

About Images

Lecture 5

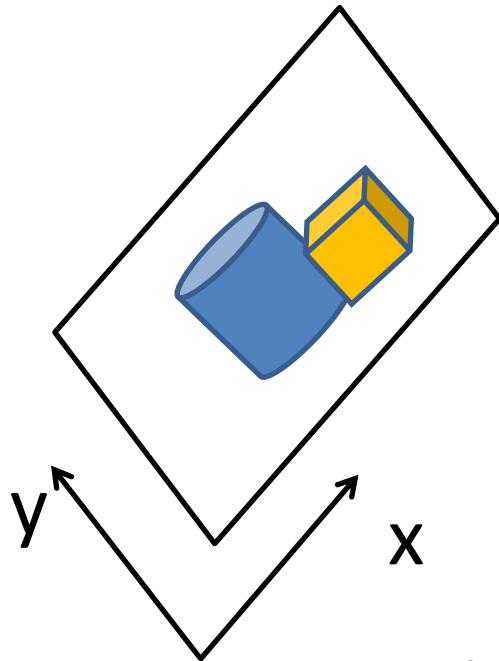
Dr Adrian Bors

THE UNIVERSITY *of York*

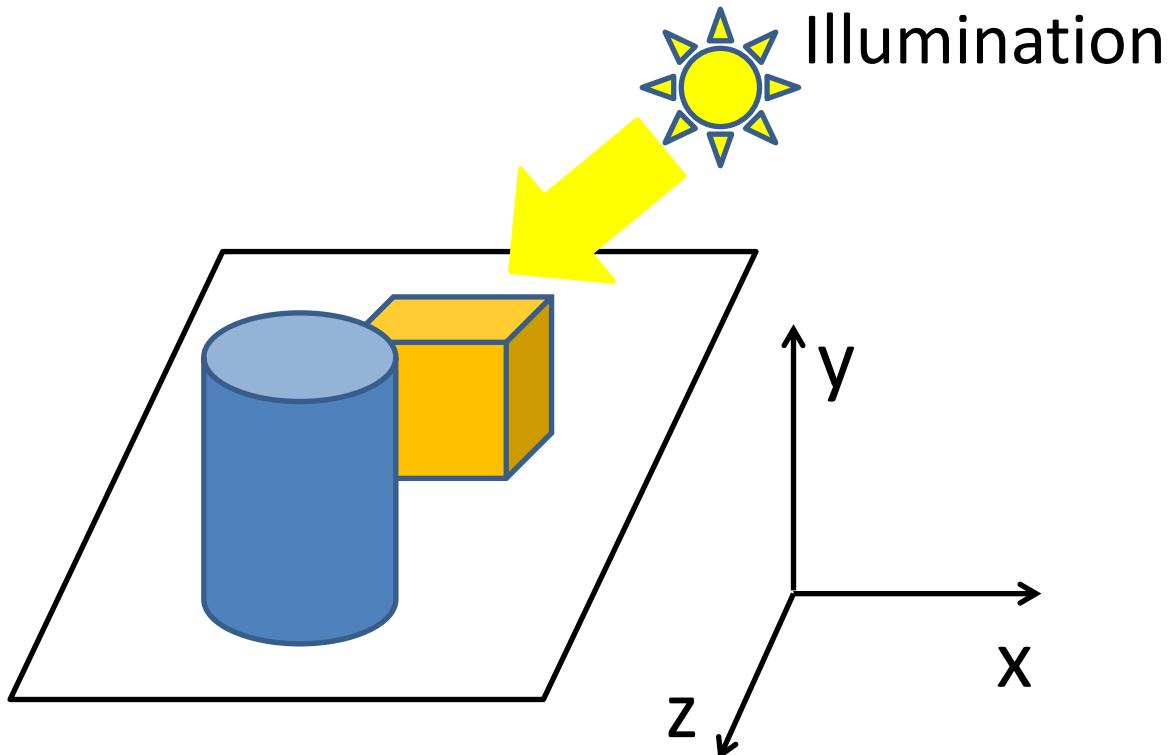
Today's Topics

- Images and histograms
 - Graphics and vertices
 - Pinhole camera
 - Thin lens camera
 - Using Images
-

Scenes and Images



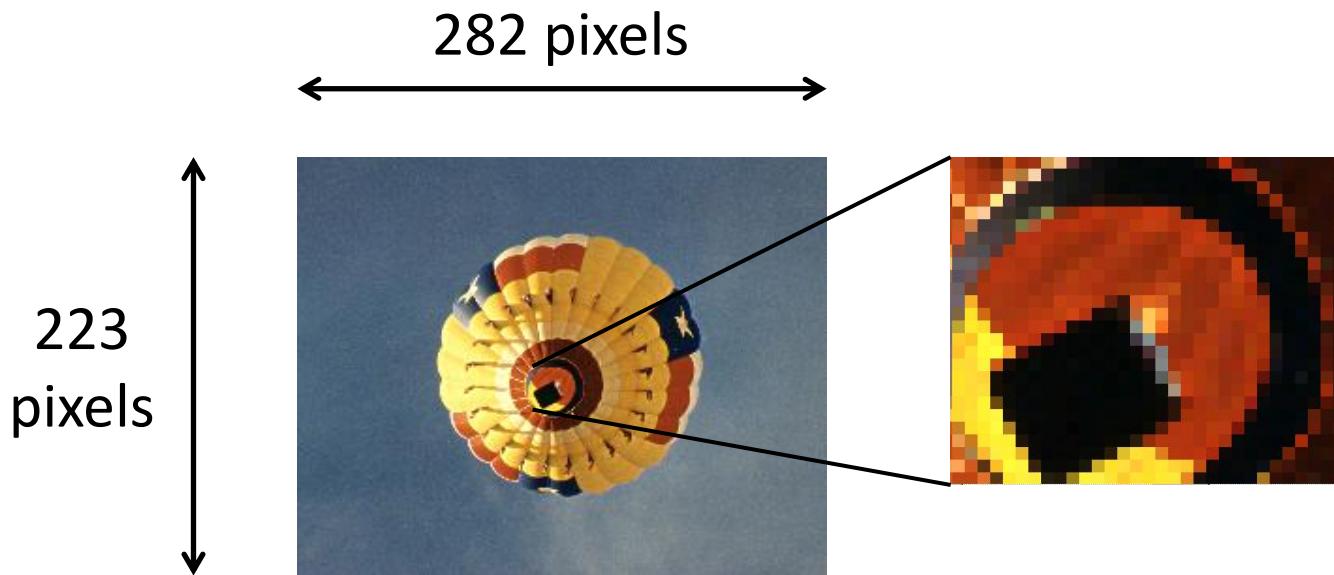
Images represent
a projection of
the information
from scene in 2D



3D Scenes – Real in Vision
– Created in Graphics

What is an image?

- An image is a rectangular grid of pixels characterized by image size and pixel values



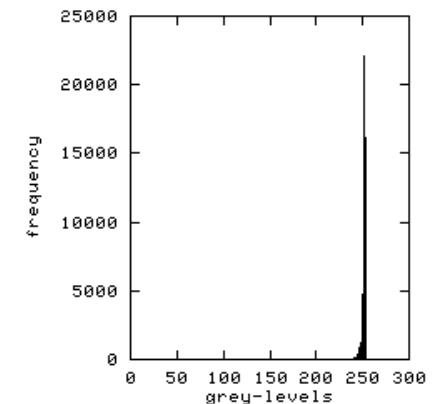
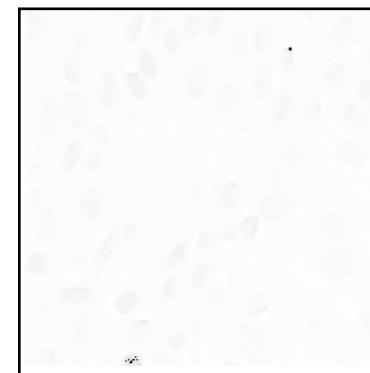
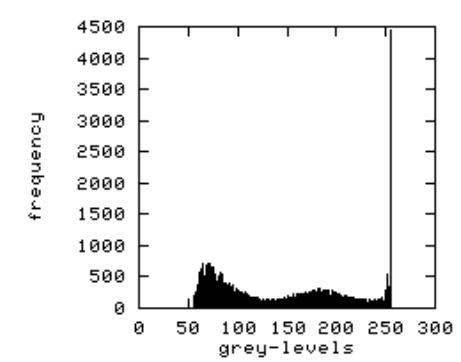
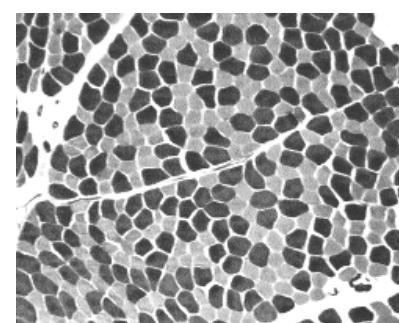
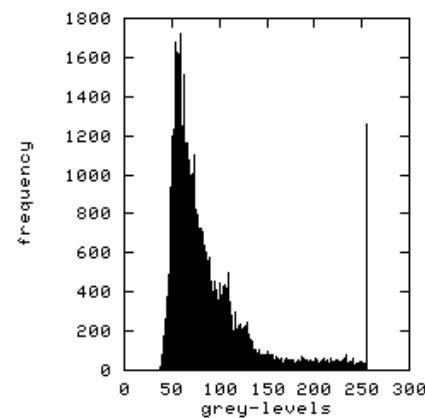
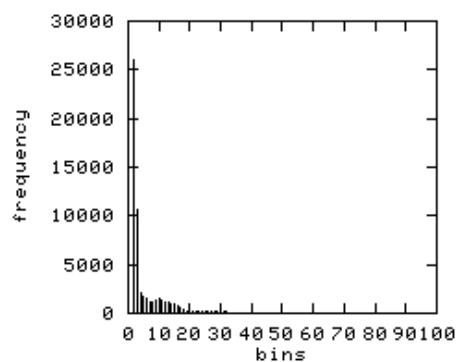
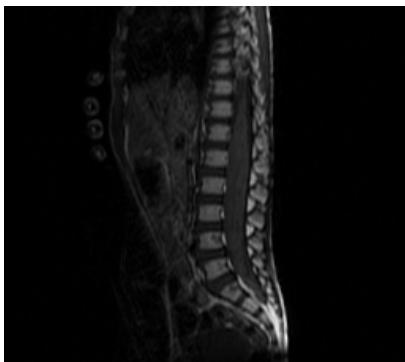
Each grey-level image pixel has 8 bits so its value is in range 0-255
Each colour pixel has 3 colour components: red, green and blue

Histograms

- Histogram – represents the global statistical information from the image, which may or may not correspond to a specific object. They count the frequency of each value in the image
- Histograms are represented as 1-D arrays for grey-level images and as 3-D arrays for colour images – one for each colour component
- Histogram stretching represents a mapping of the histogram aiming to improve the contrast

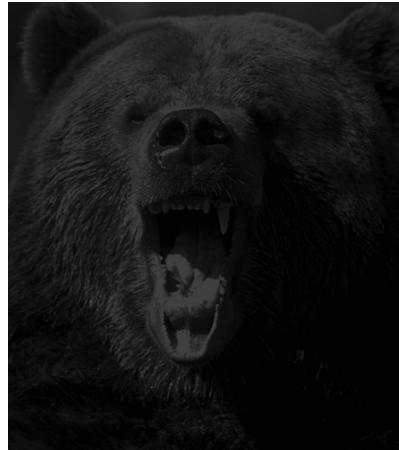
Image Histograms

The histogram represents the frequency of each pixel value in the image



Histogram Stretching

Original
Image



After
histogram
stretching



Image contrast is improved

Maximal value in
the histogram

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Histogram of
initial image

Grey levels

Project the
pixel values

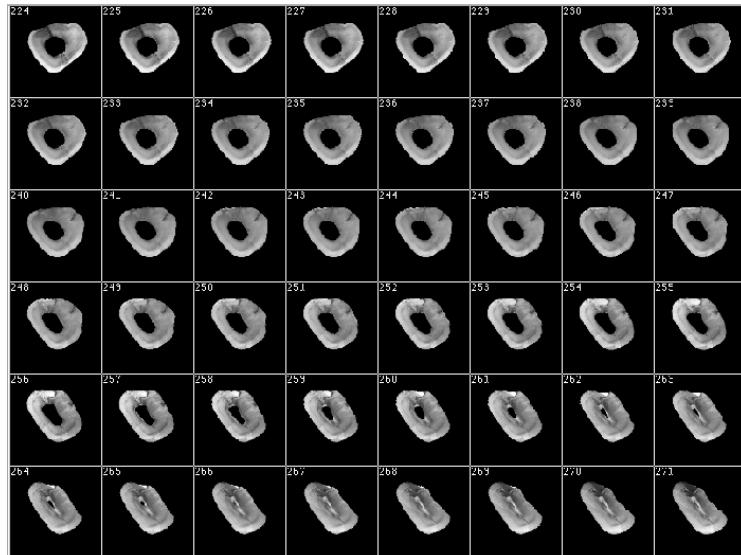
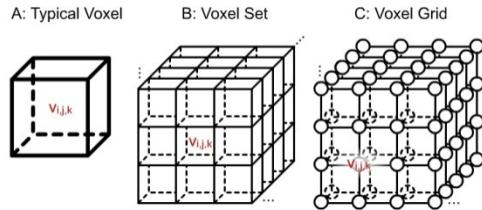
255

Grey levels

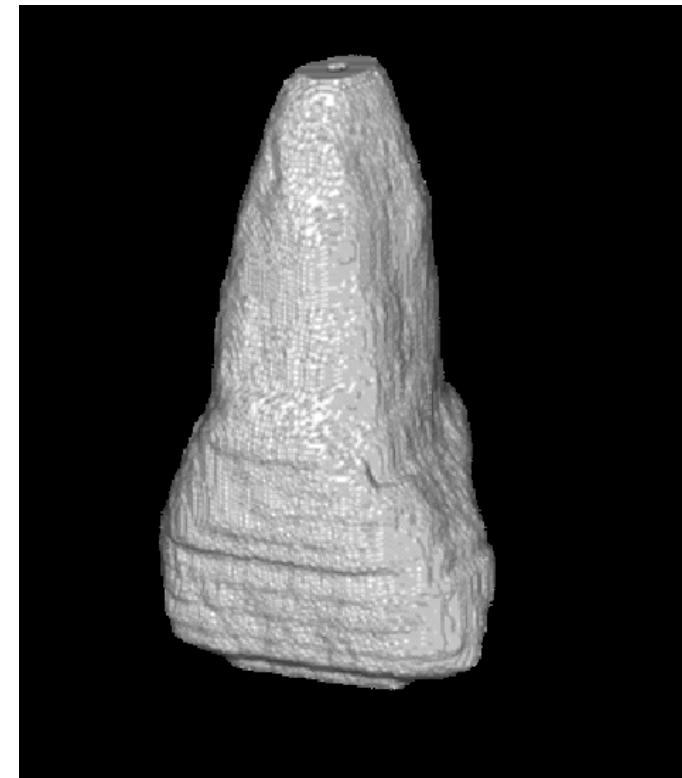
Stretched histogram

Voxel representations

By adding layers of images you can produce a volumetric (3D) image



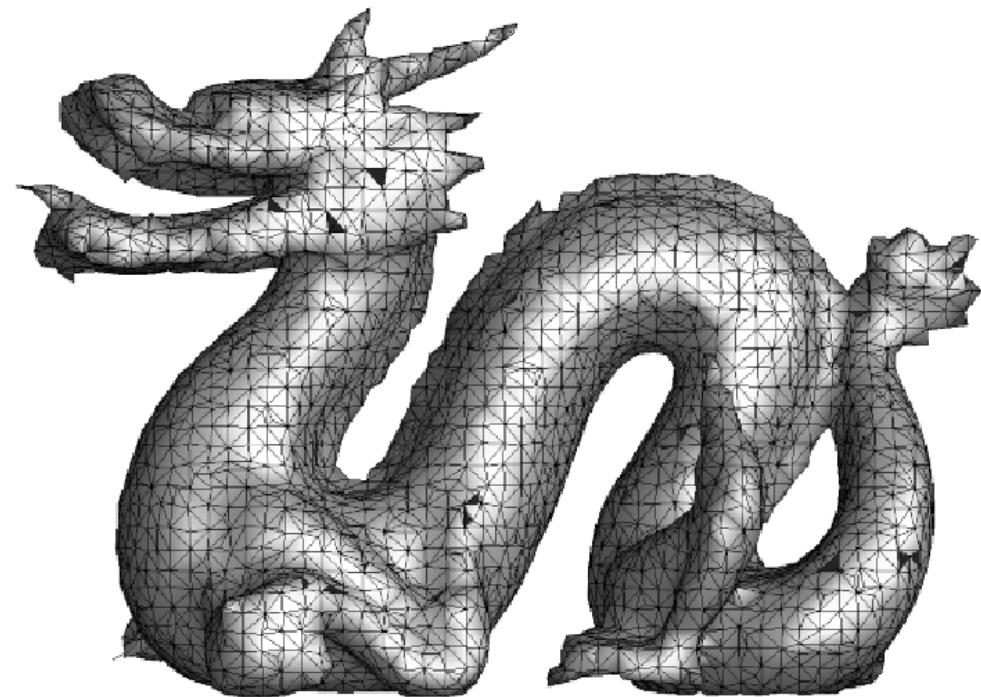
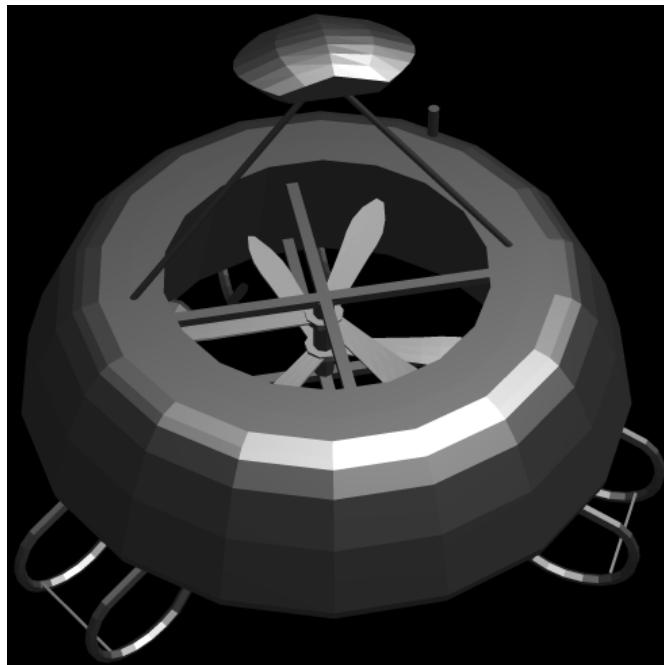
Slices



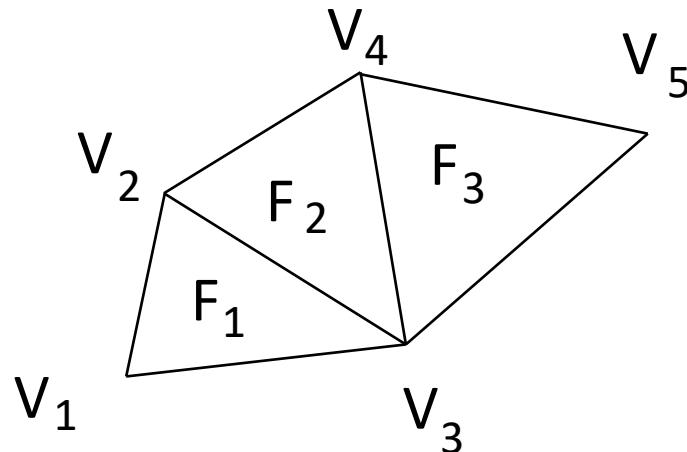
3D voxel representation

What is a Graphical Object?

- A graphical object can be represented as a mesh which is a sequence of vertices joined by polygons usually triangles.



What is graphics?



Face list

$F_1: V_1 \ V_2 \ V_3$
 $F_2: V_2 \ V_3 \ V_4$
 $F_3: V_3 \ V_4 \ V_5$

Vertex list

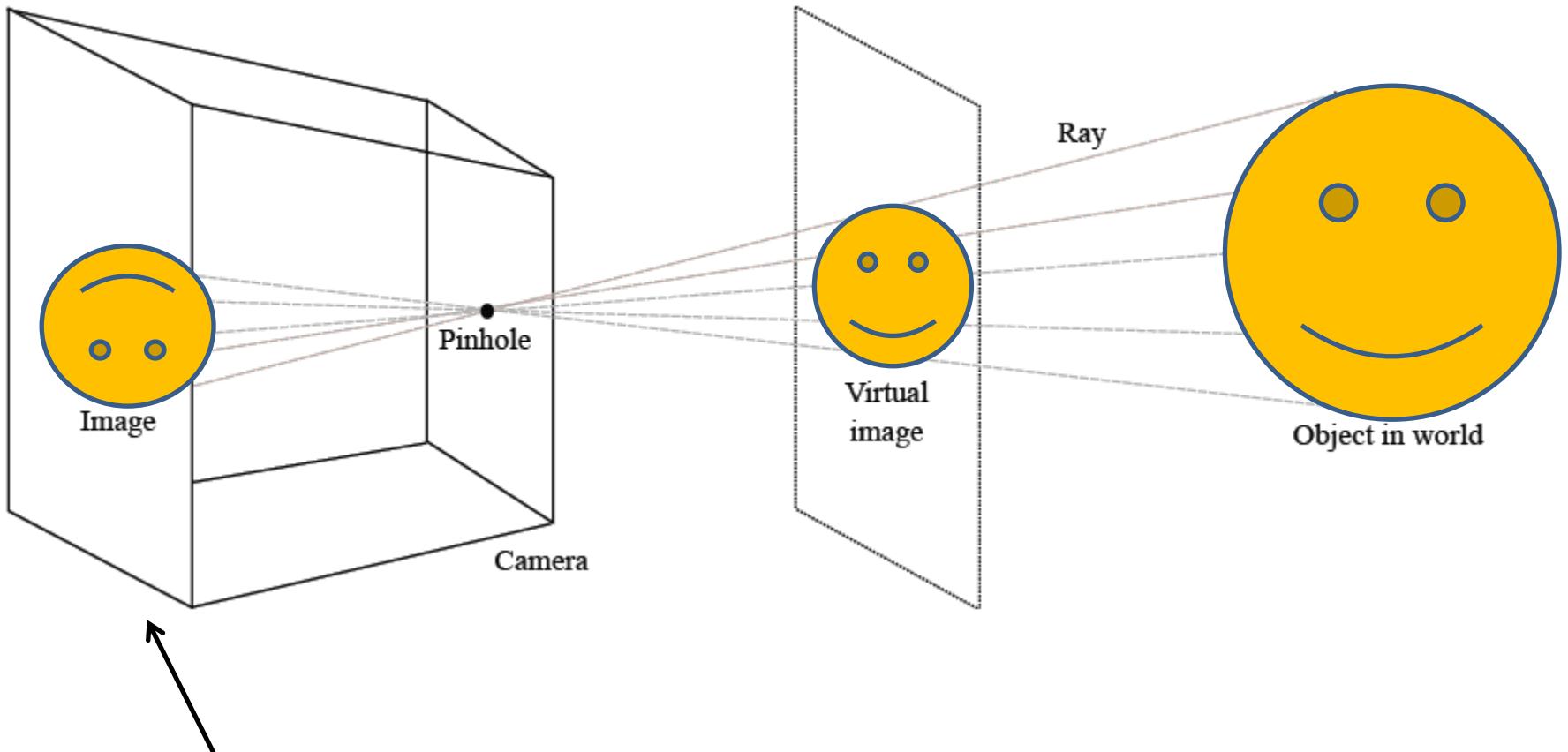
$V_1: X_1 \ Y_1 \ Z_1$
 $V_2: X_2 \ Y_2 \ Z_2$
 $V_3: X_3 \ Y_3 \ Z_3$
 $V_4: X_4 \ Y_4 \ Z_4$
 $V_5: X_5 \ Y_5 \ Z_5$

How can you access them through a program?

How are images produced?

- Images – represent projections of real scenes in the human eye or as taken by photo-camera
 - Images – represent projections of artificially generated scenes in computer graphics
 - Model of visualisation:
Pinhole camera
 - Real model:
Thin lens camera
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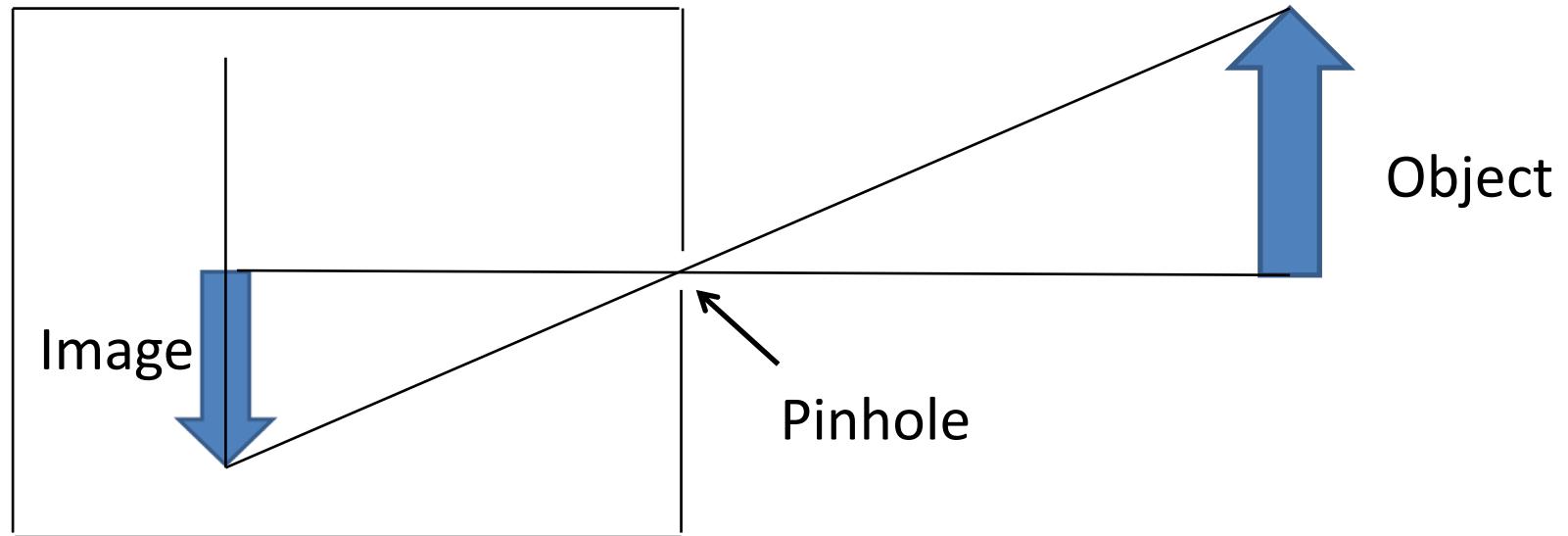
Image formation



Real camera image
is inverted

Pinhole Camera

Simplified model of camera



Pinhole Camera

- A real pinhole camera requires
 - tiny hole
 - let light pass through
- In Computer Graphics the pinhole is considered infinitely small (a single point) in an imaginary camera
- In Computer Vision - a real pinhole camera could have a hole of diameter of 0.5mm for a 6" distance to the image plane (focal length)

Pinhole Images



Pinhole Images

- Properties:
 - Continuous sharpness of depth
 - Very wide angle range
 - Exact perspective projection

Pinhole Images

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 - Continuous sharpness of depth
 - Very wide angle range
 - Exact perspective projection
- Disavantages
 - Dark images – because not enough light enters camera

Pinhole Images

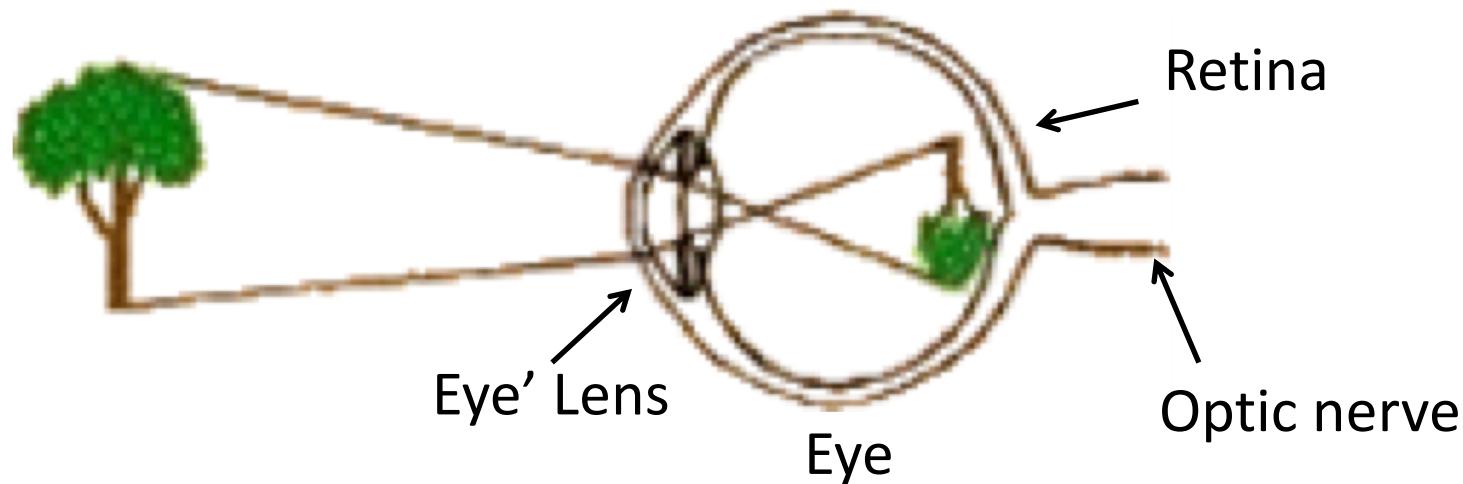
- Properties:
 - Continuous sharpness of depth
 - Very wide angle range
 - Exact perspective projection
- Dissadvantages
 - Dark images – because not enough light enters camera
- How can we improve the pinhole images
 - Increase exposure time – movement results in blurring
 - Increase the size of the pinhole – results in blurring because of the spread of light inside camera
 - Use lenses in order to concentrate light

Thin lens camera

- Real images have lenses which gathers light over a finite aperture controlling the amount of light received.
- Lenses are characterized by the focal distance f that depends on
 - Lens' curvature on the two faces
 - Lens' material
- Here we consider a single lens – Real photo-cameras use a sequence of lenses

View plane

- View plane represents the place where the image is formed.
- View plane could be:
 - Photo reactive chemicals
 - Charged-coupled device (CCD) or CMOS sensors
 - Retina – in humans and animals



Retina – equivalent to 576 Megapixels according to conservative estimates

Image Perception

Sometimes, objects are perceived by humans from disconnected segments

Subjective contours

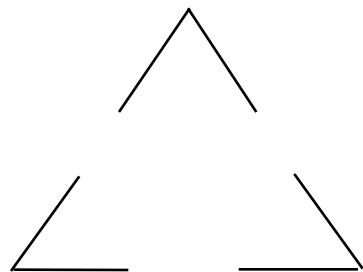


Image Perception

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Subjective contours

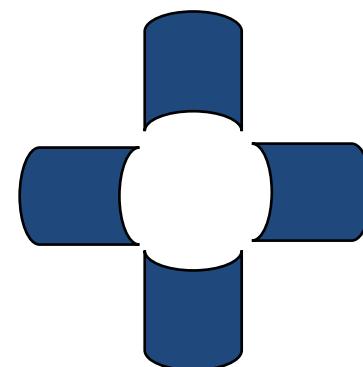
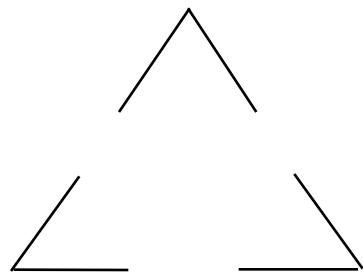


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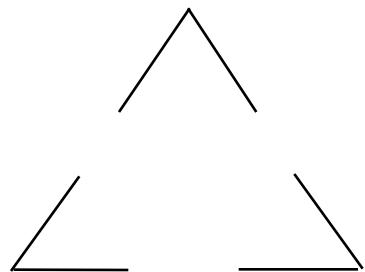


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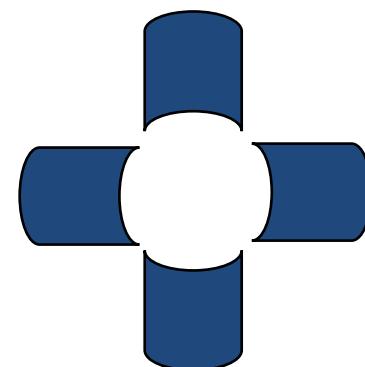
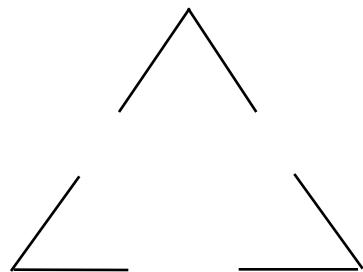
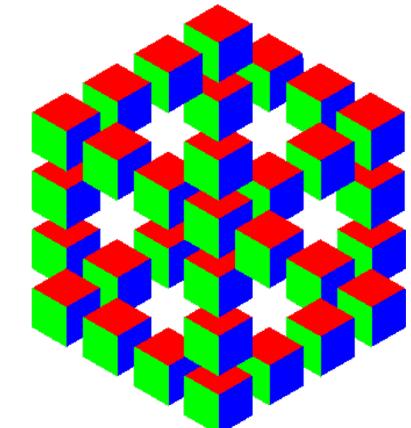
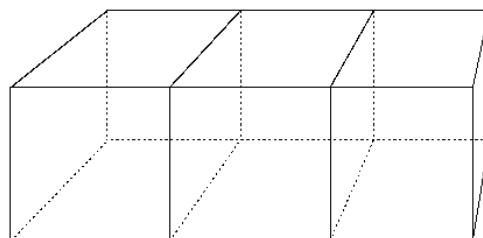
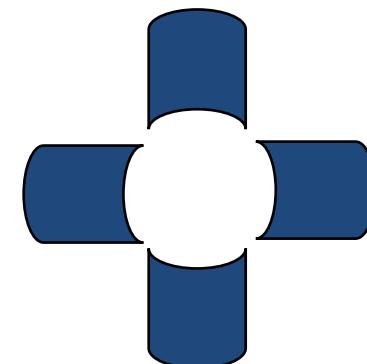
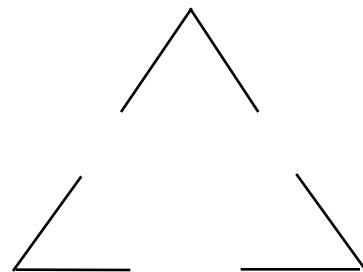


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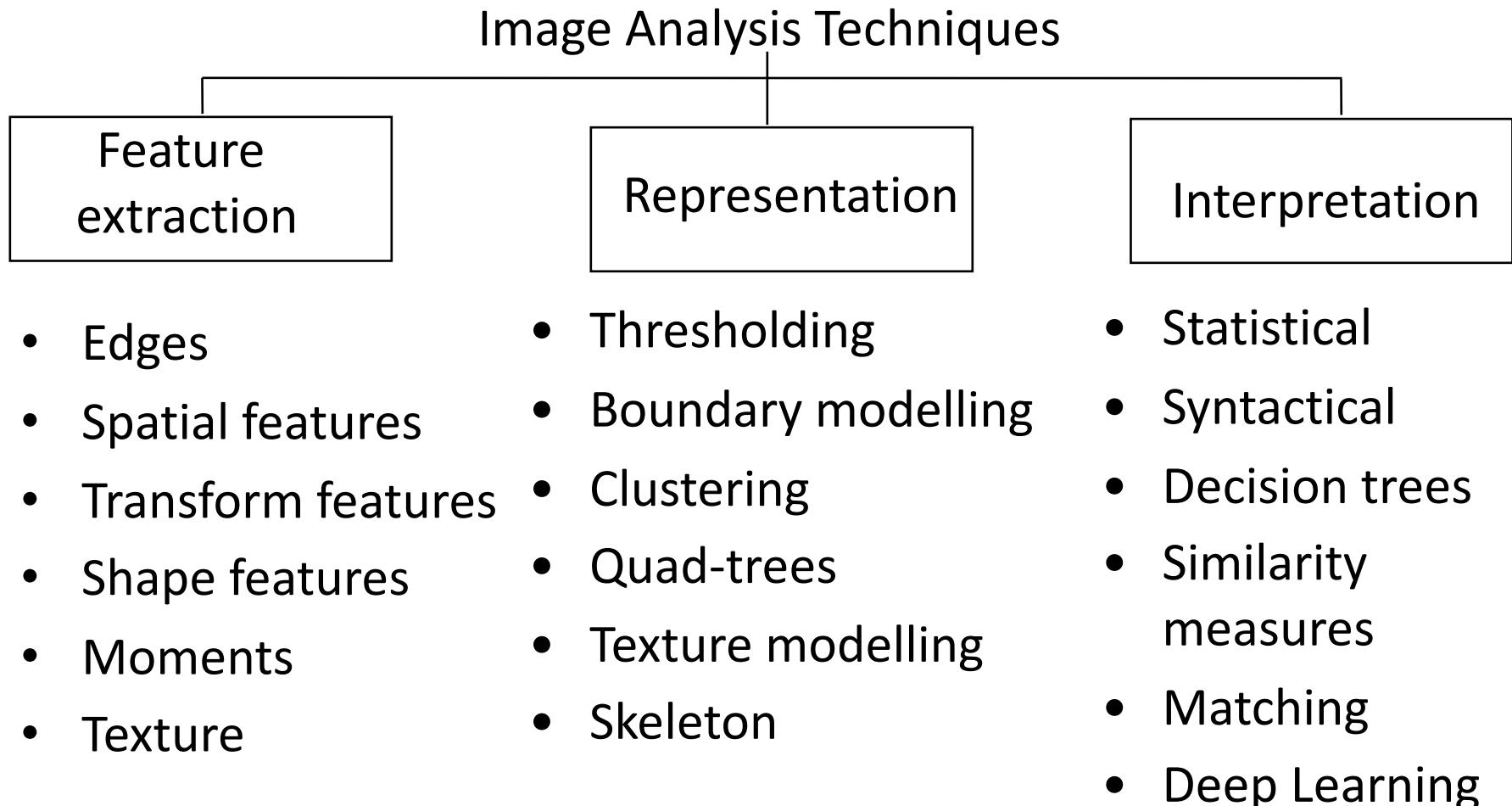
Subjective contours



Fancy logos

Figure 6.18 Change of shape caused by a projective transform. The same rectangular cross-section is represented by different polygons in the image plane.

Stages of Image Analysis by Computers



Conclusions

- Images and their representation
 - Volumetric images
 - Graphics
 - Pinhole camera images
 - Graphics and their representation
 - Analysing images
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