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# Digital Image Processing

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# Introduction to the course

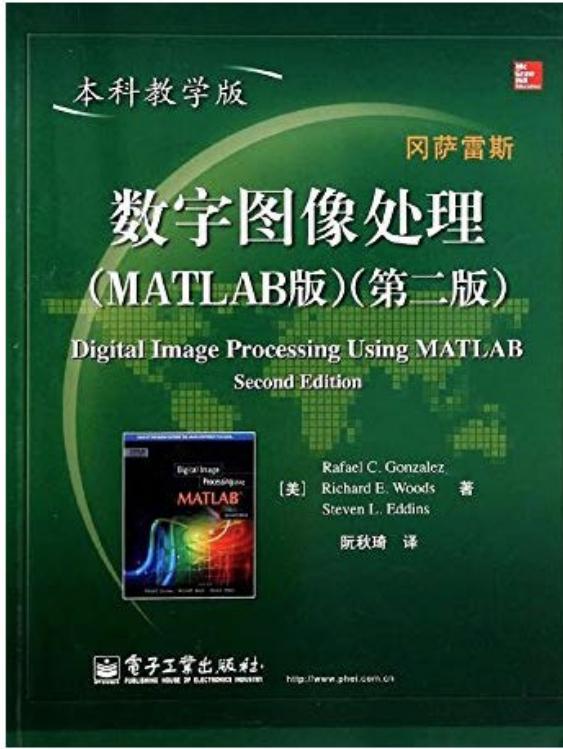
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## Grading

- Homework: 40%
- Project: 40%
- Exam: 20%
- Total: 100%

# Textbook

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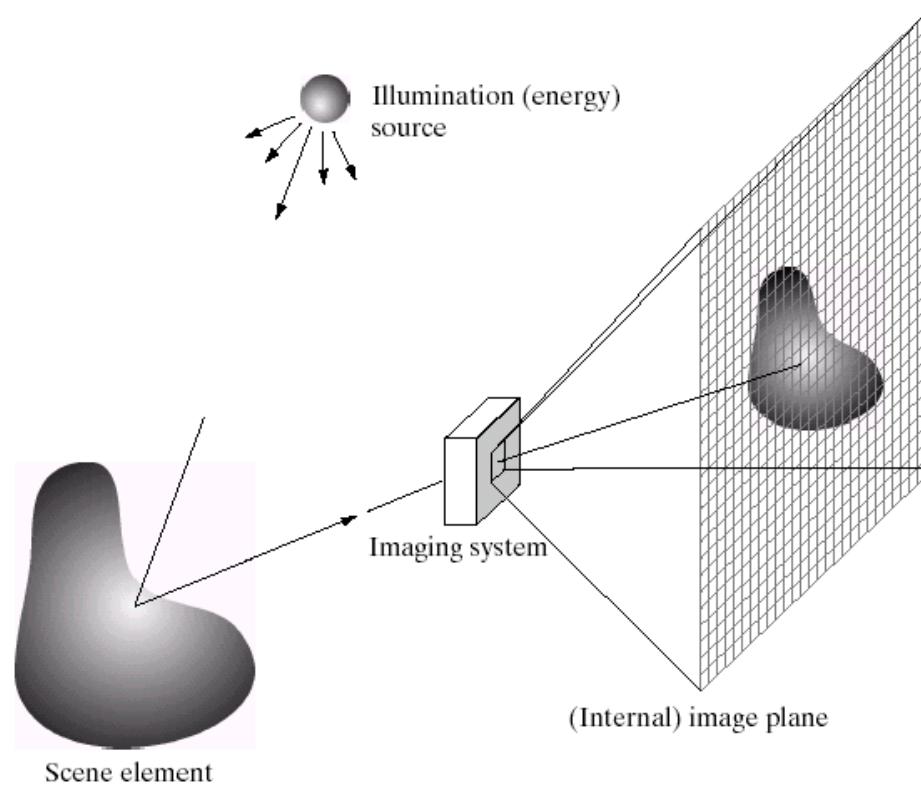


# What is digital image processing?

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# What is digital image ?

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Film

# What is digital image ?

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# Digital camera

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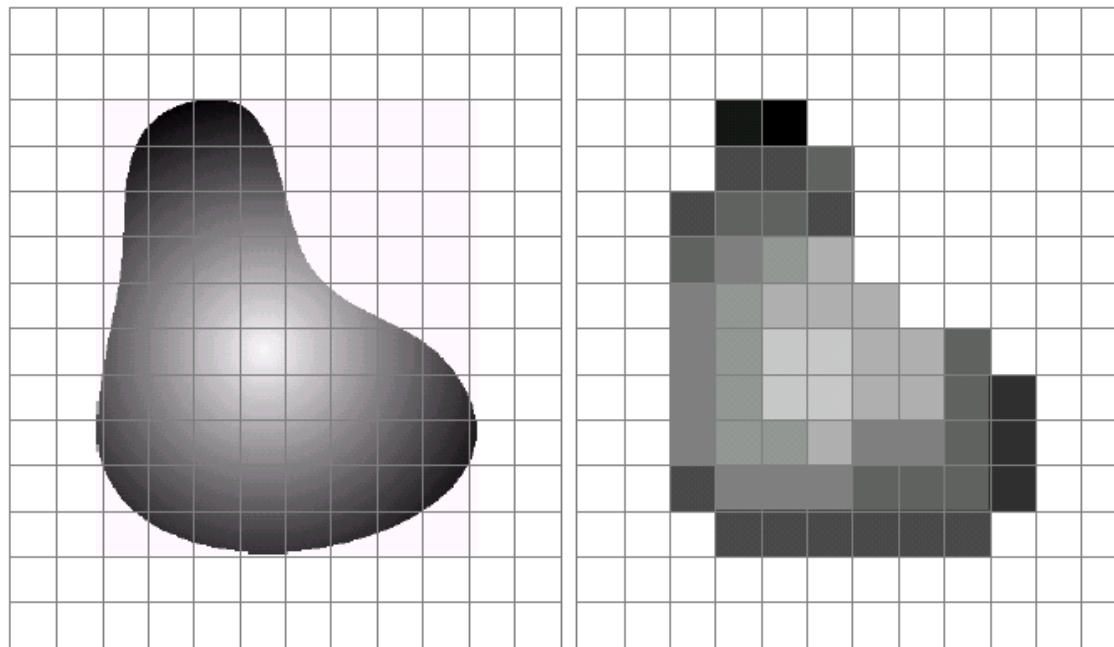


A digital camera replaces film with a sensor array

- Each cell in the array is light-sensitive diode that converts photons to electrons
- Two common types
  - Charge Coupled Device (CCD)
  - CMOS
- <http://electronics.howstuffworks.com/digital-camera.htm>

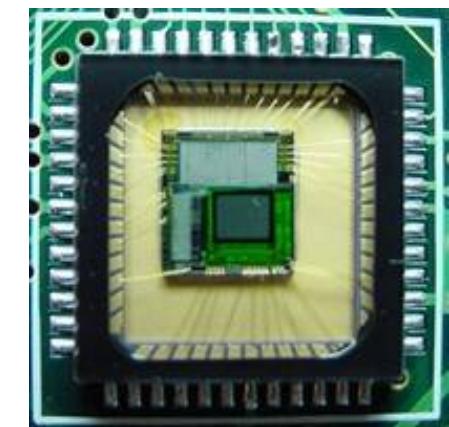
# Sensor Array

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a b

**FIGURE 2.17** (a) Continuous image projected onto a sensor array. (b) Result of image sampling and quantization.



CMOS sensor

# The applications of digital image processing

# Earth viewers (3D modeling)

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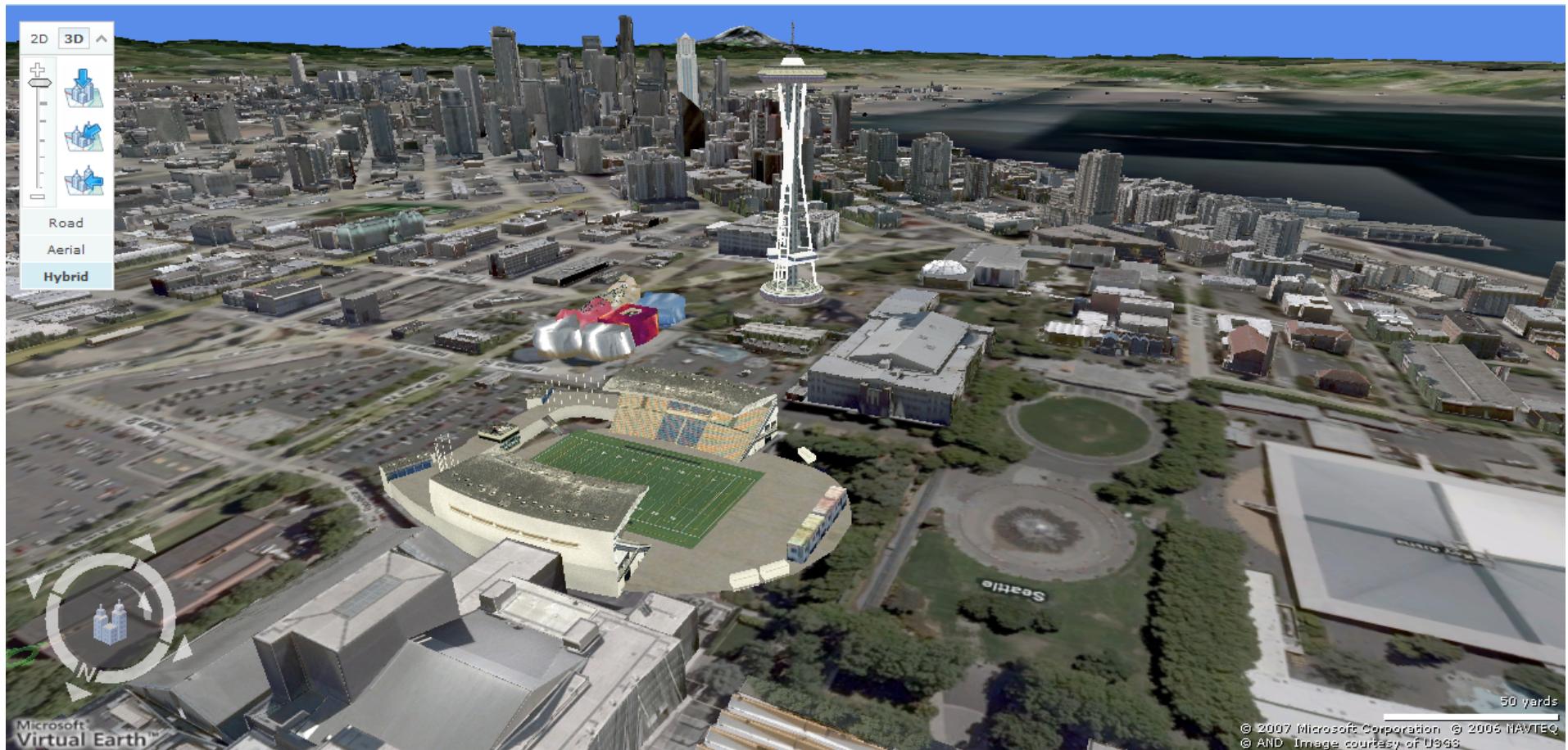
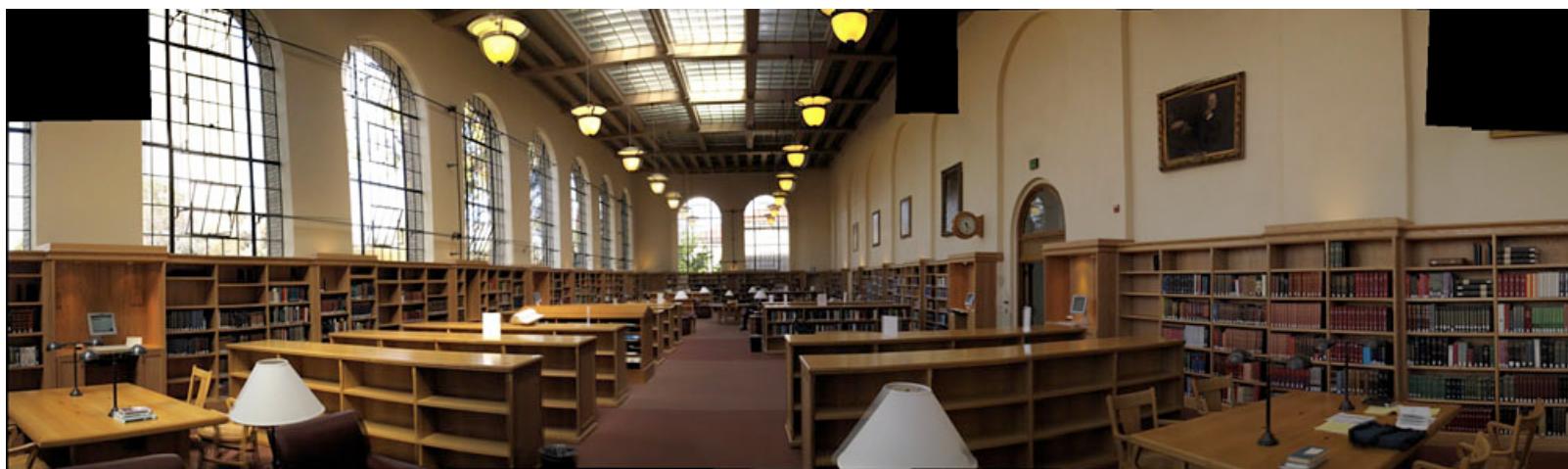
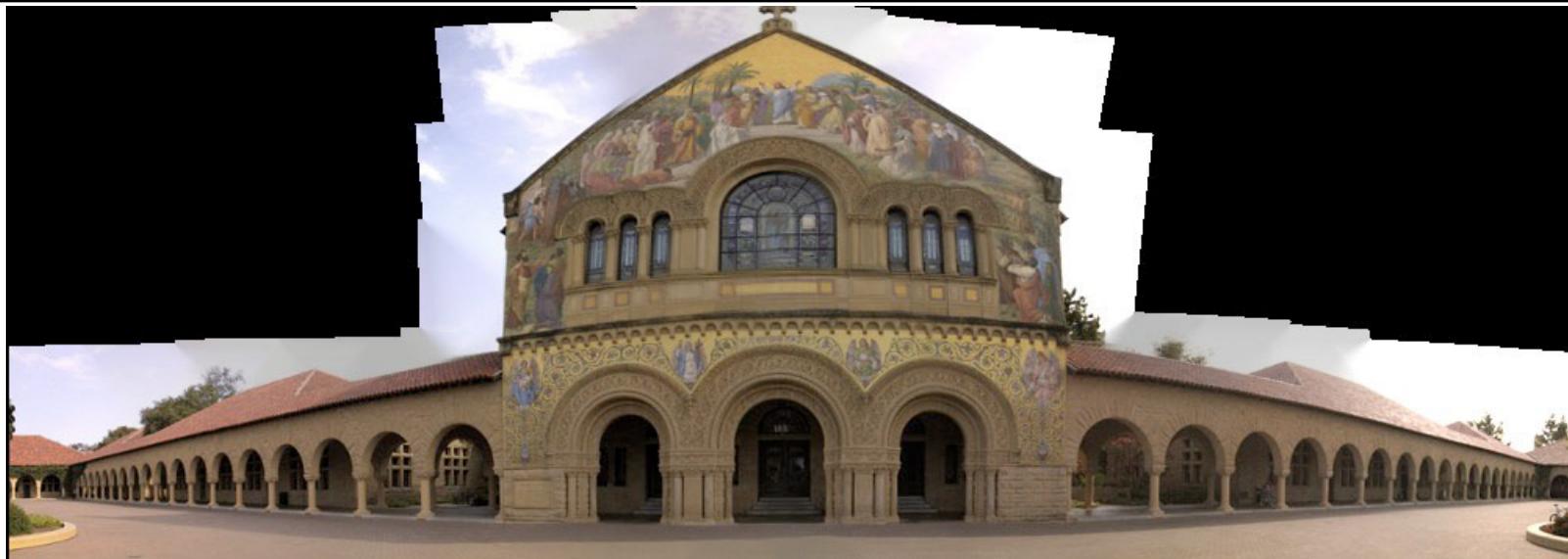


Image from Microsoft's [Virtual Earth](#)  
(see also: [Google Earth](#))

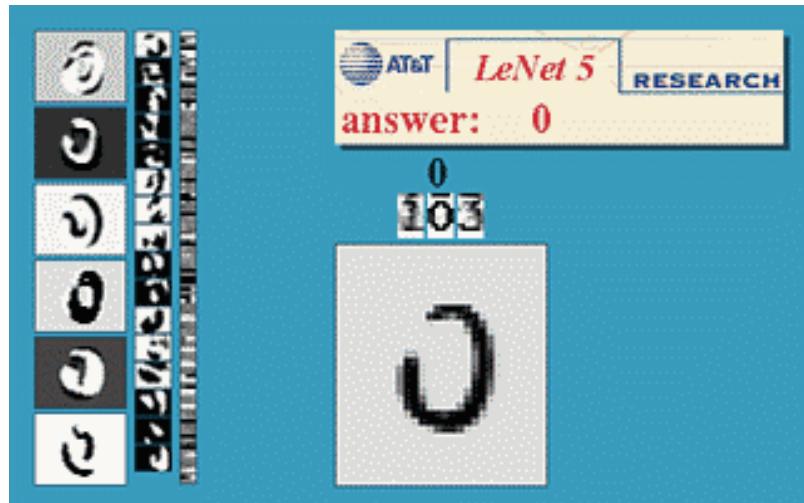


# Optical character recognition (OCR)

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Technology to convert scanned docs to text

- If you have a scanner, it probably came with OCR software



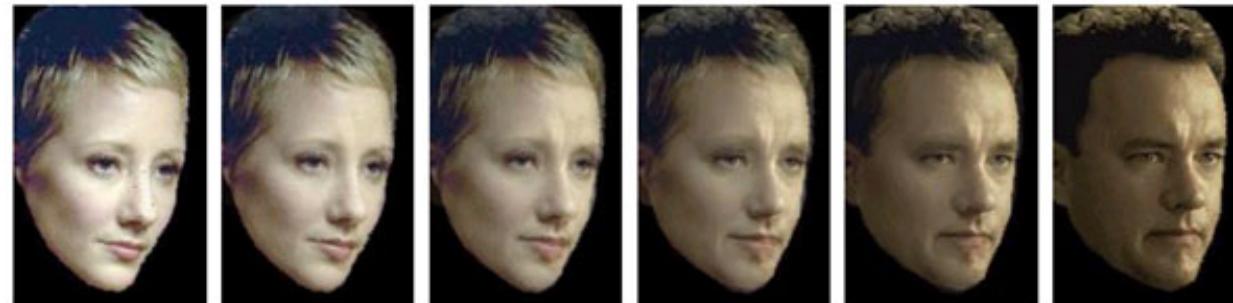
Digit recognition, AT&T labs  
<http://www.research.att.com/~yann/>



License plate readers  
[http://en.wikipedia.org/wiki/Automatic\\_number\\_plate\\_recognition](http://en.wikipedia.org/wiki/Automatic_number_plate_recognition)

# Morphing

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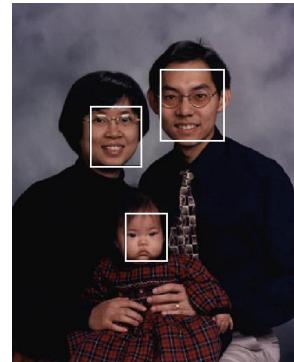
# Image Colorization

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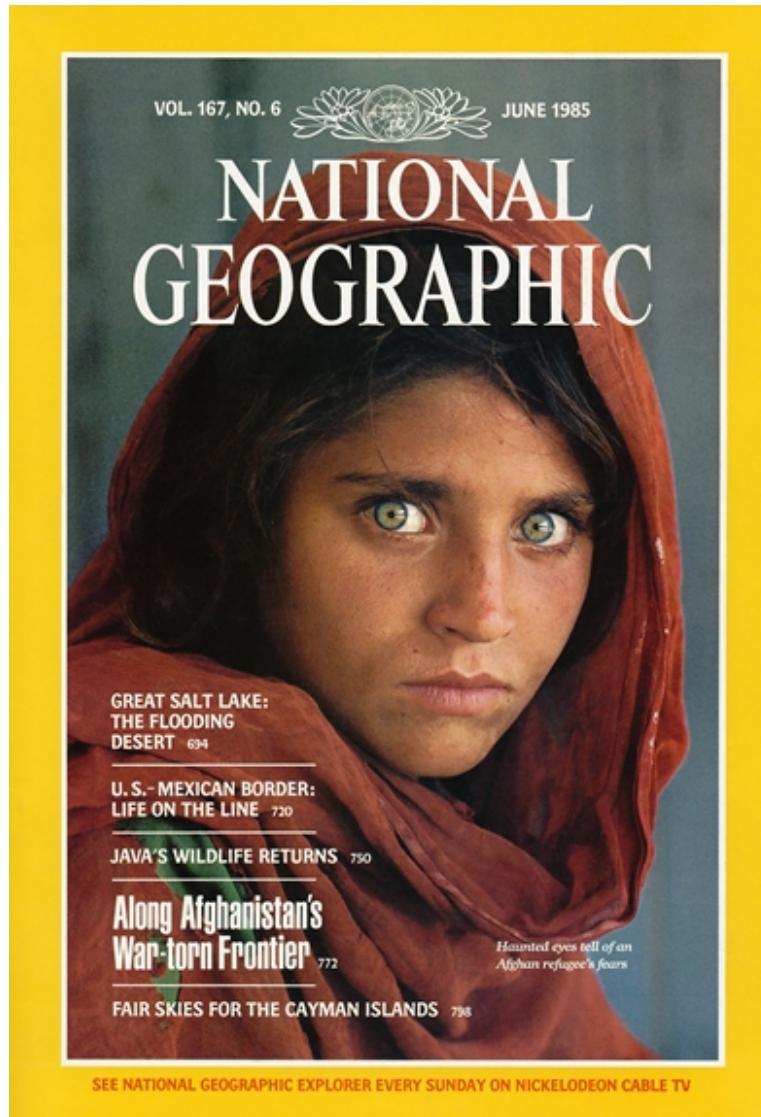
# Face detection

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# Face recognition

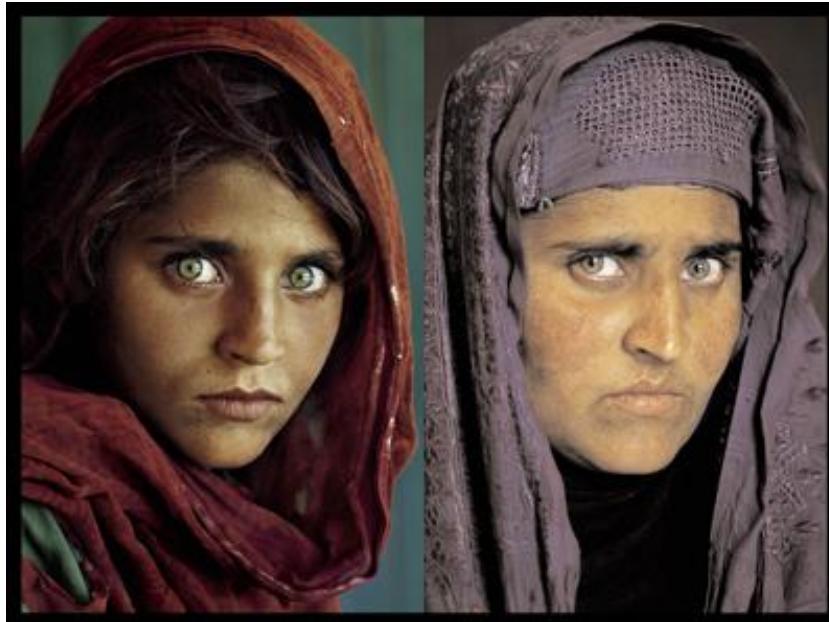
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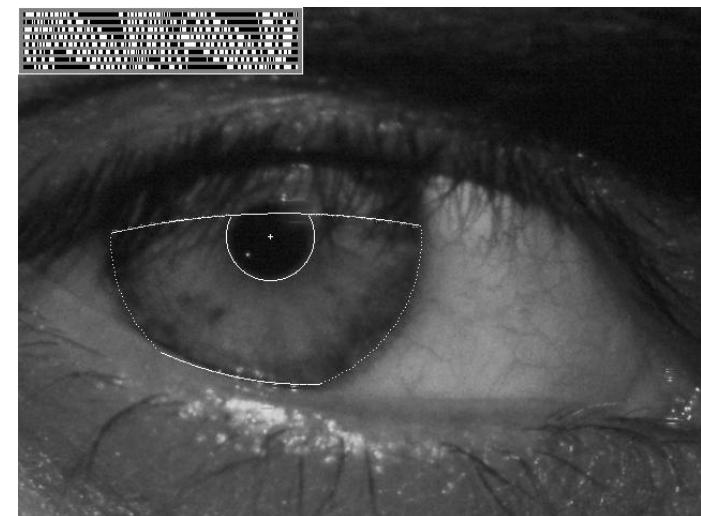
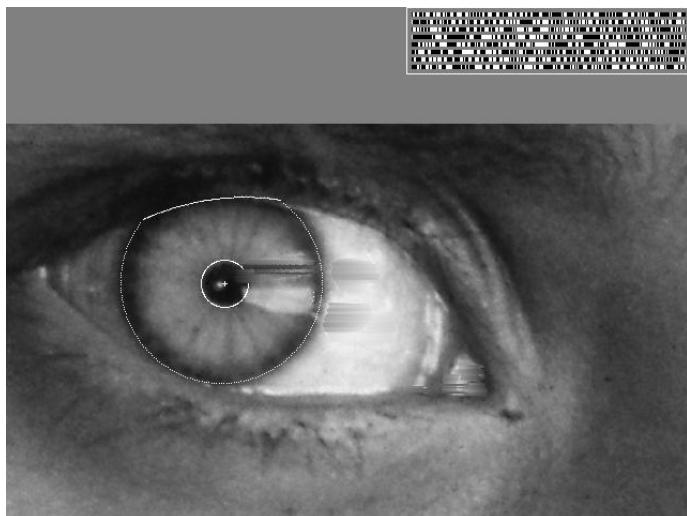
Who is she?

# Vision-based biometrics

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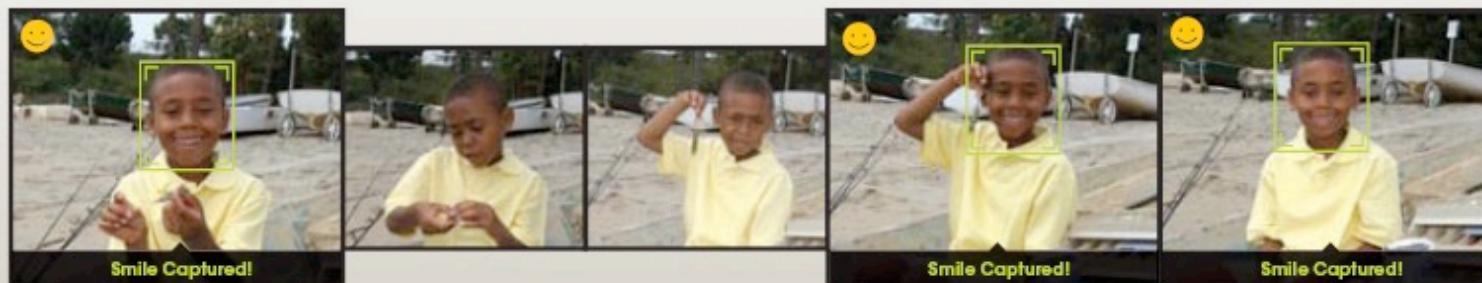
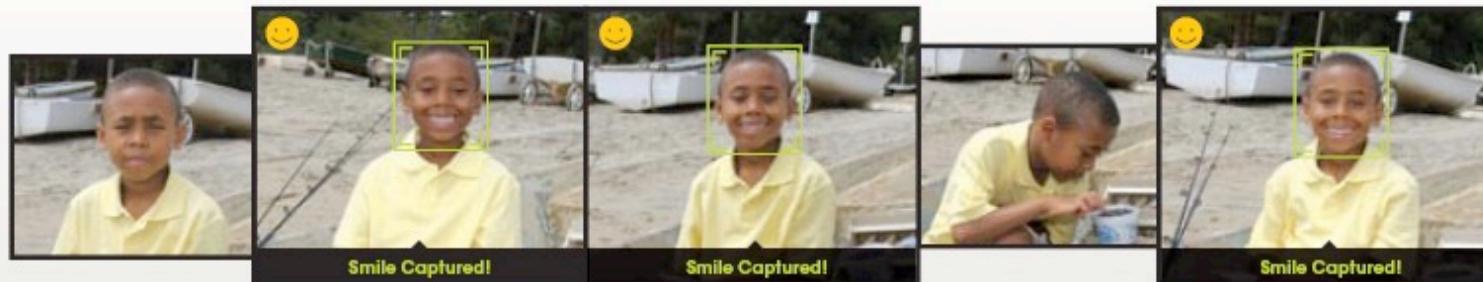
*“How the Afghan Girl was Identified by Her Iris Patterns”* Read the [story](#)



# Smile detection?

## The Smile Shutter flow

Imagine a camera smart enough to catch every smile! In Smile Shutter Mode, your Cyber-shot® camera can automatically trip the shutter at just the right instant to catch the perfect expression.



[Sony Cyber-shot® T70 Digital Still Camera](#)

# Object recognition (in supermarkets)

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## LaneHawk by EvolutionRobotics

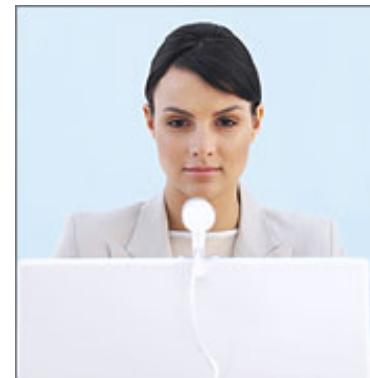
“A smart camera is flush-mounted in the checkout lane, continuously watching for items. When an item is detected and recognized, the cashier verifies the quantity of items that were found under the basket, and continues to close the transaction. The item can remain under the basket, and with LaneHawk, you are assured to get paid for it... “

# Login without a password...

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Fingerprint scanners on  
many new laptops,  
other devices



Face recognition systems now  
beginning to appear more widely  
<http://www.sensiblevision.com/>

# Object recognition (in mobile phones)



This is becoming real:

- **Lincoln** Microsoft Research
- [Point & Find](#), [Nokia](#)

# Special effects: shape capture

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*The Matrix* movies, ESC Entertainment, XYZRGB, NRC

# Smart cars

Slide content courtesy of Amnon Shashua

The screenshot shows the Mobileye website's homepage. At the top, there are navigation tabs for "manufacturer products" and "consumer products". A main banner features a car from a top-down perspective with three types of cameras highlighted: "rear looking camera", "forward looking camera", and "side looking camera". Below the banner, there are three main product sections: "EyeQ Vision on a Chip" (with an image of a chip), "Vision Applications" (with an image of a pedestrian crossing), and "AWS Advance Warning System" (with an image of a dashboard display). To the right, there are two columns: "News" and "Events". The "News" column lists articles like "Mobileye Advanced Technologies Power Volvo Cars World First Collision Warning With Auto Brake System" and "Volvo: New Collision Warning with Auto Brake Helps Prevent Rear-end". The "Events" column lists "Mobileye at Equip Auto, Paris, France" and "Mobileye at SEMA, Las Vegas, NV".

- > **EyeQ** Vision on a Chip
- > **Vision Applications**  
Road, Vehicle, Pedestrian Protection and more
- > **AWS** Advance Warning System

News

- > Mobileye Advanced Technologies Power Volvo Cars World First Collision Warning With Auto Brake System
- > Volvo: New Collision Warning with Auto Brake Helps Prevent Rear-end

Events

- > Mobileye at Equip Auto, Paris, France
- > Mobileye at SEMA, Las Vegas, NV

## Mobileye

- Vision systems currently in high-end BMW, GM, Volvo models
- By 2010: 70% of car manufacturers.
- [Video demo](#)

# Vision-based interaction (and games)

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Nintendo Wii has camera-based IR tracking built in. See [Lee's work at CMU](#) on clever tricks on using it to create a [multi-touch display](#)!



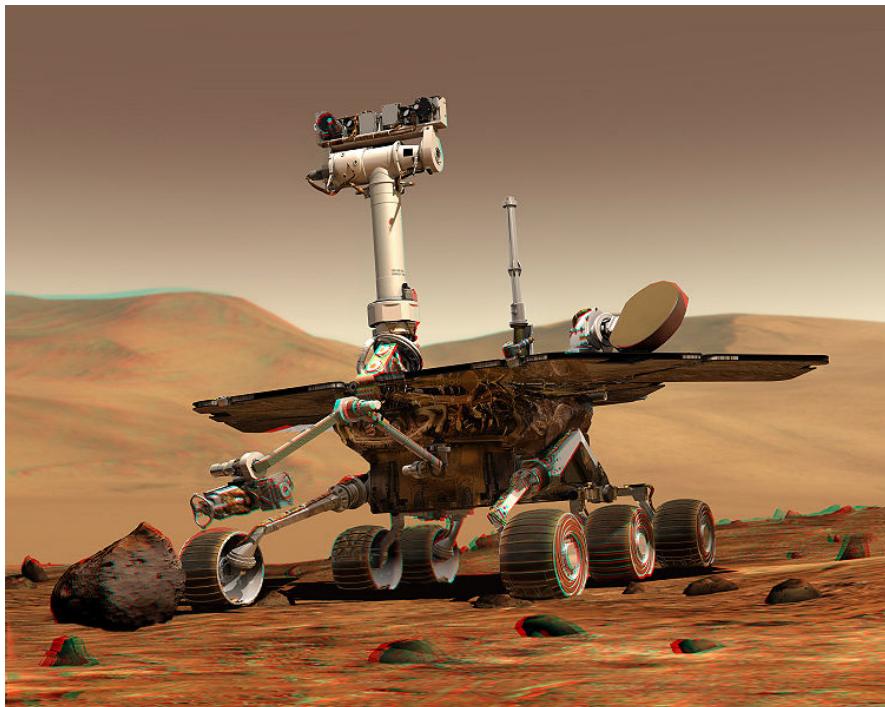
[Digimask](#): put your face on a 3D avatar.



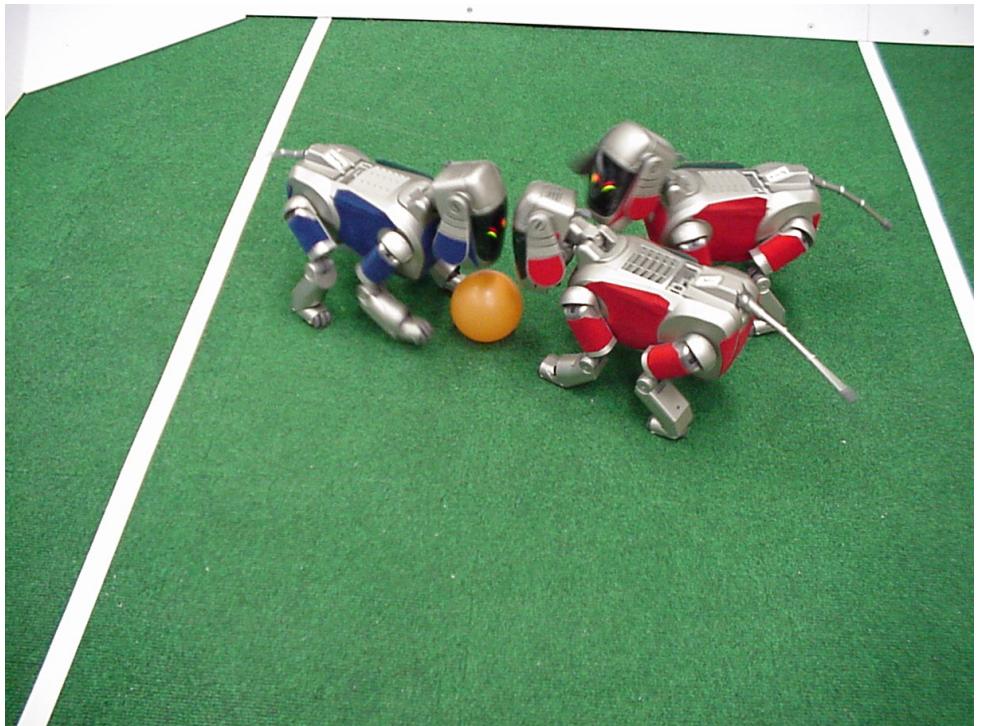
["Game turns moviegoers into Human Joysticks"](#), CNET  
Camera tracking a crowd, based on [this work](#).

# Robotics

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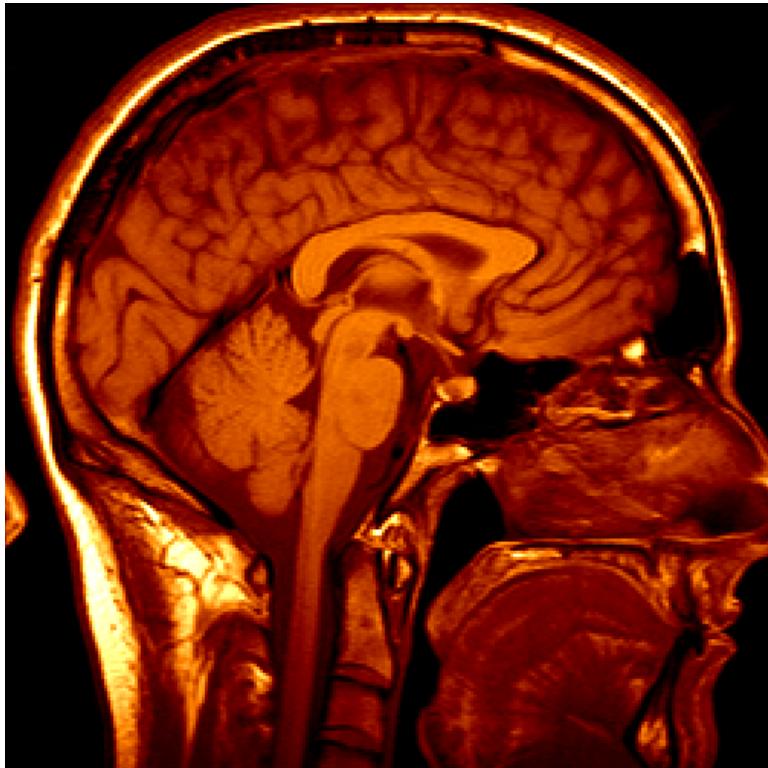
NASA's Mars Spirit Rover  
[http://en.wikipedia.org/wiki/Spirit\\_rover](http://en.wikipedia.org/wiki/Spirit_rover)



<http://www.robocup.org/>

# Medical imaging

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3D imaging  
MRI, CT



Image guided surgery  
[Grimson et al., MIT](#)

