UNIVERSITÀ DI PARMA

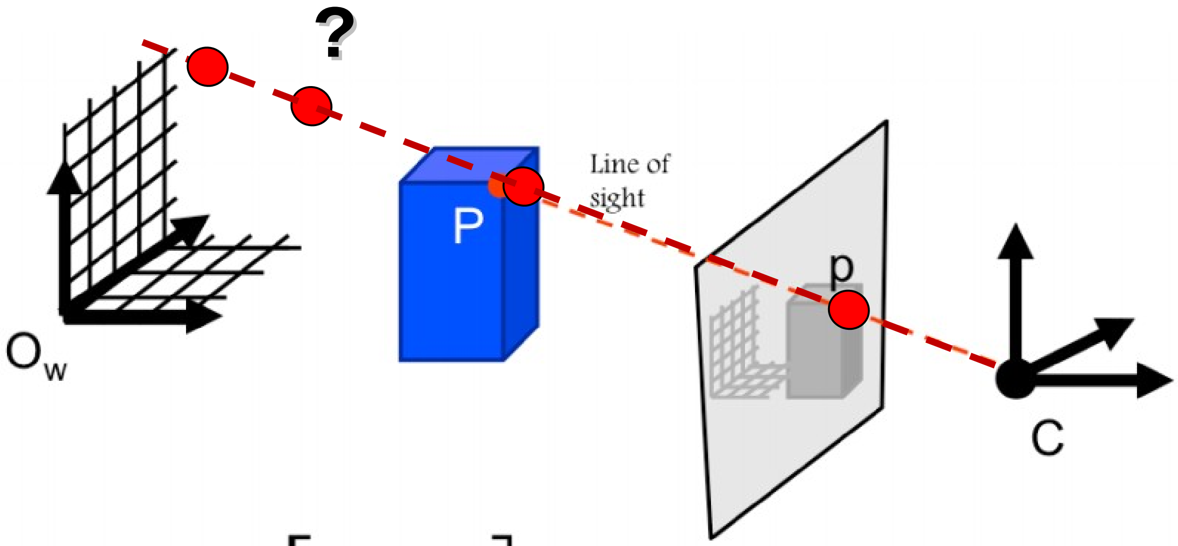
LABORATORY #5

Summary

- Inverse Perspective transformations
- We want to find world coordinates of image points

Inverse Perspective Mapping

- We already know that 3D world reconstruction is not possible from 2D images



$$M = K\begin{bmatrix} R & T \end{bmatrix}$$

Inverse Perspective Mapping

- If we add a specific costraint it can be done
- I.e. that image points belong to a specific plane Π

$$\Pi:\ \ aX+bY+cZ+d=0$$

$$\begin{bmatrix} u \\ v \\ w \end{bmatrix} = M \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix} \rightarrow \begin{bmatrix} u \\ v \\ w \\ 0 \end{bmatrix} = \begin{bmatrix} M \\ a\,b\,c\,d \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix} \qquad \begin{bmatrix} X \\ Y \\ Z \\ W \end{bmatrix} = \begin{bmatrix} M \\ a\,b\,c\,d \end{bmatrix}^{-1} \begin{bmatrix} u \\ v \\ 1 \\ 0 \end{bmatrix} \xrightarrow[euclidean]{} \begin{bmatrix} X/W \\ Y/W \\ Z/W \end{bmatrix}$$

Inverse Perspective Mapping

- Given
  - An image
  - Camera parameters
- Project image points on a given plane
- $Y = 0$
  - $(a, b, c, d) = (0, 1, 0, 0)$

Inverse Perspective Mapping

- When Y = 0
- We can simplify M
- M becomes a 3×3 matrix!

$$\begin{bmatrix} u \\ v \\ w \end{bmatrix} = M \begin{bmatrix} X \\ 0 \\ Z \\ 1 \end{bmatrix} \rightarrow \begin{bmatrix} u \\ v \\ w \end{bmatrix} = M'_{(3\times3)} \begin{bmatrix} X \\ Z \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} X \\ Z \\ 1 \end{bmatrix} = M'^{-1} \begin{bmatrix} u \\ v \\ 1 \end{bmatrix}$$