



$$\text{Camera} \rightarrow P = \vec{CP}$$

- Given
- 1) camera intrinsics
  - 2) height of camera =  $h$
  - 3) the upward camera axis is perpendicular to the ground plane  $\vec{m}$  (upward vector)
- $\vec{g}$  (ground vector)  $\vec{m} \cdot \vec{g} = 0$

$K^{-1}x$  = ray towards the point

$h$  = height of camera

$\vec{m}$  = direction of down/up axis

To find point  $p$  on the ground

We essentially need to compute the magnitude of  $\vec{CP}$  as the direction of  $\vec{CP} = K^{-1}x$

$$K^{-1}x \cdot \vec{m} = \|K^{-1}x\| \cdot \|\vec{m}\| \cos \theta$$

$$\text{magnitude of } \vec{CP} = \frac{h}{\cos \theta} \quad (\text{pythagoras using trigonometry})$$

$$\text{magnitude} = h$$

$$(K^{-1}x^*)^T (\vec{m}^*)$$

$$\text{direction} = K^{-1}x^*$$

\* (\*) represents normalized vector unit = 1

$$\vec{p} = \underbrace{h}_{\text{magnitude}} \cdot \underbrace{(K^{-1}x^*)^T (\vec{m}^*)}_{\text{direction}}$$

Note: people multiply negative sign (-1) depending on what is the direction of  $\vec{m}$