Workshop on Computer vision, graphics and Image processing

Overview of CV

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What is Computer vision?

“Vision is the process of discovering from images what is present in the world, and where it is" (David Marr).

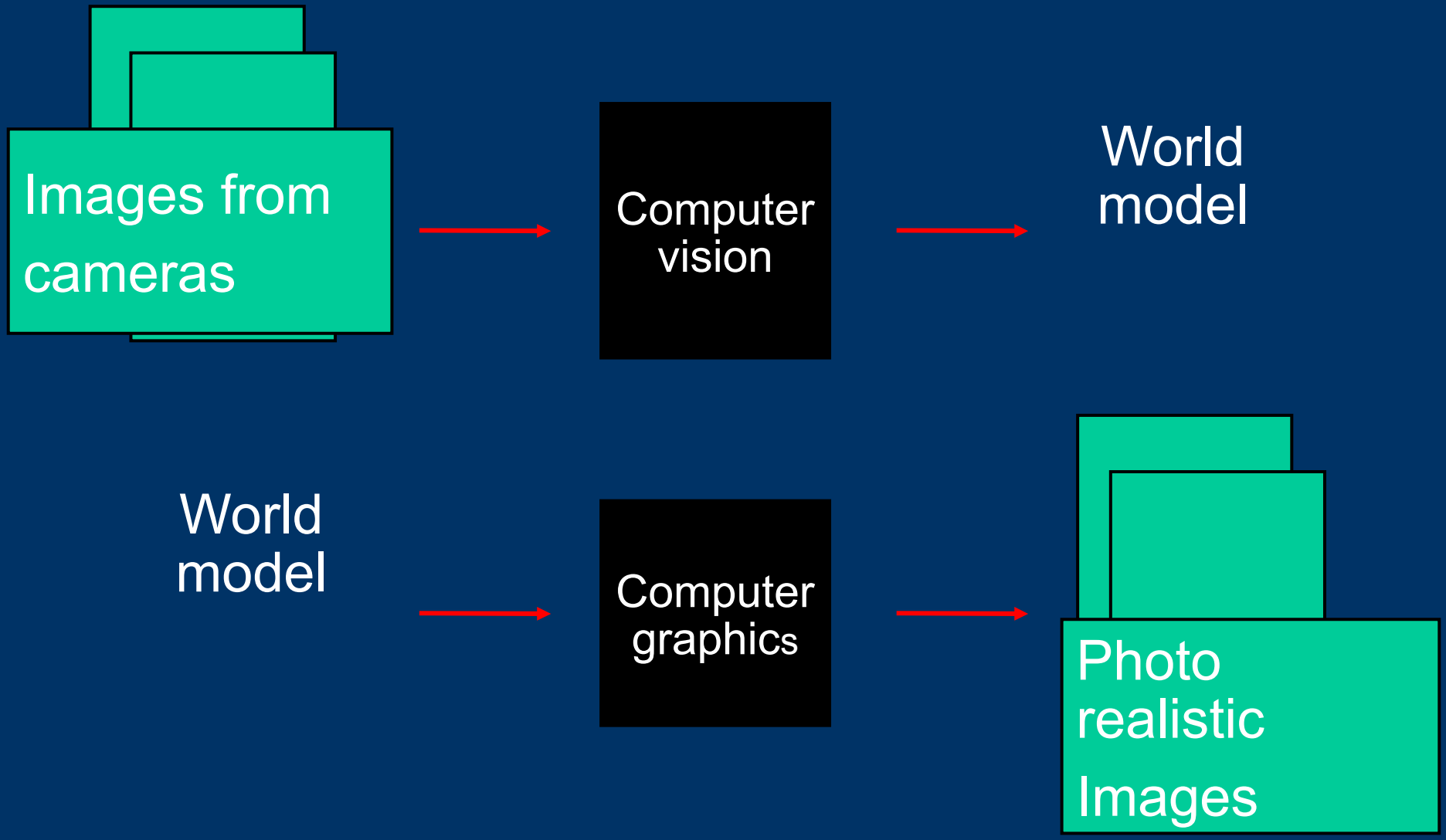
Why CV

- An image is a huge array of gray level values of individual pixels Taken individually,

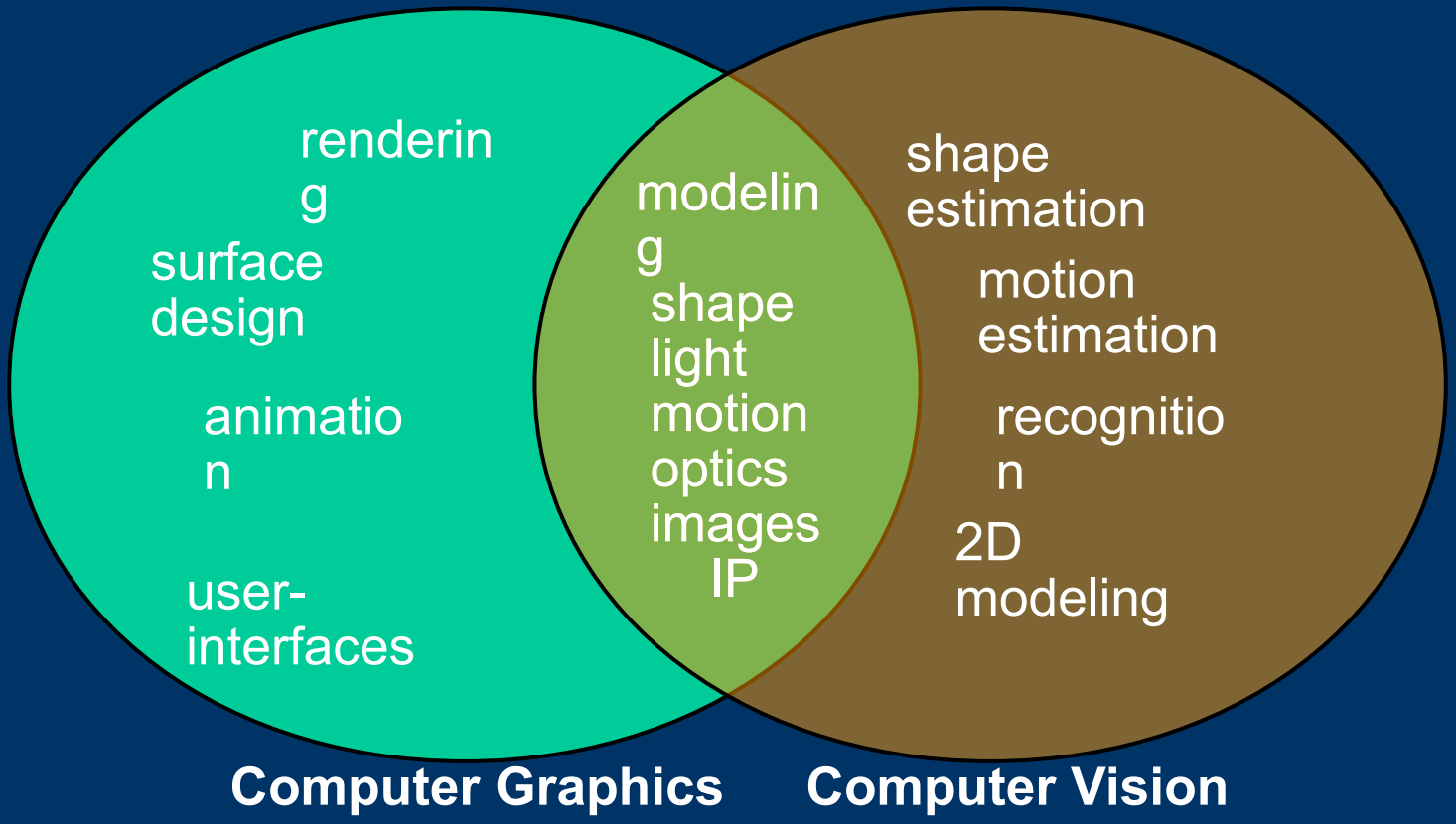
- A robot needs information like "object ahead", "table to the left", or "person approaching" to perform its tasks

- The conversion of this huge amount of low level information into usable high level information is the subject of computer vision

What is Computer Vision ?



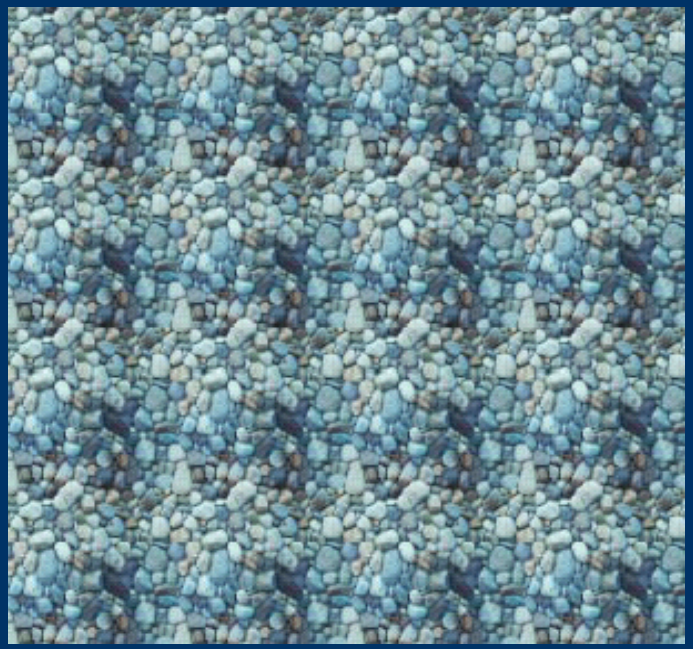
Intersection of Vision and Graphics



Texture generation

Input image

Simple repetition



New texture generated from input

Application ares

Film production (the “match move” problem)

Heads-up display for cars

Tourism

Architecture

Training

Technical challenges:

Recognition of scene

Accurate sub-pixel 3-D pose

Real-time, low latency

Visually guided surgery: recognition and registration

Automobile navigation

Lane departure warning system

Pedestrian detection

Vision in One Image

- Representing local properties of the image
  - Sharp changes are important in practice -- find “edges”
  - We wish to establish correspondence between points in different images, so we need to describe the neighborhood of the points
  - Representing texture by giving some statistics of the different kinds of small patch present in the texture.
    - Tigers have lots of bars, few spots
    - Leopards are the other way

Vision in Multiple Images

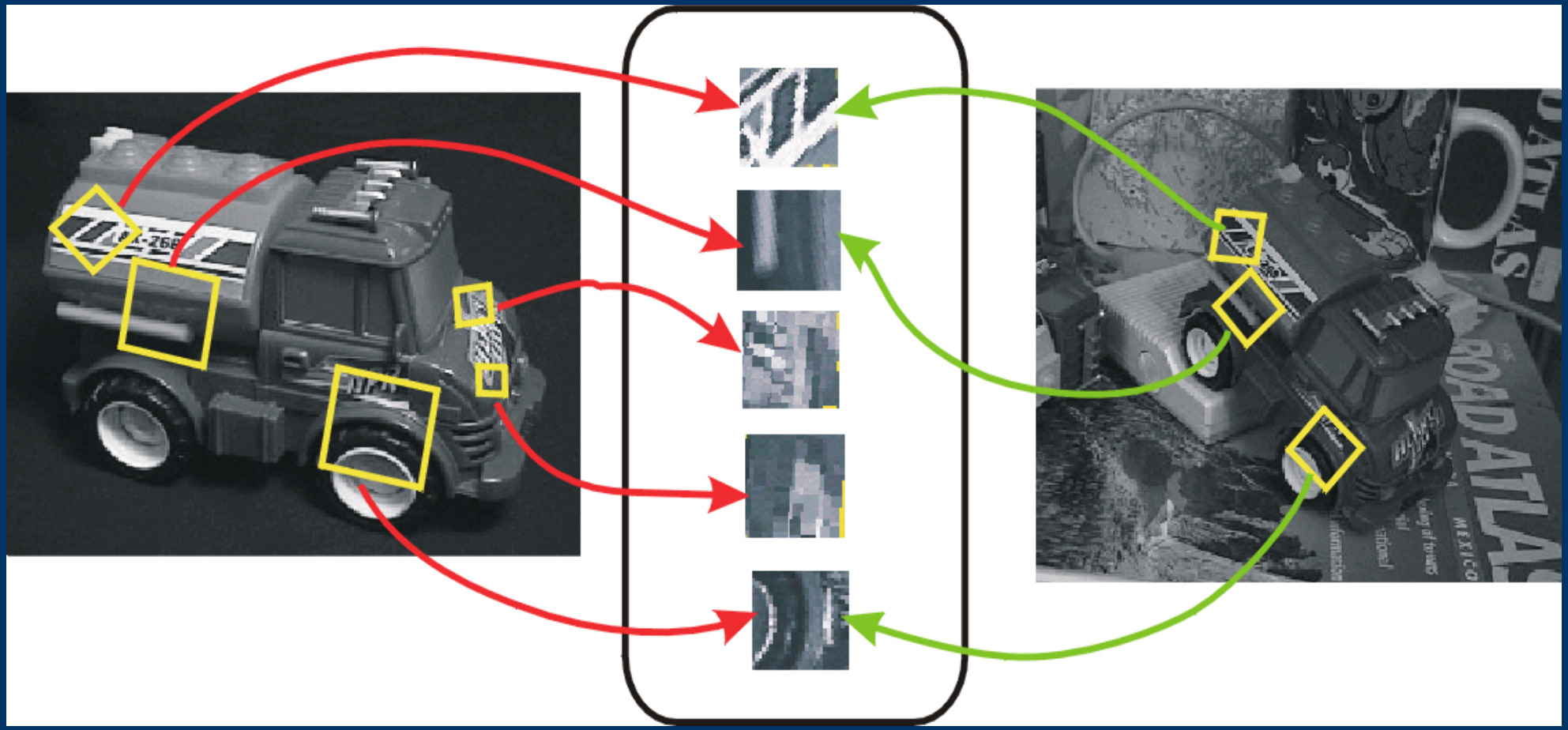
- The geometry of multiple views
  - Where could it appear in camera 2 (3, etc.) given it was here in 1?
  - Stereopsis
  - What we know about the world from having 2 eyes
- Structure from motion
  - What we know about the world from many eyes
    - or, more commonly, our eyes moving.
- Correspondence
  - Which points in the images are projections of the same 3D point?
  - Solve for positions of all cameras and points.

High Level Vision

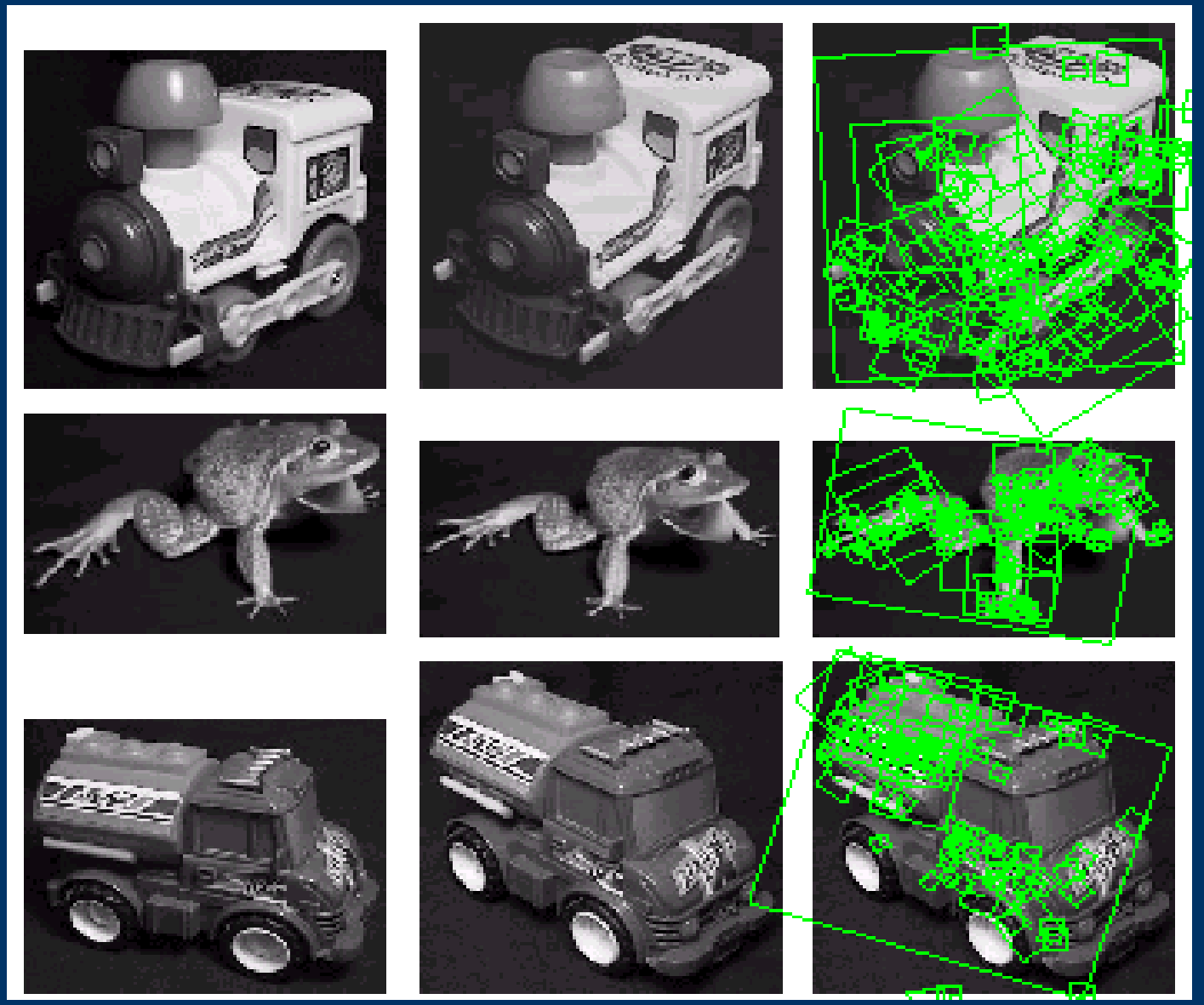
- Model based vision
  - find the position and orientation of known objects
- Using classifiers and probability to recognize objects
  - Templates and classifiers
    - how to find objects that look the same from view to view with a classifier
  - Relations
    - break up objects into big, simple parts, find the parts with a classifier, and then reason about the relationships between the parts to find the object

Invariant Local Features

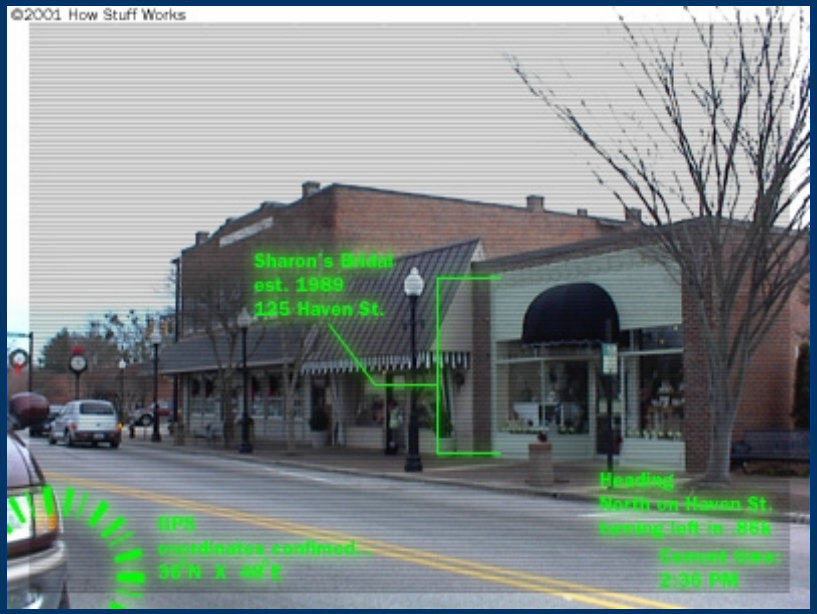
Image content is transformed into local feature coordinates that are invariant to translation, rotation, scale, and other imaging parameters (SIFT)



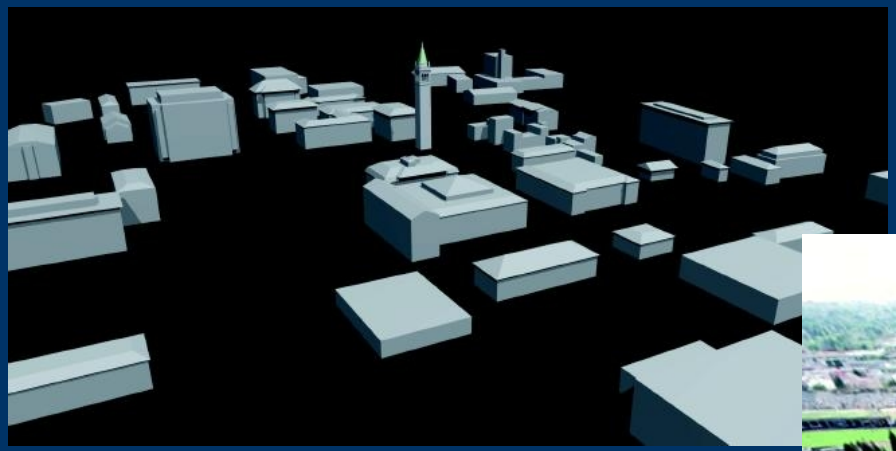
Examples of view interpolation



Few more examples



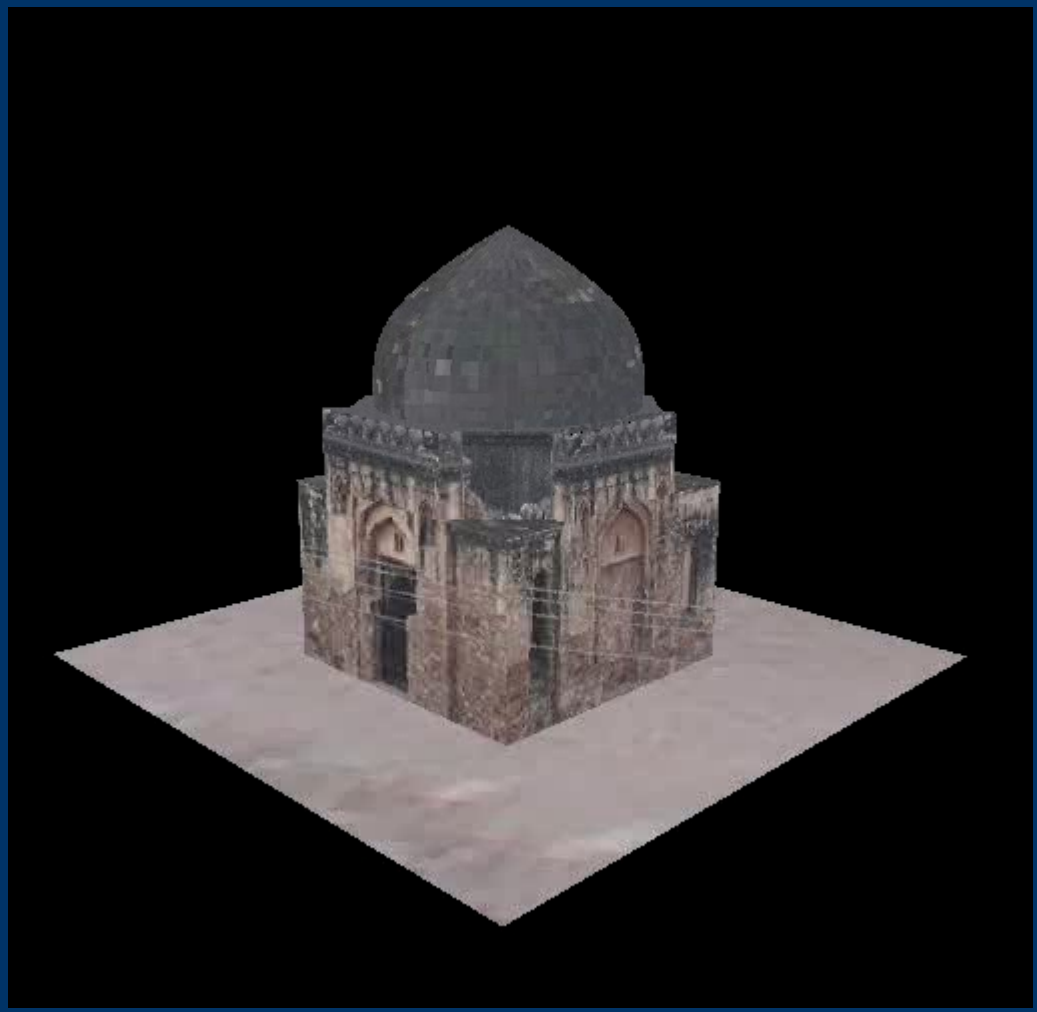
3D Shape Reconstruction



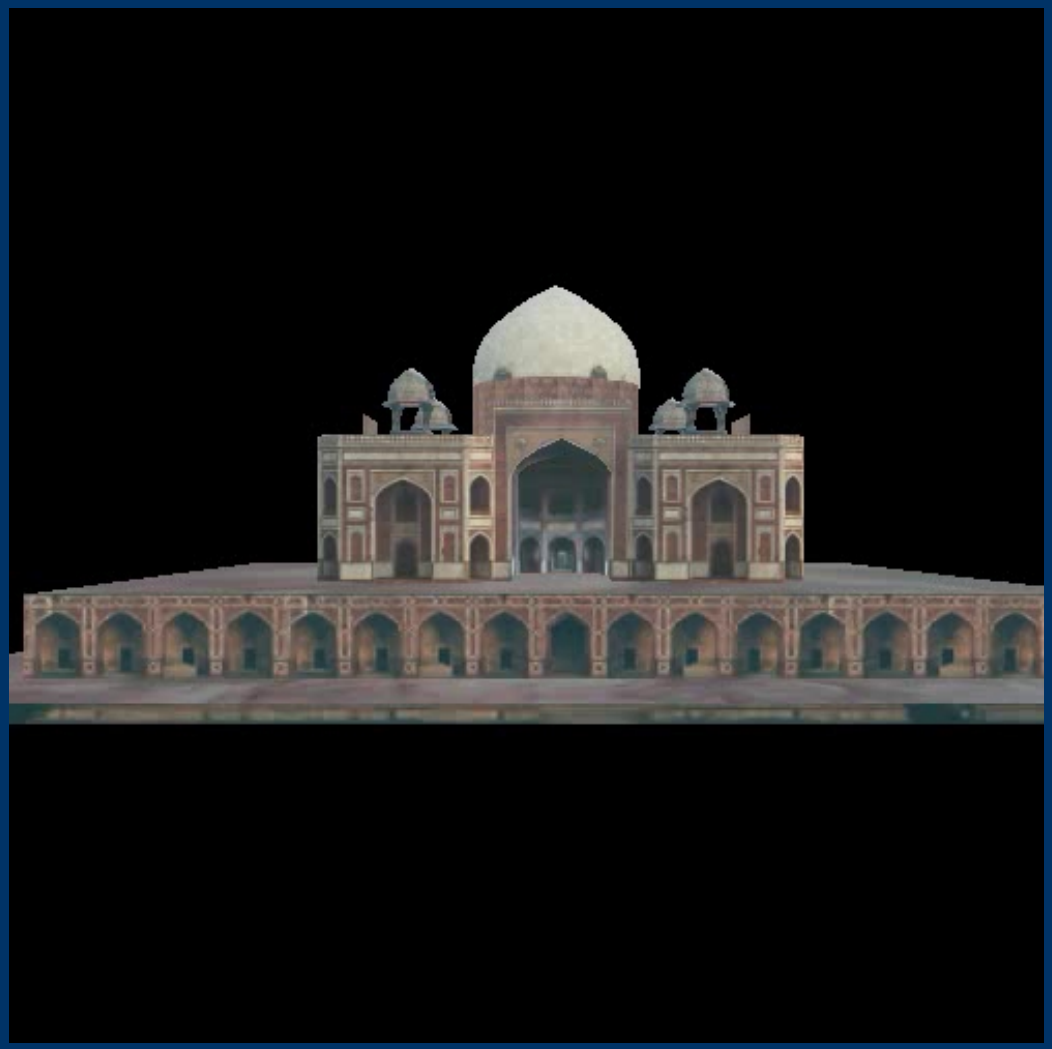
Debevec, Taylor, and Malik, SIGGRAPH 1996

Face Modeling

Single view reconstruction



Two view reconstruction



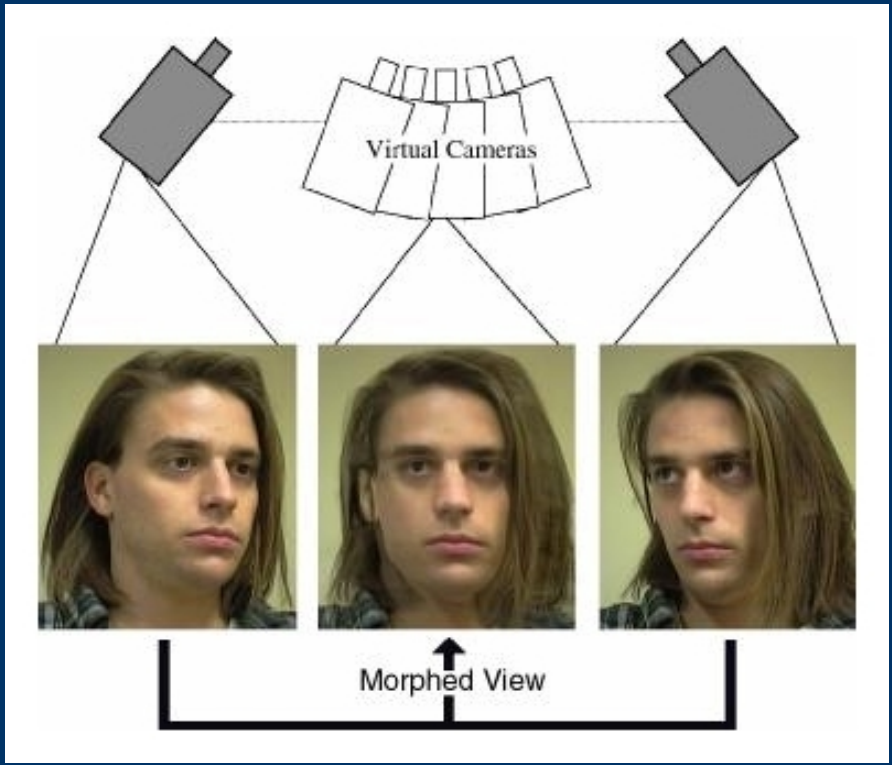
Single view with 3D model (Input Image)

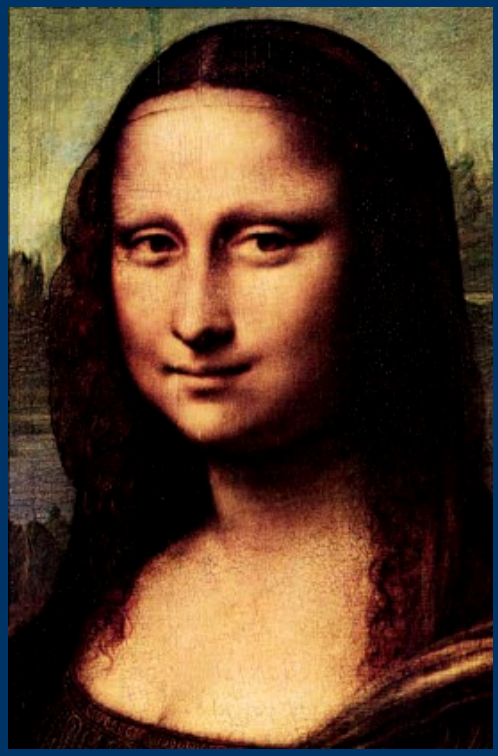
Single view with 3D model

Single view with 3D model

View Morphing

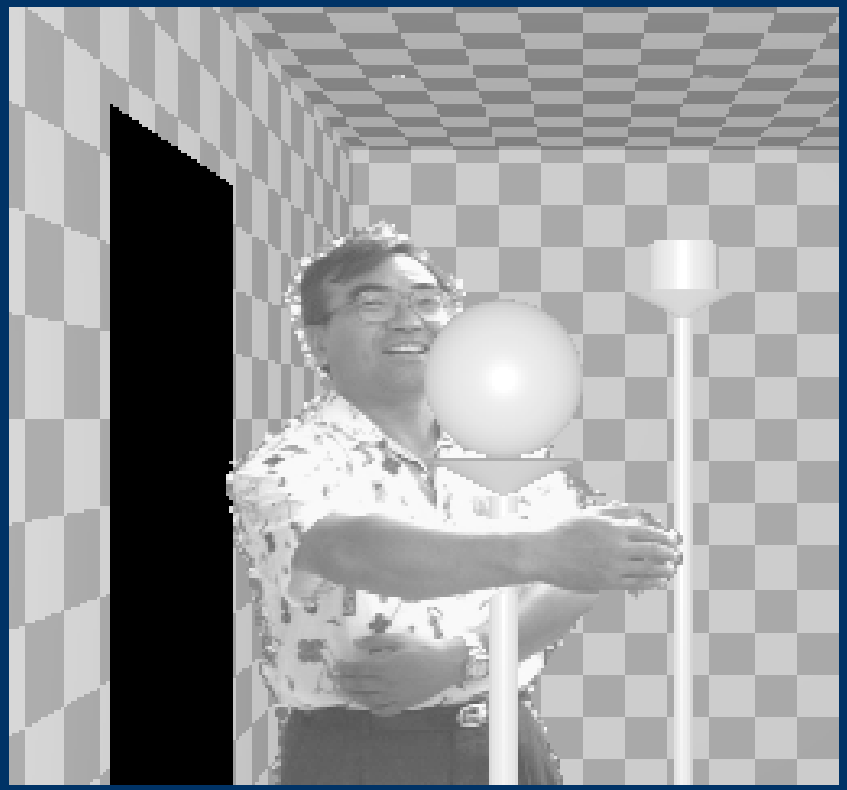
Morph between pair of images using epipolar geometry [Seitz & Dyer, SIGGRAPH'96]





Z-keying: mix live and synthetic

Takeo Kanade, CMU (Stereo Machine)

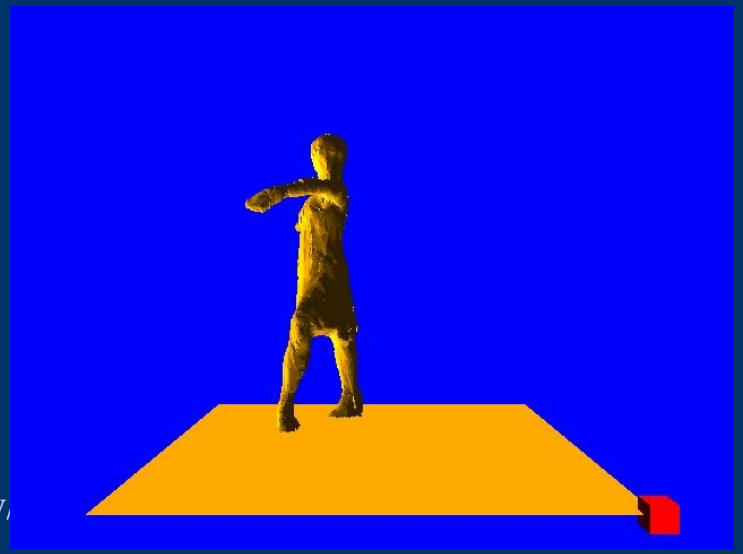


Virtualized Reality™

Takeo Kanade, CMU

collect video from 50+ stream

reconstruct 3D model sequences

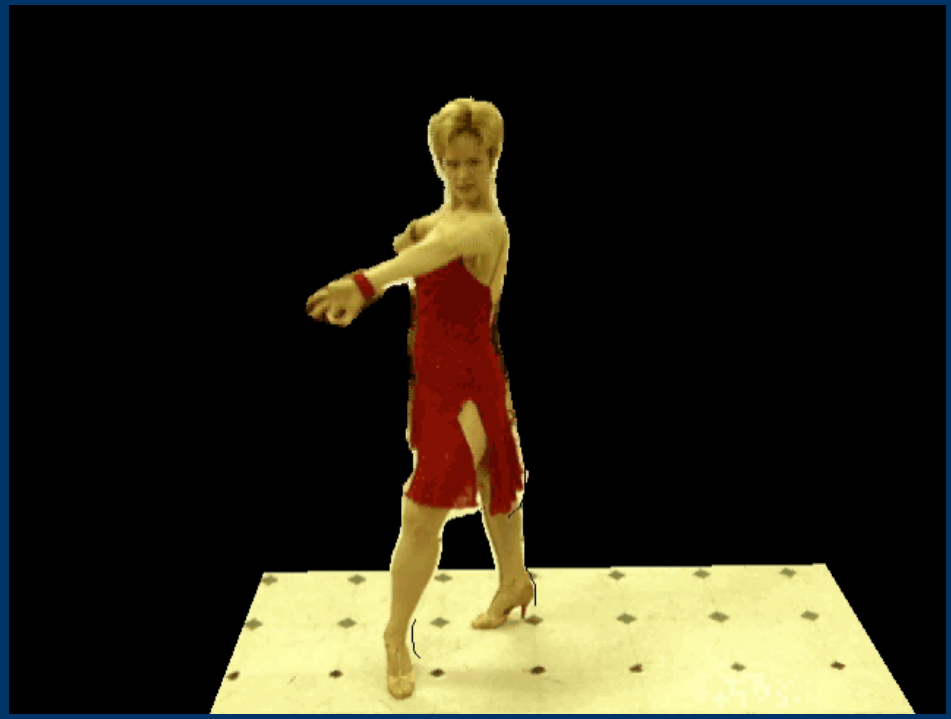


http://www.cs.cmu.edu/afs/

Virtualized Reality™

Takeo Kanade, CMU

generate new video



steerable version used for SuperBowl XXV

"eye vision" system

Mathematics used

Euclidean geometry
Projective geometry
Vector calculus
Optimization
Probabilistic estimation