Improving Retinal Prosthetics Through Artificial Intelligence

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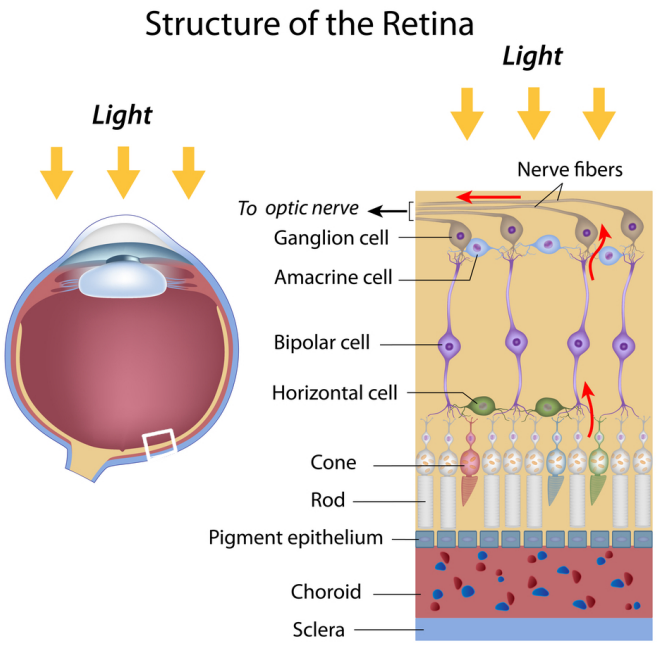
Outline

- Background
  - Relevant Biology of The Retina
  - System Structures of A Retinal Prosthetic
  - Image Analysis Techniques With AI
- Understanding Digital Media With AI
- AI In Retinal Prosthetics

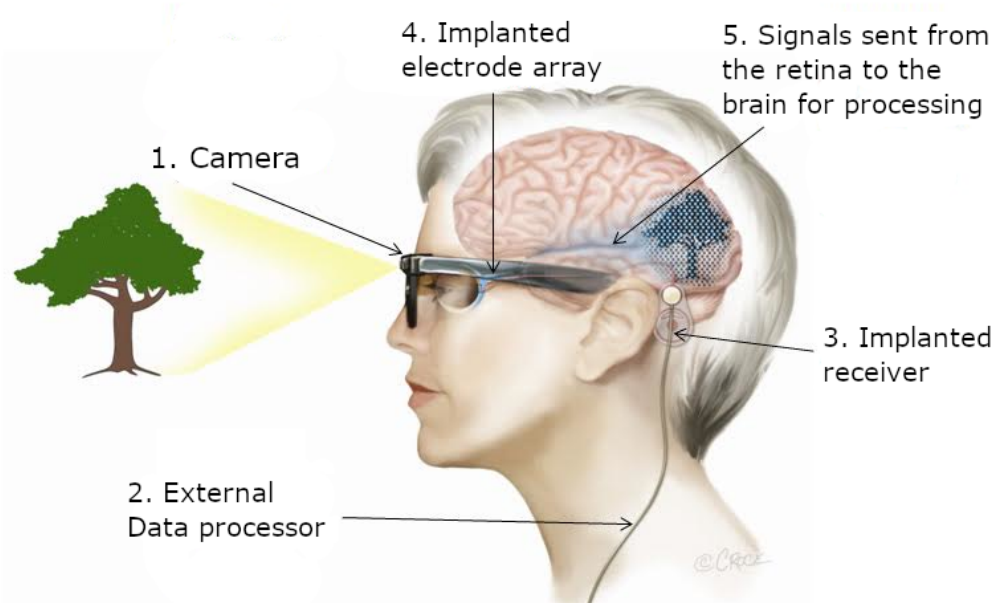
The Retina

- Responsible for receiving and processing light
- The photoreceptive layer is composed of rods and cones, responsible for sensing light
- Ganglion cells in the retina output signals to the brain



Retinal Prosthetic System Structure

- Camera
- Telemetry unit
- Processing device
- Electrode implant



Simulating Vision of Retinal Prosthetic Patients

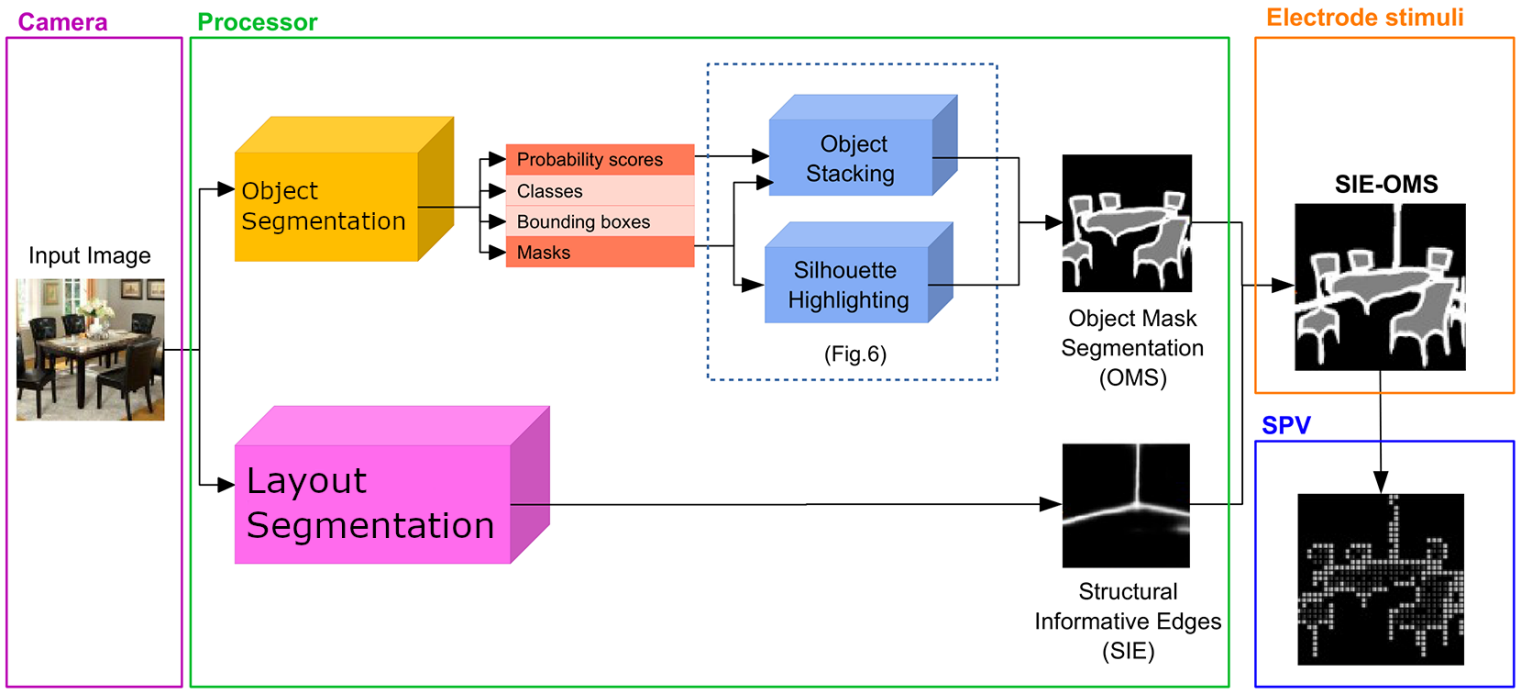
- Simulates the visual experience of a patient with a retinal prosthetic
- Pulse–2–Percept
- Phosphenification

Image Segmentation

- Partitions an object in an image into sets of segments
- Relies on edge detection techniques to define contours

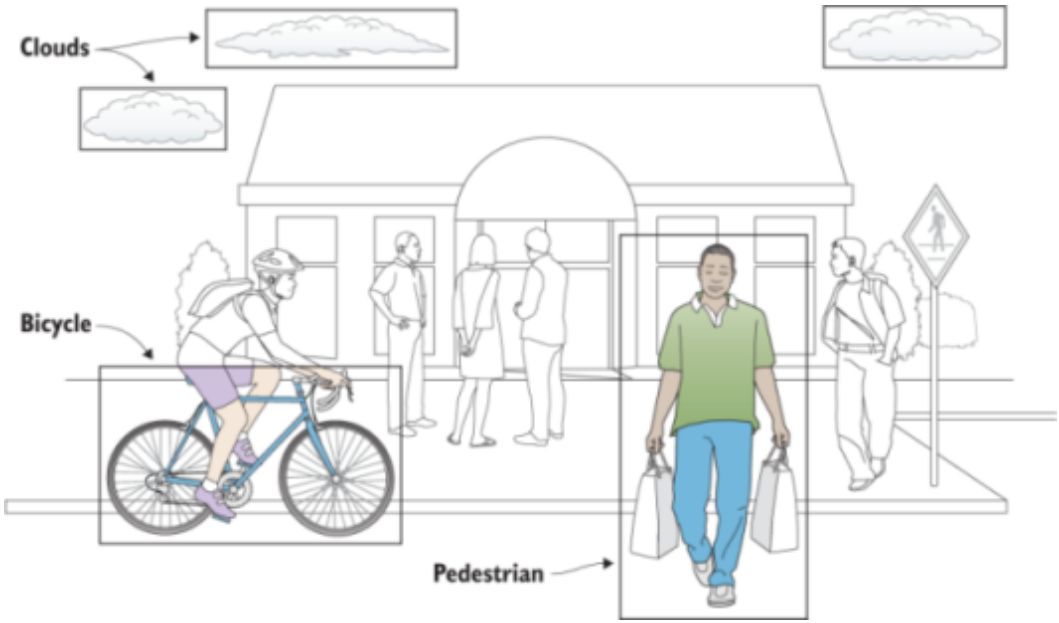
Scene Reconstruction

- Uses segmented objects and layouts to construct a scene
- Indoor scenes pose different challenges from outdoor scenes



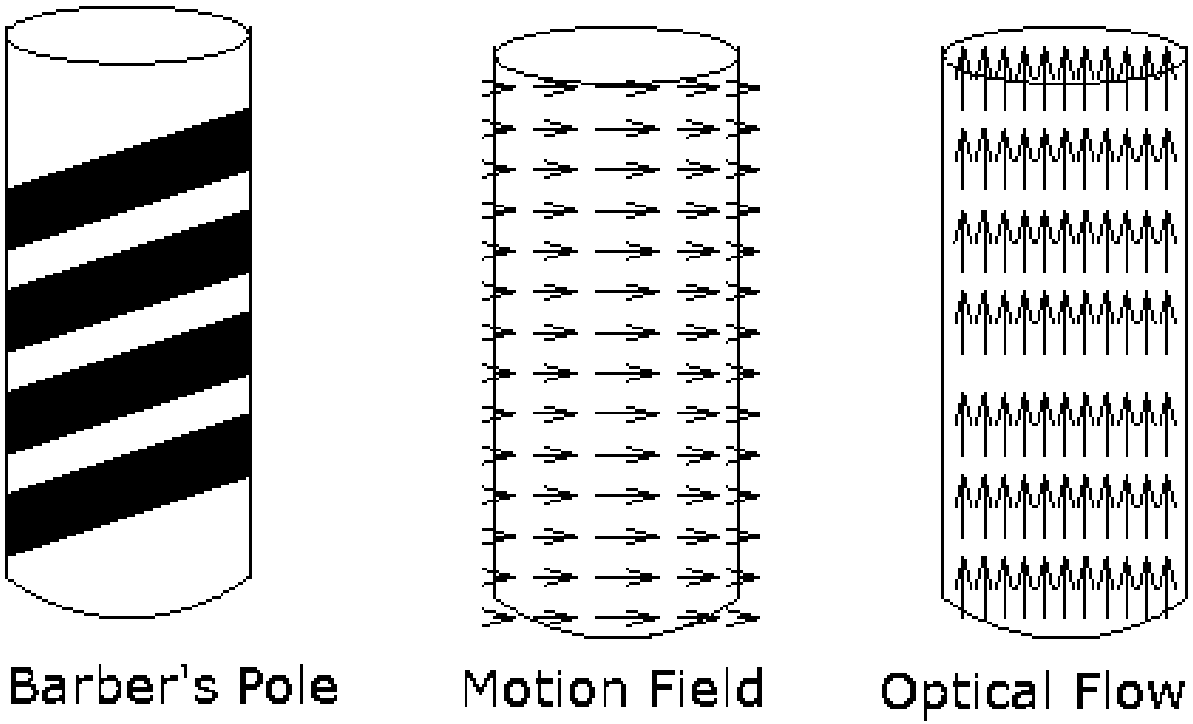
Object Detection & Recognition

- Detects objects in a scene
- Process responsible for identifying objects
- Objects have differing importance in detail (i.e. cars vs faces)



Optical Flow & Motion Estimation

- Used to determine the apparent movement of objects in a scene
- Estimates motion by pixel brightness or feature tracking

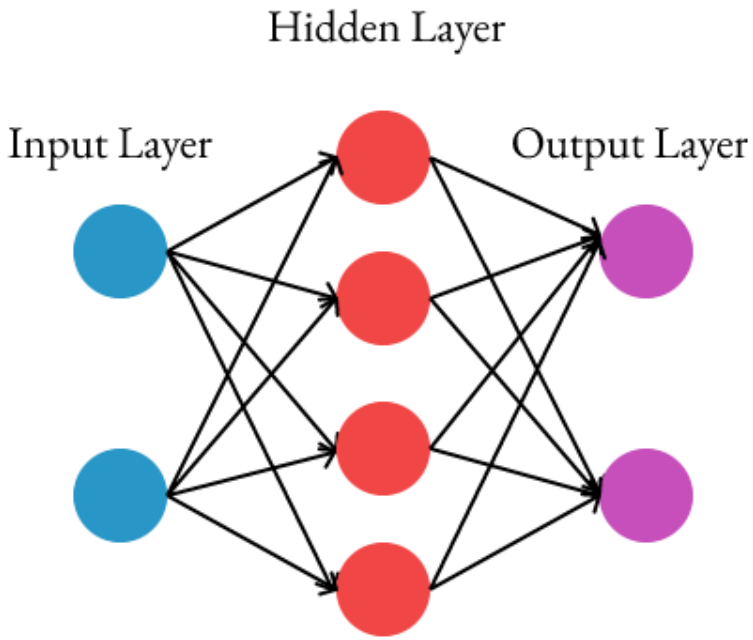


Outline

- Background
- Understanding Digital Media With AI
  - Neural Networks
  - Computer Vision
- AI In Retinal Prosthetics

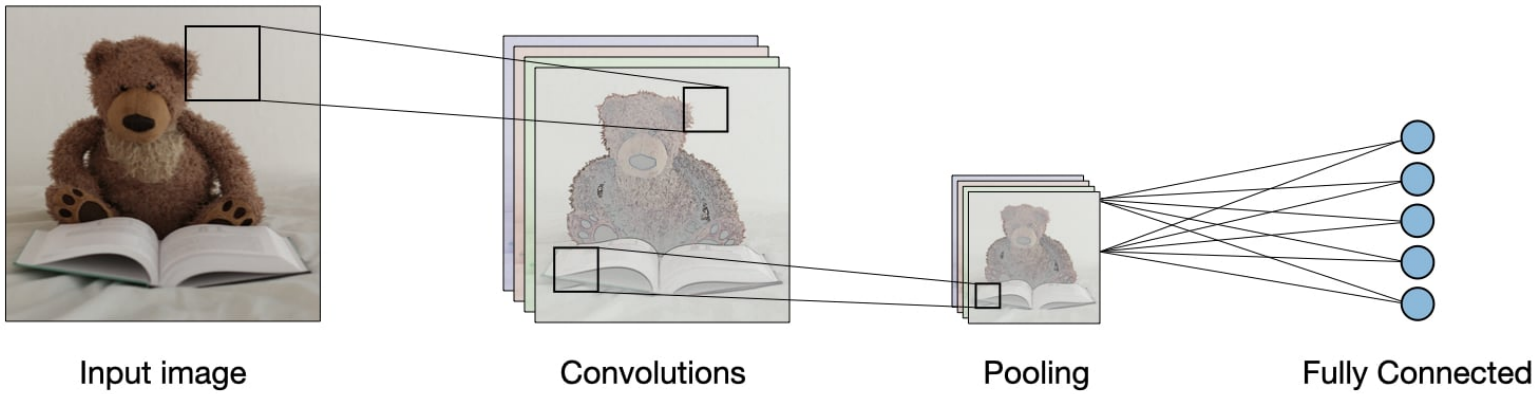
Neural Networks (1/2)

- Named after and follows the structure of the human brain
- Used to classify and find patterns in data



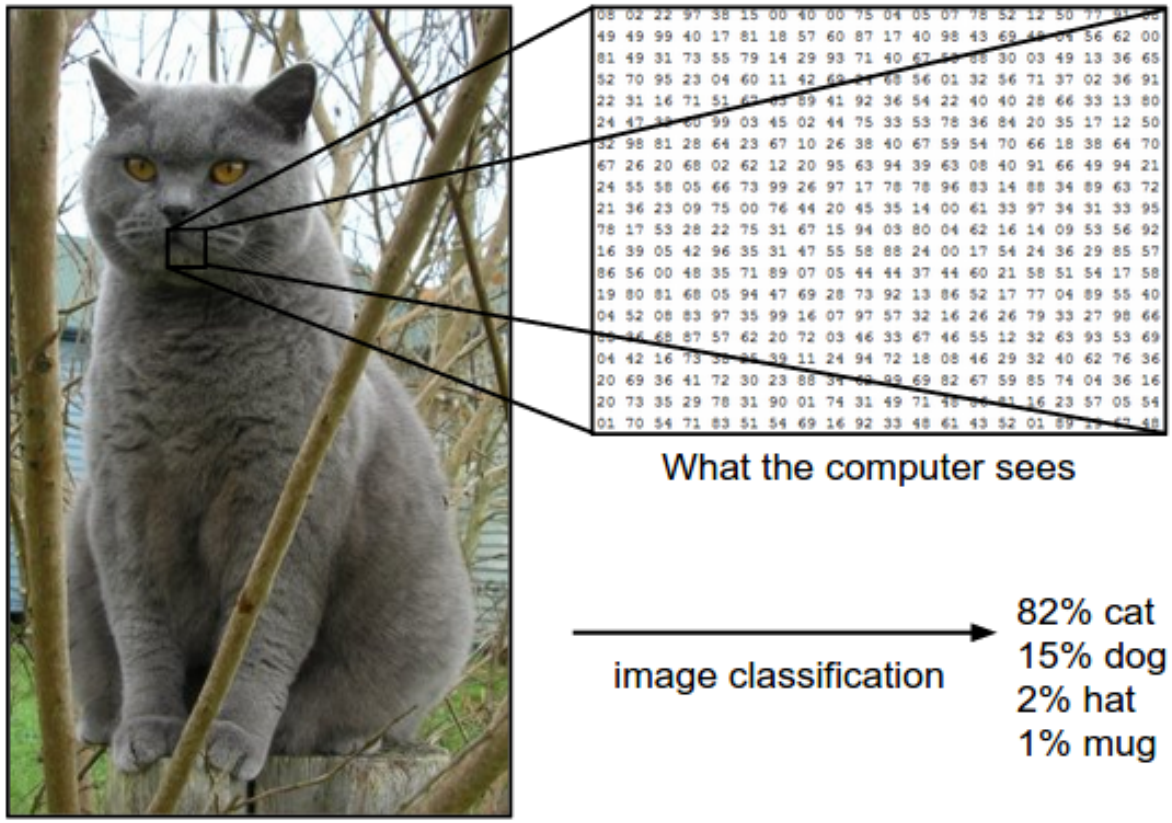
Neural Networks (2/2)

- Deep learning is a classification of neural networks
- Convolutional Neural Networks



Computer Vision

- Made to mimic the human visual system
- Uses AI to find patterns to determine the content of an image



Applying AI to Improve Artificial Vision

- Improving image segmentation speed and accuracy
- Identifying objects and avoiding collisions
- Expanding scene reconstruction capability

Condition	Accuracy	Precision
Saliency	0.51	0.53
Depth	0.54	0.56
Segmentation	**0.68**	**0.73**
Combination	0.66	0.72

Figure: Table 1. Based on Han et al., 2021

Classification Methods	Overall Accuracy(%)
Adaboost	77.50
MLP	32.50
SVM	61.25
NeuCube	90.50

Figure: Table 1. Based on Ge et al., 2017

Future Work

- Computation of moving and occluded objects
- Prioritization of objects in a scene
- Variations in environments

References I

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