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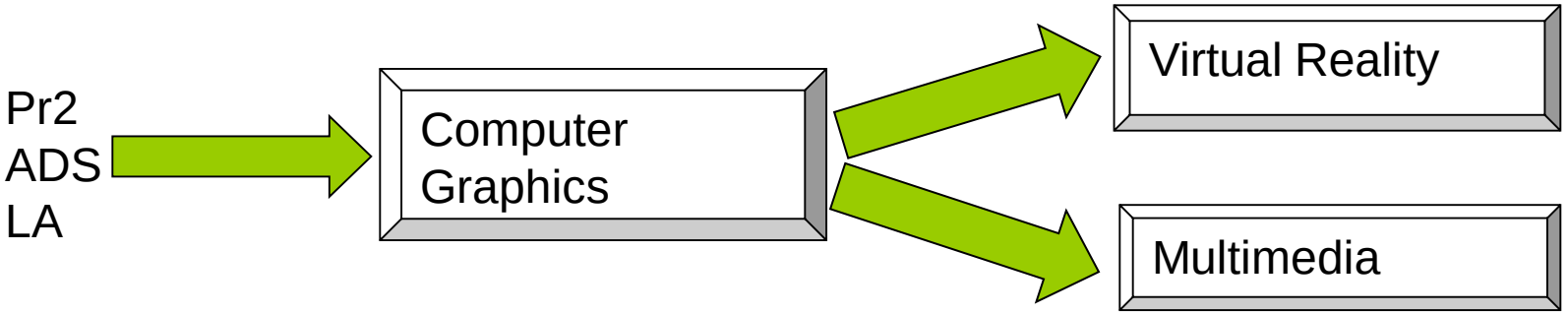
Computer Graphics

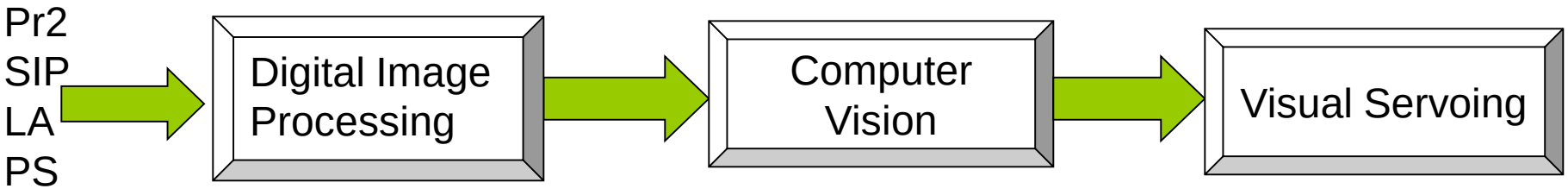
Presentation with Some Typical Applications

Outline

- Related courses: What are the Differences?
  - Digital Image Processing
  - Computer Vision
  - Computer Graphics
  - Virtual reality
  - Multimedia
  - Robot Vision (Visual Servoing)
- Applications

The Big Picture





What is Computer Vision

- Computer vision: is the study and application of methods which allow computers to **"understand"** image content.
- The term "**understand**" means here that specific information is being extracted from the image for a specific purpose:

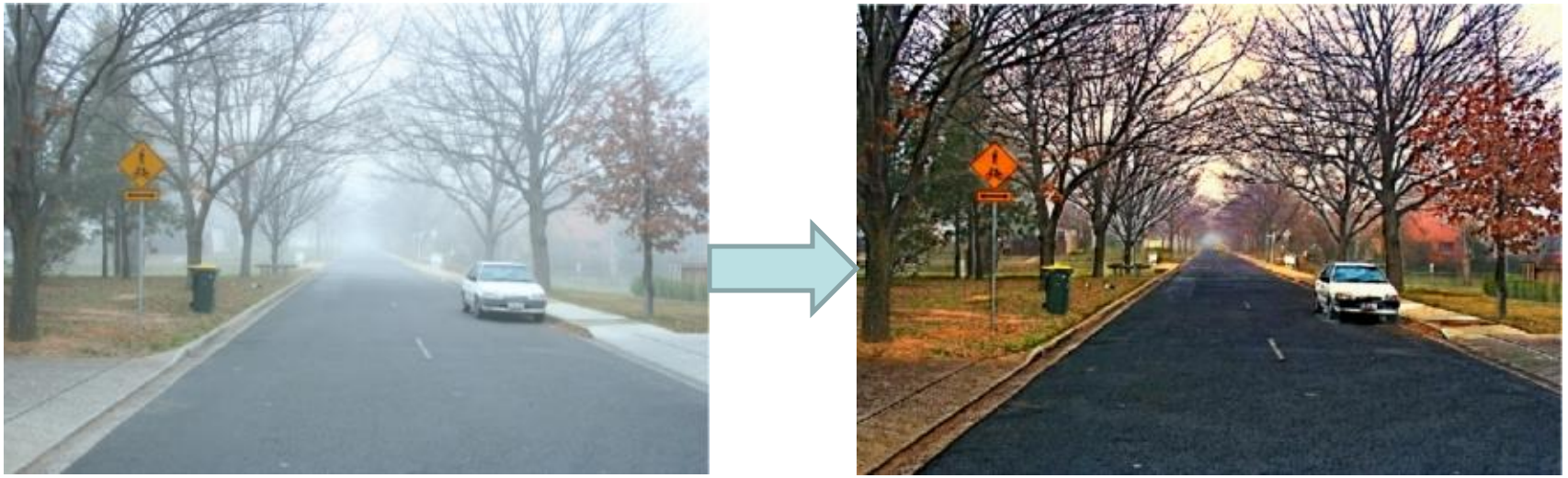
- The aim of computer vision is to make computers "see" by processing images or video
- Endow our robots the ability of vision similar to speech recognition.

Computer Vision

- The goal of computer vision is to make computer work like human visual perception, namely, to understand and recognize the world through visual information, such as, images or videos.
- Human visual perception, after millions of years of evolution, is extremely good in understanding and recognizing objects or scenes. To have similar abilities to human visual perception (or beyond), computer scientists have been attempting to develop algorithms by relying on various visual information, and this course is about these algorithms.
- In case you are wondering why we should care about computer vision, consider this: if you think your visual perception system is important and beneficial, so is computer vision.

Image Processing Example

- Left: foggy input image
- Right: the result of a fog removal algorithm



Computer Vision

- Computer vision is about how to make computer work like human eyes (**or beyond**).

Inputs:

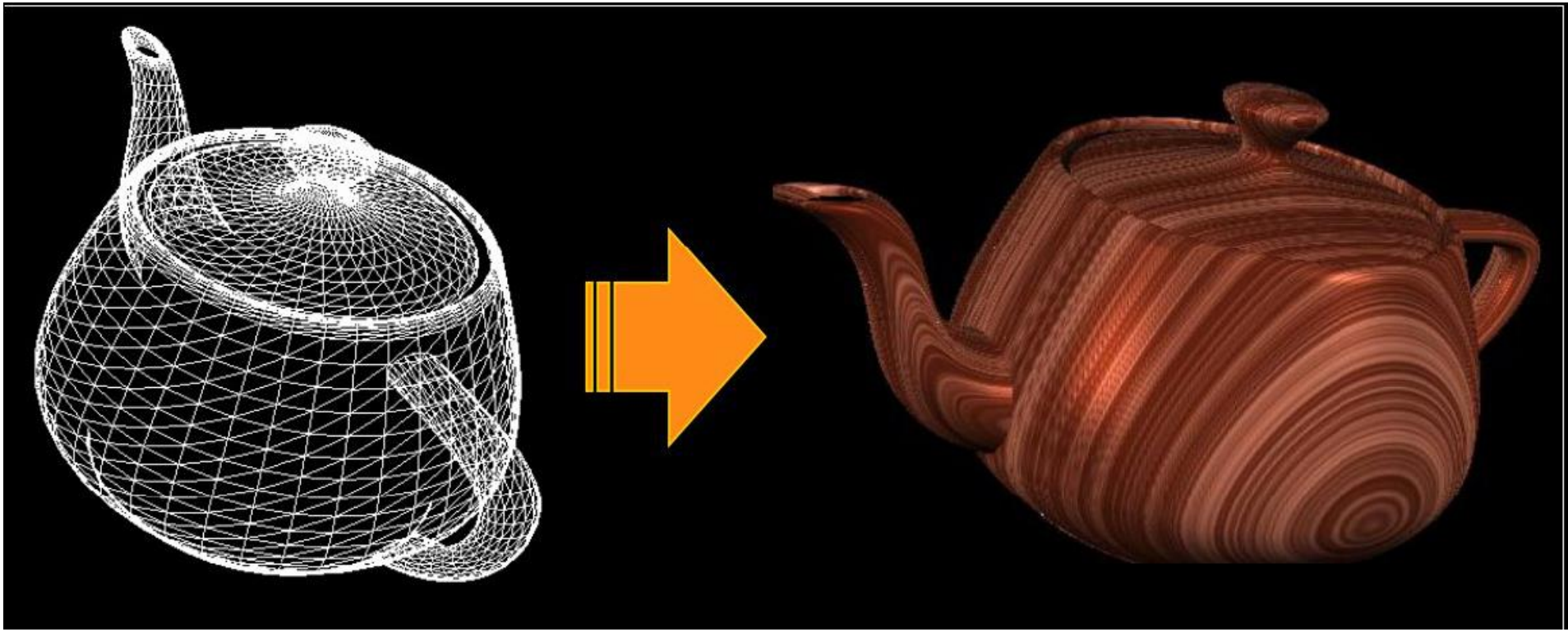
- Visual Data (primarily: 2D images and videos)

Outputs:

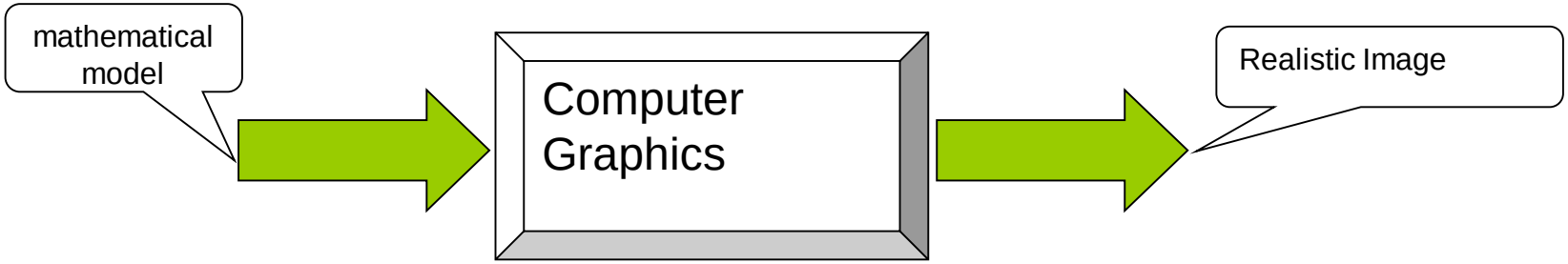
- Information of the visual contents of the input images or videos

Computer Graphics

- Computer Graphics: from mathematical models of a 3D world to 2D images

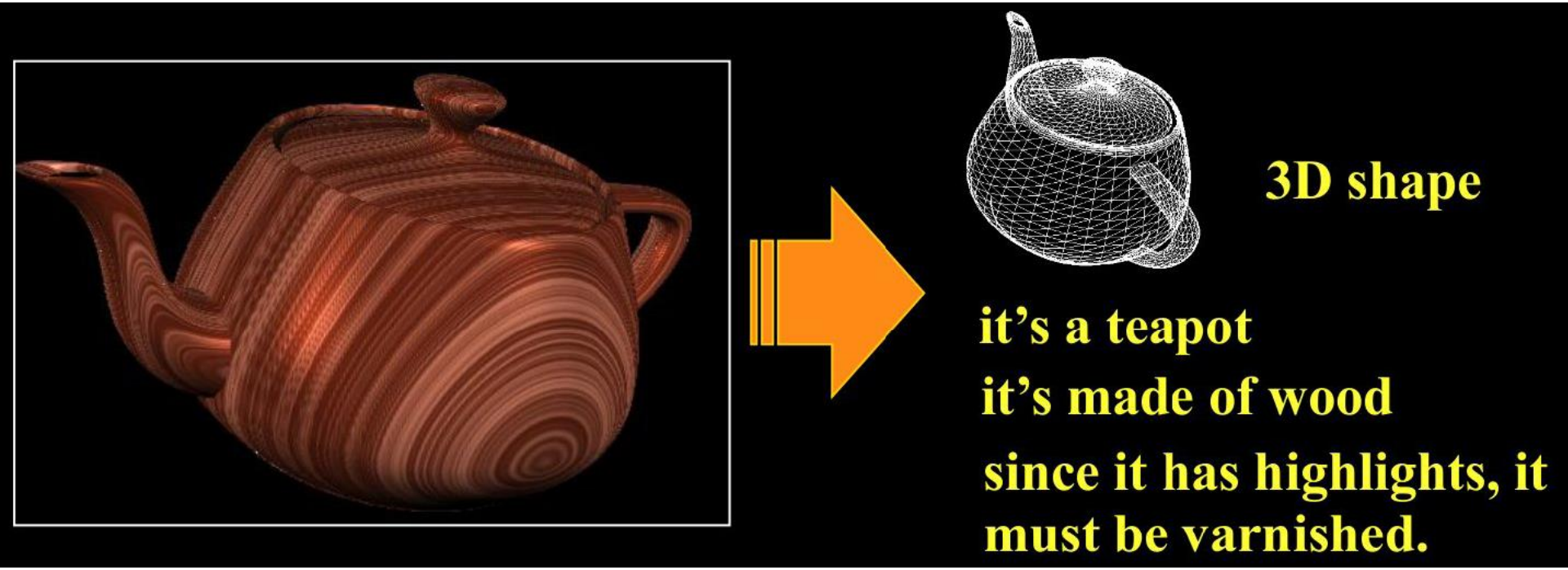


Computer Graphics



Computer Graphics vs. Computer Vision

- Computer Vision: from 2D images to the visual information

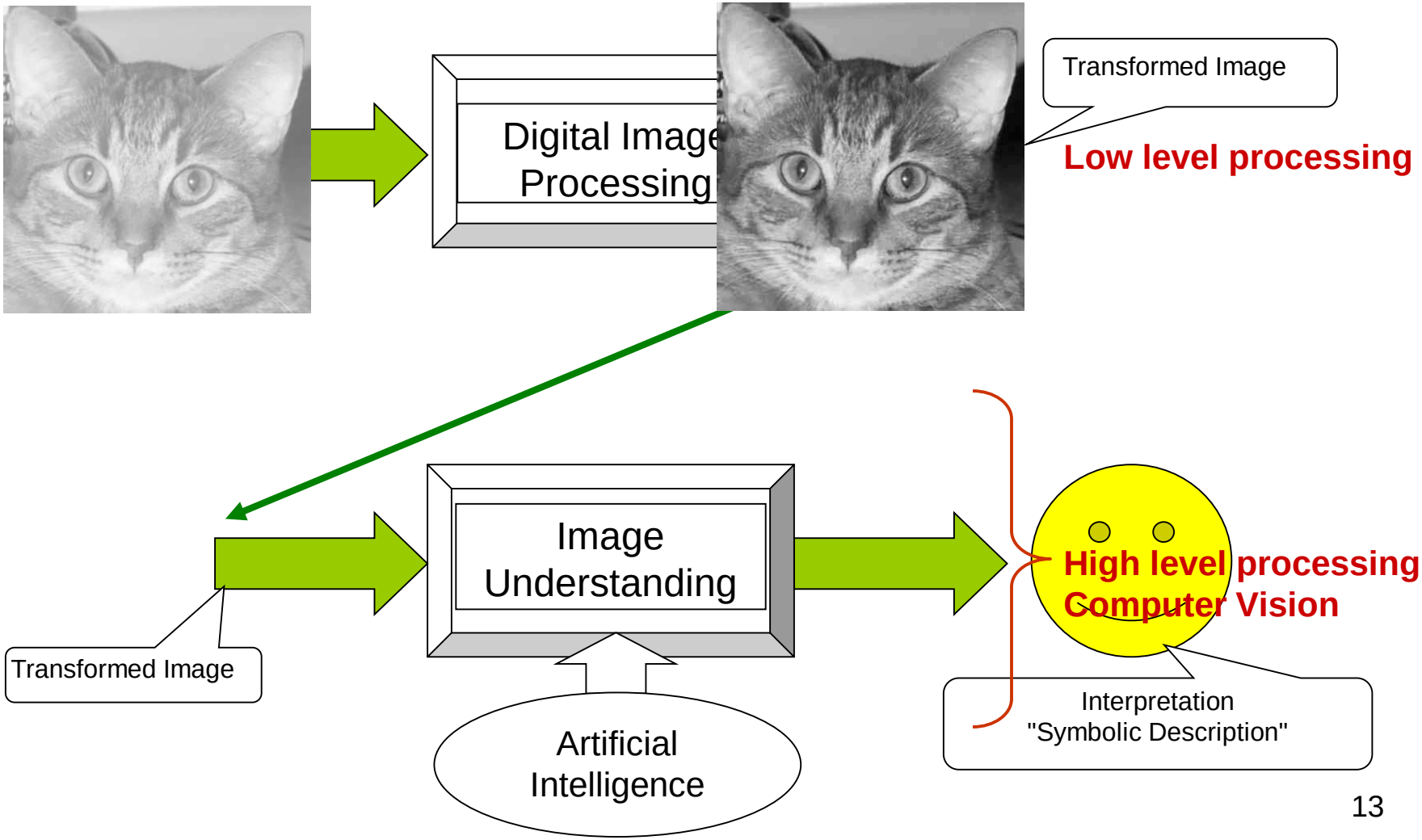


Computer Graphics

Computer Graphics involves display, manipulation and storage of pictures and experimental data for proper visualization using a computer.

- GUI
- Scientific Visualization
- Simulation studies: Simulators
- CAD/CAM design (VLSI, Construction, Circuits)
- Multimedia
- Entertainment (movie, TV Advt., Games etc.)
- Virtual reality
- Education and Training

Digital Image Processing vs. Computer Vision



Why Computer Vision?

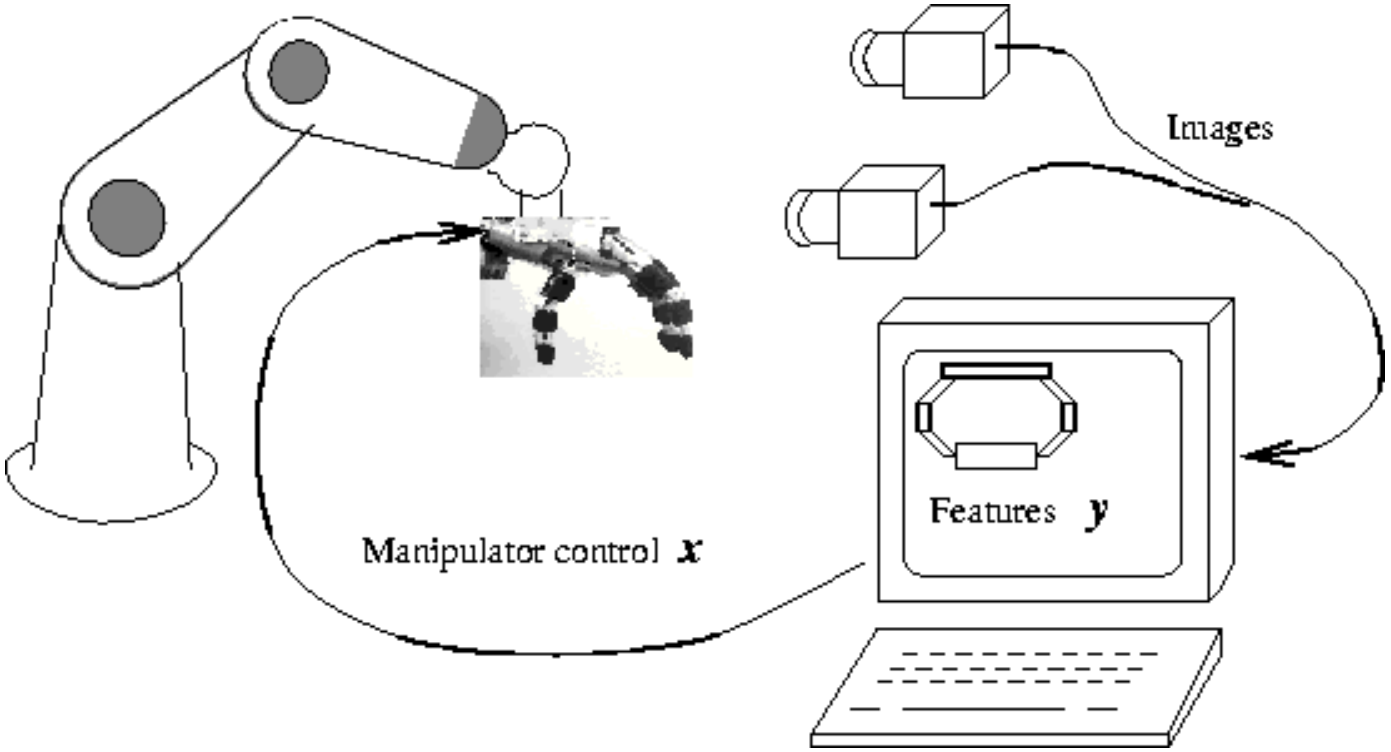
- A direct answer: if you think your eyes are important, so is computer vision.

The potential applications are immense:

- Gaming technology
- Biomedical imaging
- Robotics & servoing
- Security/surveillance
- Computer graphics
- Human-computer interactions
- Intelligent vehicle systems (driverless cars: CMU Driverless Racing Car 2007)
- Many more...

CMU Driverless Racing Car 2007)

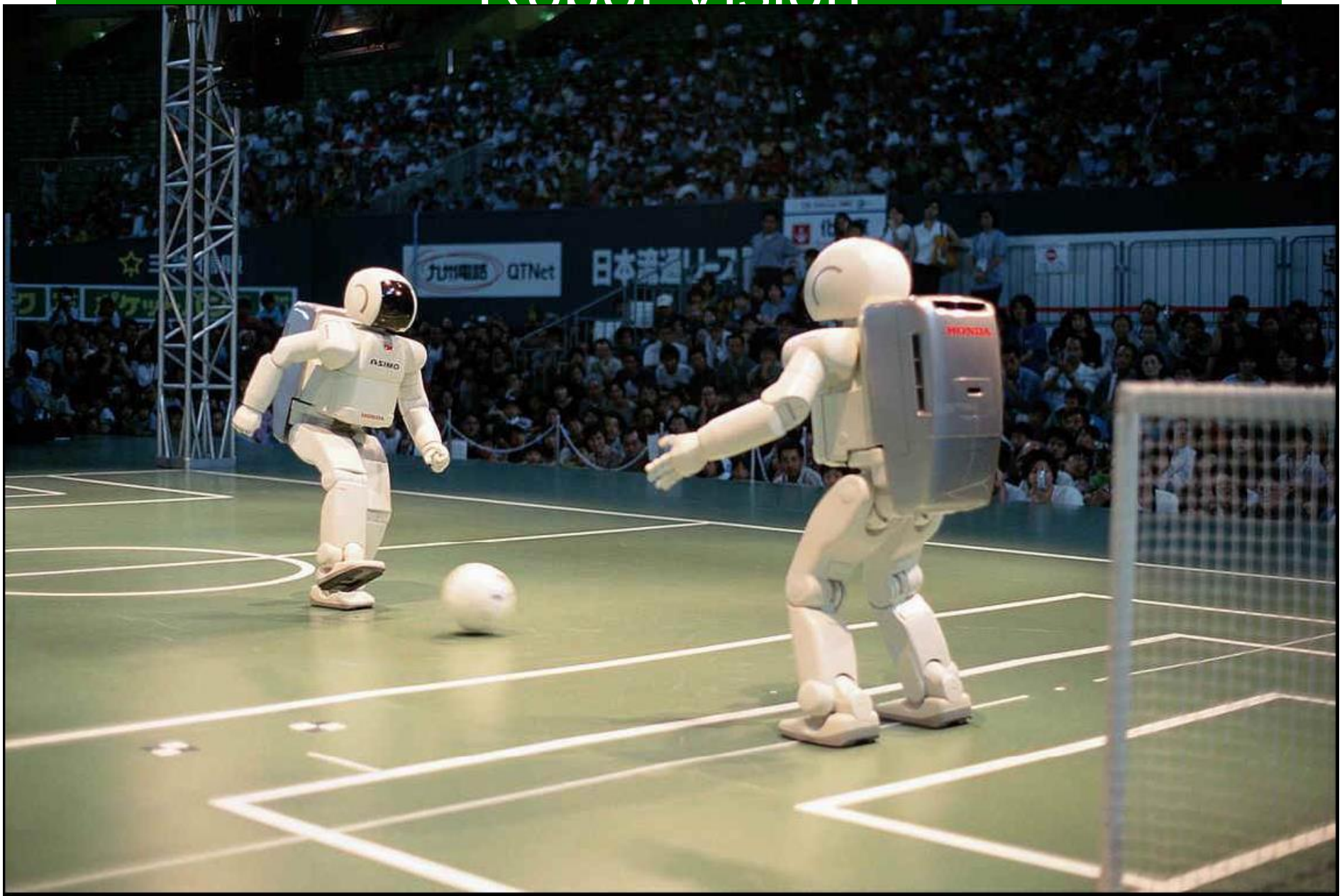
Visual Servoing Systems



Description of a basic visual servoing system:

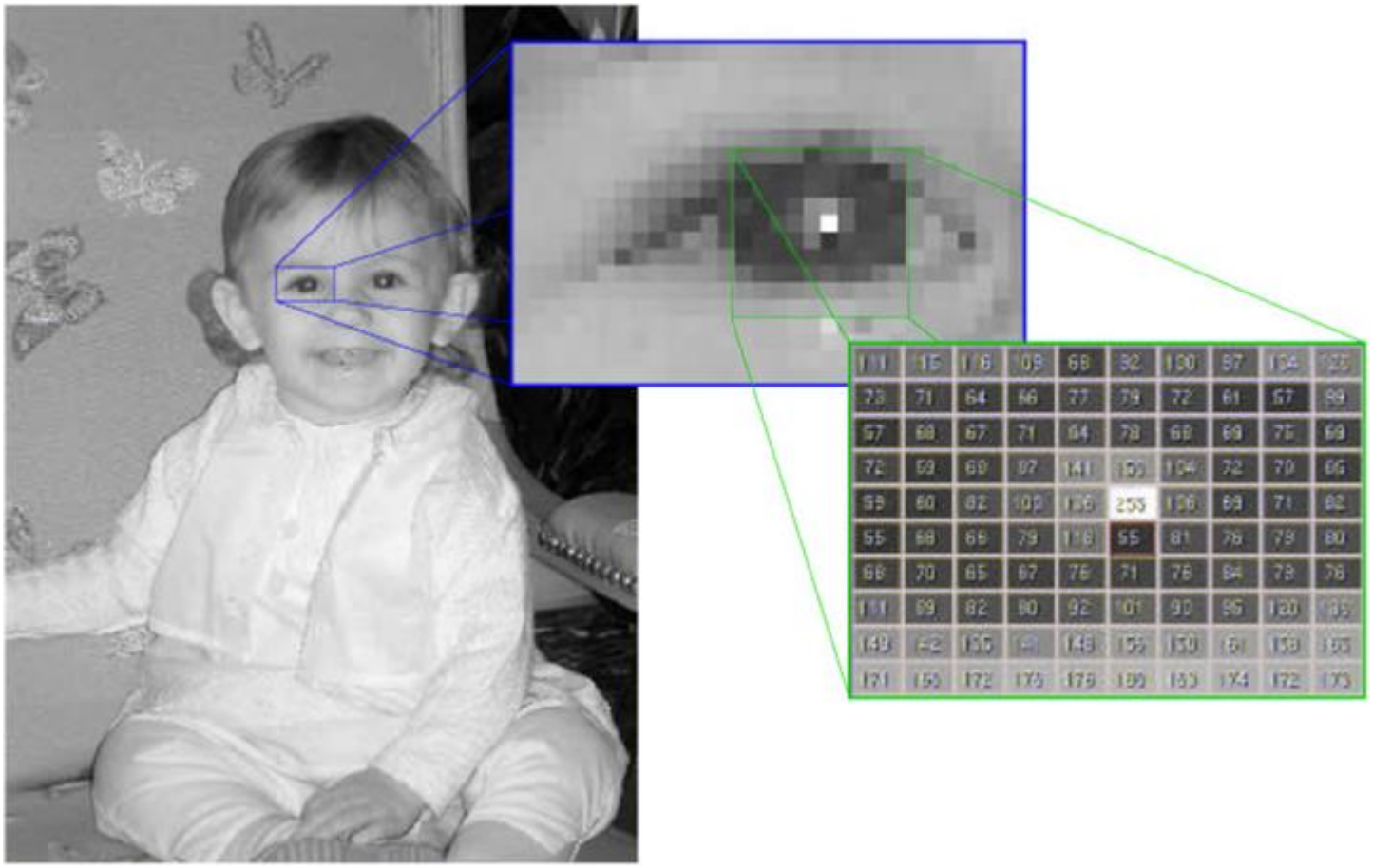
Typical visual control setup uses two cameras placed so that they can observe the workspace from two different viewpoints. Placement is arbitrary, and the controller has no prior knowledge of the camera locations, their relation to the robot, or the robot kinematics.

Robot Vision

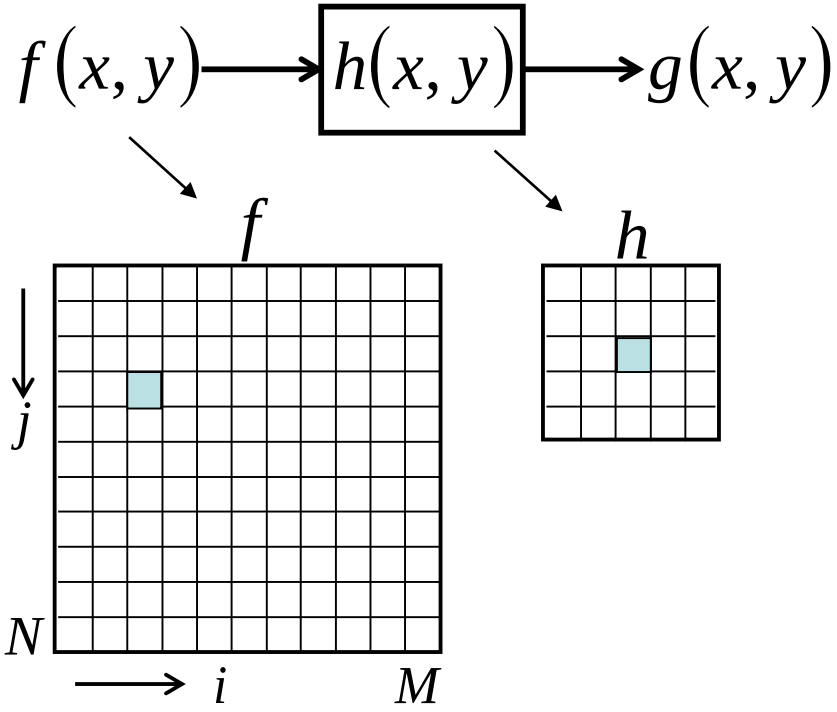


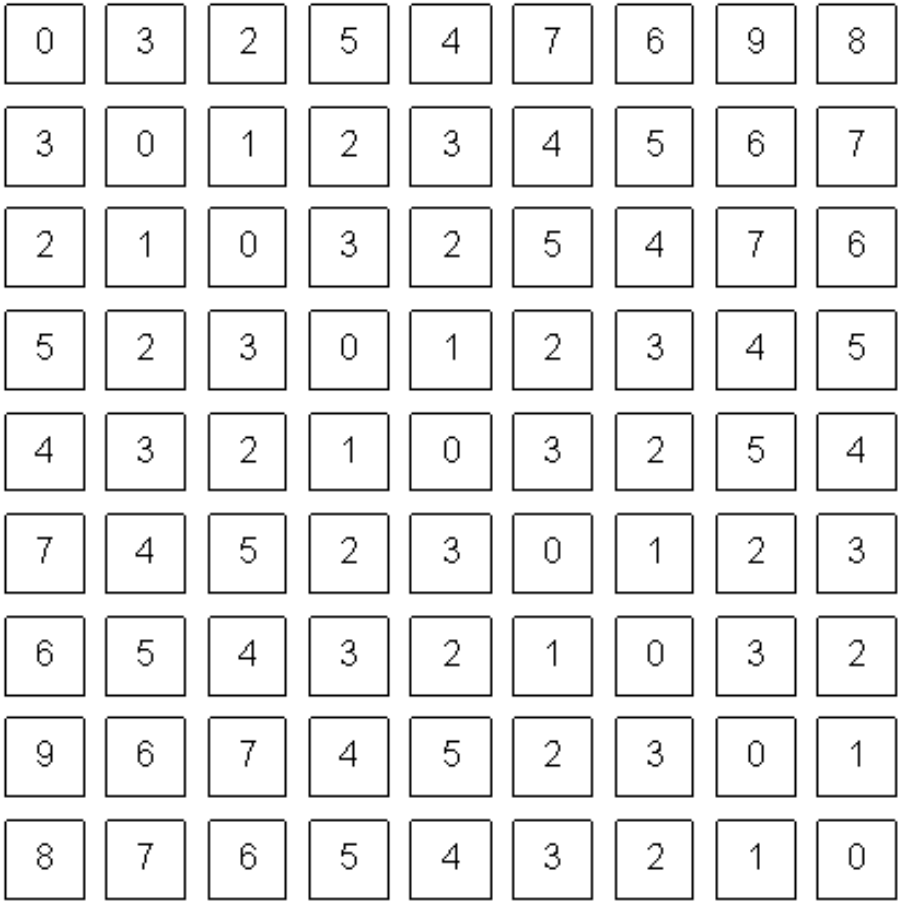
A Picture is Worth 1000 Words

Digital Images ➔ Linear Algebra



Images are Discrete and Finite



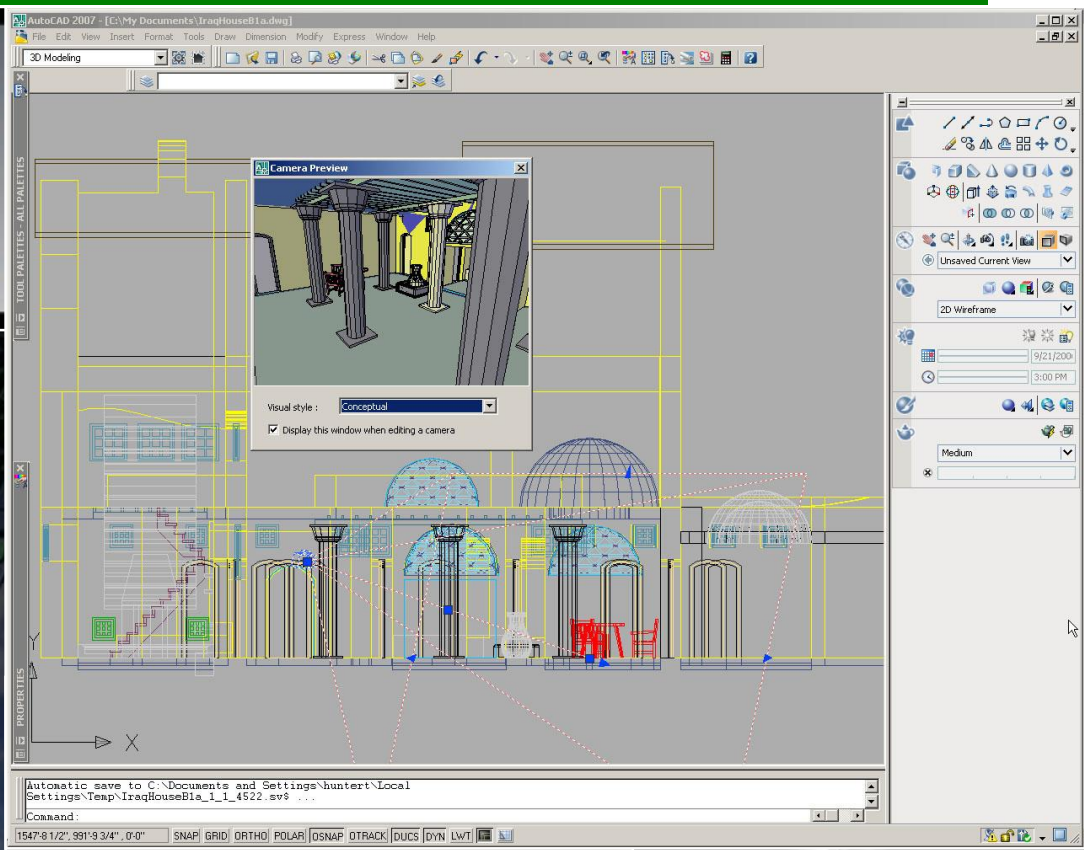


- What a computer sees

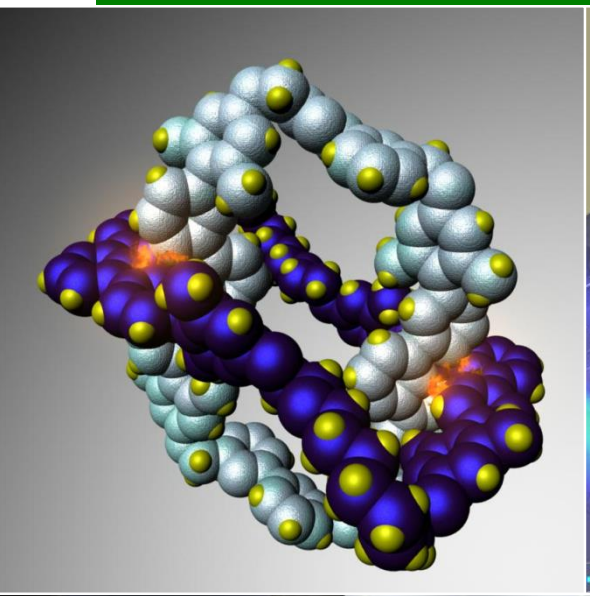
Some Applications Of Computer Graphics

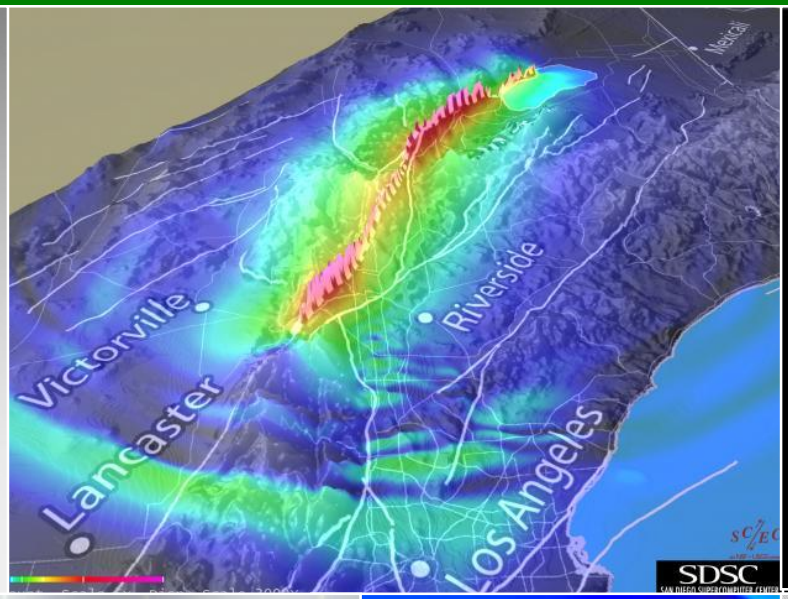
- Some of the application areas which make heavy use of computer graphics are:
  - Computer aided design
  - Scientific visualisation
  - Films
  - Games
  - Virtual/Augmented Reality
- **NOTE:** There are lots more and there is huge overlap between these different areas

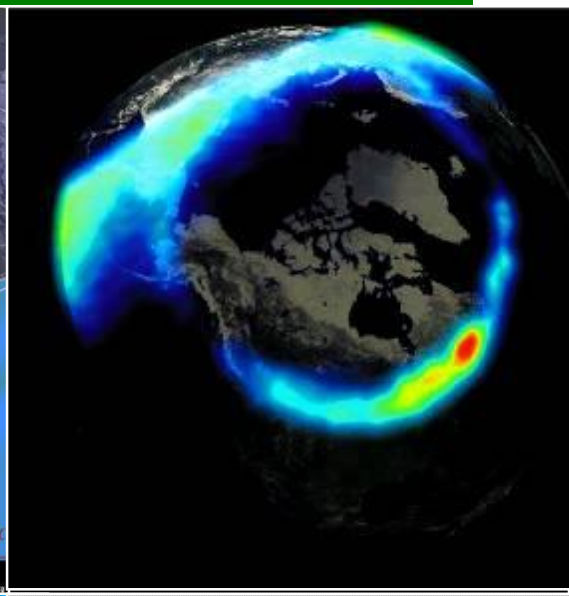
Computer Aided Design

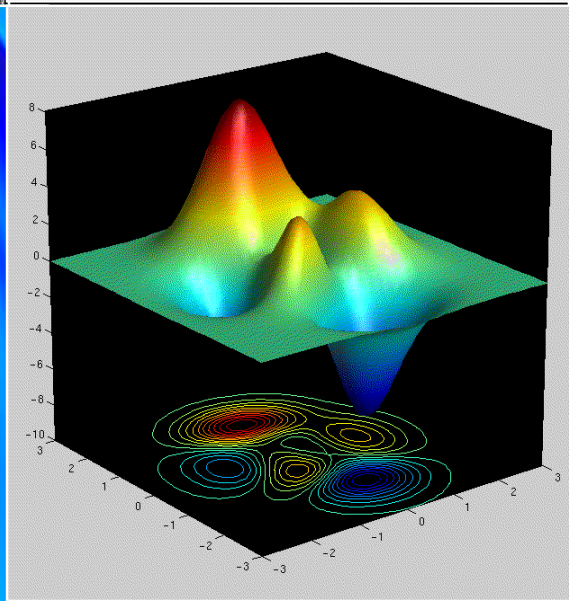


Scientific Visualisation





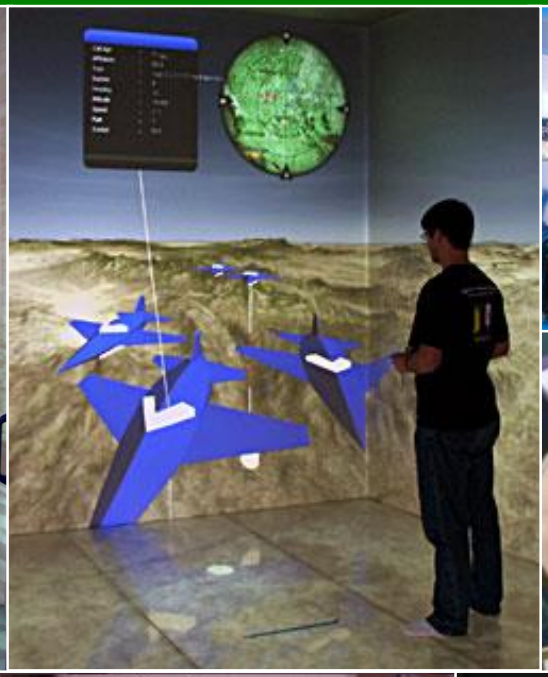


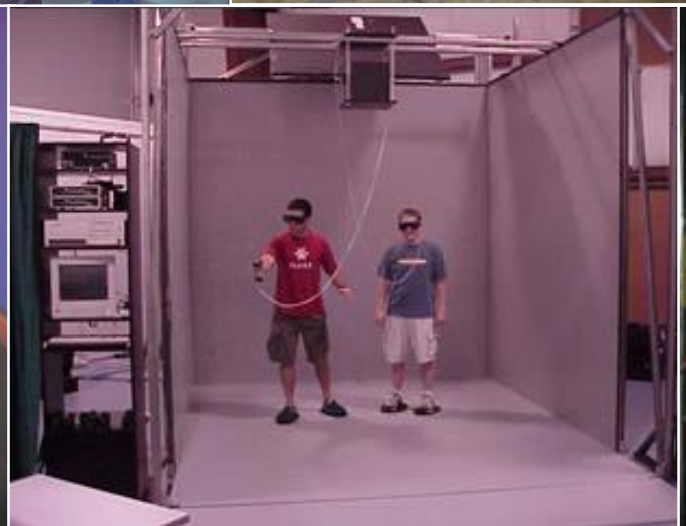


Films

Games

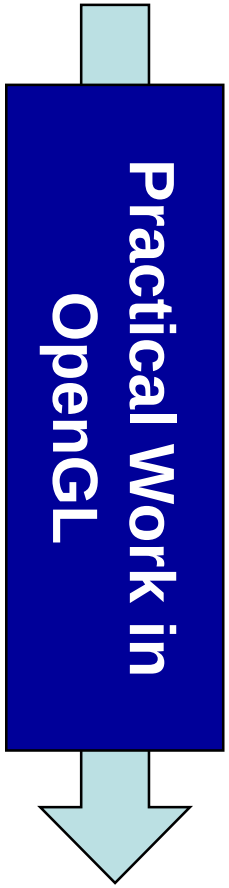
Virtual/Augmented Reality





Course Outline

- The course will follow this outline
  - Viewing in 2D
  - Raster Graphics
  - Viewing in 3D
  - 3D Object Modelling
  - Illumination and Surface Rendering
  - Animation



- “Computer Graphics with OpenGL”, D. Hearn & M. P. Baker, Prentice Hall, 2003