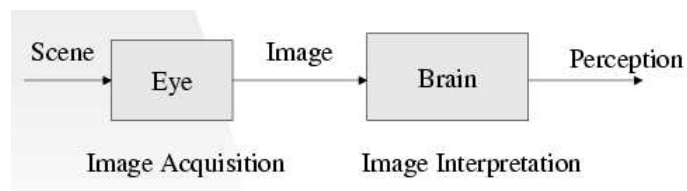


CAP5415 Computer Vision  
Spring 2003

Khurram Hassan-Shafique

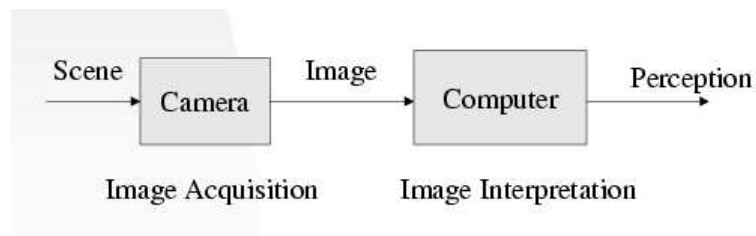
## Vision

- Vision is the process of discovering what is present in the world and where it is by looking.



# Computer Vision

- Computer Vision is the study of analysis of pictures and videos in order to achieve results similar to those as by men.



## Example

Finding People in images

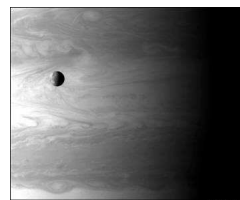
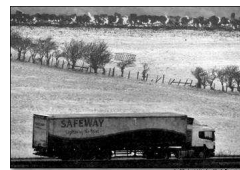
Problem 1: Given an image I

Question: Does I contain an image of a person?

## “Yes” Instances

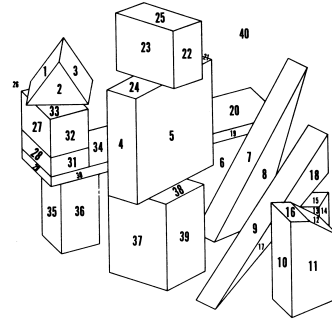


## “No” Instances



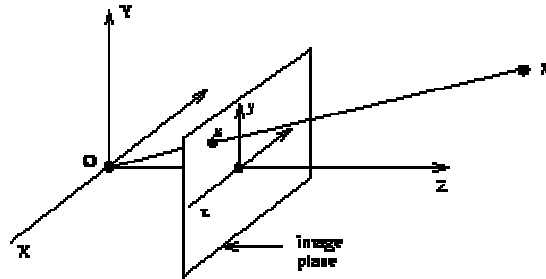
# From Turing to Marr

## A Brief History

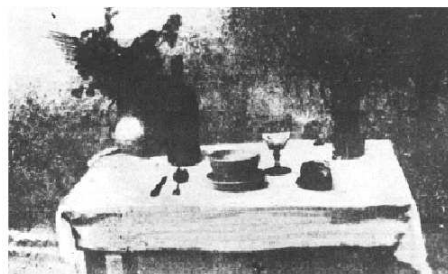


## Course Overview

# Imaging Geometry



# Camera Modeling



Pinhole Cameras  
Lenses  
Camera Parameters  
and Calibration

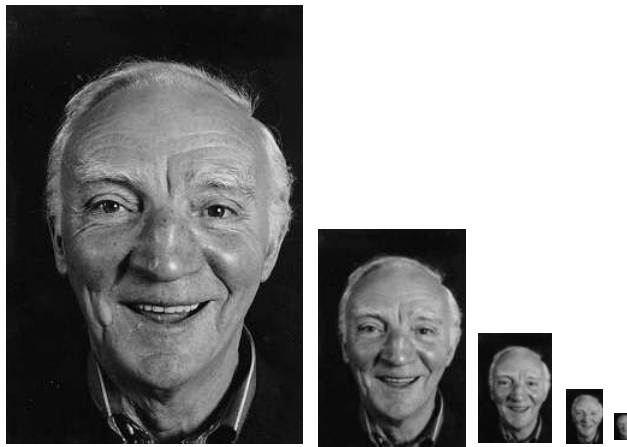
**Figure 1.16** The first photograph on record, *la table servie*, obtained by Nicéphore Niepce in 1822. *Collection Harlinge-Viollet.*

## Image Filtering and Enhancing



- Linear Filters and Convolution
- Image Smoothing
- Edge Detection
- Pyramids

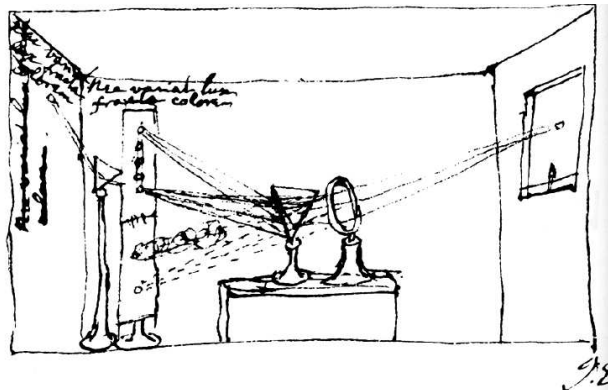
## Image Filtering and Enhancing



## Region Segmentation

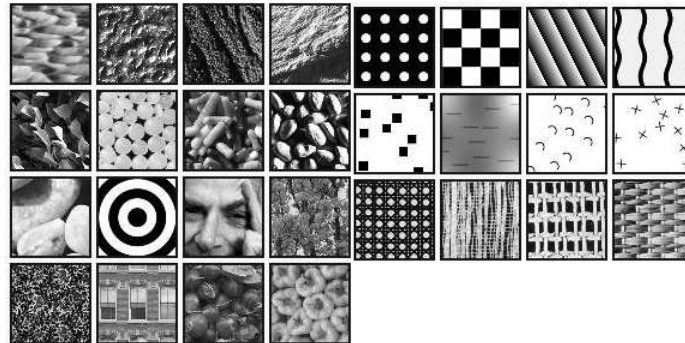


## Color

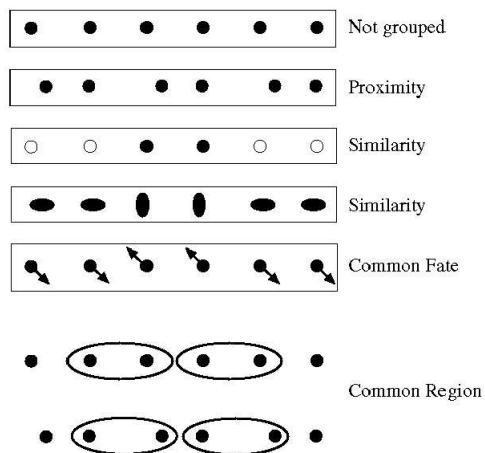


4.1 NEWTON'S SUMMARY DRAWING of his experiments with light. Using a point source of light and a prism, Newton separated sunlight into its fundamental components. By reconverging the rays, he also showed that the decomposition is reversible.

# Texture

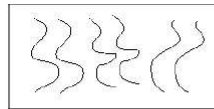


# Perceptual Organization

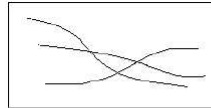




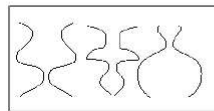
## Perceptual Organization



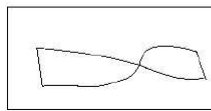
Parallelism



Continuity



Symmetry

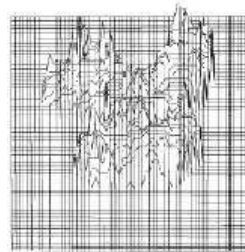
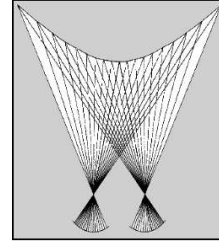


Closure

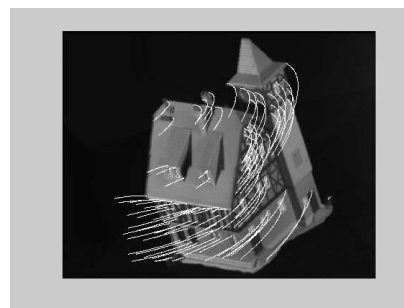
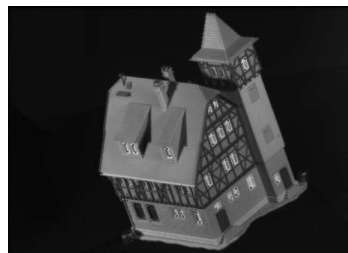
## Shape Analysis



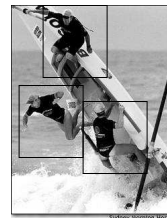
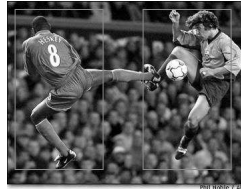
## Stereopsis



## Motion and Optical Flow



## High Level Vision

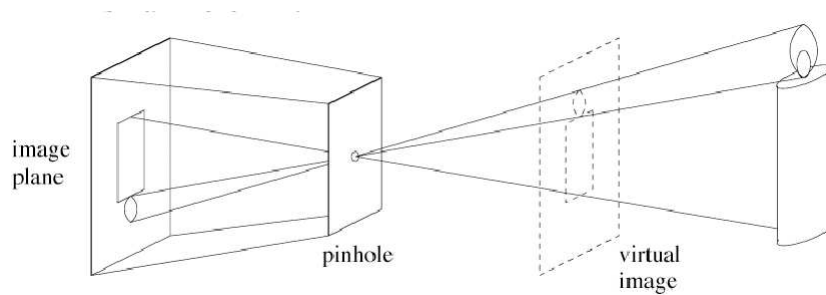


## Applications (Mosaics)

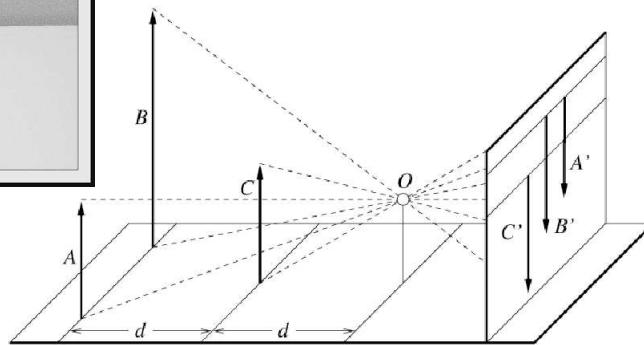


# Imaging Geometry

## Pinhole Camera

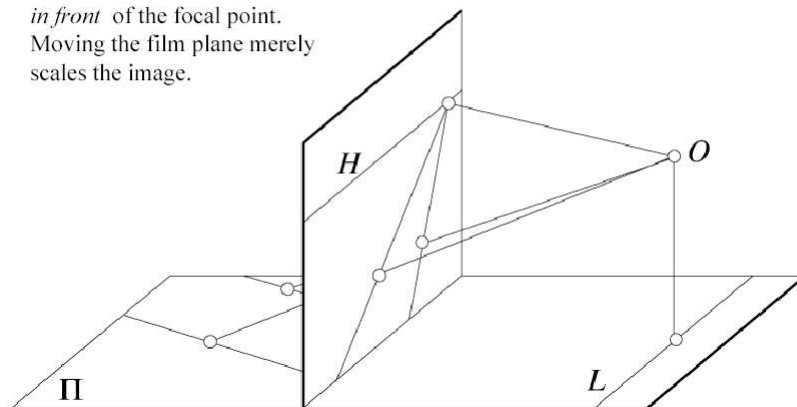


## Perspective Projection



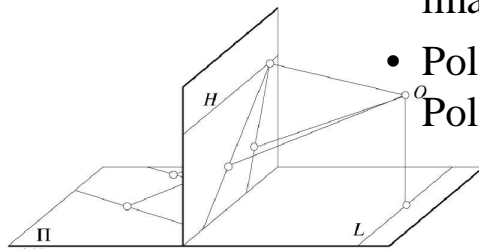
## Perspective Projection

Common to draw film plane  
*in front* of the focal point.  
Moving the film plane merely  
scales the image.

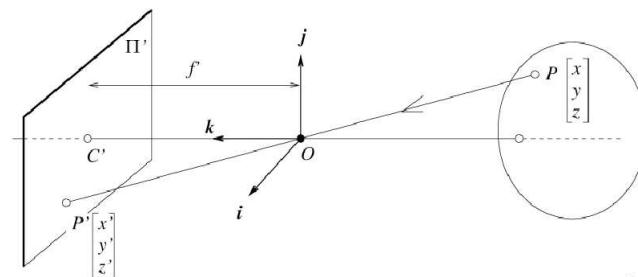


## Perspective Projection

- Points go to Points
- Lines go to Lines
- Planes go to whole image or Half-planes
- Polygons go to Polygons



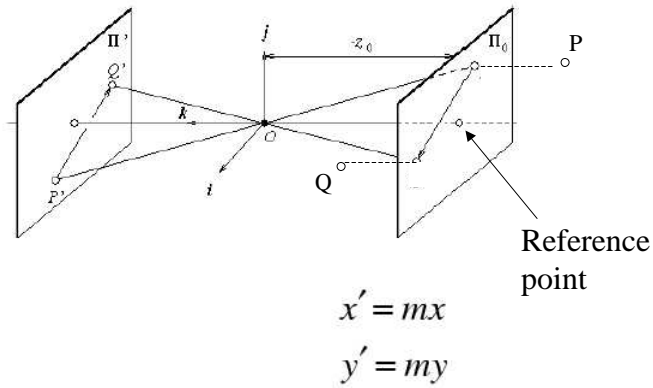
## Perspective Projection



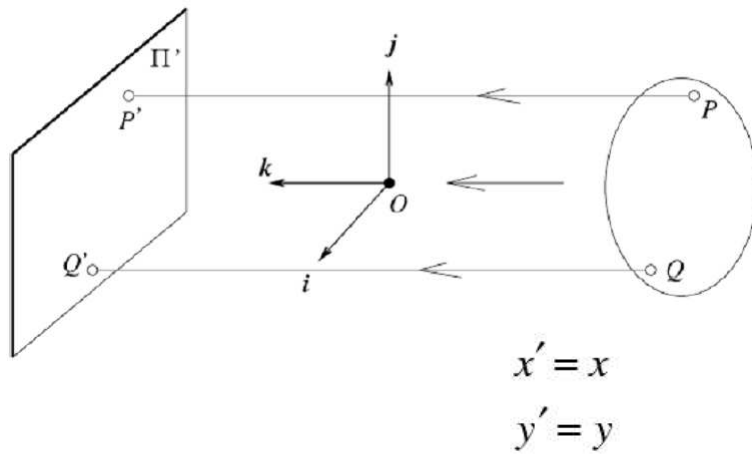
$$x' = f' \frac{x}{z}$$

$$y' = f' \frac{y}{z}$$

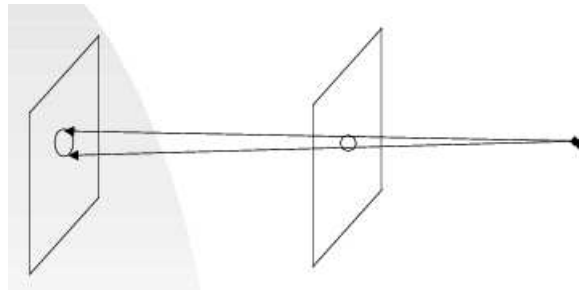
## Weak Perspective Projection



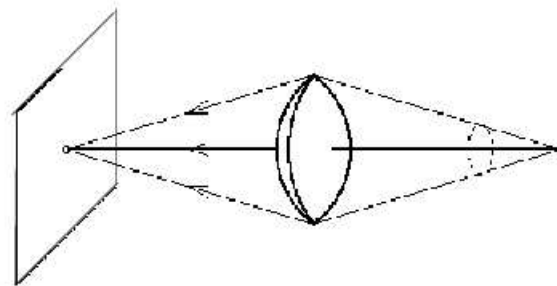
# Orthographic Projection



## Why Lenses

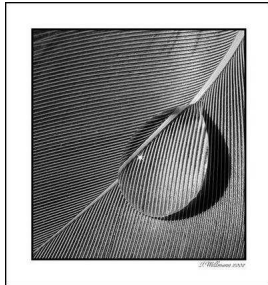


## Why Lenses

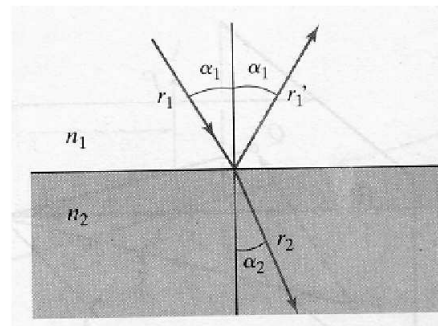




## Issues with Lenses

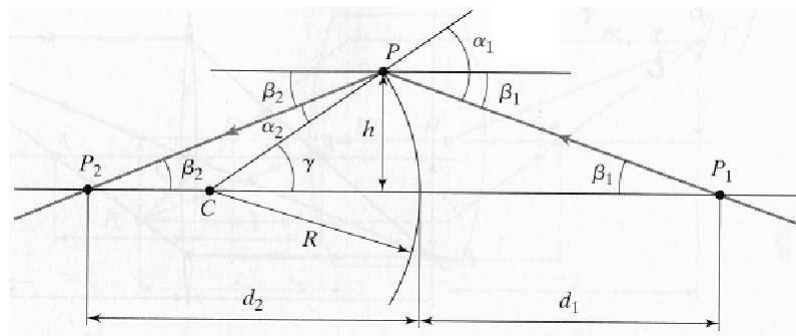


Snell's law

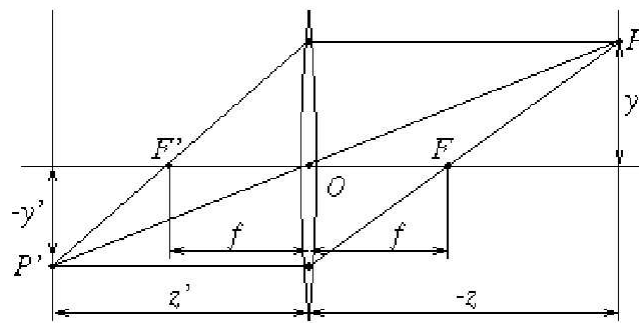


$$n_1 \sin(\alpha_1) = n_2 \sin(\alpha_2)$$

## Refraction



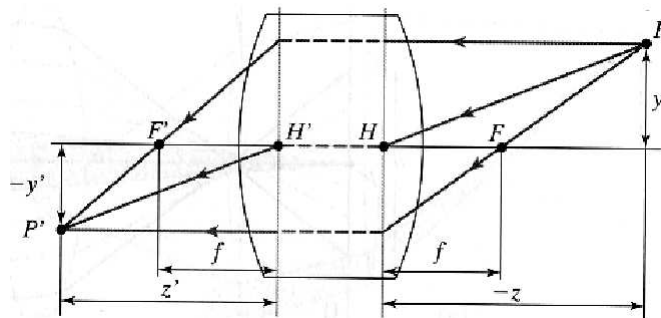
## Thin Lens Model



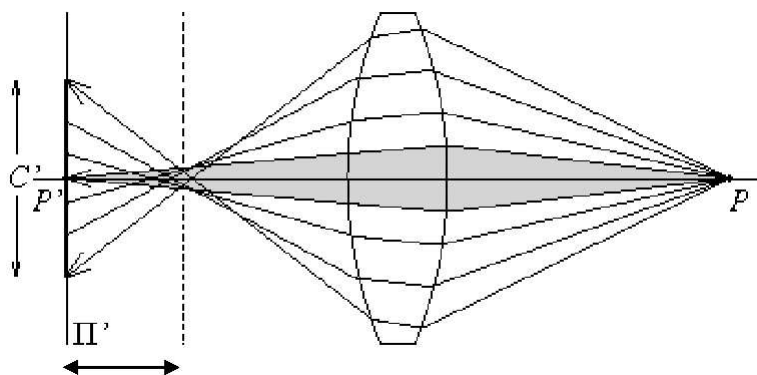
$$\frac{1}{z'} - \frac{1}{z} = \frac{1}{f}$$

$$f = \frac{R}{2(n-1)}$$

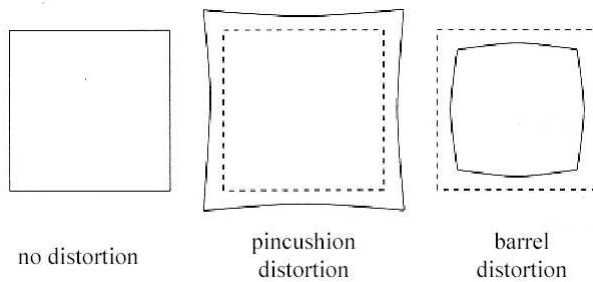
## Thick Lens



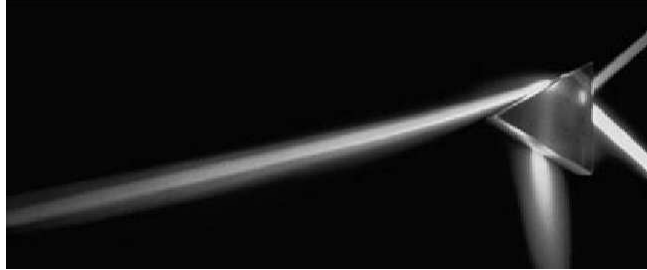
## Spherical Aberration



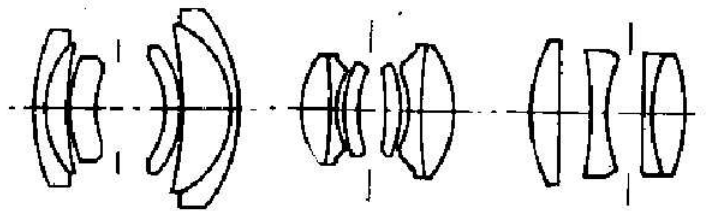
## Distortions



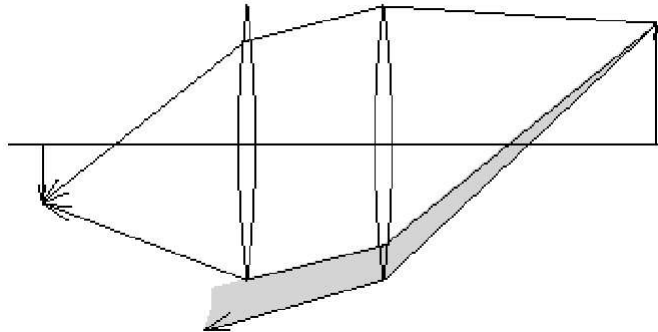
## Chromatic Aberration



## Compound Lenses



## Vignetting



## Suggested Reading

- Chapter 1, David A. Forsyth and Jean Ponce, "Computer Vision: A Modern Approach",