



CS231.Nhập môn Thị giác máy tính

Bài 00. Giới thiệu môn học



Giảng viên



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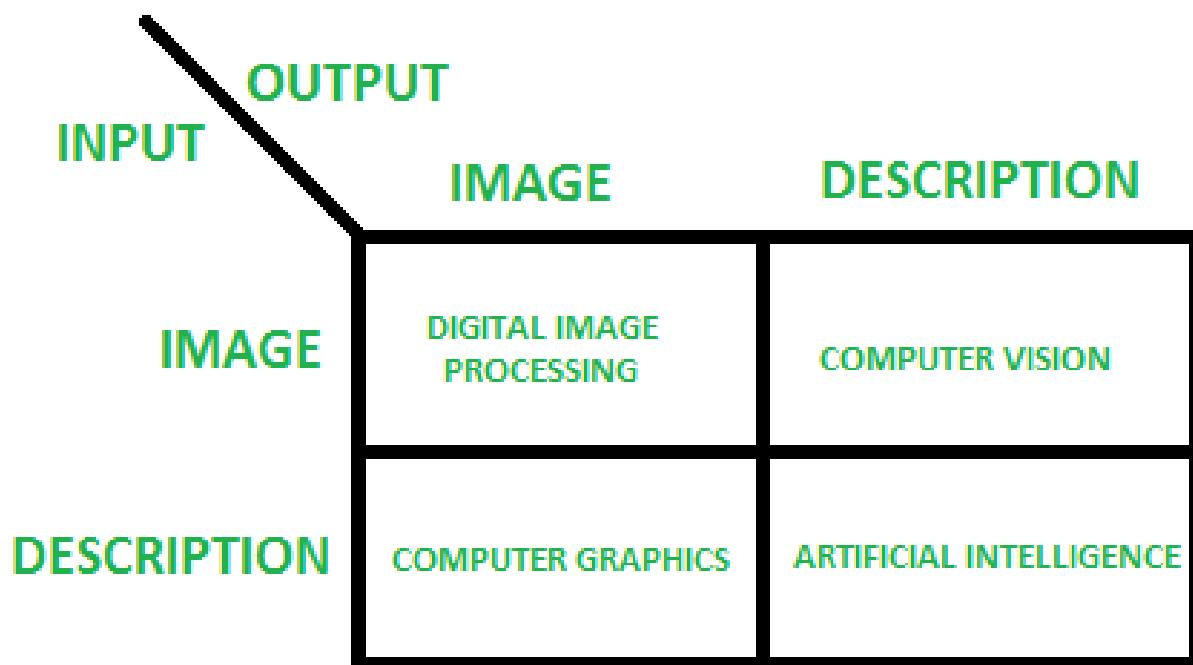


1. Thông tin chung

Tên môn học (tiếng Việt):	Nhập môn Thị giác Máy tính
Tên môn học (tiếng Anh):	Introduction to Computer Vision
Mã môn học:	CS231
Thuộc khối kiến thức:	Đại cương <input type="checkbox"/> ; Cơ sở nhóm ngành <input type="checkbox"/> ; Cơ sở ngành <input type="checkbox"/> ; Chuyên ngành <input checked="" type="checkbox"/> ; Tốt nghiệp <input type="checkbox"/>



2. Mô tả môn học





2. Mô tả môn học

- Môn học này giới thiệu các nội dung căn bản trong ngành Thị giác máy tính, bao gồm các chủ đề về:
 1. low-level computer vision: image → image



Before

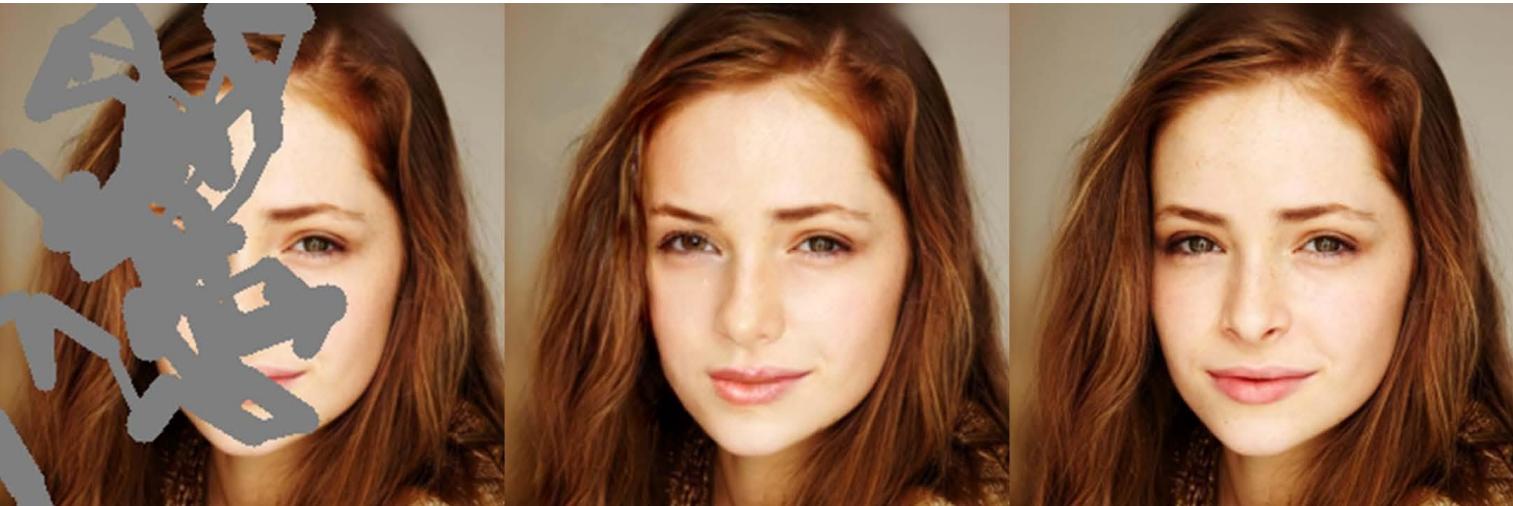


After





• Image Inpainting





2. Mô tả môn học

- Môn học này giới thiệu các nội dung căn bản trong ngành Thị giác máy tính, bao gồm các chủ đề về:
 1. low-level computer vision: image → image
 2. mid-level computer vision: image → feature

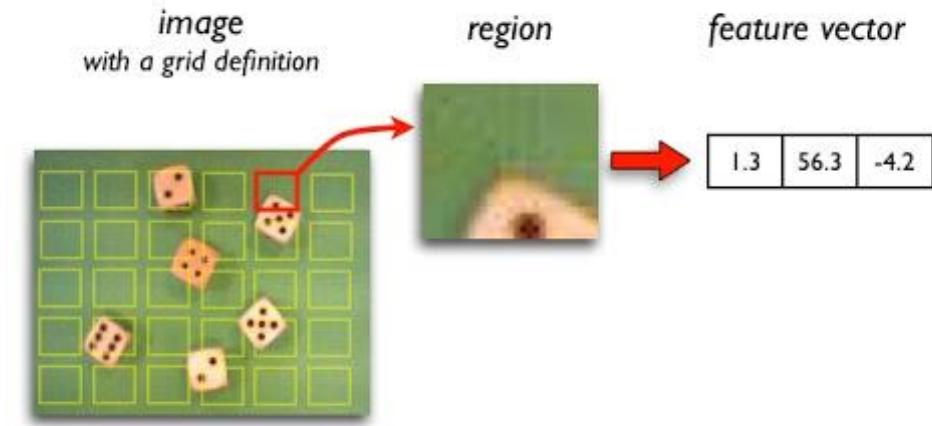
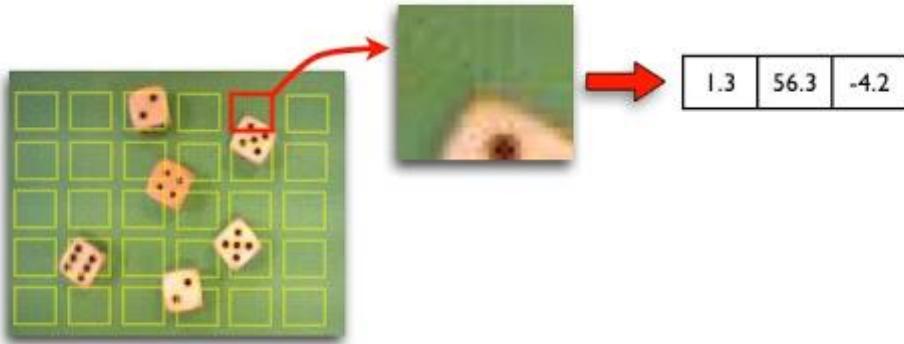




image
with a grid definition

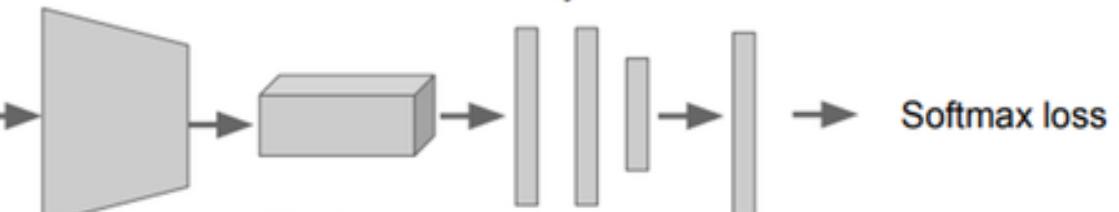


Convolution
and Pooling



Image

Fully-connected
layers



Feature extractor

Classifier



2. Mô tả môn học

- Các chủ đề cụ thể gồm:
 - rút trích và khai thác thông tin trên ảnh,
 - các loại đặc trưng thị giác cấp thấp và phương pháp biểu diễn đặc trưng thị giác cấp thấp,
 - các kĩ thuật so khớp ảnh,
 - các kĩ thuật phân đoạn ảnh, phương pháp theo vết (tracking).



3. Mục tiêu môn học

1. Làm việc ở mức độ cá nhân và cộng tác nhóm để trình bày và giải quyết một số bài toán liên quan tới Thị giác máy tính.
2. Hiểu và giải thích được các khái niệm cơ bản, thuật ngữ liên quan tới Thị giác Máy tính



3. Mục tiêu môn học

3. Ứng dụng các kiến thức căn bản về Thị giác máy tính để ứng dụng vào các vấn đề đơn giản trong thực tế.
4. Ứng dụng các công cụ hỗ trợ, thư viện mở về Thị giác Máy tính.



4. Nội dung

Tuần 1	Giới thiệu về ảnh/video số
Tuần 2-4	<p>Khái niệm và các phương pháp rút trích đặc trưng cấp thấp trên ảnh</p> <ul style="list-style-type: none">• Biên, cạnh• Đặc trưng vân ảnh• Đặc trưng màu sắc• Đặc trưng hình dáng• Biểu diễn đặc trưng toàn cục, cục bộ



4. Nội dung

Tuần 5-7

Khái niệm và các phương pháp phân đoạn ảnh

- **Phân đoạn ảnh dựa trên gom cụm (K-Means, MeanShift)**
- **Phân đoạn ảnh dựa trên đồ thị (GraphCut)**



4. Nội dung

Tuần
8 - 12

Khái niệm và các phương pháp so khớp ảnh

- Phát hiện điểm nổi bật (Keypoint / Interest Points / Blobs)
- Rút trích và biểu diễn đặc trưng cục bộ (SIFT, SURF)
- So khớp ảnh
- RANSAC



4. Nội dung

Tuần 13 –15

Khái niệm và các phương pháp theo vết (tracking)

- Optical Flow



5. Đánh giá

A4. Cuối kỳ - LT cuối kỳ - Đề án cuối kỳ		70 %
A3. Thực hành		30 %





What is computer vision ?





What is vision ?

- Human Vision

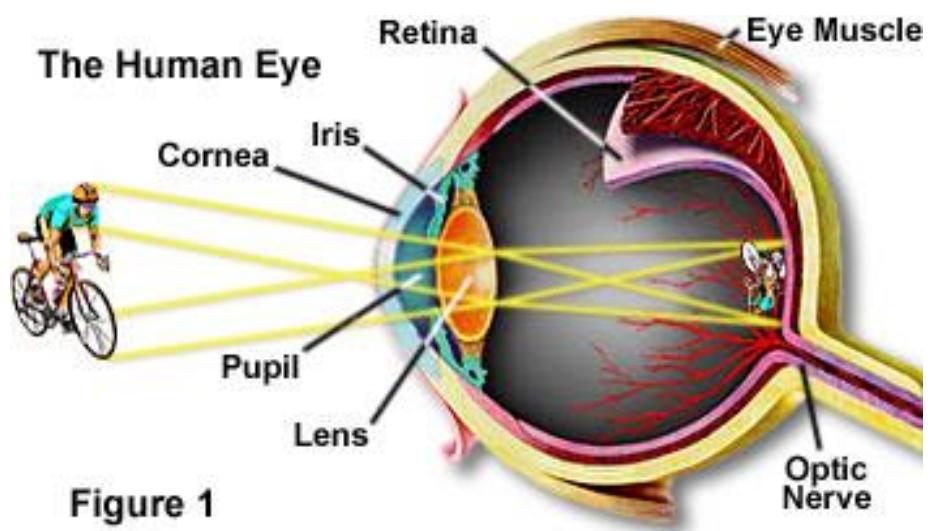


Figure 1

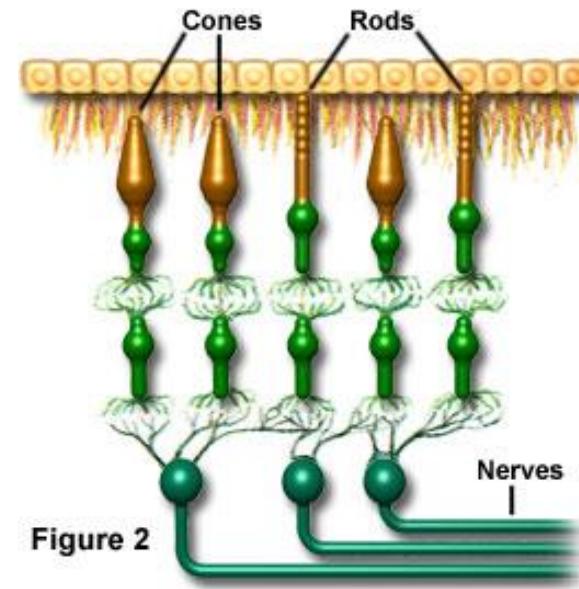
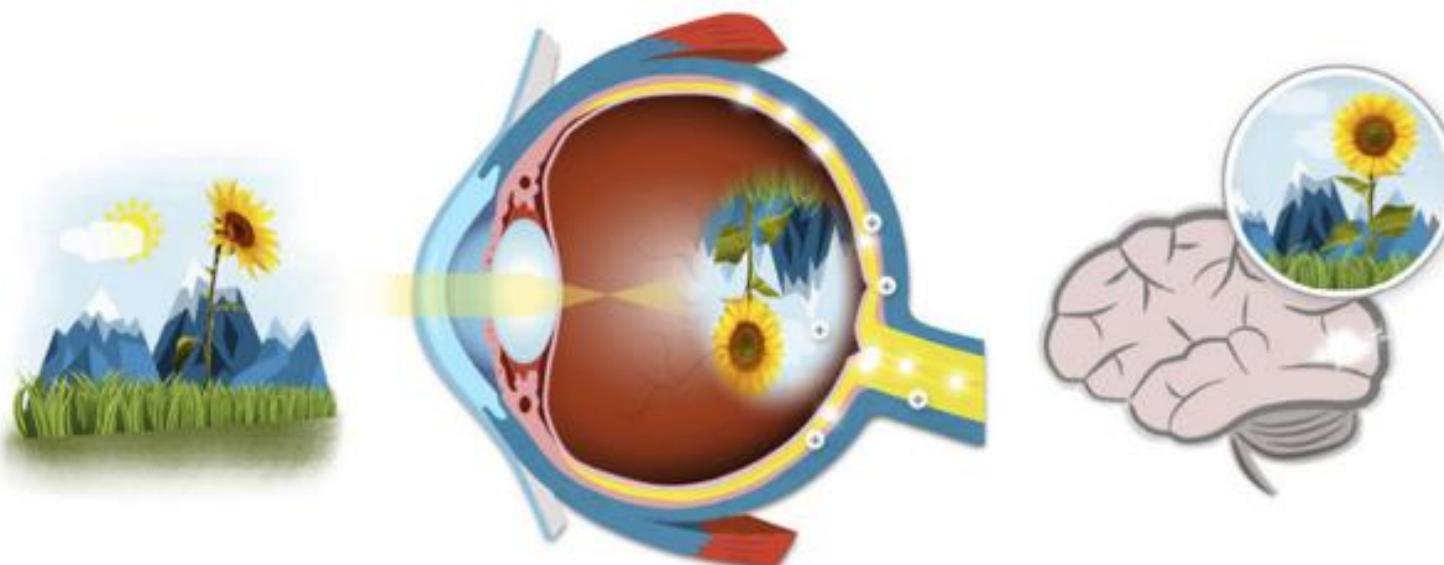


Figure 2



What is vision ?

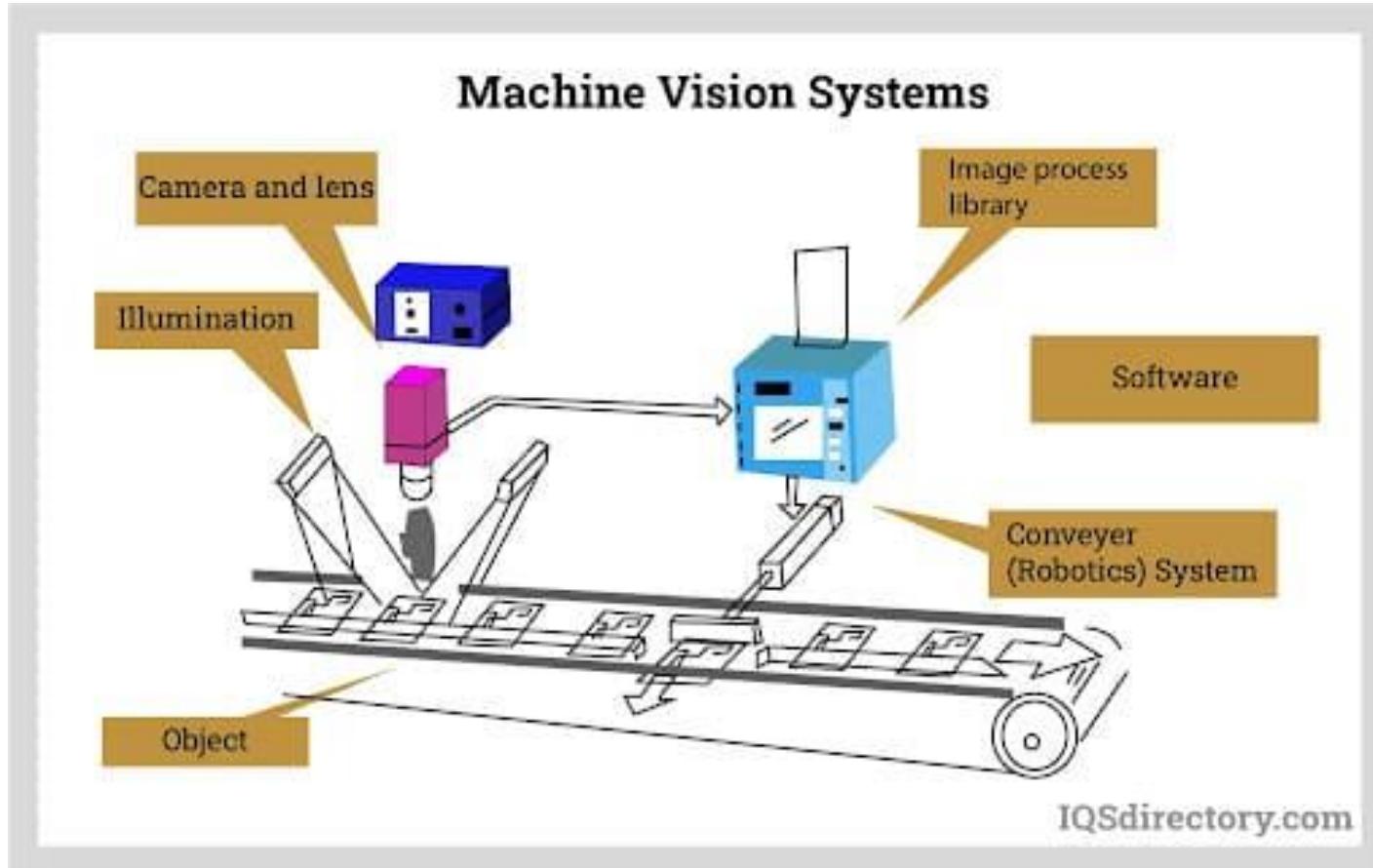
- Human Vision





What is vision ?

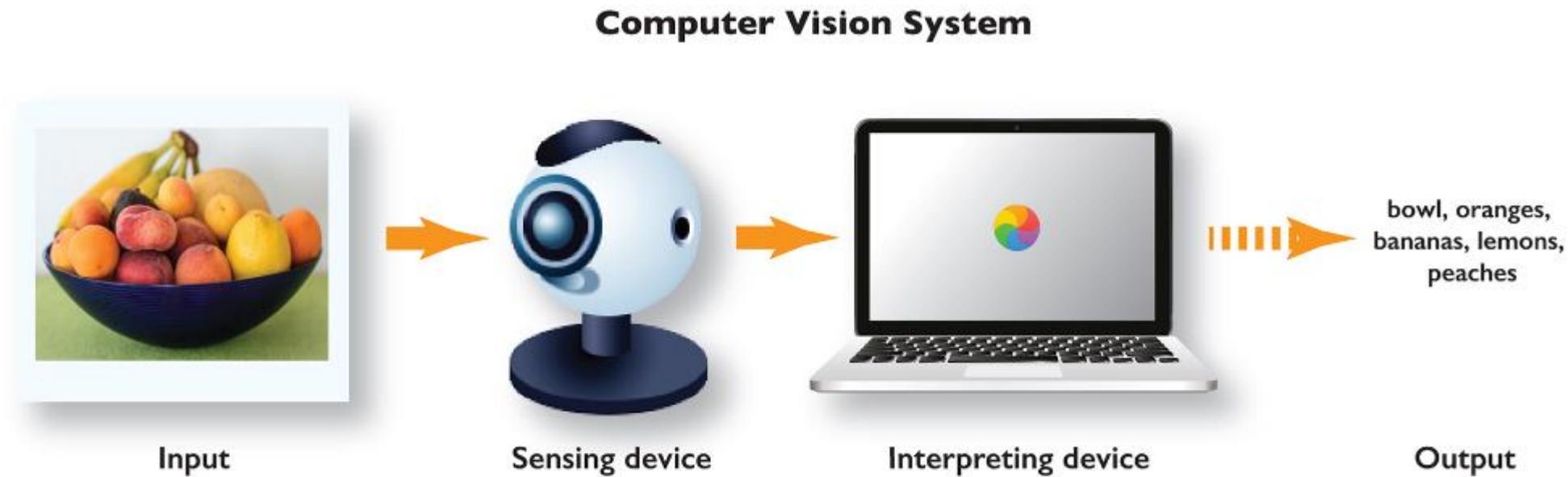
- Machine Vision





What is vision ?

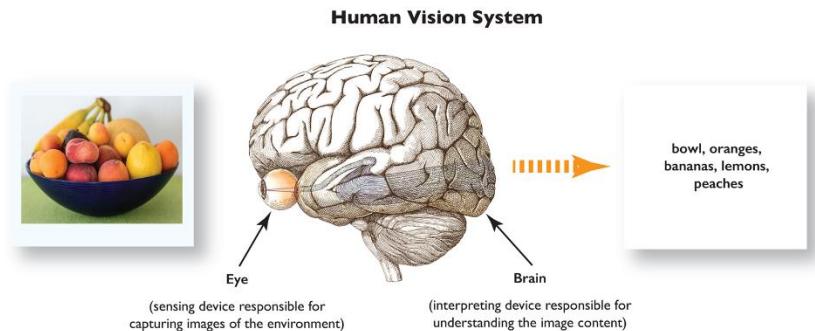
- Computer vision





What is vision ?

- Human vs Computer vision





What is digital image ?

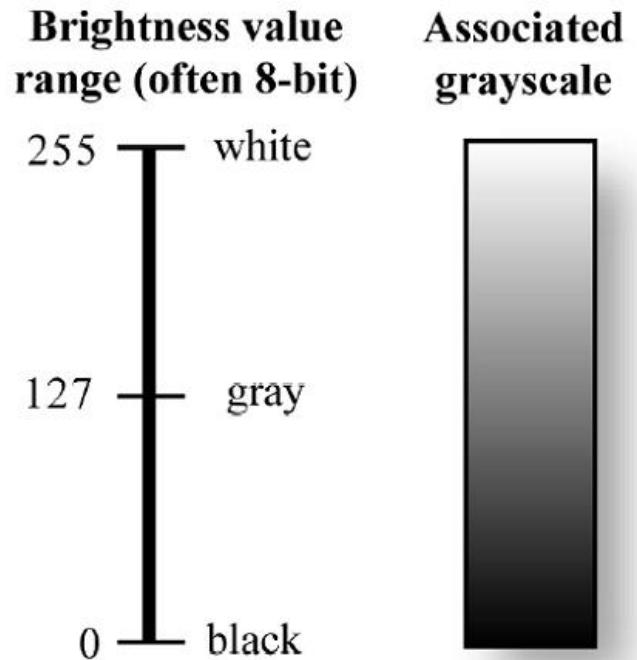
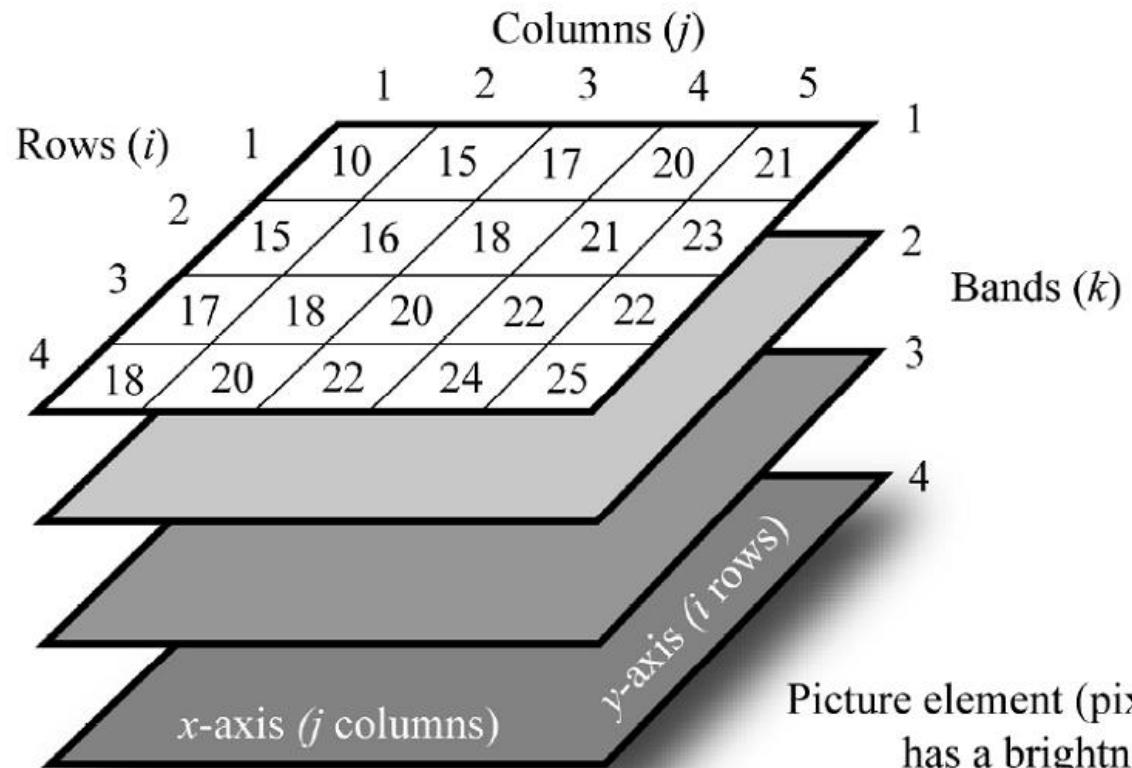
The screenshot shows a web browser window with the following details:

- Title Bar:** W Digital image - Wikipedia
- Address Bar:** en.wikipedia.org/wiki/Digital_image
- Toolbar:** Includes icons for Back, Forward, Stop, Refresh, Home, and others.
- Bookmark Bar:** Apps, Bookmarks, Mua, MachineLearning, BaoCaoGiuaki-Nov..., Other bookmarks.
- User Account:** Not logged in, Talk, Contributions, Create account, Log in
- Page Navigation:** Article, Talk, Read, Edit, View history, Search Wikipedia, Search icon.
- Main Content:**
 - Section Header:** Digital image
 - Text:** From Wikipedia, the free encyclopedia
 - Text:** For broader coverage of this topic, see [Digital imaging](#).
 - Text:** A **digital image** is an image composed of picture elements, also known as *pixels*, each with *finite, discrete quantities* of numeric representation for its intensity or gray level that is an output from its two-dimensional functions fed as input by its spatial coordinates denoted with *x, y* on the x-axis and y-axis, respectively.^[1] Depending on whether the image resolution is fixed, it may be of [vector](#) or [raster](#) type. By itself, the term "digital image" usually refers to [raster images](#) or [bitmapped images](#) (as opposed to [vector images](#)). [citation needed]



What is digital image ?

Digital Image Terminology

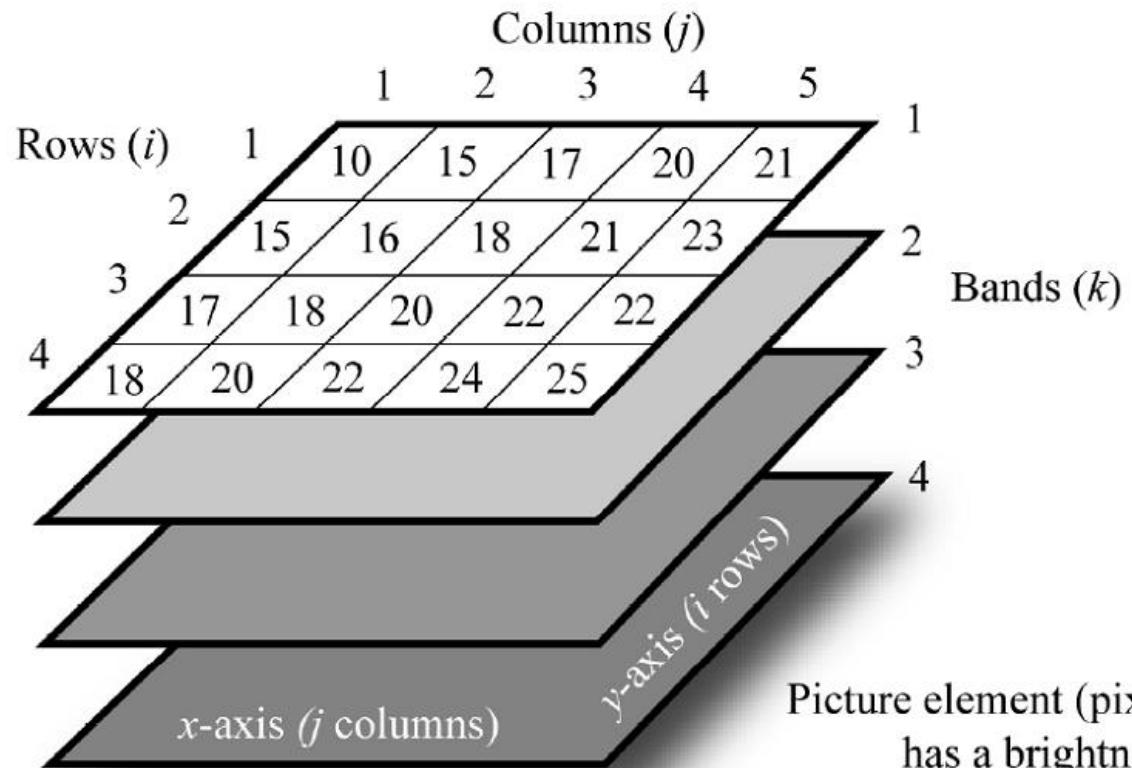


Jensen

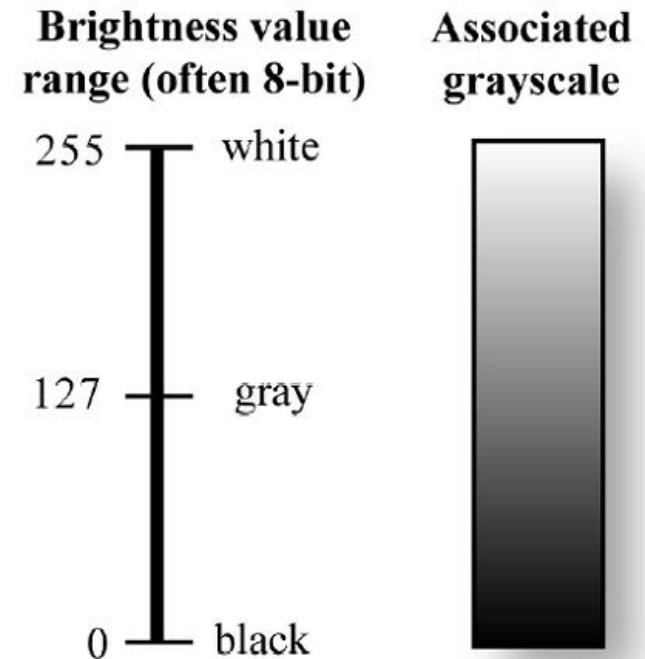


What is digital image ?

Digital Image Terminology



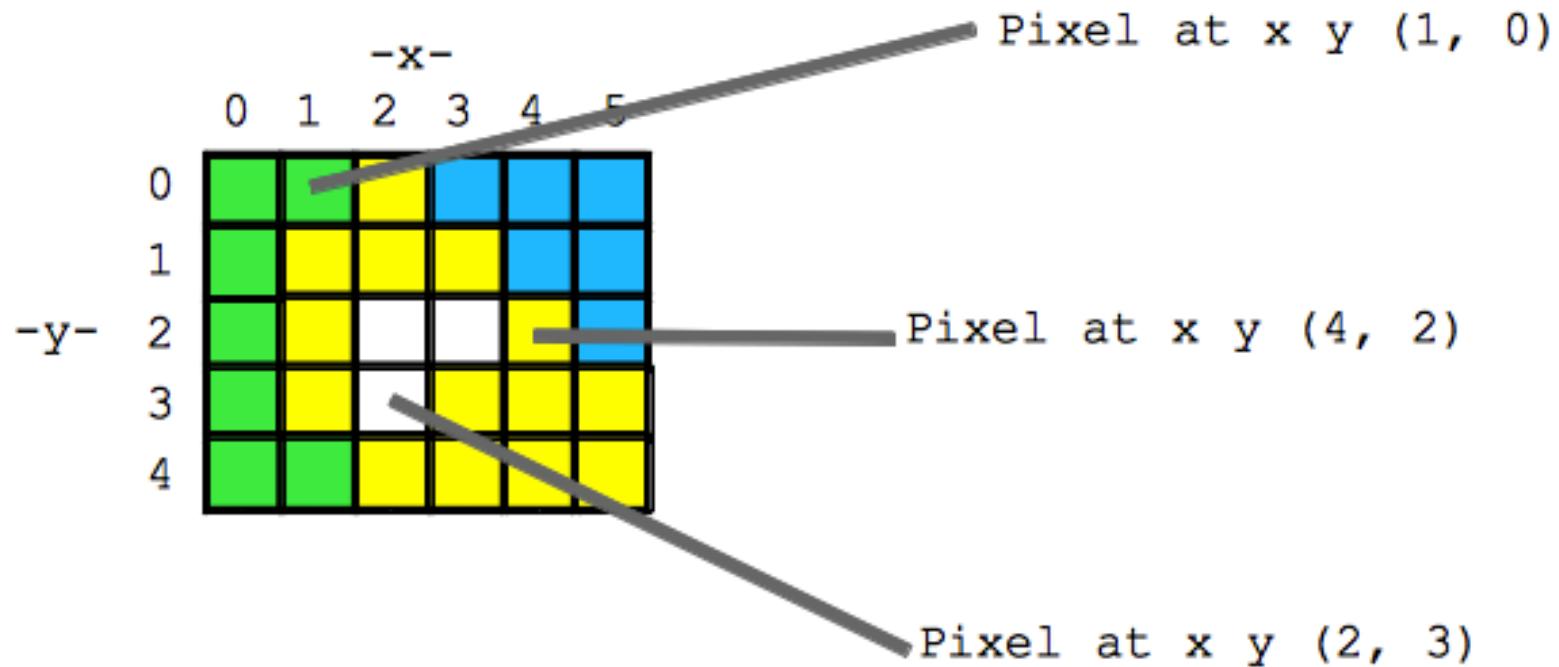
Picture element (pixel) at location row 4, column 4, band 1
has a brightness value of 24, i.e., $BV_{4,4,1} = 24$



Jensen

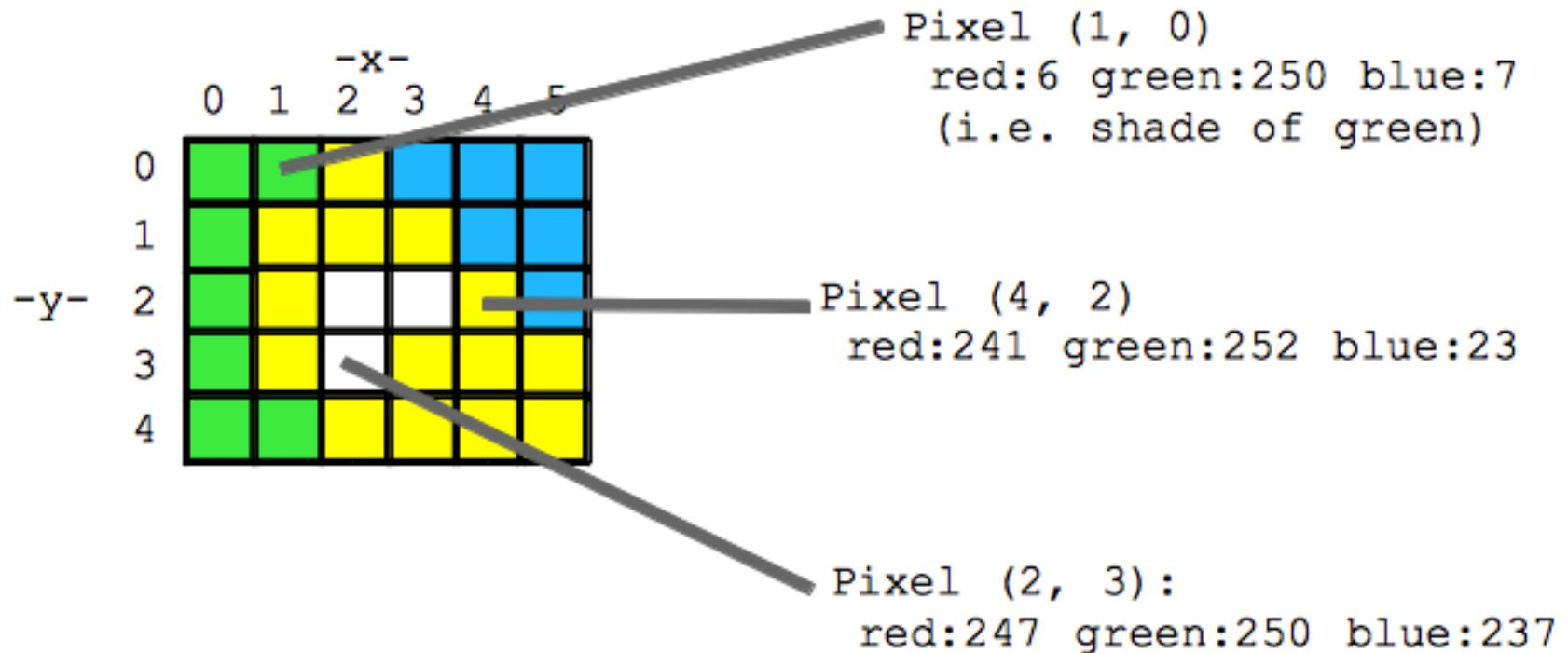


What is digital image ?





What is digital image ?





What is computer vision ?

+





What is computer vision ?

H



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What is computer vision ?

- <https://www.ibm.com/topics/computer-vision>
- <https://www.coursera.org/learn/introduction-computer-vision-watson-opencv>



What is computer vision ?

The screenshot shows a web browser window with the following details:

- Title Bar:** "What is Computer Vision? | IBM" with a yellow background.
- Address Bar:** "ibm.com/topics/computer-vision".
- Header:** "IBM" logo, followed by navigation links: "Automation" (underlined), "Strategy and vision", "Approach", "Technology", and "What's next ▾".
- Main Content:**
 - Section Title:** "What is computer vision?"
 - Text:** "Use machine learning and neural networks to teach computers to see defects and issues before they affect operations".
 - Call-to-Action:** "Explore Maximo Visual Inspection" button with a blue gradient and white text.
- Background Image:** A dark, abstract background featuring glowing blue circuit board patterns.



What is computer vision ?

- Computer vision is a field of artificial intelligence (AI)



What is computer vision ?

- Computer vision is a field of artificial intelligence (AI) that enables computers and systems to **derive meaningful information** from digital images, videos and other visual inputs



What is computer vision ?

- Computer vision is a field of artificial intelligence (AI) that enables computers and systems to **derive meaningful information** from digital images, videos and other visual inputs — and **take actions** or make **recommendations** based on that information.



What is computer vision ?

- Computer vision is a field of artificial intelligence (AI) that enables computers and systems to derive meaningful information from digital images, videos and other visual inputs — and take actions or make recommendations based on that information. If AI enables computers to think, computer vision enables them to see, observe and understand.



What is computer vision ?

- Computer vision works much the same as human vision, except humans have a head start.



What is computer vision ?

- Computer vision works much the same as human vision, except humans have a head start. Human sight has the advantage of lifetimes of context to train how to tell objects apart, how far away they are, whether they are moving and whether there is something wrong in an image.



What is computer vision ?

- Computer vision trains machines to perform these functions, but it has to do it in much less time with cameras, data and algorithms rather than retinas, optic nerves and a visual cortex. Because a system trained to inspect products or watch a production asset can analyze thousands of products or processes a minute, noticing imperceptible defects or issues, it can quickly surpass human capabilities.



What is computer vision ?

- Computer vision is used in industries ranging from energy and utilities to manufacturing and automotive – and the market is continuing to grow. It is expected to reach USD **48.6** billion by 2022⁽¹⁾

1. <https://www.forbes.com/sites/bernardmarr/2019/04/08/7-amazing-examples-of-computer-and-machine-vision-in-practice/#3dbb3f751018>



Why use computer vision?

Like all technologies,

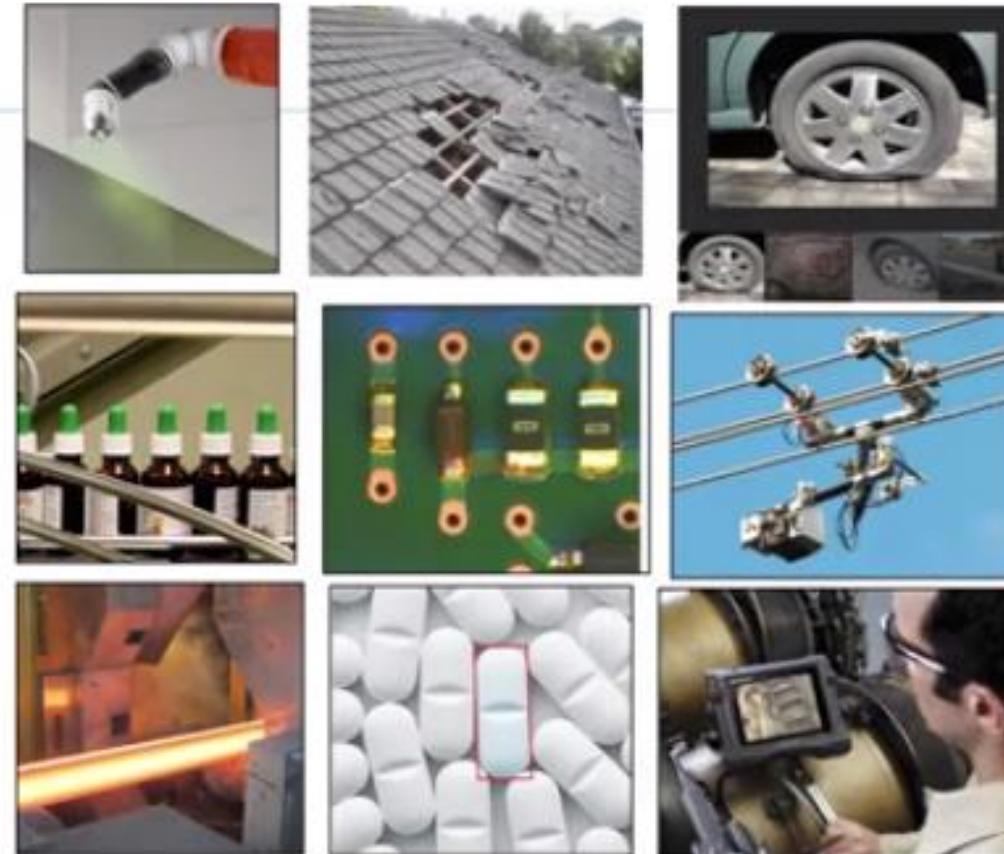
- Slower → Faster
- Expensive → Cheap
- Manual → Automated
- Difficult → Easy
- Inconvenient → Convenient
- Unscalable → Scalable



Computer vision applications

Industries

- Automotive
- Food & Beverage
- Manufacturing
- Pharmaceutical
- Supply chain
- Energy & Utilities
- Hospitality
- Life Sciences
- Human Resources
- Insurance





Computer vision examples

7 Amazing Examples Of Computer And Machine Vision In Practice



Bernard Marr Contributor ⓘ
Enterprise Tech

Follow

<https://www.forbes.com/sites/bernardmarr/2019/04/08/7-amazing-examples-of-computer-and-machine-vision-in-practice/?sh=2f5b2b8f1018>



Computer vision examples

1. Autonomous vehicles
2. Google Translate app
3. Facial recognition
4. Healthcare
5. Real-time sports tracking
6. Agriculture
7. Manufacturing



Computer vision examples

1. Autonomous vehicles

Computer vision is necessary to enable self-driving cars. Manufacturers such as Tesla, BMW, Volvo, and Audi use multiple cameras, lidar, radar, and ultrasonic sensors to acquire images from the environment so that their self-driving cars can detect objects, lane markings, signs and traffic signals to safely drive.



Self-driving car



A self-driving car, also known as an autonomous vehicle, driverless car, or robo-car, is a vehicle that is capable of sensing its environment and moving safely with little or no human input. [Wikipedia](#)



Computer vision examples

1. Autonomous vehicles



<https://www.youtube.com/watch?v=tIThdr3O5Qo>



Computer vision examples

2. Google Translate app

All you need to do to read signs in a foreign language is to point your phone's camera at the words and let the Google Translate app tell you what it means in your preferred language almost instantly. By using optical character recognition to see the image and augmented reality to overlay an accurate translation, this is a convenient tool that uses computer vision.



Google Translate 4+
Translate 108 languages
Google LLC
#1 in Reference
★★★★★ 4.5 • 65.8K Ratings
Free



Google Translate

Google LLC Tools

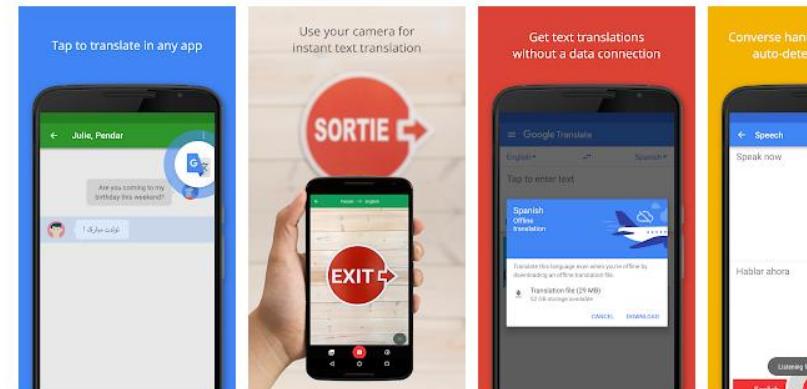
★★★★★ 8,027,274 ▾

3+

This app is available for your device

Add to Wishlist

Install





Computer vision examples

2. Google Translate app



<https://mashable.com/article/word-lens-japanese>



<https://www.hellotech.com/blog/the-5-best-free-translation-apps>



Computer vision examples

3. Facial recognition

China is definitely on the cutting edge of using [facial recognition technology](#), and they use it for police work, payment portals, security checkpoints at the airport and even to dispense toilet paper and prevent theft of the paper at Tiantan Park in Beijing, among many other applications.



Facial recognition system



A facial recognition system is a technology capable of matching a human face from a digital image or a video frame against a database of faces, typically employed to authenticate users through ID verification services, works by pinpointing and measuring facial features from a given image. [Wikipedia](#)



Computer vision examples

3. Facial recognition



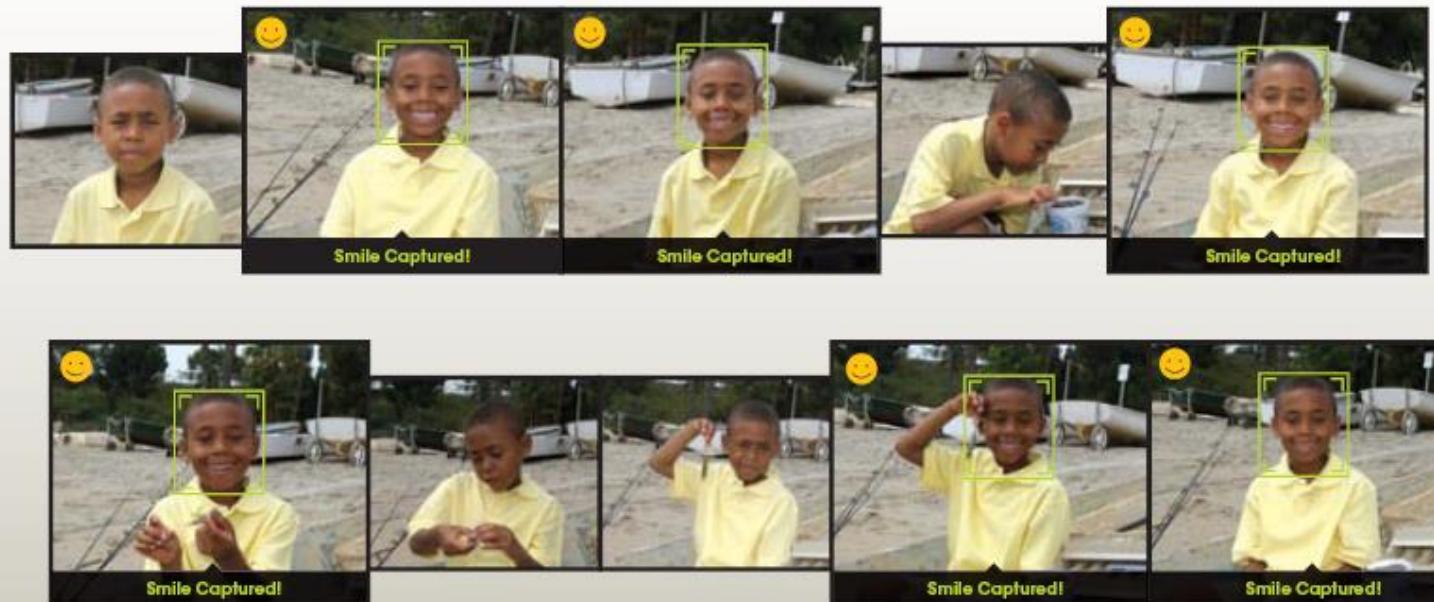
- Many new digital cameras now detect faces
 - Canon, Sony, Fuji, ...



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.

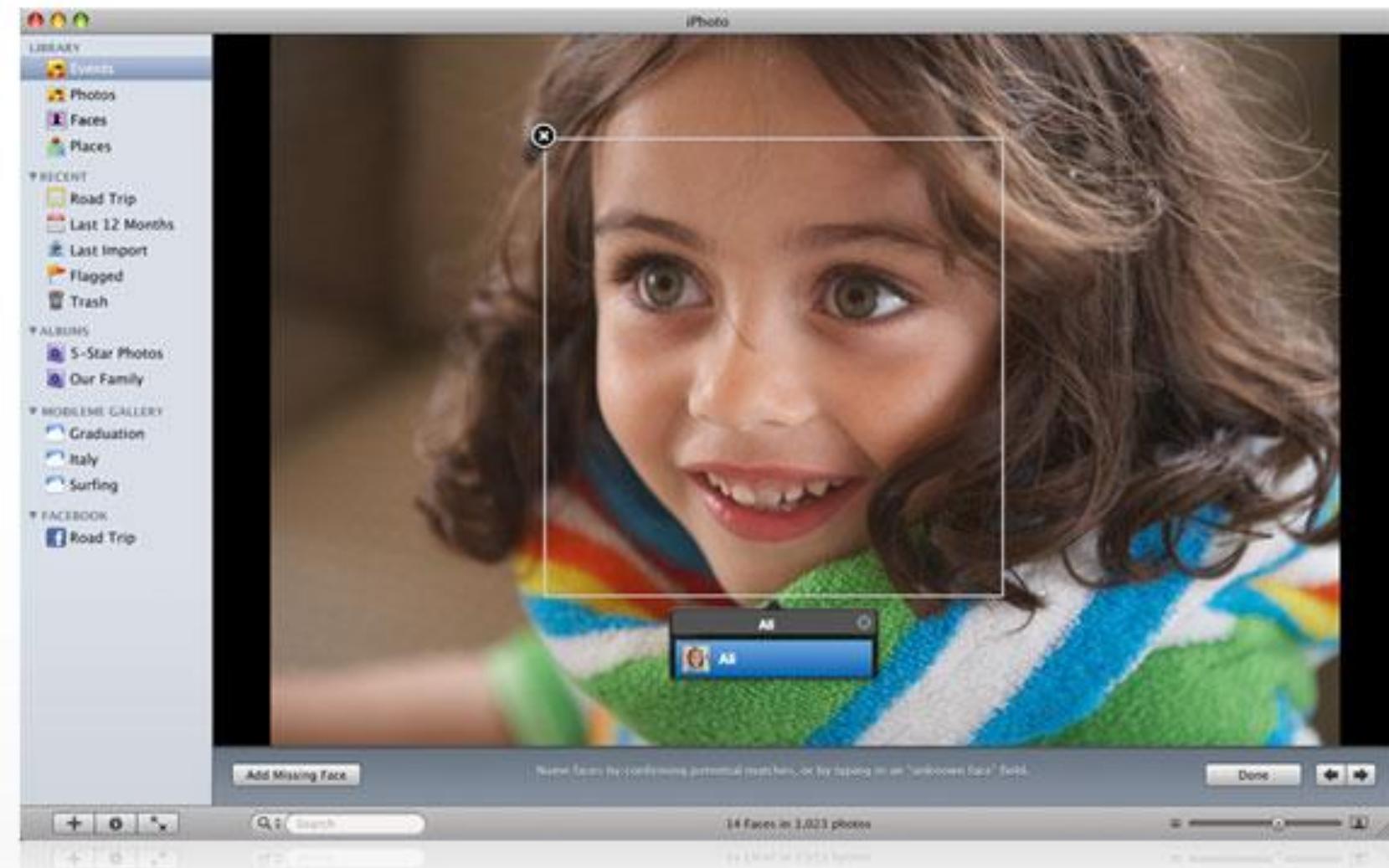


[Sony Cyber-shot® T70 Digital Still Camera](#)

Source: S. Seitz



Face recognition: Apple iPhoto, Facebook, Google, etc

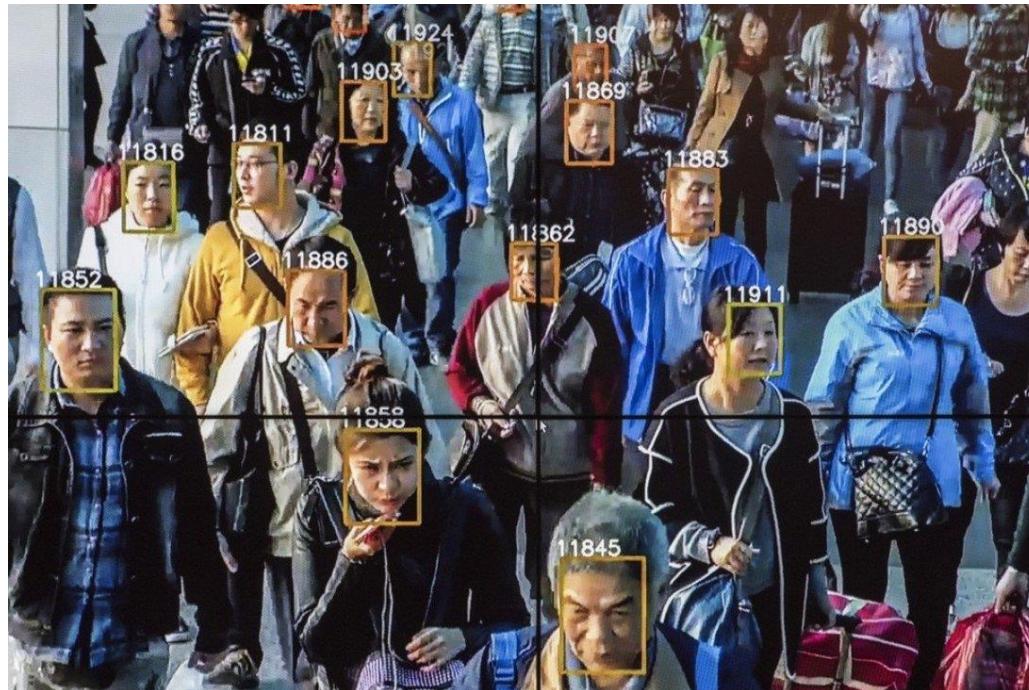




Computer vision examples

3. Facial recognition

Shanghai airport first to launch automated clearance system using facial recognition technology



https://www.scmp.com/tech/enterprises/article/2168681/shanghai-airport-first-launch-automated-clearance-system-using?module=perpetual_scroll&pgtype=article&campaign=2168681



Computer vision examples

3. Facial recognition

Alibaba launches 'smile to pay' facial recognition system at KFC in China



An Alibaba employee demonstrates 'Smile to Pay', an automatic payment system that authorizes payment via facial recognition

Alex Wong / Staff / Getty Images



Computer vision examples

4. Healthcare

Since [90 percent of all medical data is image based](#) there is a plethora of uses for computer vision in medicine. From enabling new medical diagnostic methods to analyze X-rays, mammography and other scans to monitoring patients to identify problems earlier and assist with [surgery](#), expect that our medical institutions and professionals and patients will benefit from computer vision today and even more in the future as its rolled out in [healthcare](#).





Computer vision examples

4. Healthcare



assisted living, patient monitoring
[Lan et al, PAMI 2012]



autism screening (sàng lọc tự kỷ)

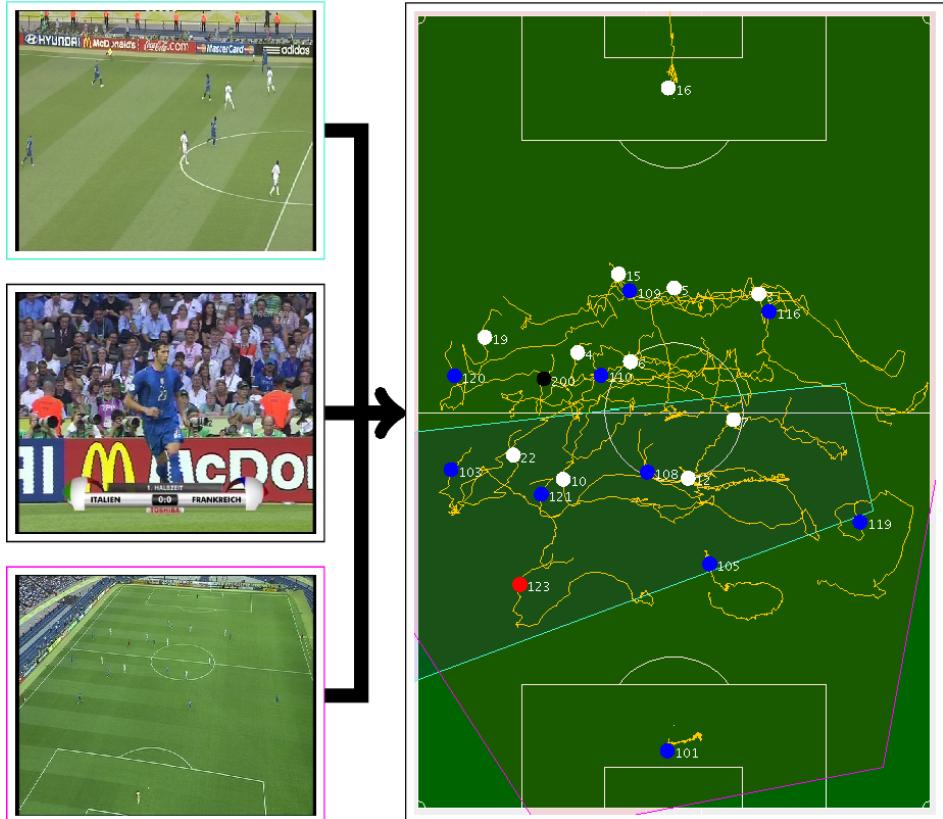
<http://www.gatech.edu/newsroom/release.html?nid=60509>



Computer vision examples

5. Real-time sports tracking

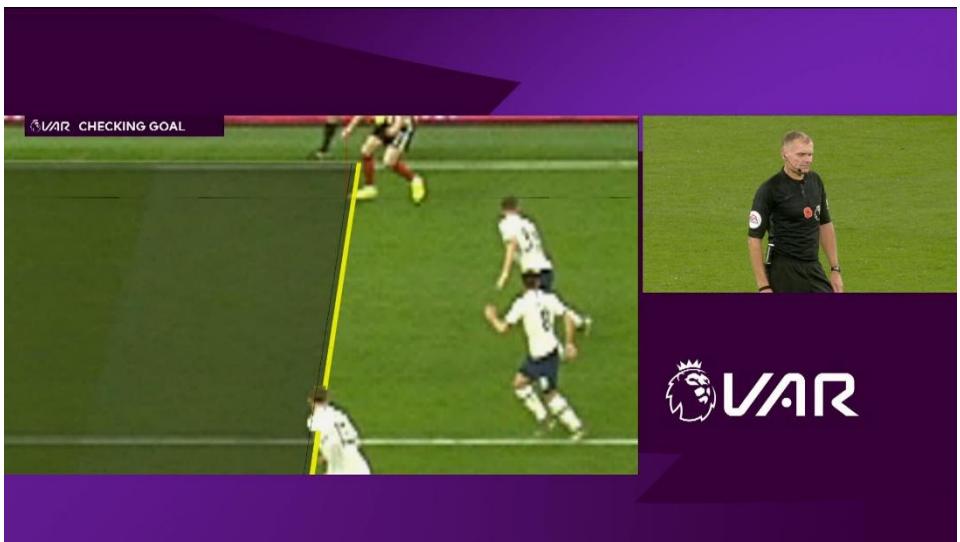
Ball and puck tracking on televised sports has been common for a while now, but computer vision is also helping play and strategy analysis, player performance and ratings, as well as to track the brand sponsorship visibility in [sports broadcasts](#).





Computer vision examples

5. Real-time sports tracking



<https://www.skysports.com/football/news/11095/11928910/var-premier-league-clubs-call-for-change-in-marginal-offside-calls>



Computer vision examples

6. Agriculture

At [CES 2019](#), John Deere featured a semi-autonomous combine harvester that uses artificial intelligence and computer vision to analyze grain quality as it gets harvested and to find the optimal route through the crops.

There's also great potential for computer vision to identify weeds so that herbicides can be sprayed directly on them instead of on the crops. This is expected to [reduce the amount of herbicides needed by 90 percent](#).



Computer vision examples

6. Agriculture

computer vision in agriculture

X |

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About 139,000,000 results (0.57 seconds)

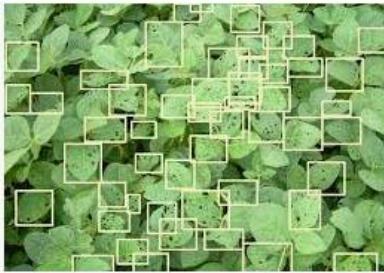
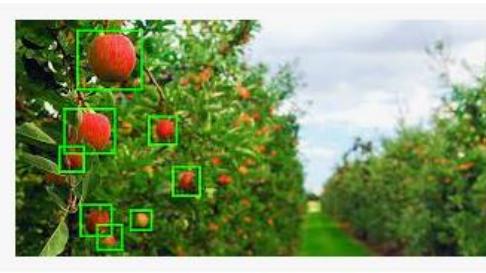
The agricultural industry has witnessed several contributions of computer vision-artificial intelligence (AI) models in areas such as **planting, harvesting**, advanced analysis of weather conditions, weeding and plant health detection and monitoring. Jan 31, 2021





Computer vision examples

Screenshot of a Google search results page for "computer vision in agriculture". The search bar shows the query. Below it, the "Images" tab is selected. A row of category thumbnails includes: robot, fruit, opencv, drone, object detection, precision agriculture, cvpr, machine learning, and crop. The main content area displays eight search results, each with an image and a brief description:

- 
Computer Vision In Agriculture. Humans ...
sushantjha8.medium.com
- 
Croptracker - Computer Vision in Agtech
croptracker.com
- 
Machine Vision Saving Agriculture: One ...
automate.org
- 
Application of Computer Vision in ...
medium.com
- 
5 Top Computer Vision Startups ...
startus-insights.com
- 
Application of Computer Vision in ...
medium.com
- 
Driving Agriculture into the Future ...
medium.com
- 
Machine Vision Applications in ...
medium.com



Computer vision examples

7. Manufacturing

Computer vision is helping manufacturers run more safely, intelligently and effectively in a variety of ways. Predictive maintenance is just one example where equipment is monitored with computer vision to intervene before a breakdown would cause expensive downtime. Packaging and product quality are monitored, and defective products are also reduced with computer vision.

<https://www.devteam.space/blog/10-examples-of-using-machine-vision-in-manufacturing/>



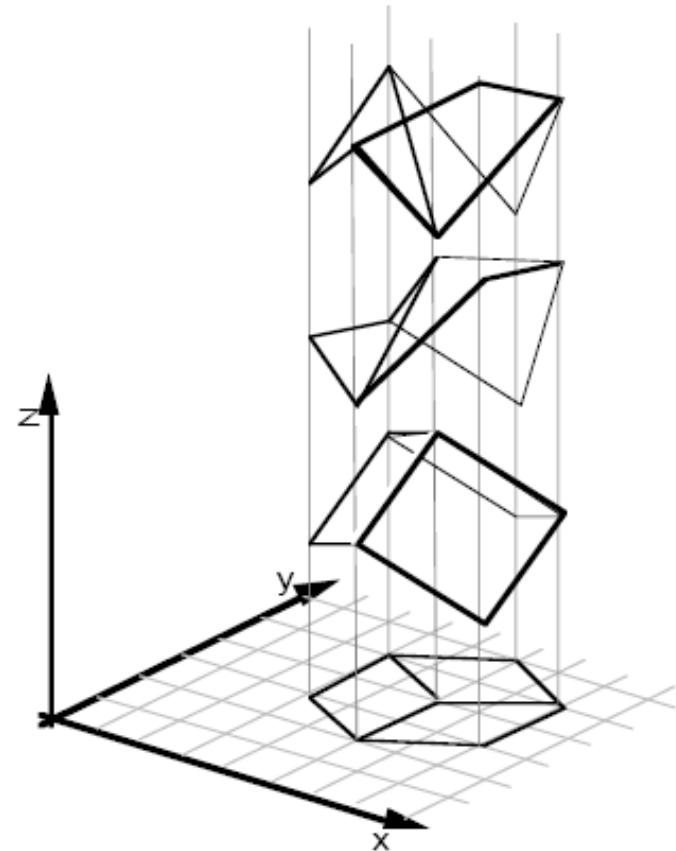


Why vision is so hard?



Why is vision so hard?

- Ill-posed problem



[Sinha and Adelson 1993]



Challenges 1: view point variation



Michelangelo 1475-1564

slide by Fei Fei, Fergus & Torralba



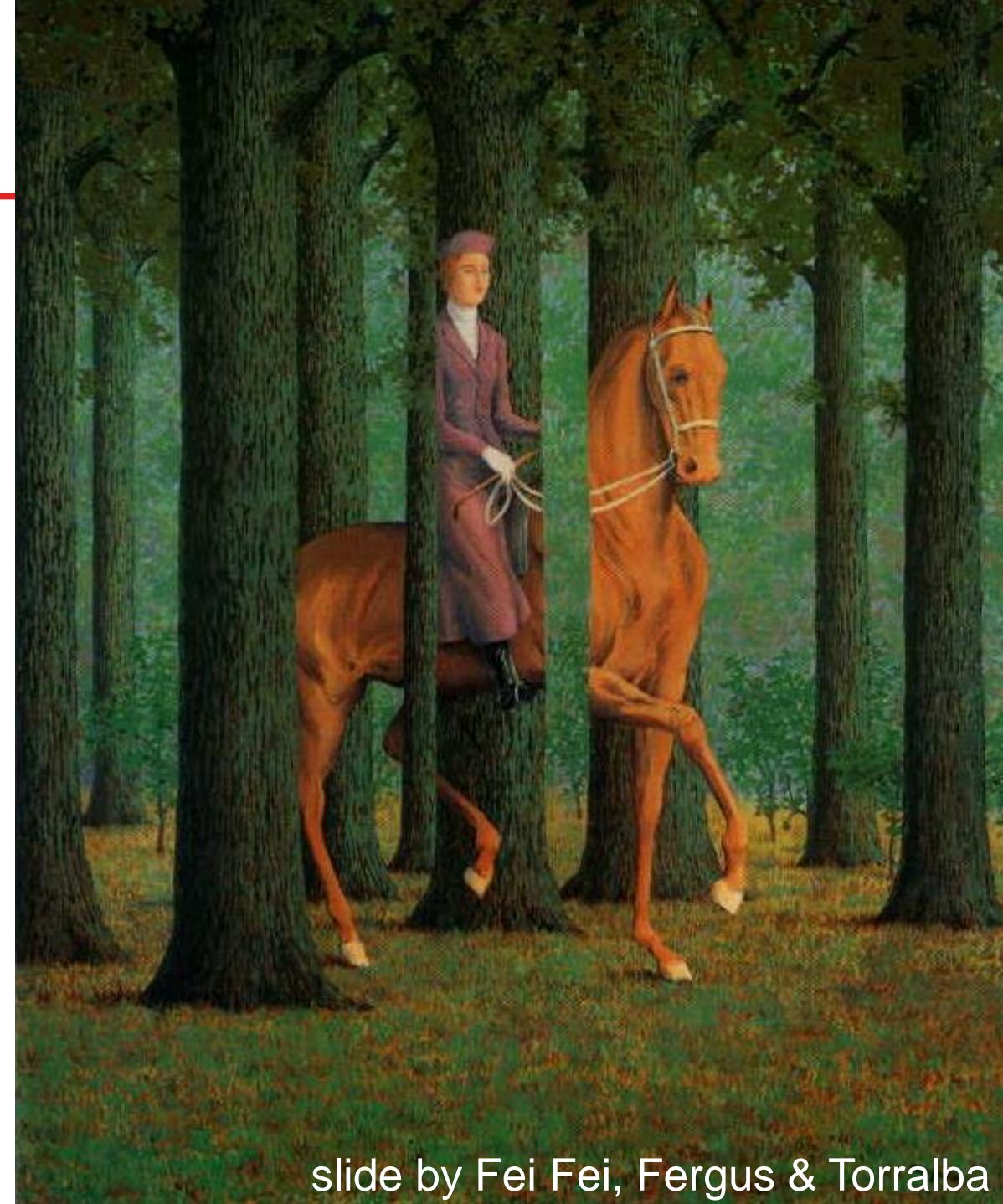
Challenges 2: illumination



slide credit: S. Ullman



Challenges 3: occlusion



Magritte, 1957

slide by Fei Fei, Fergus & Torralba

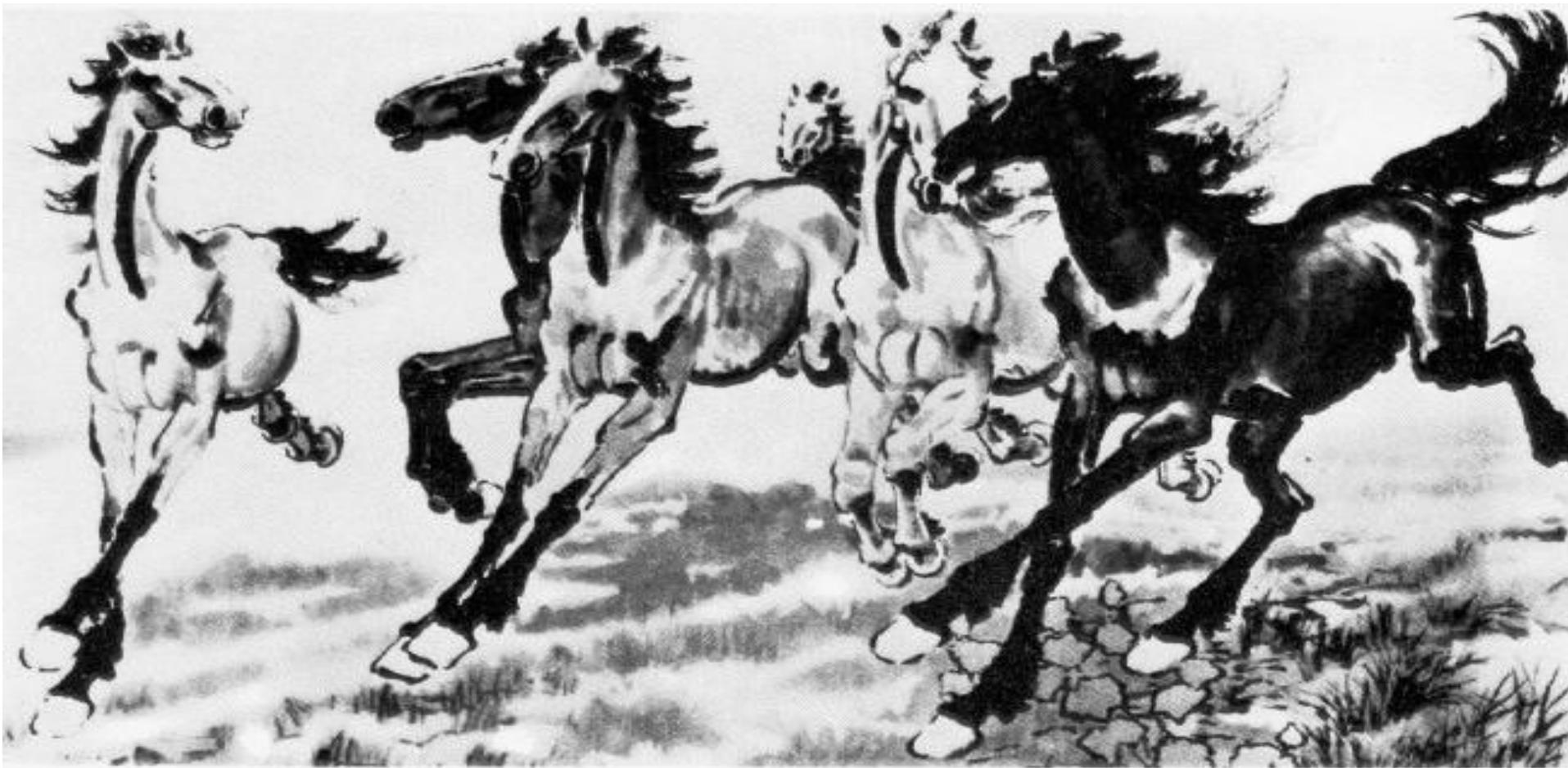


Challenges 4: scale





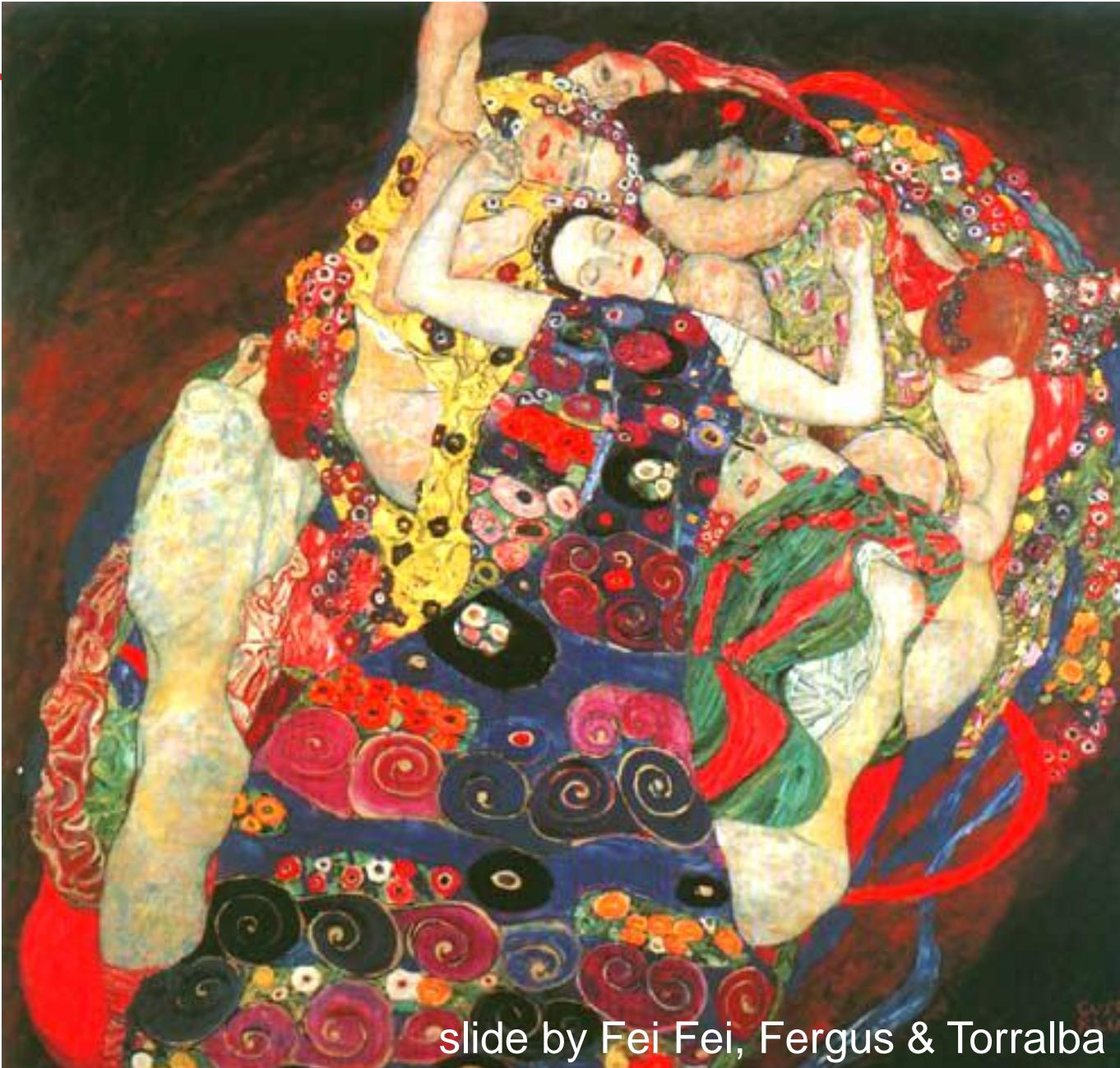
Challenges 5: deformation



Xu, Beihong 1943



Challenges 6: background clutter



Klimt, 1913

slide by Fei Fei, Fergus & Torralba



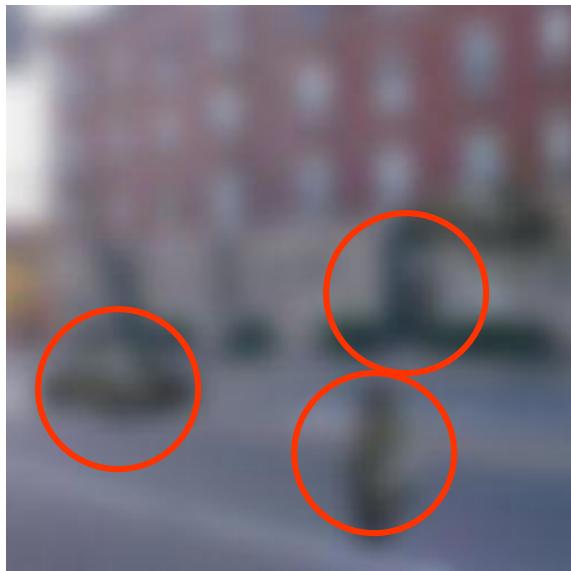
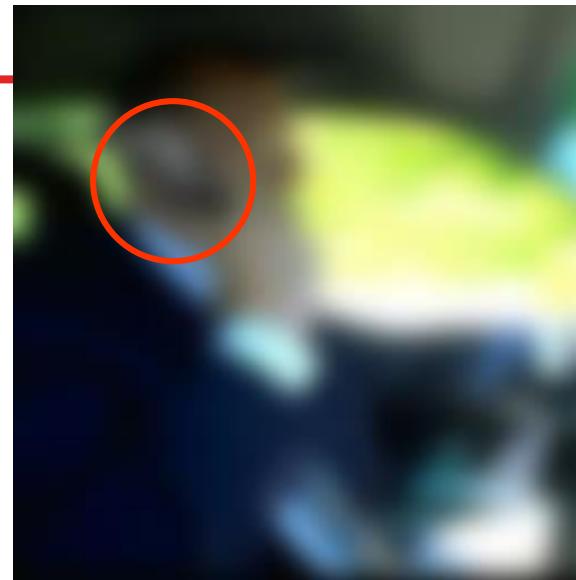
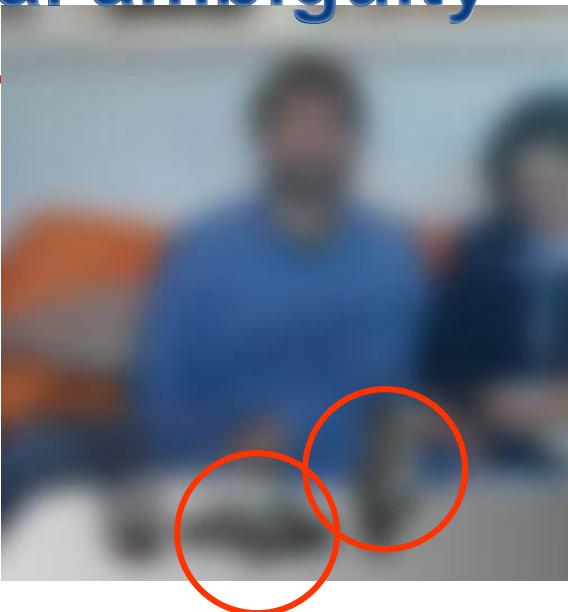
Challenges 7: object intra-class variation



slide by Fei-Fei, Fergus & Torralba



Challenges 8: local ambiguity





Challenges 9: the world behind the image

