Introduction to Computer Vision

Dr. Gerhard Roth

COMP 4900D
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General Information

Instructor: Adjunct Prof.

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Office Hours: 8:30 to 10:00, HP5270

TA:

Course website:

http://people.scs.carleton.ca/~roth/comp4900d-11/

Course Organization

Textbook: Introductory Techniques for 3-D Computer Vision, by Trucco and Verri

No longer in print, CD has scanned chapters

Also contains SzeliskiBook_20100903_draft which will be used for some of the course (to be decided

Two parts:

Part I (Before Feb. break) – Introduction, Review of linear algebra, Image formation, Image processing, Edge detection, Corner detection,

Line fitting, Ellipse finding.

Part II (After Feb. break) – Camera calibration, Stereo, Recognition, Augmented reality.

Evaluation

Four or five assignments (50%)

-two before break and two after

-three of them will involve programming

Two mid-terms (50%)

-one right after break, one at end of term (just before the exam period)

-will cover material up to that point, so once tested material in first part is not tested again

What is Computer Vision?

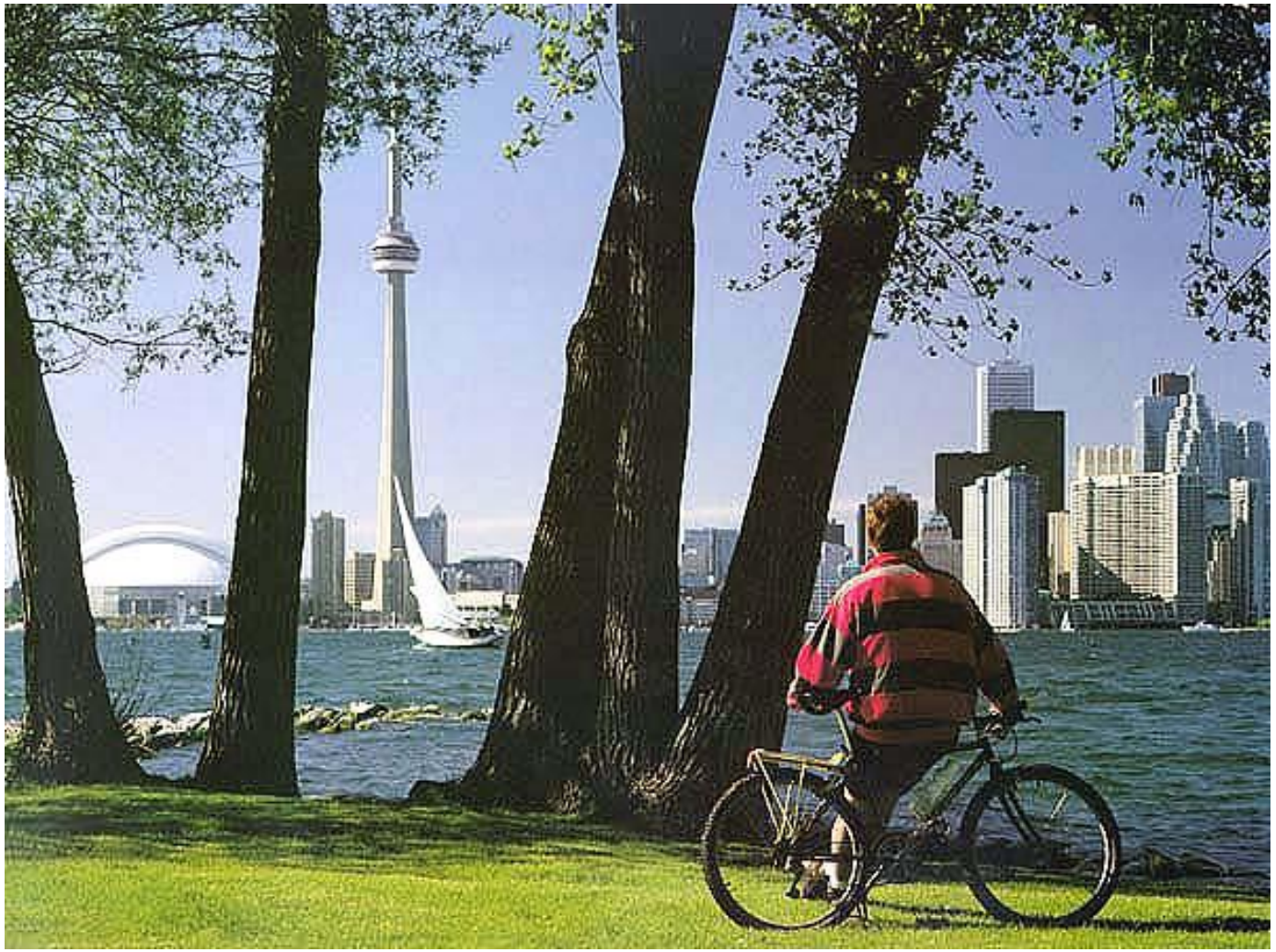
The goal of computer vision is to develop algorithms that allow computer to “see”.

Computer vision is sometimes called the inverse problem of computer graphics

Also called

- Image Understanding
- Image Analysis
- Machine Vision

General visual perception is hard



Digital Image

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A brief history of computer vision

- 1960s - started as a student summer project at MIT.
- 1970s and 80s – part of AI – understanding human vision and emulating human perception.
- 1990s – depart from AI , geometric approach.
- Today – various mathematical methods (statistics, differential equations, optimization), applications (security, robotics, graphics).
- Many applications of computer vision are now in common usage

What is Computer Vision?

Trucco & Verri:

Computing properties of the 3-D world from one or more digital images.

Properties: mainly physical (geometric, dynamic, etc.)

One common definition:

Computer vision is inverse optics or inverse graphics.

Related fields

- Image Processing
  - Generates one image from another – i.e. sharpen
- Pattern Recognition
  - Learn patterns for classifying or analyzing data – i.e. character recognition
- Photogrammetry
  - Measures 3d quantities from multiple 2d images – i.e. model building
- Computer graphics
  - Take a virtual scene and render it – i.e. gaming
- Human/Computer Interfaces
  - Ways of interacting between a computer and a human – i.e. kinect for xbox

Our Time

It is a good time to do computer vision now, because:

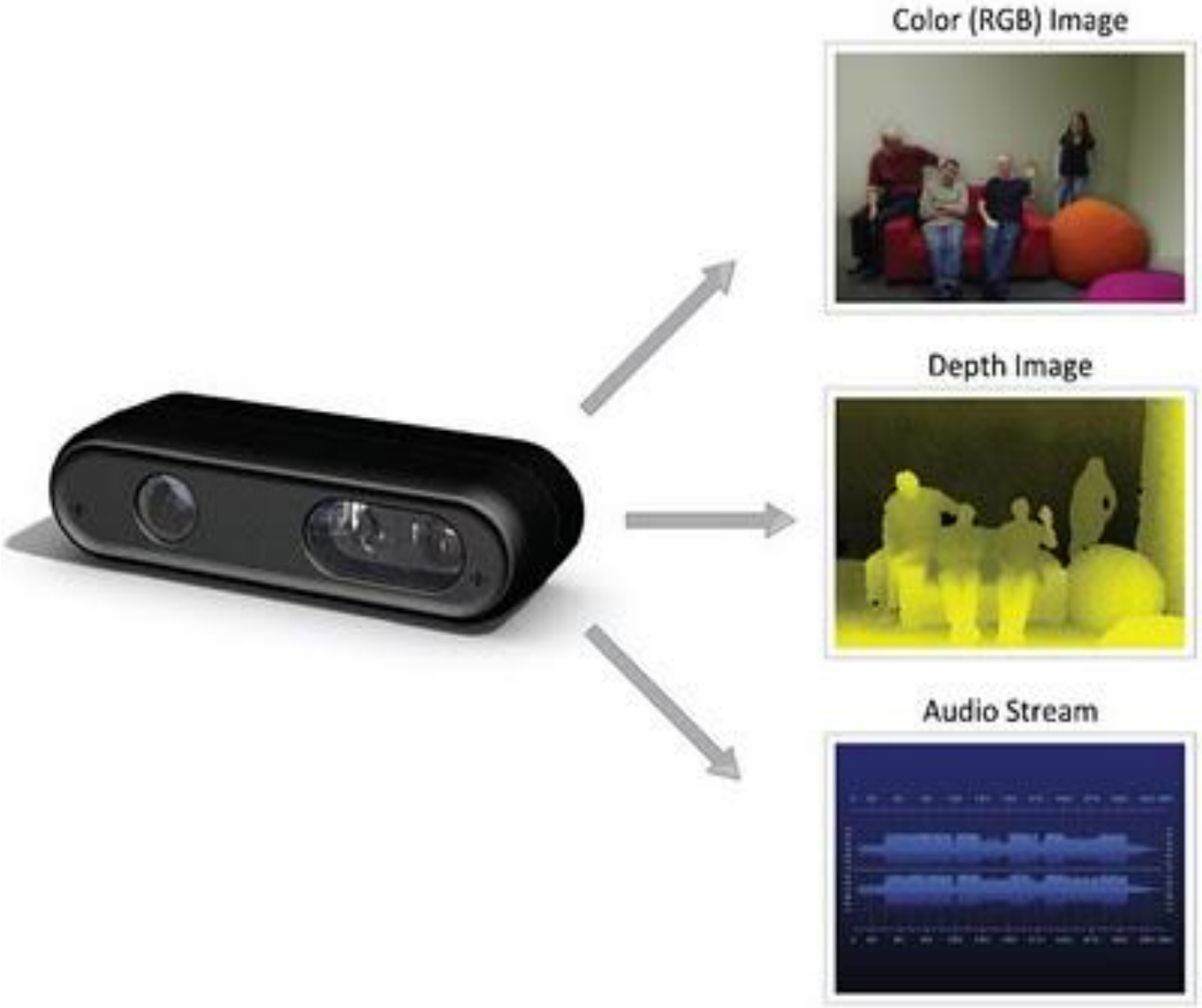
- Powerful computers
- Inexpensive cameras
- Algorithm improvements
- Understanding of vision systems
- Modern computer networks

Human Computer Interfaces

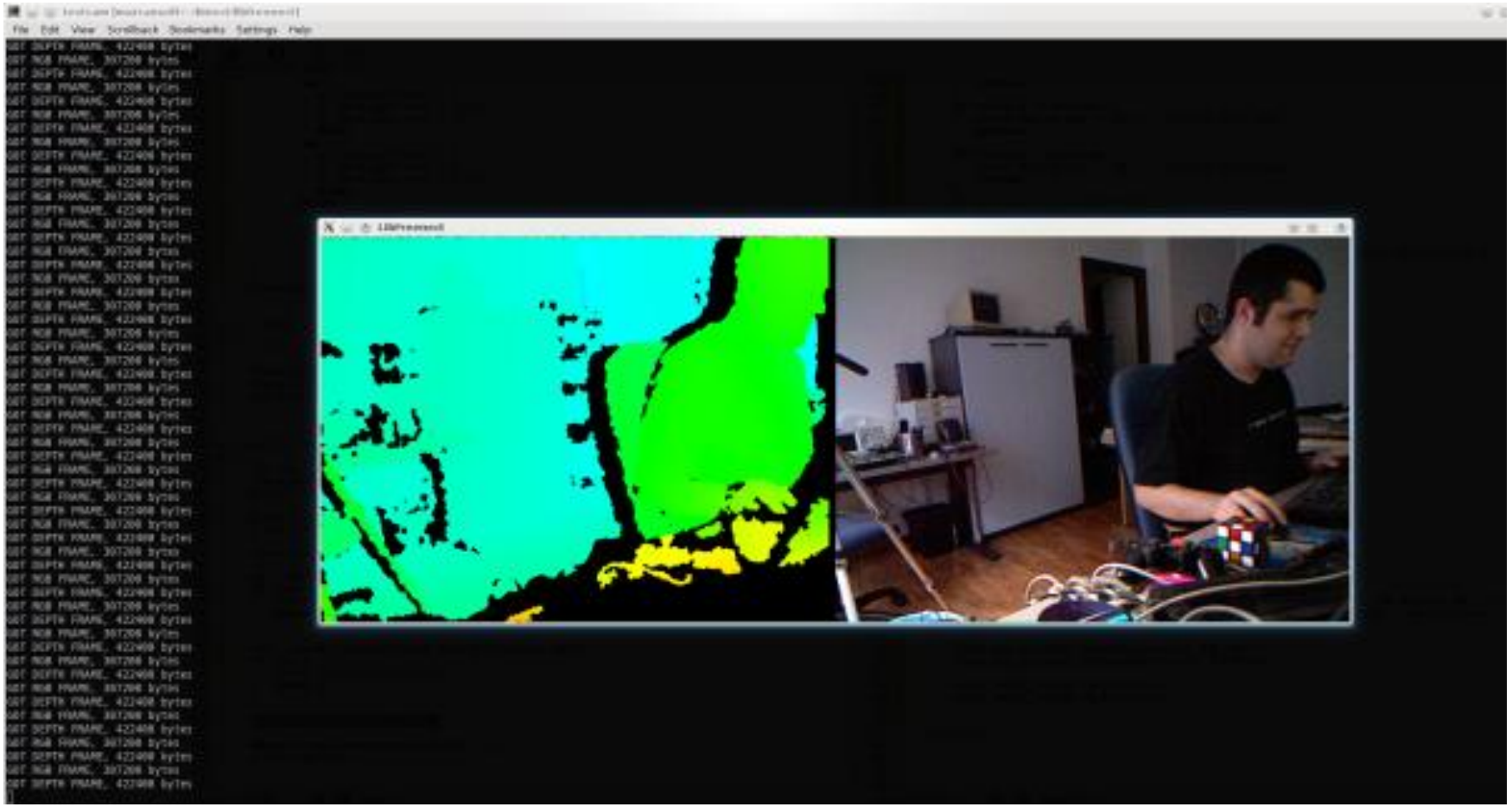
- Microsoft Kinect camera
  - Uses infrared projected patterns
  - Single camera sees these and computes 3d data
  - Basically depth values on top of image pixel values
- 3d depth data is easier to use than 2d
  - At least for applications such as motion detection
  - Can detect motion of a person (including arms/legs)
- Use this motion information to control game
  - A more complex input device than the Wii
  - Wii also uses computer vision technology

Typical structure light system

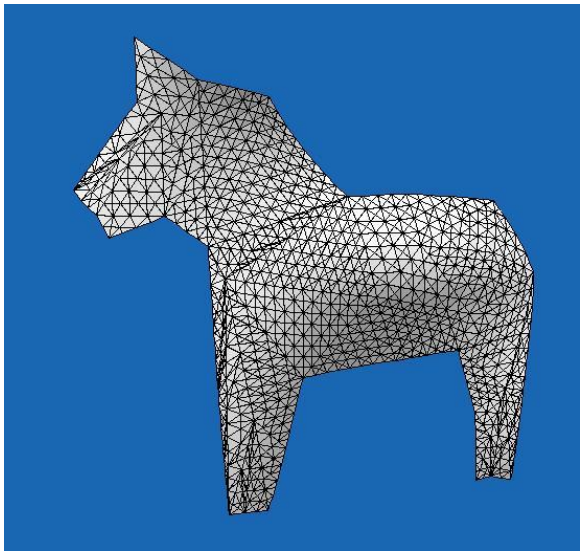
Kinect system



Kinect system

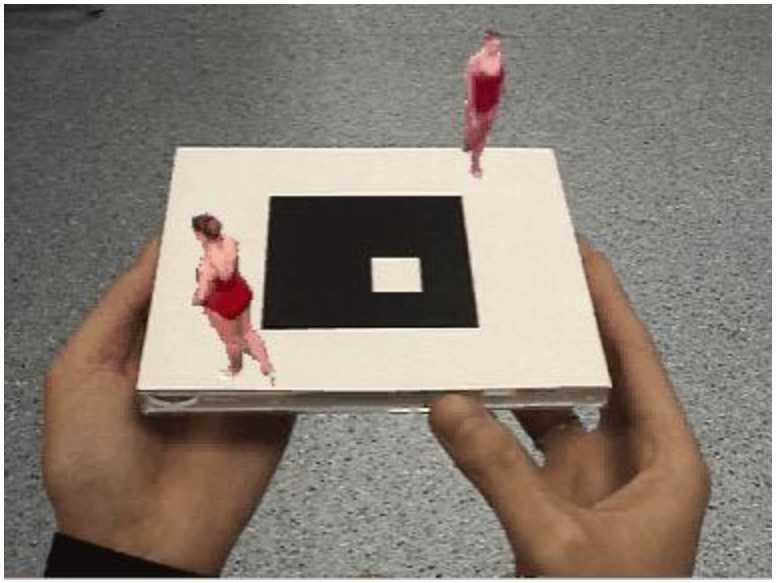


3D Reconstruction



Augmented Reality

Fig. 2: A Virtual Object on a Card



Panoramic Mosaics


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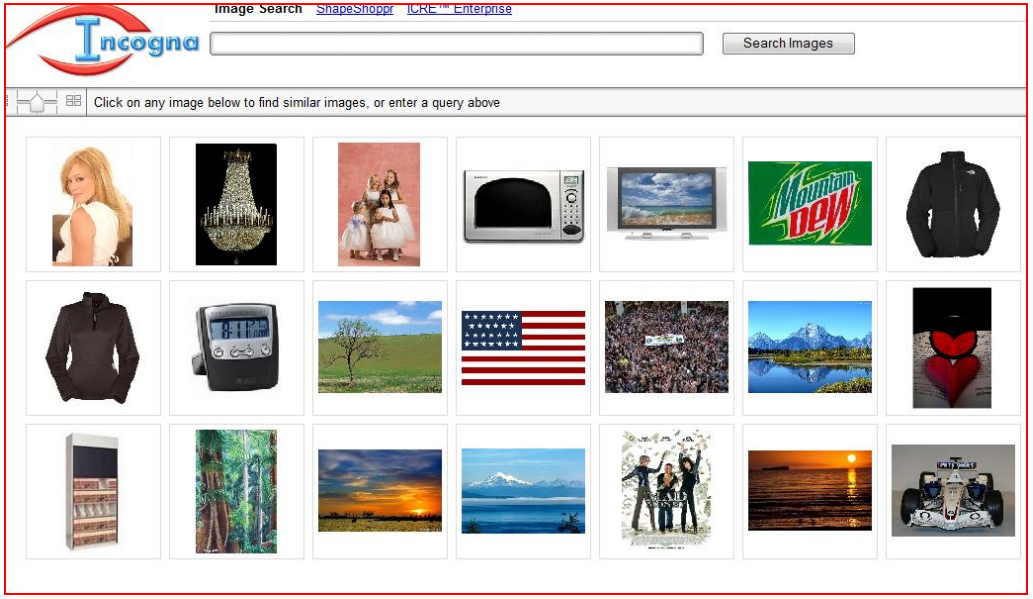
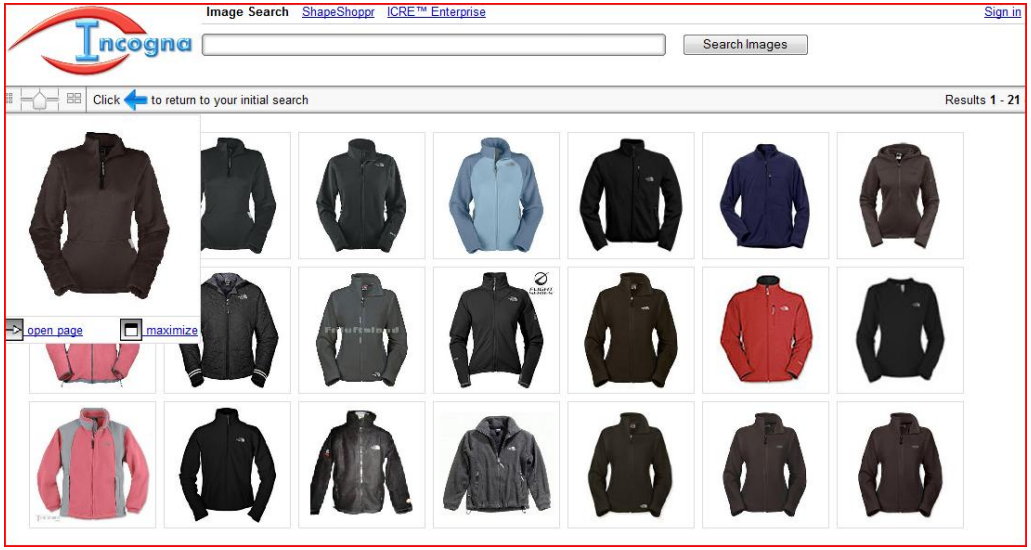
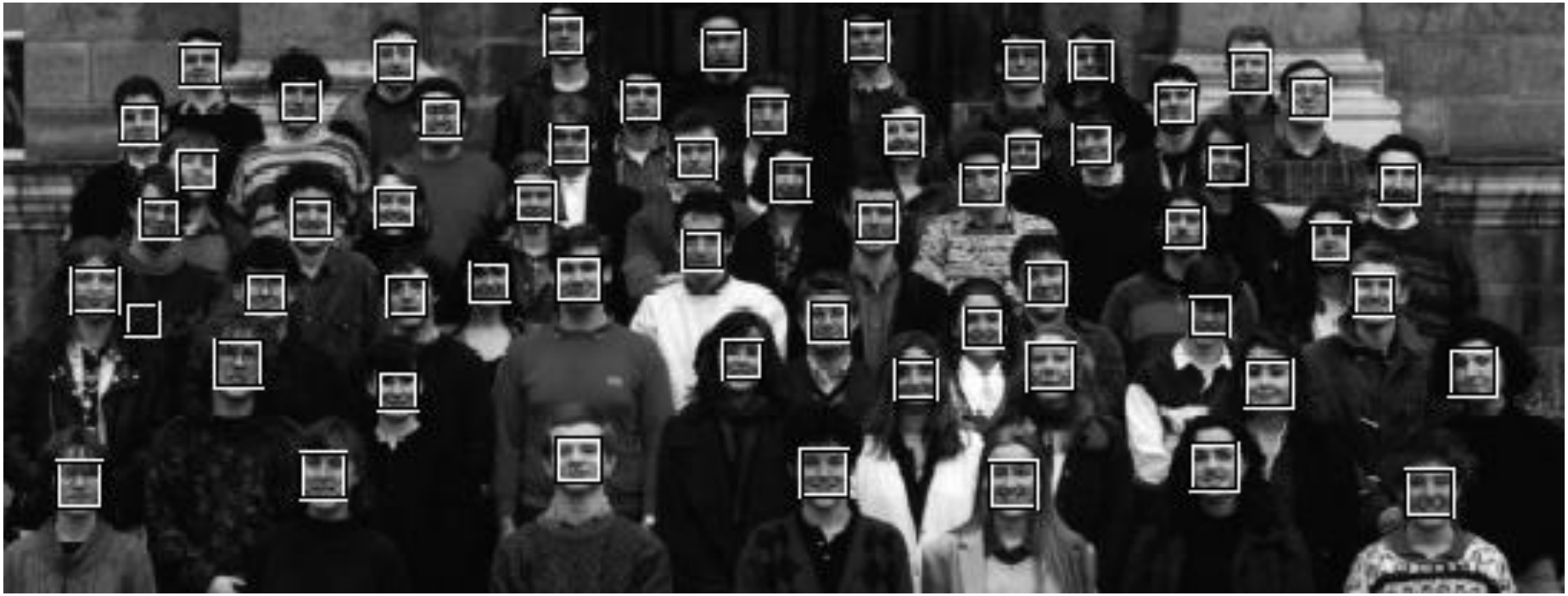
Image Search: www.incogna.com





Applications: Recognition



Applications: Special Effects

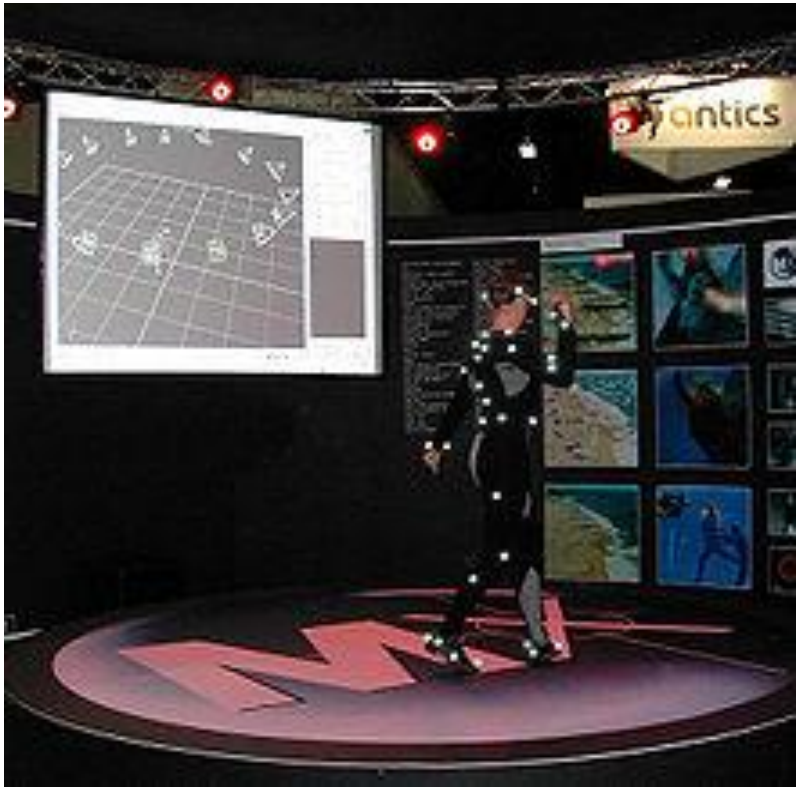
ESC Entertainment, XYZRGB, NRC

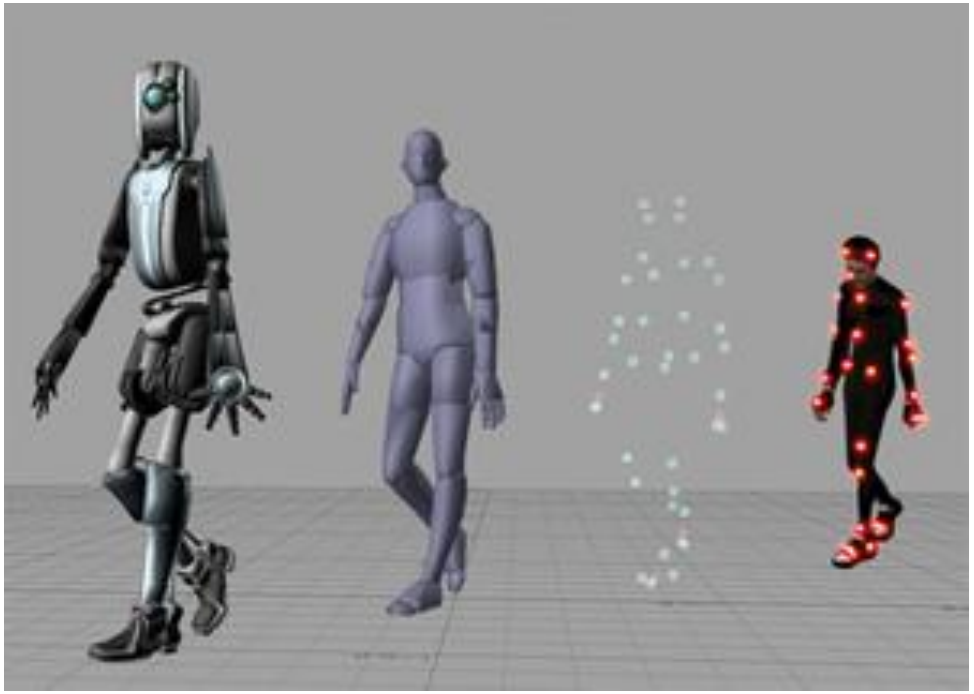
Applications: Special Effects

Andy Serkis, Gollum, Lord of the Rings

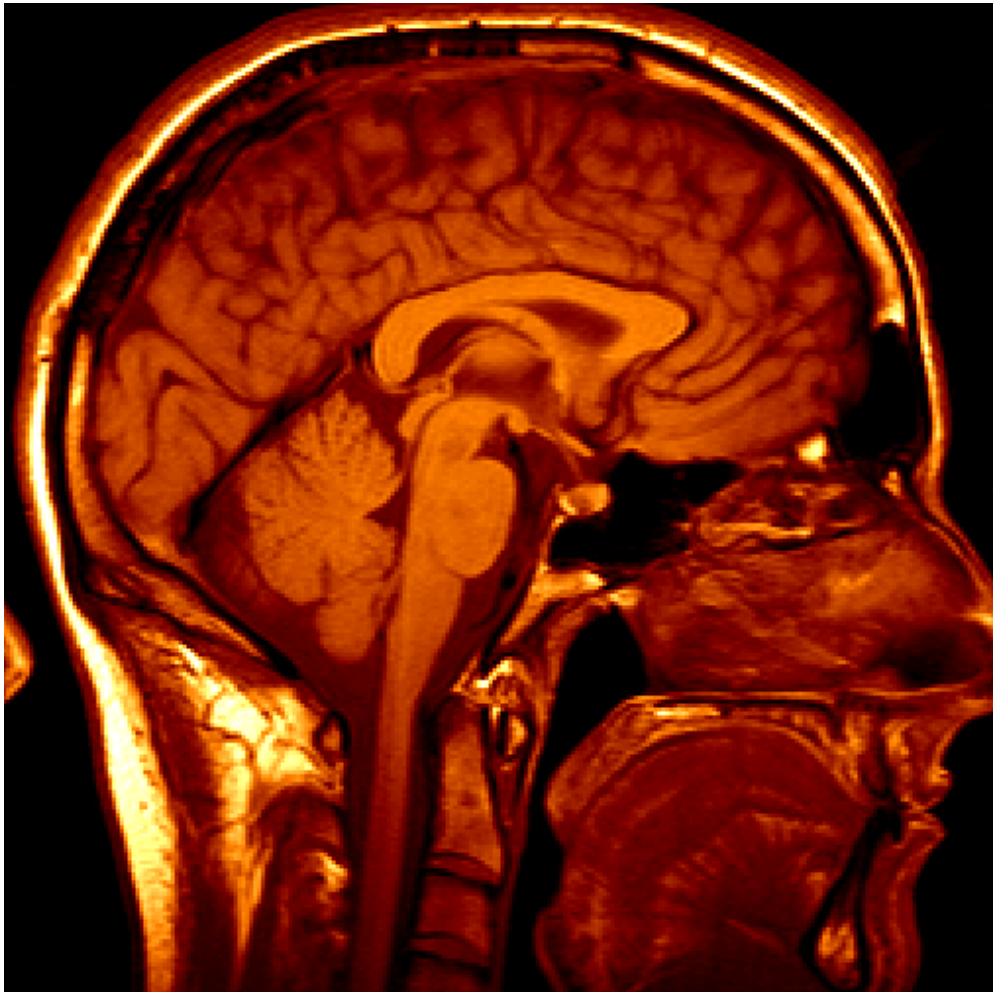
Motion capture systems

- Put retro-reflective balls everywhere
- Track these in real-time to get 3d positions

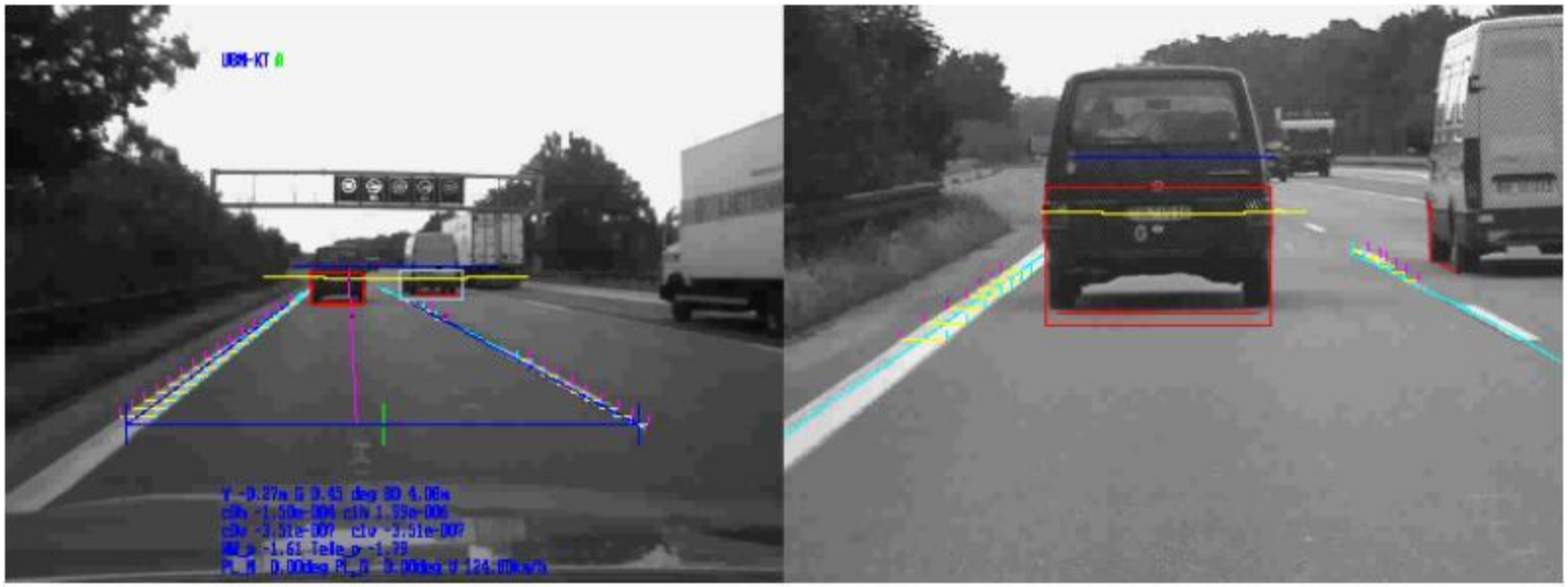




Applications: Medical Imaging

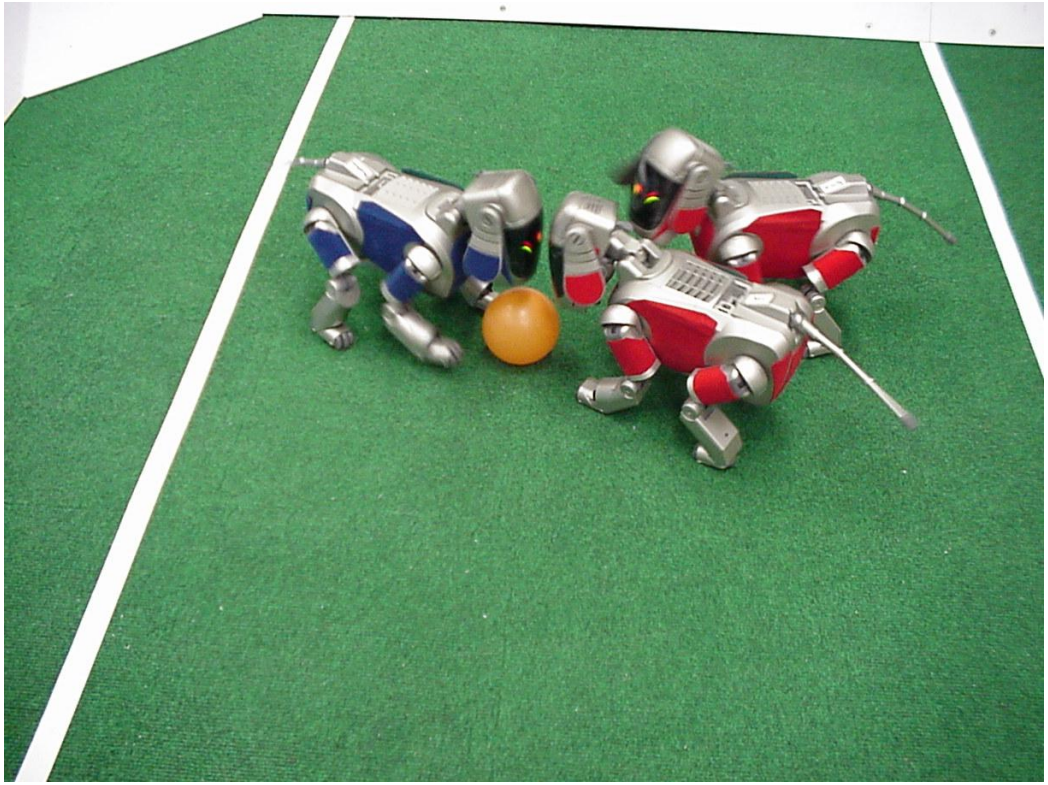


Autonomous Vehicle

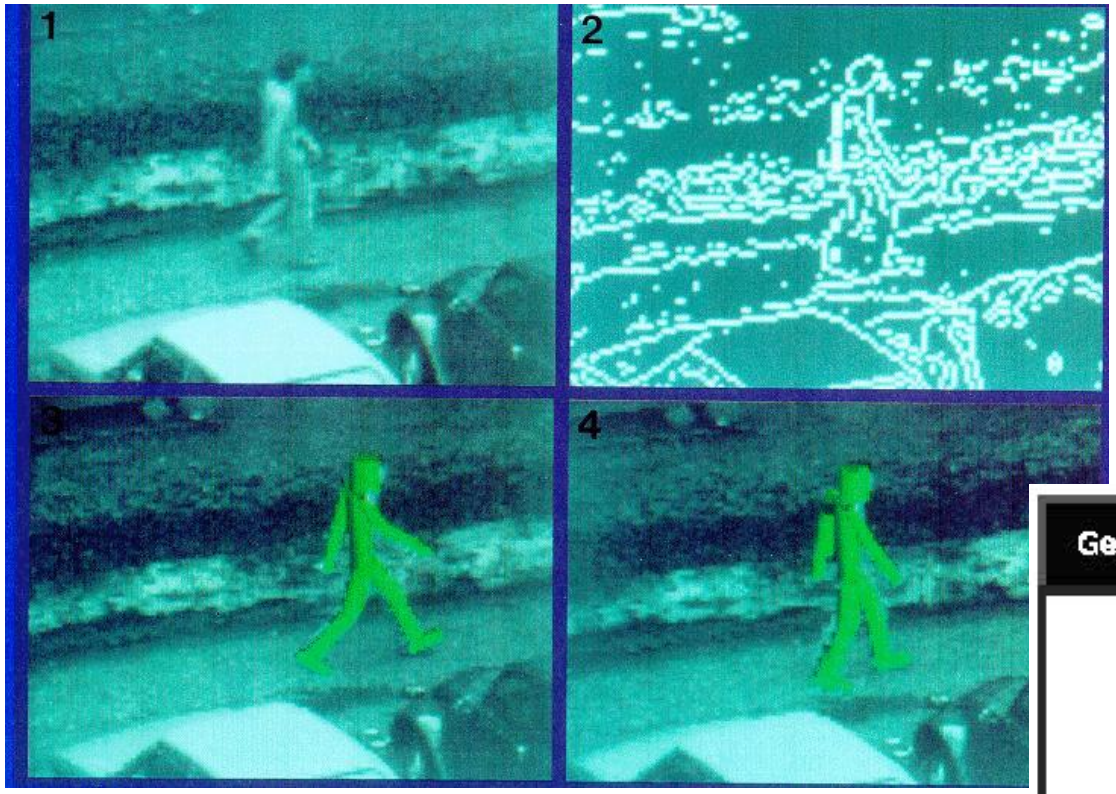


Flakey, SRI

Applications: Robotics



Applications: Surveillance



Mathematical tools

- Linear algebra
- Vector calculus
- Euclidean geometry
- Projective geometry
- Differential geometry
- Differential equations
- Numerical analysis
- Probability and statistics

Programming tools

- OpenCV
  - Widely used OpenSource library written in C/C+
  - Capable of running in real-time applications
  - OS/hardware/window-manager independent
  - Generic image/video loading, saving and acquisition
  - Both low and high level API
  - In windows require Visual Studio environment
  - Works on Linux and on Android phone
  - Many example programs in sample directory
  - OpenCV Wiki and on-line documentation

Course CD

- Contains OpenCV and an example program
- Along with a copy of the course web site
  - But you should look at the web site for current updates
- http://opencv.willowgarage.com/wiki/ has detailed instructions on how to compile
- Easiest approach
  - Install some version of Visual Studio (Version 8)
  - Install OpenCV (OpenCV-2.1.0-win32-vs2008)
  - In directory OpenCV example open the HarrisCorner project
  - To try out different example programs replace HarrisCorner.cpp with the other .cpp and .c files