 Vanishing Points

Two-point Perspective:

The image plane intersects two world-coordinate axes. Lines parallel to those planes will form two vanishing points in the image plane.



These parallel lines do not intersect

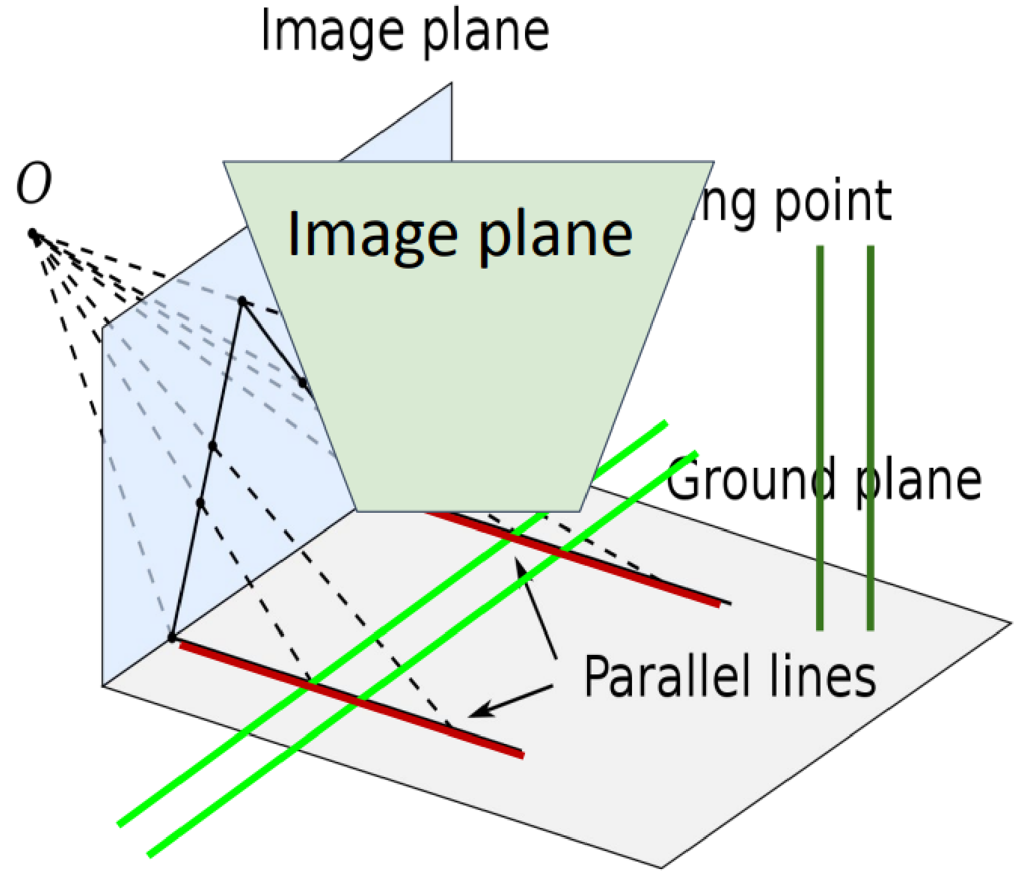


The vanishing points are on the image plane but not in the image frame in this example.

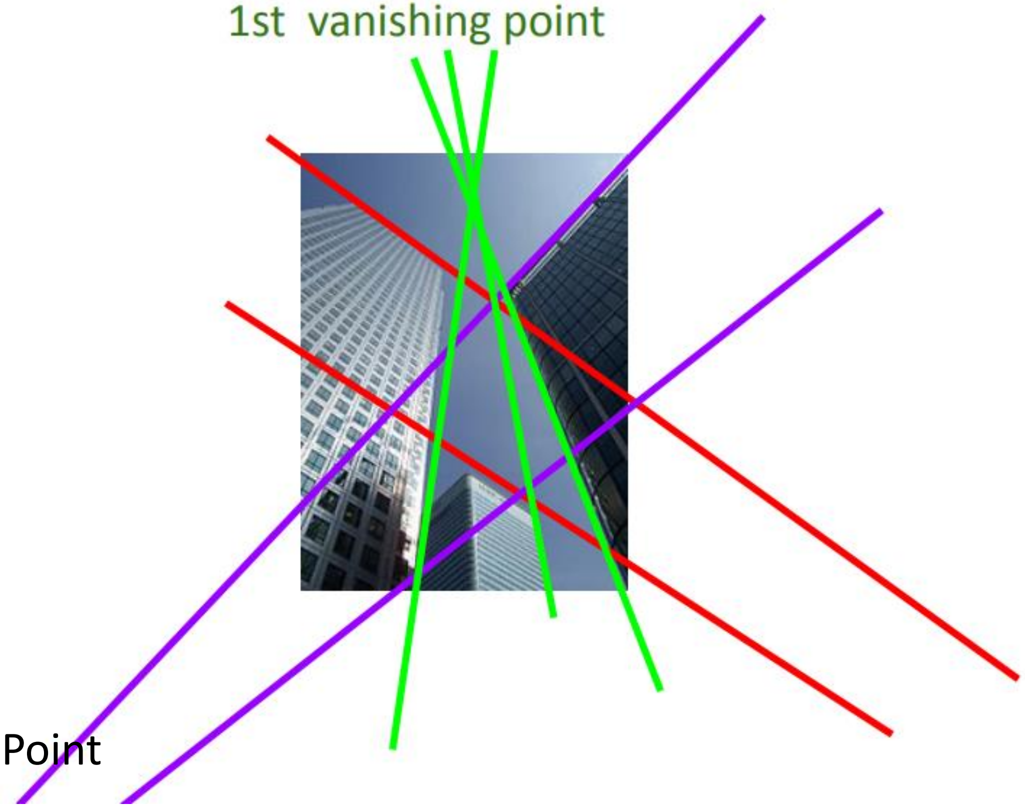
Three-point Perspective: 3 Vanishing Points

Three-point Perspective:

The image plane intersects the x, y, and z world-coordinate axes and therefore lines parallel to these axes intersect, resulting in three different vanishing points.



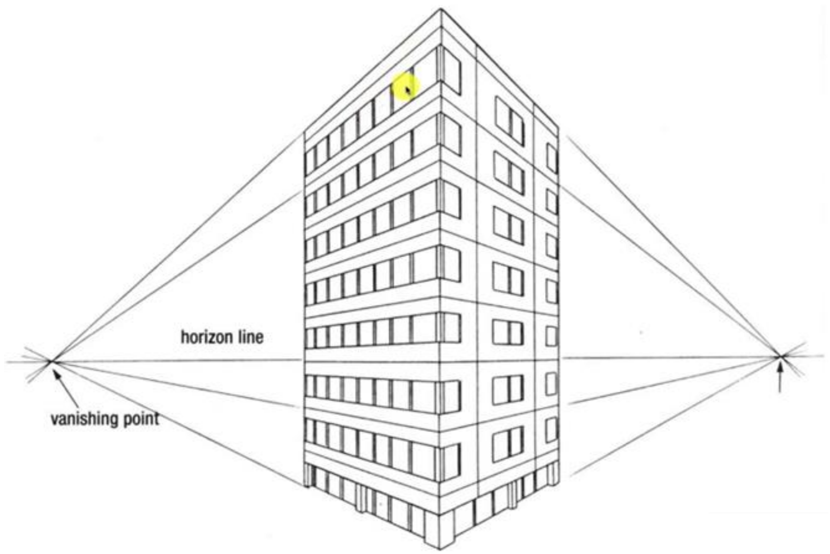
Three-point Perspective: 3 Vanishing Points

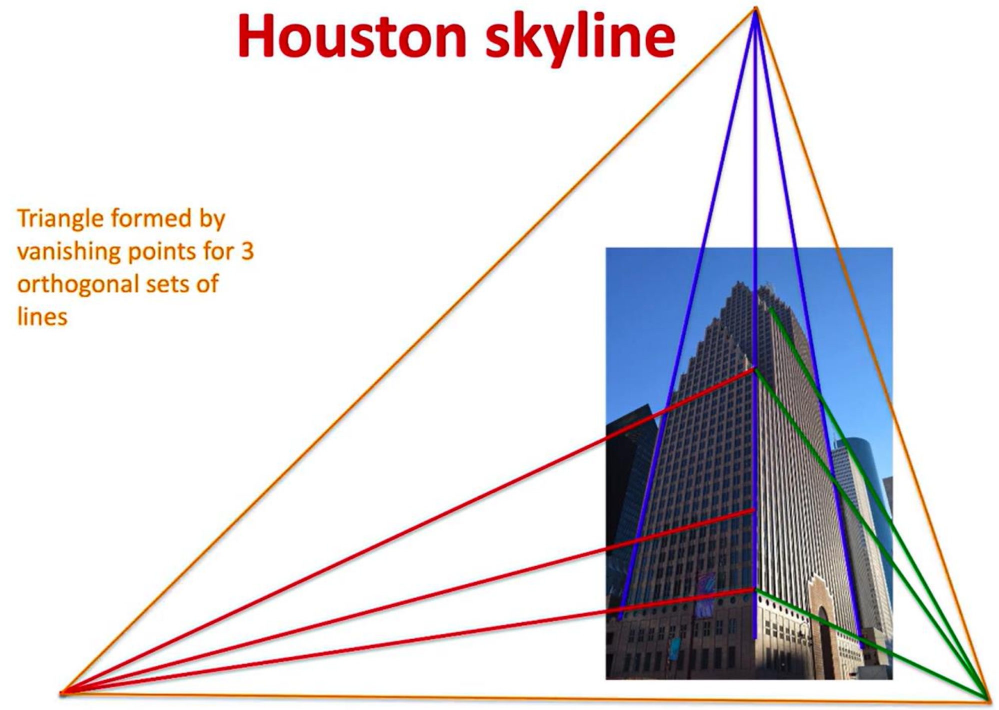


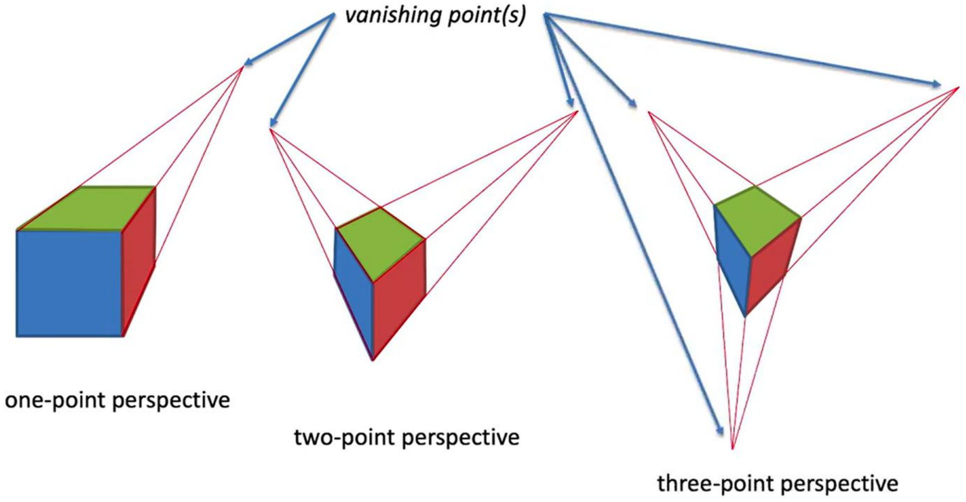
The image plane intersects the x, y, and z world-coordinate axes and therefore lines parallel to these axes intersect, resulting in three different vanishing points.

Vanishing Points

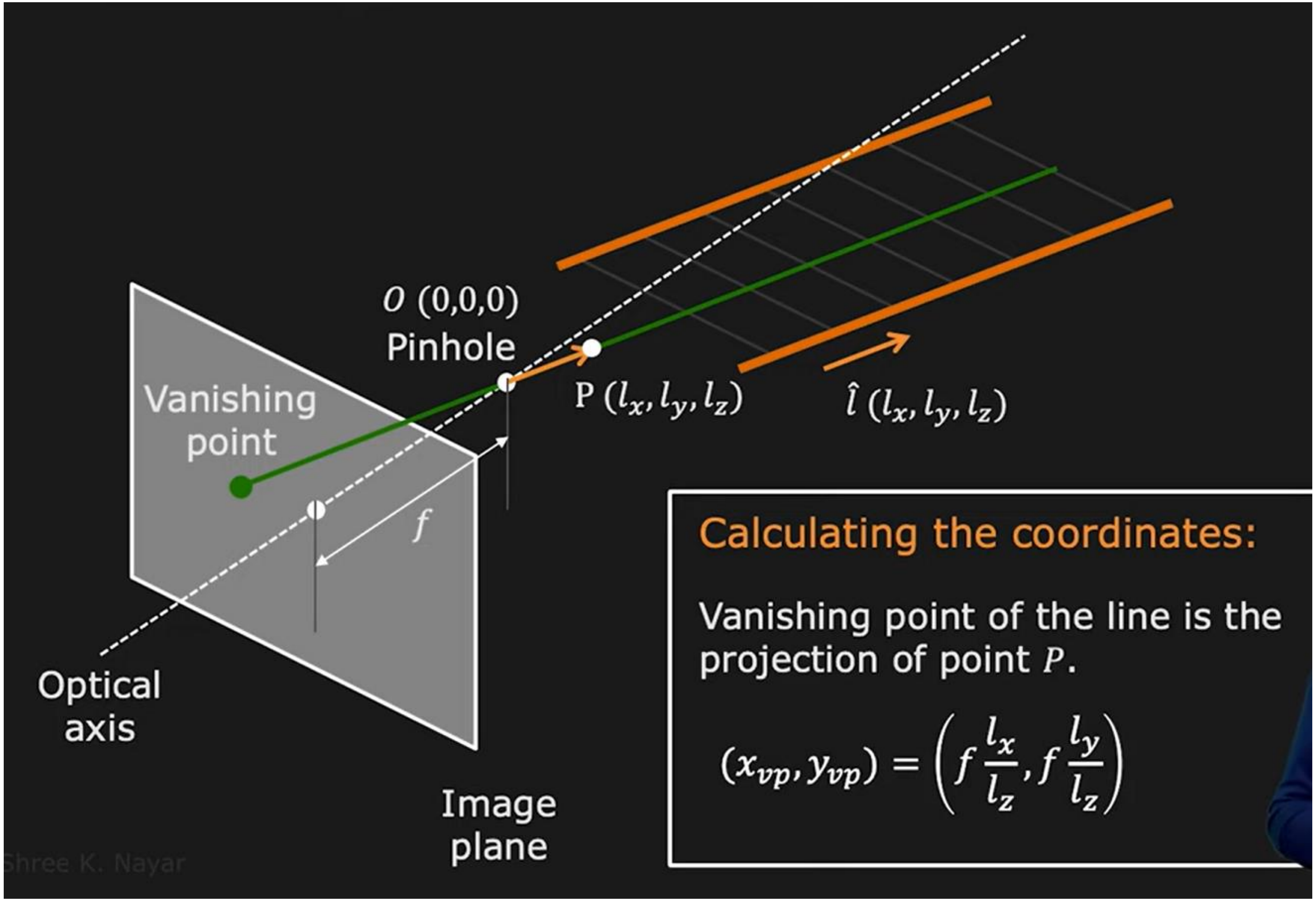
https://www.joshuanava.biz/manga-2/images/1829_99_459-vanishing-point-drawings-city.jpg



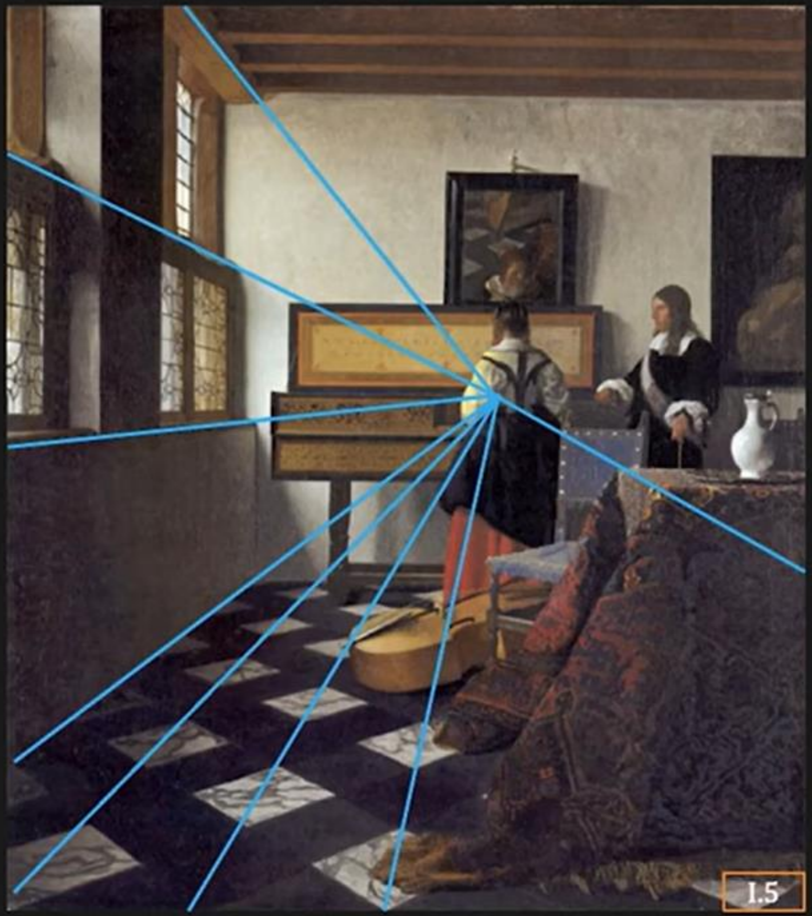




Finding the Vanishing Point



Use of Vanishing Point in Art



The Music Lesson, Johannes Vermeer, c. 1662-1664

The artist placed the important subject at the dominant vanishing point (converged by large #of parallel lines).
The artist wants to draw your attention to the activity "Artist playing the piano".

False Perspective

References

- https://cave.cs.columbia.edu/Statics/monographs/Image%20Formation%20FPCV-1-1.pdf
- Pinhole and Perspective Projection | Image Formation