

# **Sensors for Robotics**

Introduction

# Human Sensing

Sense:

- Vision
- Audition
- Gustation
- Olfaction
- Tactition

What sensed:

- EM waves
- Pressure waves
- Chemicals - flavor
- Chemicals - odor
- Contact pressure

# Human Sensing

## Sense

- Thermoception
- Nociception
- Equilibrioception
- Proprioception

## What sensed:

- Heat
- Pain
- Sense of balance
- Body awareness

# Animal Sensing

- Magnetoception (birds)
- Electroception (sharks, etc.)
- Echolocation (bats, etc.)
- Pressure gradient (fish)

# Human Sensors

Sense:

- Vision
- Audition
- Gustation
- Olfaction
- Tactition

Sensor:

- Eyes
- Ears
- Tongue
- Nose
- Skin

# Human Sensors

Sense:

- Thermoception
- Nociception
- Equilibrioception
- Proprioception

Sensor:

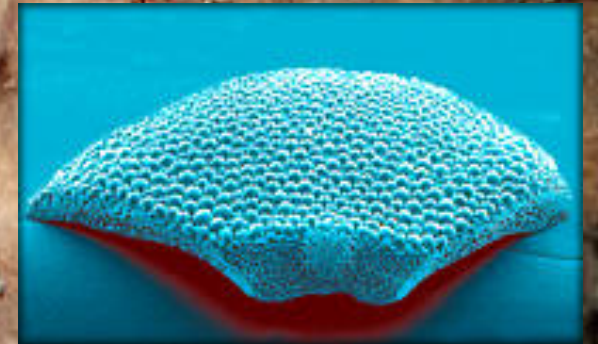
- Skin
- Skin, organs, joints
- Ears
- Muscles, joints

# Common Animal Sensors

Sensor	Phenomena
Eye	Electromagnetic waves in <i>some</i> sub-spectrum
Ear	Pressure waves between about 10 hz and 100kHz (animal-dependent)
Nose	Concentration of airborne molecules
Tongue	Concentration of dissolved molecules, etc.
Skin	Pattern of pressure on animal's surface
Proprioceptive system	Pattern of nerve impulses from muscles

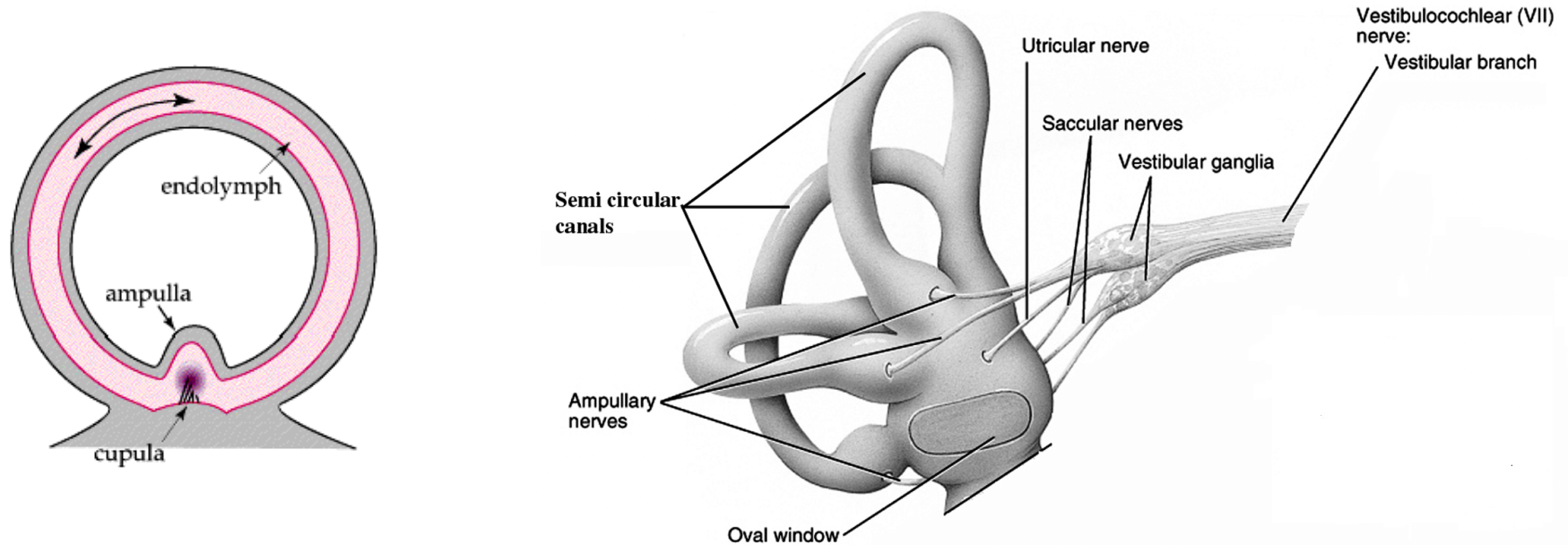
# Unusual Animal Sensors

- Magnetoreceptor: Sensing of earth's magnetic field. Seen in newts, birds, rats and maybe humans.
- Electric field sensing: Seen in a variety of fish.
- Cerci: Cockroach airflow sensors
- Body as eye: Brittlestar covered with optically perfect lenses





# Biological Rotation Sensor



- **semicircular canals** detect angular acceleration
- 3 canals: one per plane
- inertia of fluid causes deflection of sensory element

# **Biomimetic: Robot design as creature design**

- Animal sensory systems adapted to functional needs and environment.
- Robots can use non-biological sensors which suit them to their ‘ecosystems’
- e.g., neutron-sniffing robodog, UAV with weather radar, etc.

# Robot Sensors

## Sense:

- Vision
- Audition
- Gustation
- Olfaction
- Tactitions
- Thermoception
- Nociception

## Sensor:

- Camera
- Microphone
- Chemical sensors
- Chemical sensors
- Contact sensors
- Thermocouple
- ?



# Robot Sensors

## Sense:

- Equilibrioception
- Proprioception
- Magnetoception
- Electroception
- Echolocation
- Pressure gradient

## Sensor:

- Accelerometer
- Encoders
- Magnetometer
- Voltage sensor
- Sonar
- Array of pressure sensors?



# Robot Sensors

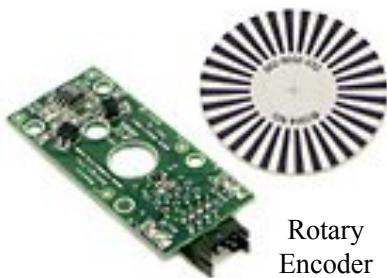
- EM spectrum beyond visual spectrum
  - (RADAR, LIDAR, radiation, infrared)
- Chemical sensing beyond taste and smell
- Hearing beyond human range
- Lots more.

# Robot Sensors - localization

Do you recognize the difference between the two categories?



Linear Encoder



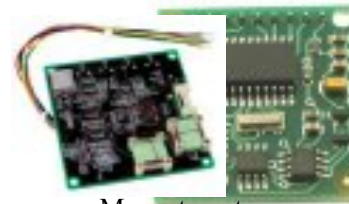
Rotary Encoder



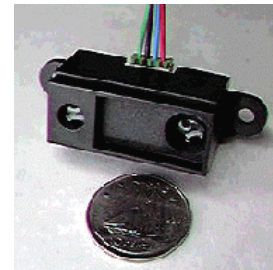
Accelerometer



Gyroscope



Magnetometer  
Compass



Infrared Ranging



IR Modulator  
Receiver



Sonar Ranging



GPS



Camera



Laser triangulation



Laser Rangefinder

# Robot Sensors – specific tasks



Metal Detector



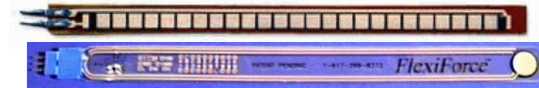
Gas



Pyroelectric Detector



Pressure



Resistive Bend



Radiation



Lever Switch



Magnetic Reed Switch



PIR



CDS Cell



Compass



Microphone



Piezo Bend