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# LABORATORY #4b

# Summary



- Inverse Perspective Mapping (IPM)
- Given an image, project all points on a specific plane

# Inverse Perspective Mapping

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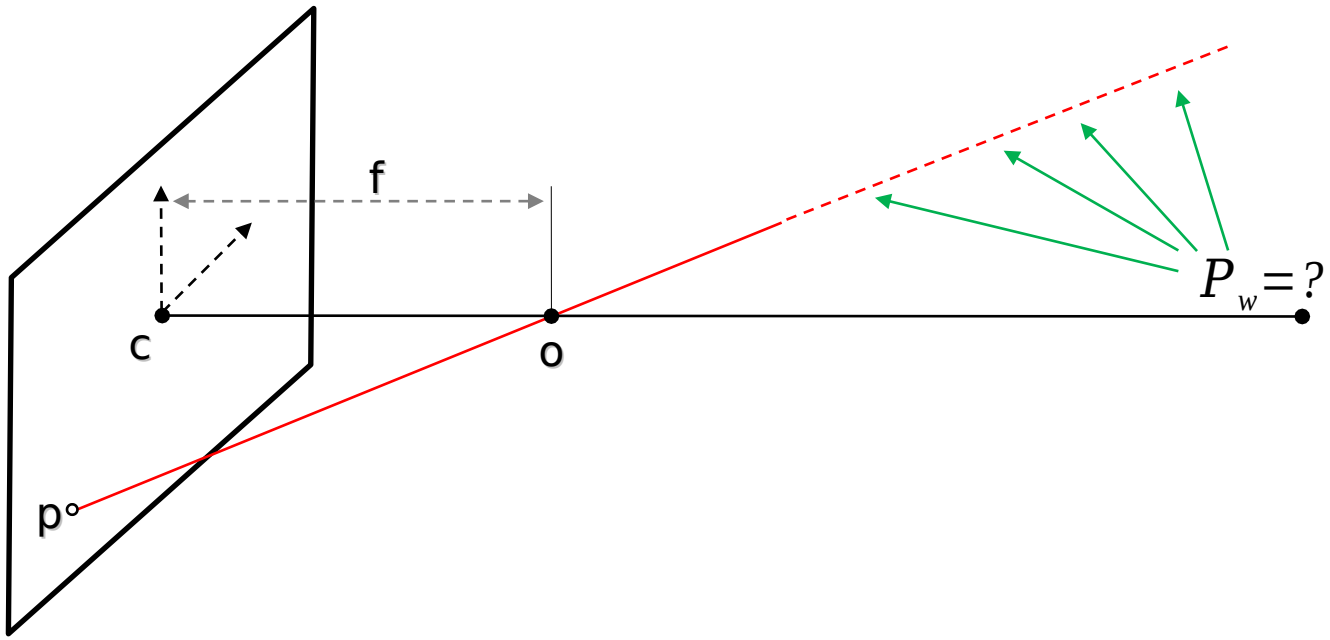
- Given an image point find corresponding world point



# Inverse Perspective Mapping

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- The result can only be a straight line (line of sight)
- It is not possible to invert M

$$p = MP_w \quad \rightarrow \quad P_w = M^{-1} p$$

# Inverse Perspective Mapping

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- In order to invert we can add another constraint
- i.e. $P_w$ belonging to a given world plane

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

# Inverse Perspective Mapping

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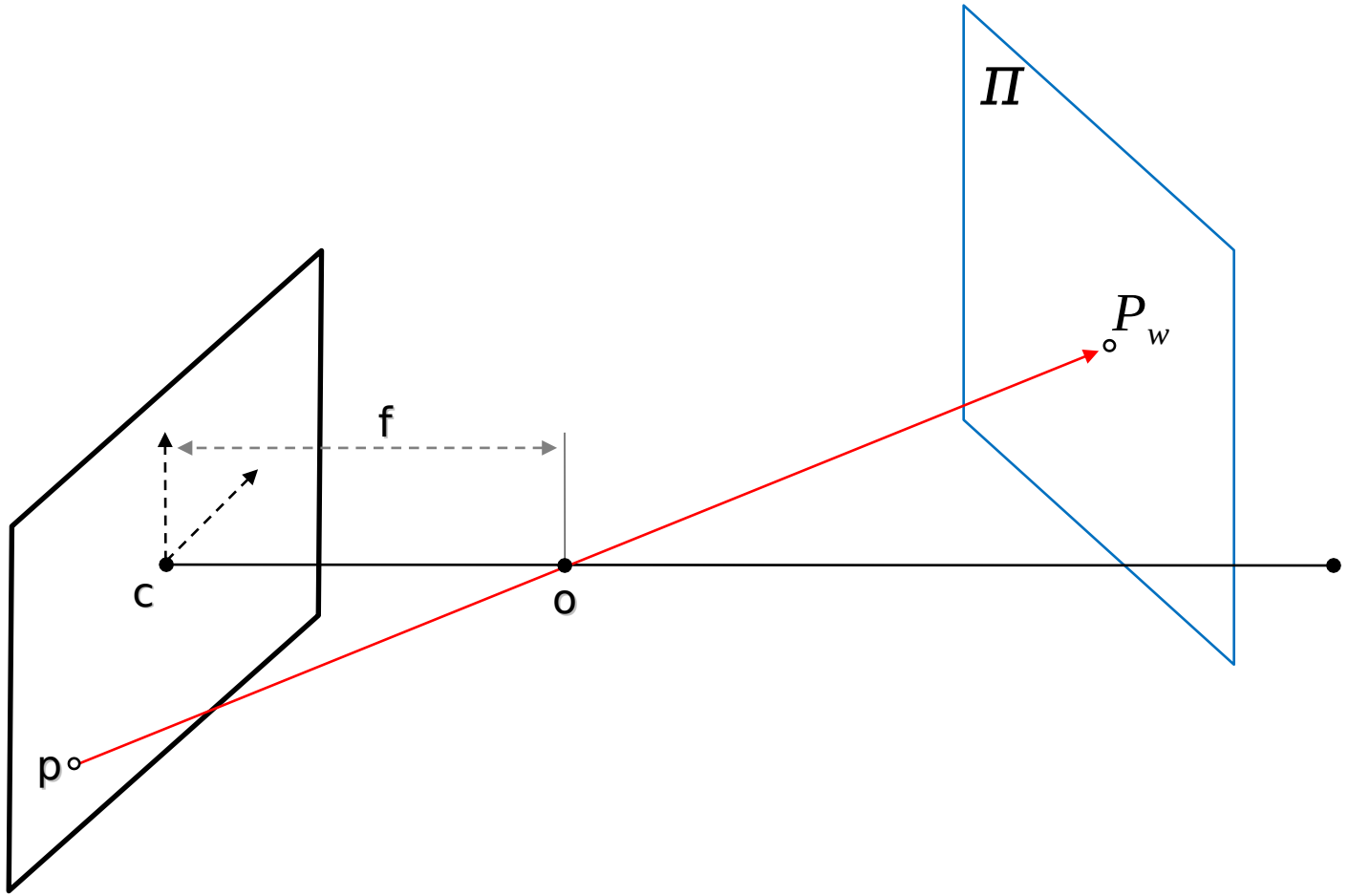

# Inverse Perspective Mapping

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- In such a case we can invert M since basically we add a line obtaining a 4×4 matrix

$$p = \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} = \begin{bmatrix} M & & & \\ a & b & c & d \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix}$$

# Inverse Perspective Mapping

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- The 4×4 matrix can now be inverted

$$P_w = \begin{bmatrix} M \\ a & b & c & d \end{bmatrix}^{-1} p$$

# Homework

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- Given an image and camera parameters use the plane y=0 to reproject pixels

# Homework

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- Use y=0 plane
  - (a, b, c, d) ⟶ (0, 1, 0, 0)
- Invert M and for each p (u, v) obtain X and Z

$$\begin{bmatrix} X \\ 0 \\ Z \\ W \end{bmatrix} = \begin{bmatrix} m_{11} & m_{12} & m_{13} & m_{14} \\ m_{21} & m_{22} & m_{23} & m_{24} \\ m_{31} & m_{32} & m_{33} & m_{34} \\ m_{41} & m_{42} & m_{43} & m_{44} \end{bmatrix} \begin{bmatrix} u \\ v \\ 1 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} X \\ Z \\ W \end{bmatrix} = H \begin{bmatrix} u \\ v \\ 1 \end{bmatrix}$$