Introduction to Computer Graphics

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CMPT370
Dr. Sean Ho
Trinity Western University

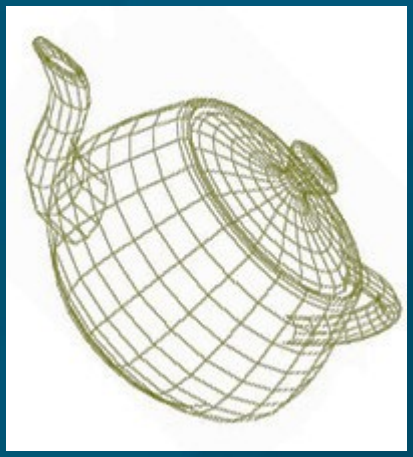
TRINITY WESTERN UNIVERSITY

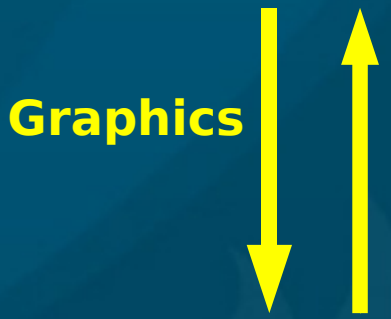
What's on for today

- Visual computing:
  - Computer graphics and image analysis
- Objectives of visual computing
  - Capture and understand reality
  - Emulate and enhance reality
  - Parthenon video
- Image formation
  - Camera model
  - Light and colour models

Graphics vs. image analysis

- Computer graphics is synthetic:
  - From an internal data structure (representation):
    - Triangle mesh, VRML, etc.
  - Produce (render) an image





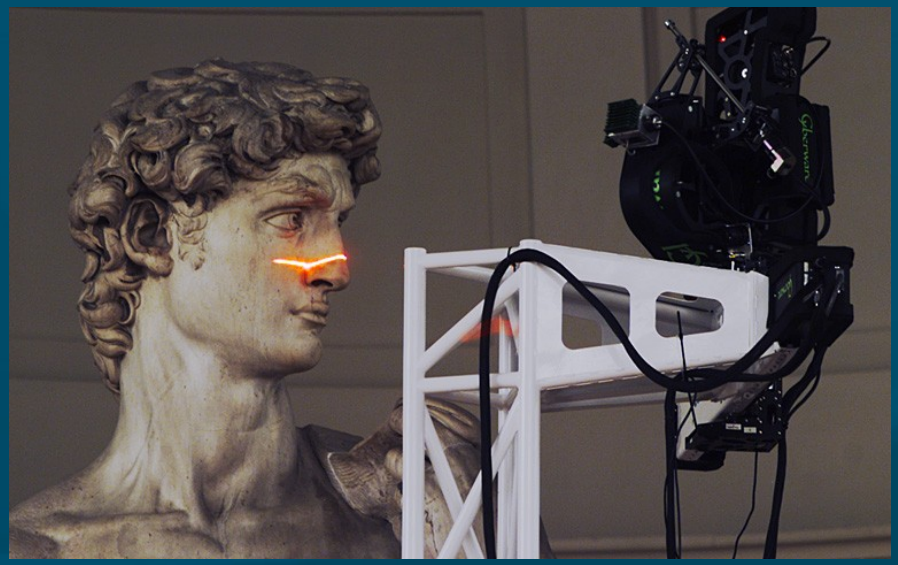
- Image analysis is analytic:
  - From an image of real world:
    - Digicam, video, MRI/CT, satellite
  - Produce an representation of the objects of interest

Objectives of graphics/analysis

- Image Analysis:
  - Capture reality
    - Image acquisition: camera, laser rangefinder, etc.
  - Understand reality
    - Object recognition: segmentation
- Graphics:
  - Emulate reality
    - Photorealistic rendering, physically-based modelling
  - "Enhance" reality
    - Special effects, unrealistic physics

Objectives: Capture reality

- Acquire a representation of the world
  - Want it as faithful as possible to reality
  - Higher resolution, broader dynamic range
  - Optics/engineering/hardware

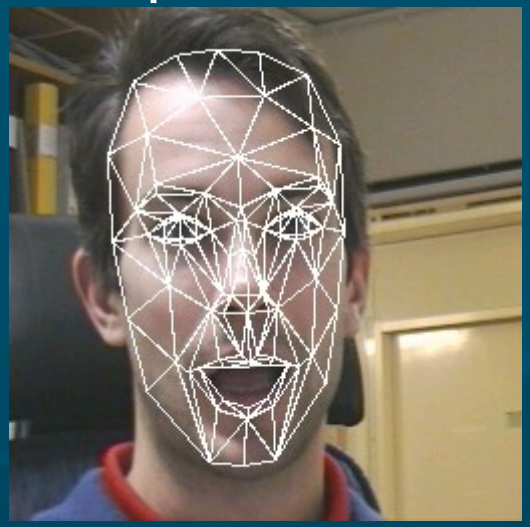


Digital Michelangelo

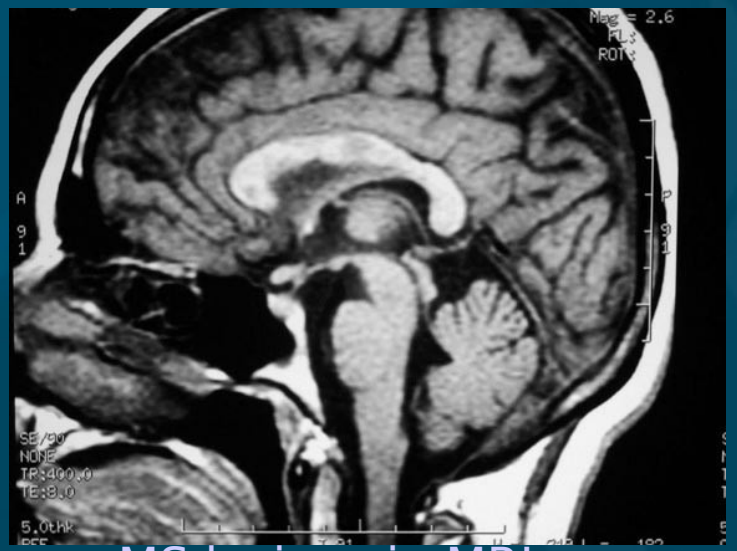
High Dynamic Range (HDR) image

Objectives: Understand reality

- Interpretation and segmentation:
  - Finding objects of interest within an image
- Object representation:
  - Compact data structures suitable for, e.g.
    - Population analysis and discrimination



Face recognition (AAM)



MS lesions in MRI

Objectives: Emulate reality

- Try to get as close to reality as possible
  - Modelling: geometry, texture, etc. of objects
  - Lighting/shading: behaviour of light
  - Animation: natural motion of objects

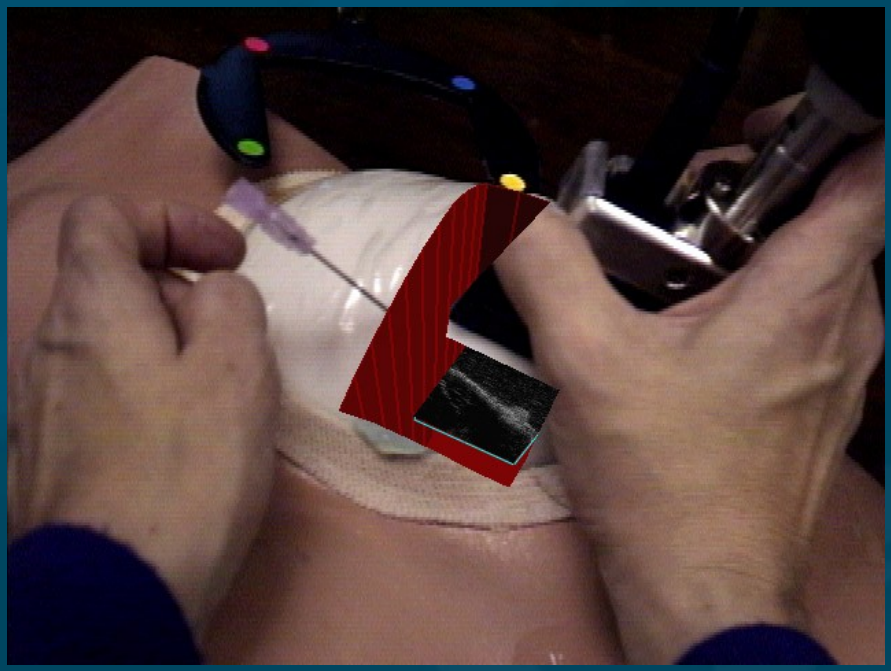
- The "uncanny valley": not-quite-realistic human characters are very disconcerting

Soanala: 3DSMax using sub-surface scattering for skin

Objectives: “Enhance” reality

- Combine real and generated elements
- Movie special effects
- Augmented reality HUD for telesurgery, manufacturing/design, etc.

Photorealistic rendering

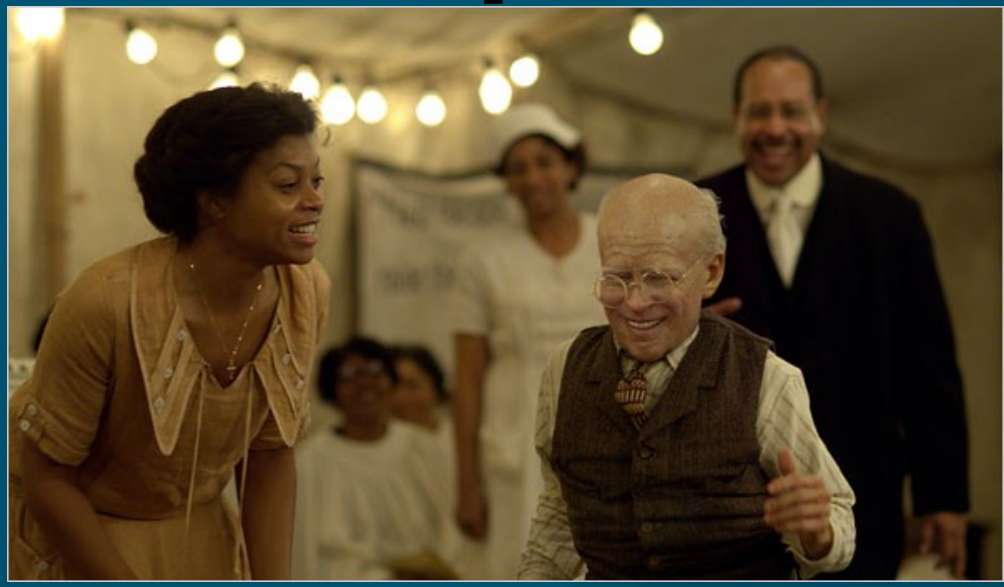


UNC AR
ultrasound breast biopsy

Parthenon ex. (SIGGRAPH 04)

- The Debevec/USC Parthenon is just one example of combining image analysis and computer graphics
  - 53 pano laser scans
  - 90 million polygons
  - Custom scanning rig for sculptures in London's Parthenon Museum
  - Time-lapse daylight sequence uses HDR images taken in Marina Del Rey
  - Total production time: 58 days (37-CPU render farm)

“Benjamin Button” example



Merrick Morton / Paramount

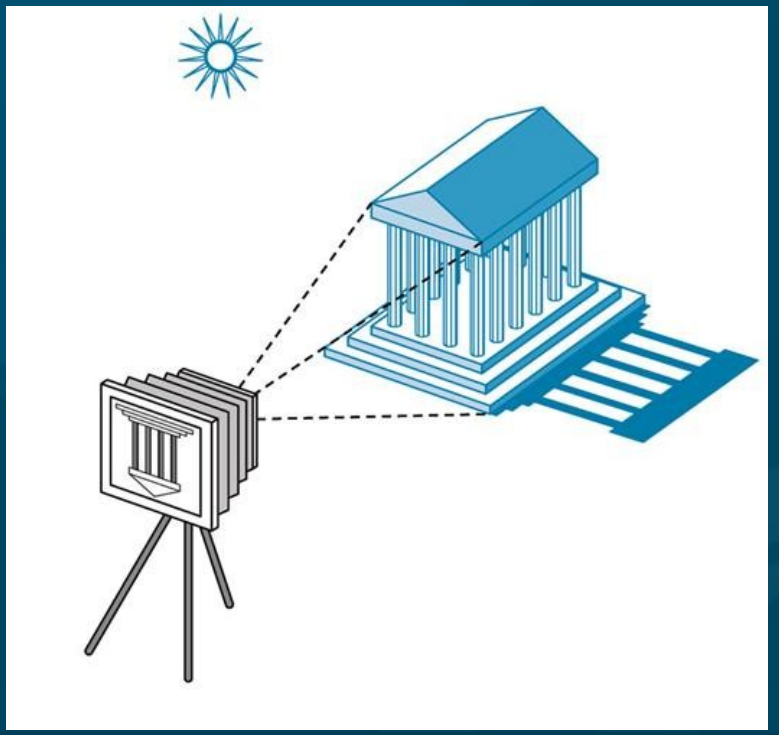
- Body uses various petite actors
- Face is modelled in 3D
- Facial expressions of Brad Pitt captured and pasted onto 3D model
- Database of ~120 emotional expressions portrayed by Pitt, motion-captured in 3D
- Match subject motion, lighting, background, camera lens, ...

CG Society article

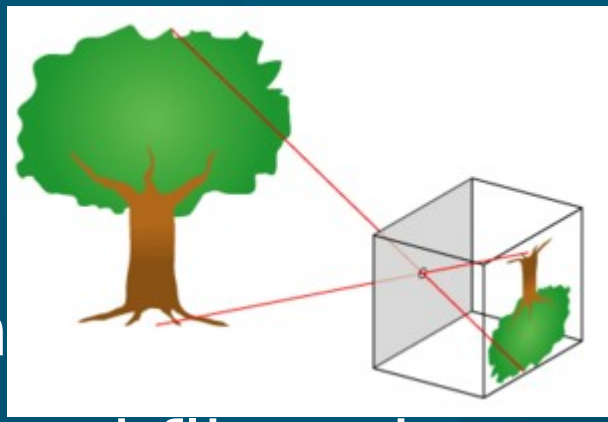
RopeOfSilicon / BenjaminButtonFX.com

Image formation

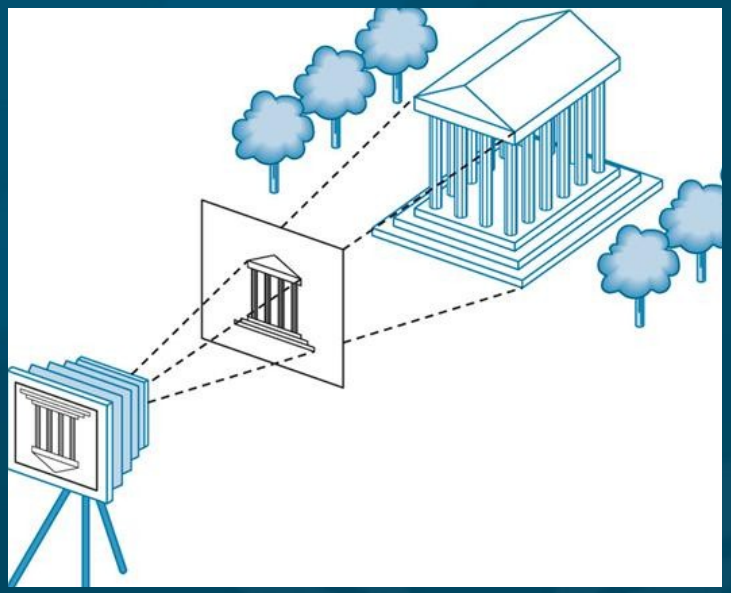
- Components to produce a static image:
  - Objects
    - Material properties: colour, shininess, bumpiness, etc.
  - Light sources
    - Colour spectrum, direction, area, etc.
  - Viewer
    - Camera model: lens, depth of field, etc.



Camera model



- The most basic is a pinhole camera
  - Image produced is upside down and flipped
  - Larger hole yields smaller depth-of-field (more blurry)
- Synthetic camera model:
  - Image plane is in front of center of projection
  - Cast rays from CoP through each pixel of image plane, into the scene



- Control depth of field? Lens distortion?