Frontiers of Computer Graphics

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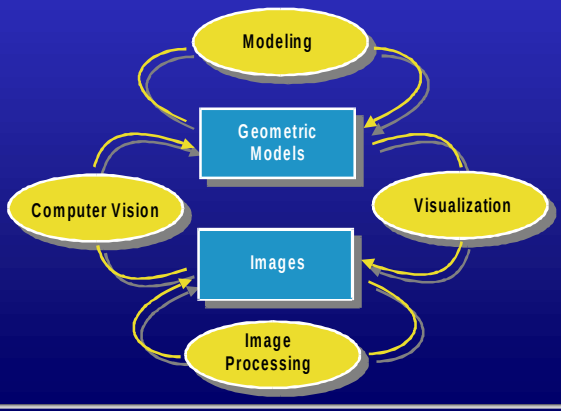
Computer Graphics

- **From data to images?**
- **Many correlated areas**

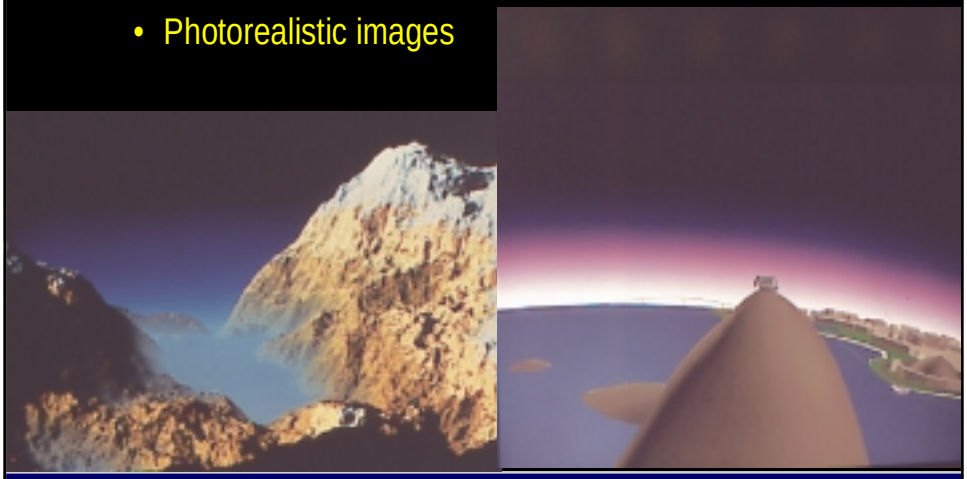


Visualization

- **Light, Camera, Simulation!**
- **Construct the scene**
  - Modeling the Geometry
- **Illuminate the scene**
  - Model the light sources
- **Photograph the scene**
  - Shading computation
  - Image generation

Visualization

- **Motivation**
  - Photorealistic images



Visualization

- **Applications**
  - Special Effects
  - Virtual Worlds
    - Movie industry
    - Television industry
    - Theme parks
    - Arcade games
  - Medical images
  - Engineering (CAD/CAM)

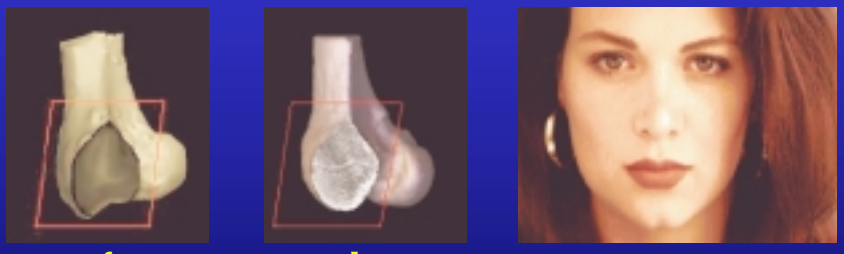
State of the art in plant modeling

Some Math Notation

- **Spaces of Graphical Objects**
  - Space of images
  - Space of audio signals
  - Space of geometric models
  - etc.
- **Operators on Spaces of Graphical Objects**

Some Math Notation

- **Graphical Objects**



Surface Volume Image

- **Shape + Attributes** $f : U \subset \mathbb{R}^m \rightarrow \mathbb{R}^n$

Some Math Notation

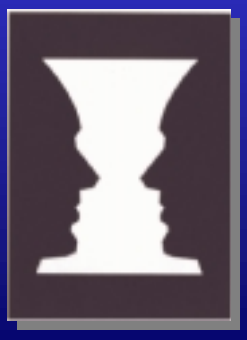
- **Visualization operator**
  - T: {geometric models} ⟶ {Images}
- **Direct Problem**
  - Given T and X, compute Y = TX
- **T computation (Rendering)**
  - Camera position
  - Scene geometry and attributes
  - Illumination information

Computer Vision

- **Human Perception**
  - Eye: Captures the scene
  - Brain: Reconstructs the scene
- **Representation and reconstruction**
  - Discretization
  - Reconstruction

Computer Vision

- **Ambiguity in the Reconstruction**



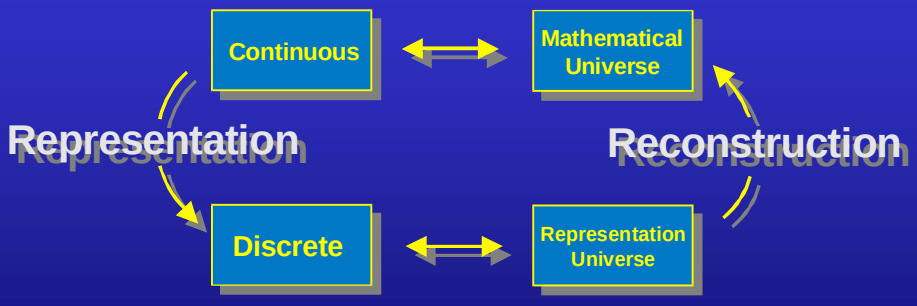
Computer Vision

- **Cognitive reconstruction**
  - Knowledge + Information
  - Intelligent reconstruction
- **Artificial intelligence**
- **Primary vision**
- **High level vision**

Some Math Notation

- **Computer Vision**
  - T: {Images} ⟶ {Models}
- **Inverse Problems**
  - Given Y and T, compute X from Y = TX
  - Given X and Y, compute T, from Y = TX
- **A simple example**
  - The virtual referee
  - Video

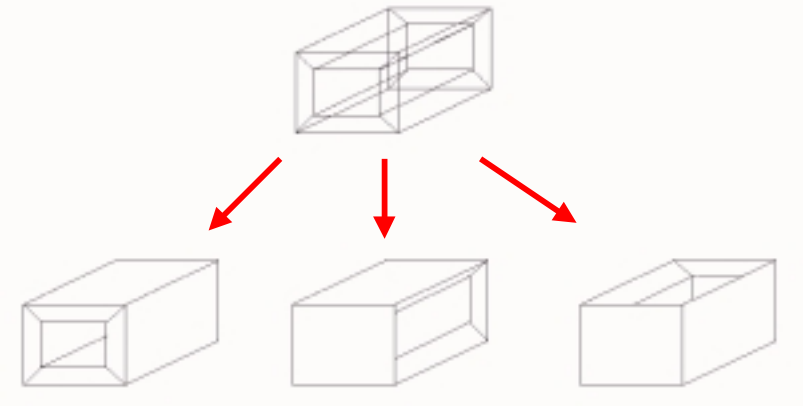
Two important problems



- ***How to represent a graphical object?***
- ***How to reconstruct a graphical Object?***

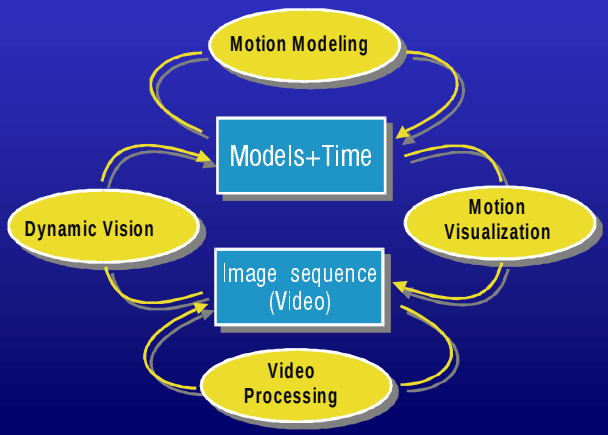
Ambiguous Reconstruction

- An example using geometric models



Computer Graphics

- **Time comes into play**



Animation

- **Continuous deformation of graphical objects**
  - Warping
  - Morphing
  - Video
- **Book and site**
  - “Warping and Morphing of Graphical Objects”
  - http://www.visgraf.impa.br/morph/

Some Math Notation

- **Visualization**
  - Direct problem
  - T: {Motion modeling} ⟶ {video}
- **Dynamic Vision**
  - Inverse problems
  - T: {Video} ⟶ {Motion models}

Computer Vision

- **Some Inverse Problems**
  - Recover Camera information
    - Camera calibration
  - Recover Geometry
  - Recover Motion
  - Recover Illumination

Computer Graphics

- **The Human factor**
  - User interface
    - Perceptibility and semantics
      - Semiotics
      - Gestalt Psychology
      - Computer Vision
  - Interactivity
  - Immersibility

The Human Factor

- **Interactivity**
  - Input and output devices
  - Haptic devices
    - Haptic mouse
    - Force feedback devices
- **Ivan Sutherland (1963)**

Computer Graphics

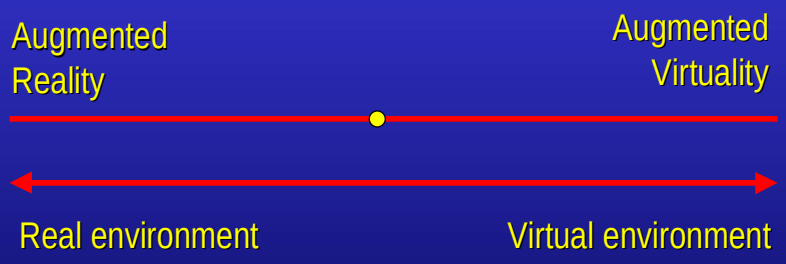
- **Immersibility**

"I see a computer display as a window in Alice's wonderland in which a programmer can depict either objects that obey well-known natural rules or purely imaginary objects that follow laws he has written into his program"

I. Sutherland, 1970, Scientific American

Immersibility

- **Mixed reality**



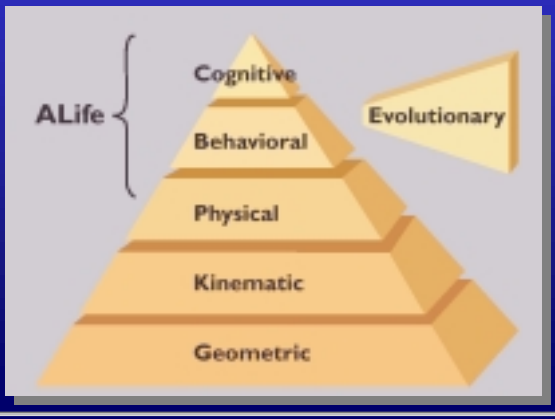
- **Virtual reality x Real Virtuality**

Real Virtuality

Scene from *101 Dalmatians* by Walt Disney

Modeling meets Vision

- **Evolution of modeling paradigms**
  - From geometry to cognition



Visualization Meets Vision

- **Classical visualization paradigm**
  - From models to image
    - Visualization = Models + Simulation
    - Direct problem
- **New visualization paradigm**
  - From Image to Models
    - Visualization = Samples + Reconstruction
    - Inverse problems

Computer Graphics

- **Main problems**
  - Real time x Huge data sets
    - "So many data so little power"
  - Devise good, very good, representation and reconstruction techniques
    - graphical objects
    - operators between graphical objects

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