

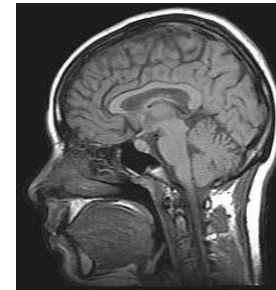
# Computer Vision 1

What is a Computer Vision?

By: Jinxiong Chai

# What is Computer Vision?

- **Computer vision** is the science and technology of machines that see.
- Concerned with the theory for building artificial systems that obtain information from images.
- The image data can take many forms, such as a video sequence, depth images, views from multiple cameras, or multi-dimensional data from a medical scanner



# Computer Vision

Make computers understand images and videos.



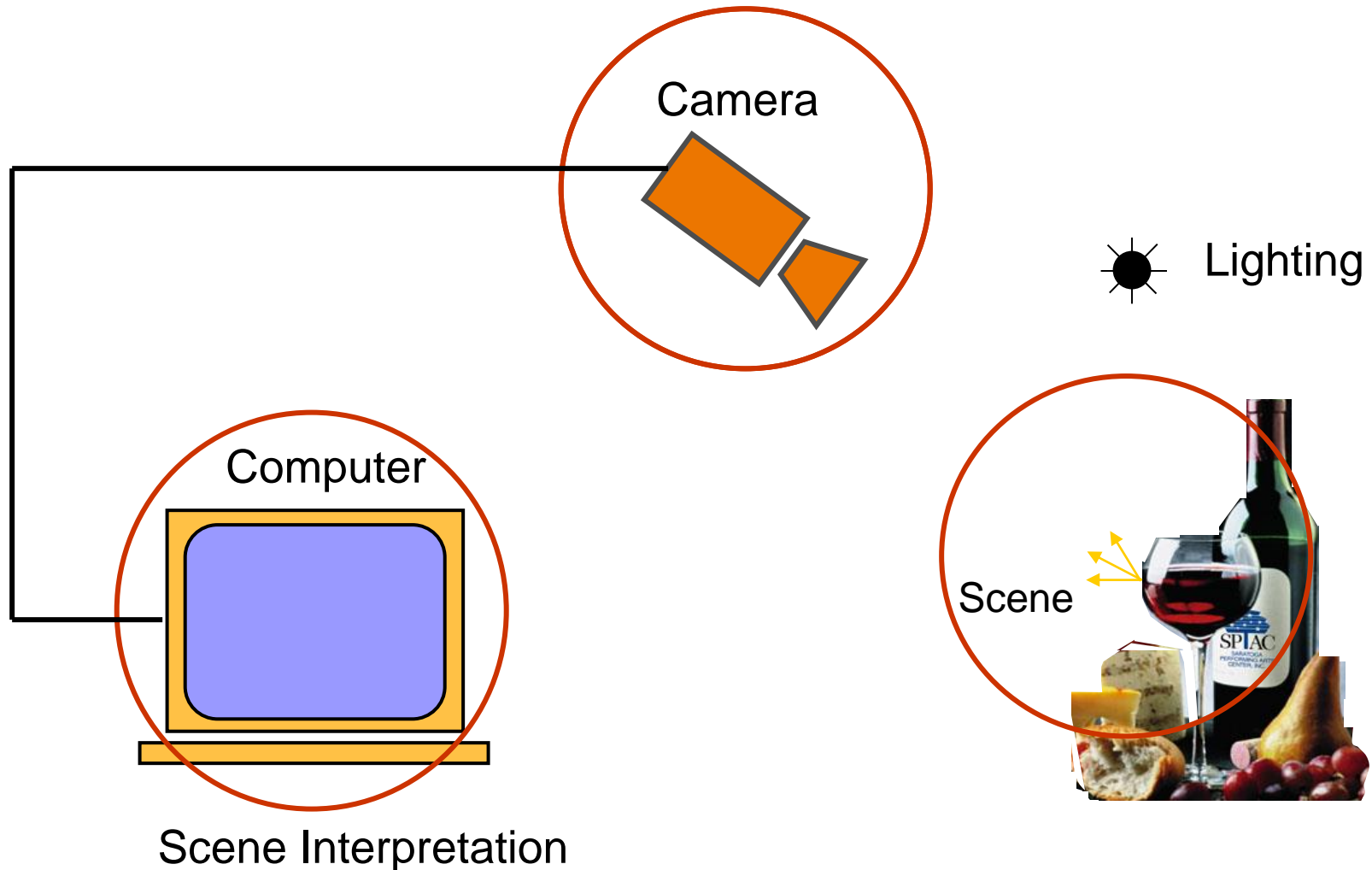
What kind of scene?

Where are the cars?

How far is the building?

...

# Components of a computer vision system



# Computer vision vs human vision

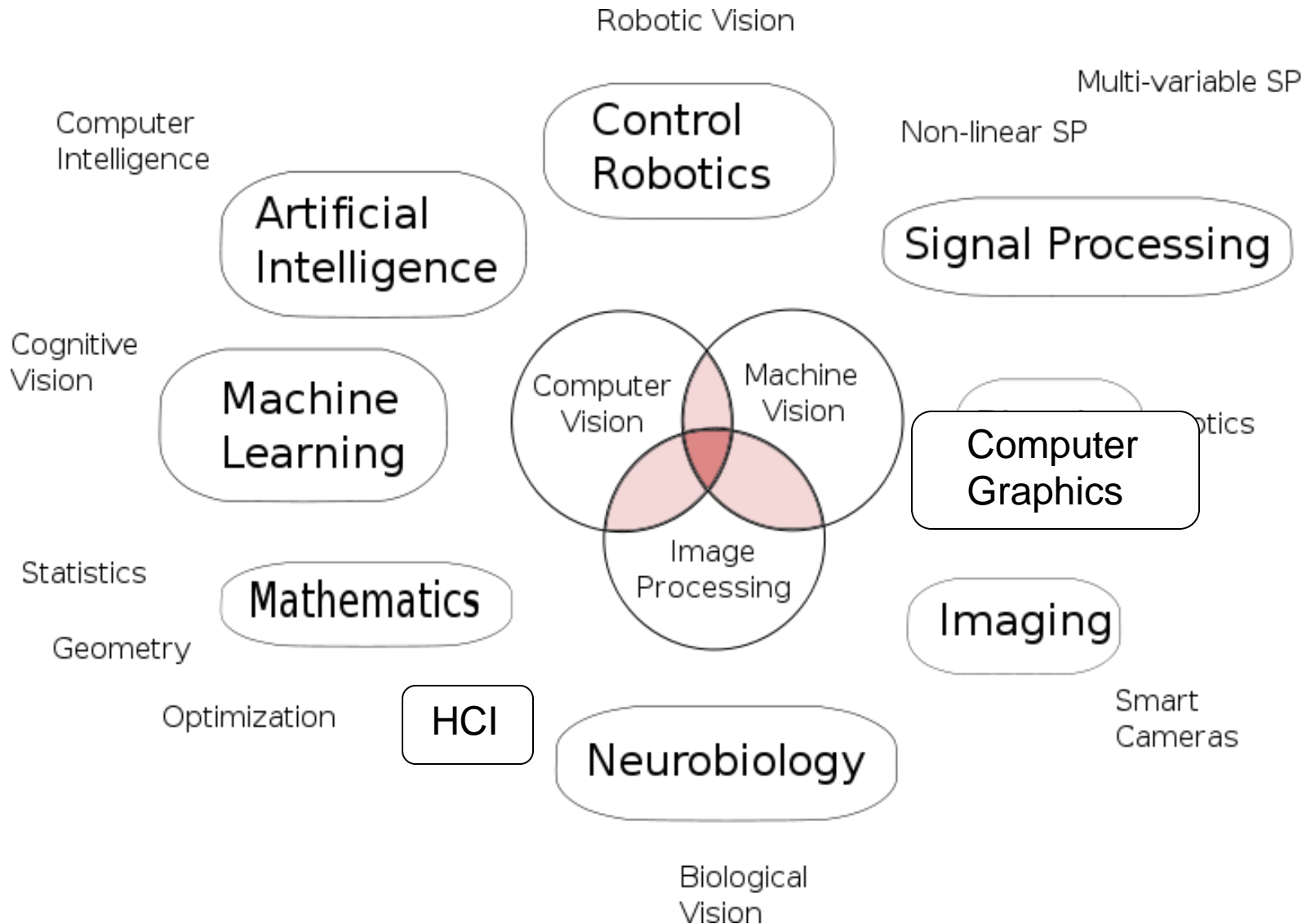


What we see

0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

What a computer sees

# Vision is multidisciplinary

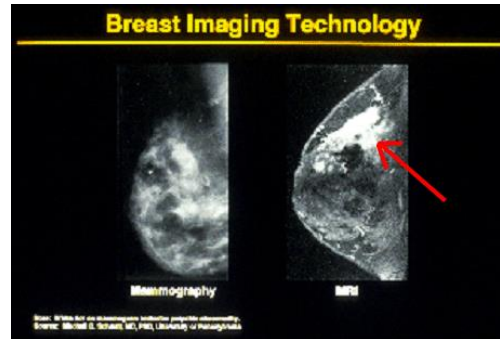




# Why computer vision matters



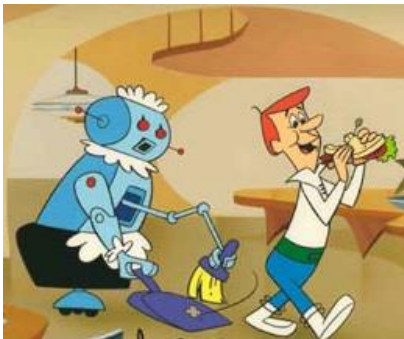
Safety



Health



Security



Comfort



Fun



Access

# A little story about Computer Vision

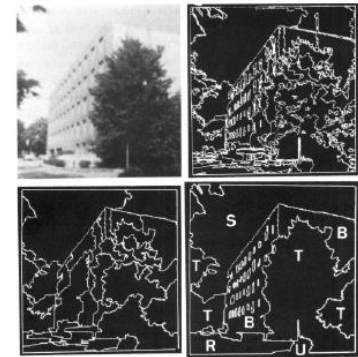
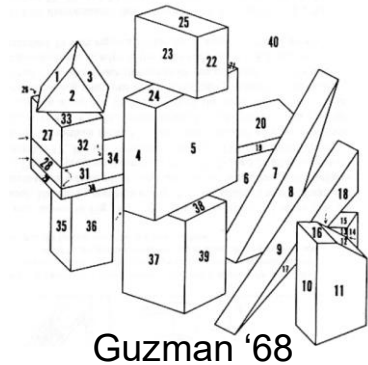
In 1966, Marvin Minsky at MIT asked his undergraduate student Gerald Jay Sussman to “spend the summer linking a camera to a computer and getting the computer to describe what it saw”.

We now know that the problem is slightly more difficult than that.

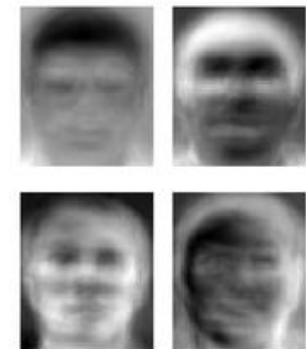


# Brief history of computer vision

- 1966: Minsky assigns computer vision as an undergrad summer project
- 1960's: interpretation of synthetic worlds
- 1970's: some progress on interpreting selected images
- 1980's: ANNs come and go; shift toward geometry and increased mathematical rigor
- 1990's: face recognition; statistical analysis in vogue
- 2000's: broader recognition; large annotated datasets available; video processing starts; vision & graphics; vision for HCI; internet vision, etc.



Ohta Kanade '78



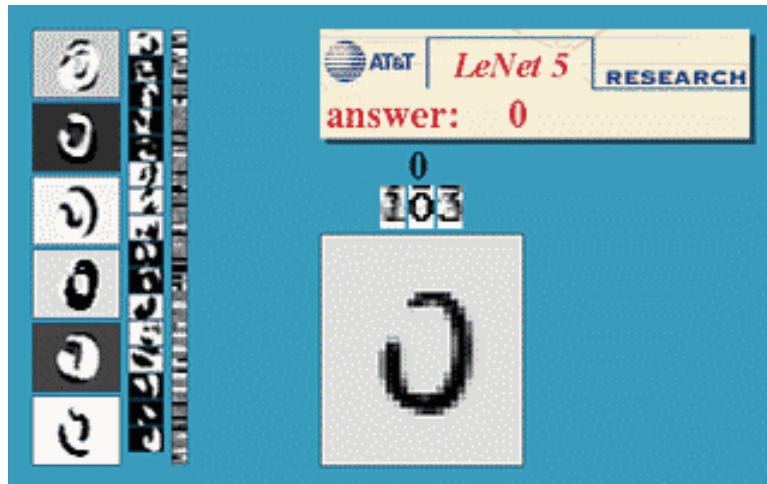
Turk and Pentland '91

How vision is used now?

# Optical character recognition (OCR)

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)

# Face detection

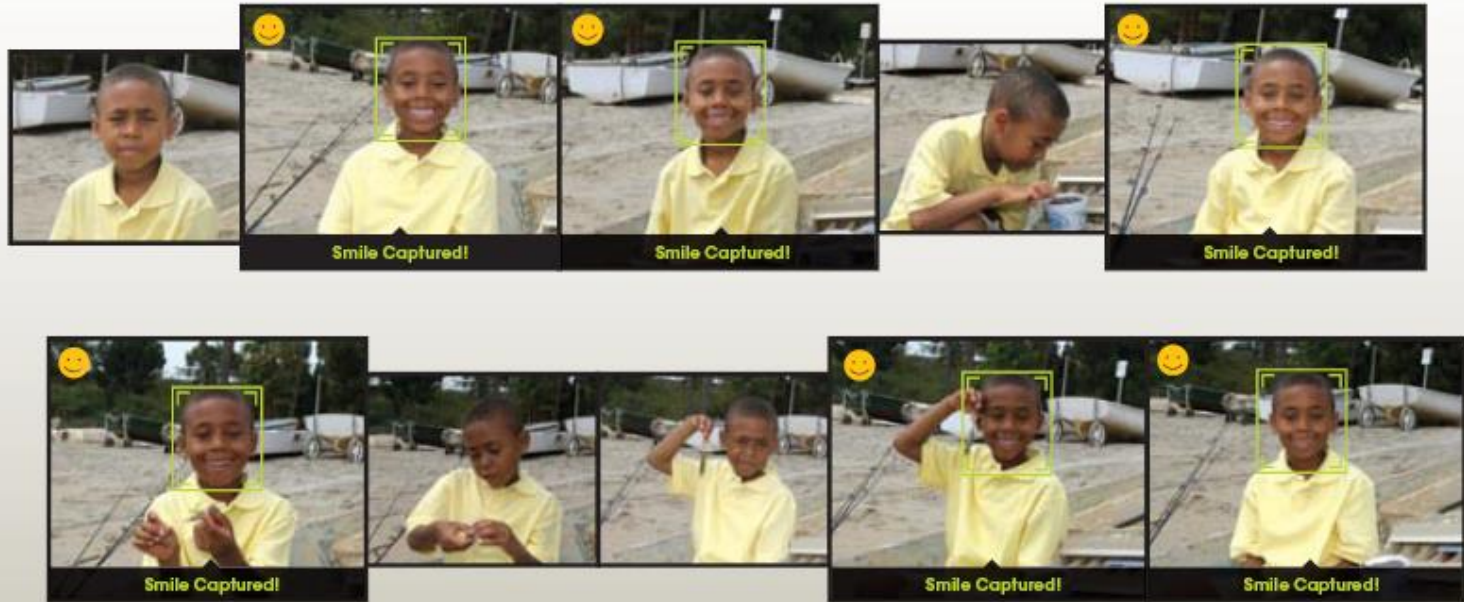


- Many new digital cameras now detect faces
  - Canon, Sony, Fuji, ...

# 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)



## [LaneHawk by EvolutionRobotics](#)

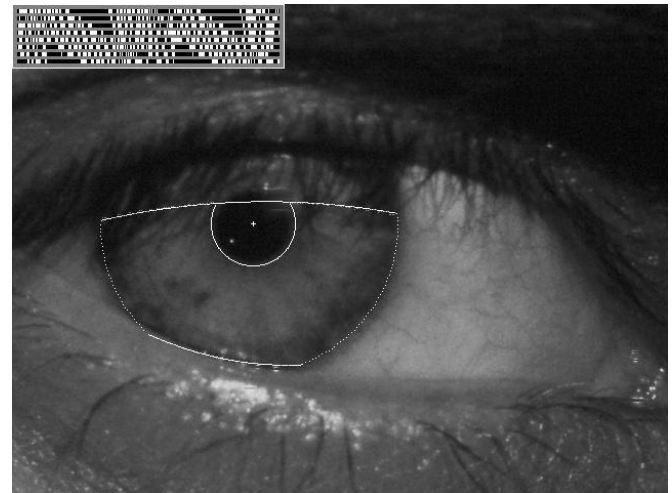
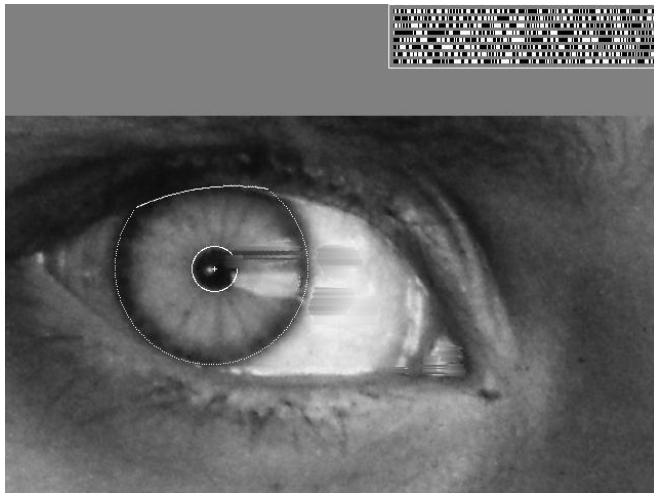
“A smart camera is flush-mounted in the checkout lane, continuously watching for items. When an item is detected and recognized, the cashier verifies the quantity of items that were found under the basket, and continues to close the transaction. The item can remain under the basket, and with LaneHawk,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



# Vision-based biometrics



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





# Login without a password...



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)



Point & Find, Nokia  
Google Goggles

# Special effects: shape capture



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

# Special effects: motion capture



*Pirates of the Caribbean*, Industrial Light and Magic

# Sports



*Sportvision* first down line

Nice [explanation](#) on [www.howstuffworks.com](http://www.howstuffworks.com)

<http://www.sportvision.com/video.html>



# Smart cars

Slide content courtesy of Amnon Shashua

The image is a screenshot of the Mobileye website. At the top, there are two navigation tabs: "manufacturer products" (active) and "consumer products". Below the tabs is the headline "Our Vision. Your Safety." and a central image of a car from a top-down perspective. Four yellow beams of light emanate from the car, labeled "rear looking camera", "side looking camera", "forward looking camera", and "rear looking camera". To the right of the car image is a "News" sidebar with two headlines: "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". Below the car image is a "Vision Applications" section with a pedestrian icon and the text "Road, Vehicle, Pedestrian Protection and more". To the left of this is an "EyeQ Vision on a Chip" section with an image of a chip. To the right is an "AWS Advance Warning System" section with a car icon and a "0.8" value. At the bottom right is an "Events" sidebar with two headlines: "Mobileye at Equip Auto, Paris, France" and "Mobileye at SEMA, Las Vegas, NV".

manufacturer products consumer products

**Our Vision. Your Safety.**

rear looking camera side looking camera forward looking camera

**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
- > all news

**Events**

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

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

# Google cars

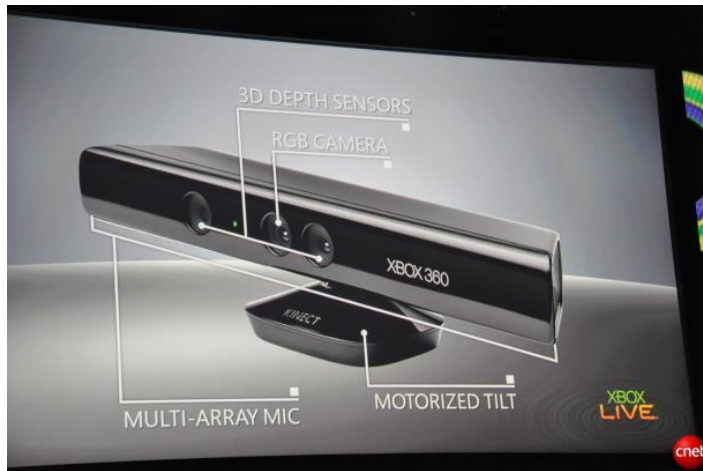


<http://www.nytimes.com/2010/10/10/science/10google.html?ref=artificialintelligence>



# Interactive Games: Kinect

- Object Recognition: <http://www.youtube.com/watch?feature=iv&v=fQ59dXOo63o>
- Mario: <http://www.youtube.com/watch?v=8CTJL5IUjHg>
- 3D: <http://www.youtube.com/watch?v=7QrnwoO1-8A>
- Robot: <http://www.youtube.com/watch?v=w8BmgtMKFbY>
- 3D tracking, reconstruction, and interaction: <http://research.microsoft.com/en-us/projects/surfacerecon/default.aspx>



# Vision in space



[NASA'S Mars Exploration Rover Spirit](#) captured this westward view from atop a low plateau where Spirit spent the closing months of 2007.

## Vision systems (JPL) used for several tasks

- Panorama stitching
- 3D terrain modeling
- Obstacle detection, position tracking
- For more, read “[Computer Vision on Mars](#)” by Matthies et al.

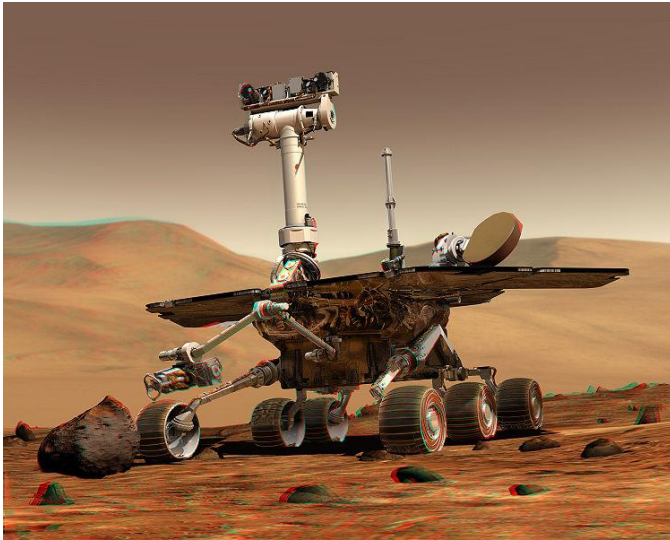
# Industrial robots



Vision-guided robots position nut runners on wheels



# Mobile robots

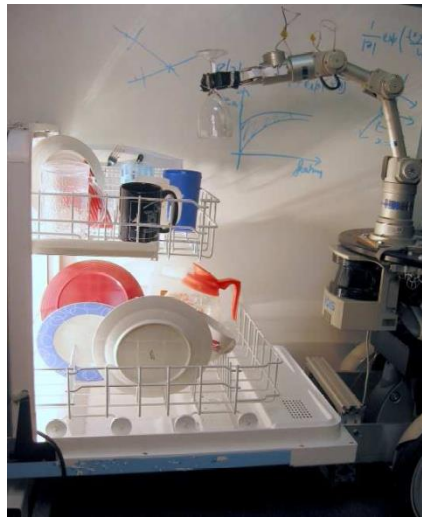


NASA's Mars Spirit Rover

[http://en.wikipedia.org/wiki/Spirit\\_rover](http://en.wikipedia.org/wiki/Spirit_rover)



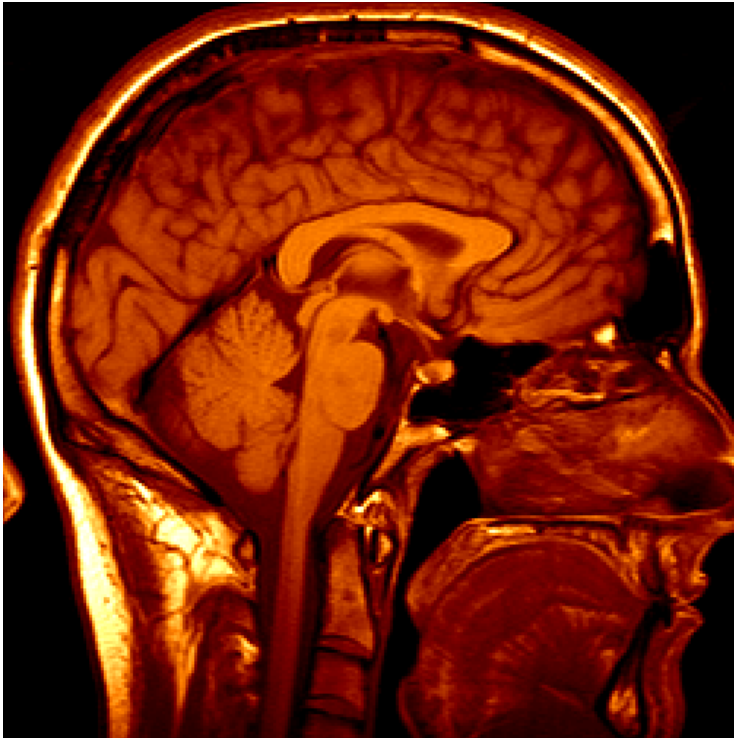
<http://www.robocup.org/>



Saxena et al. 2008

[STAIR](#) at Stanford

# Medical imaging



3D imaging  
MRI, CT



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

# Grading Criteria

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- Assignments
- Midterm exam
- Final exam
- Lab participation/discussion
- Paper readings and presentation (optional for bonus)
- Attendance 😊