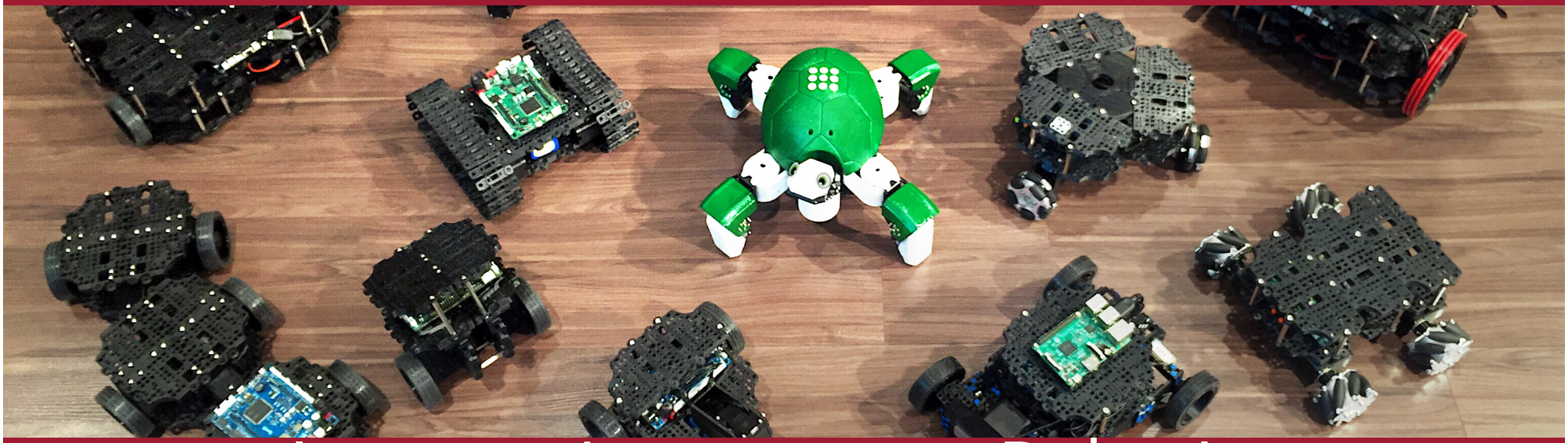
Perception



Intro. to Autonomous Robotics

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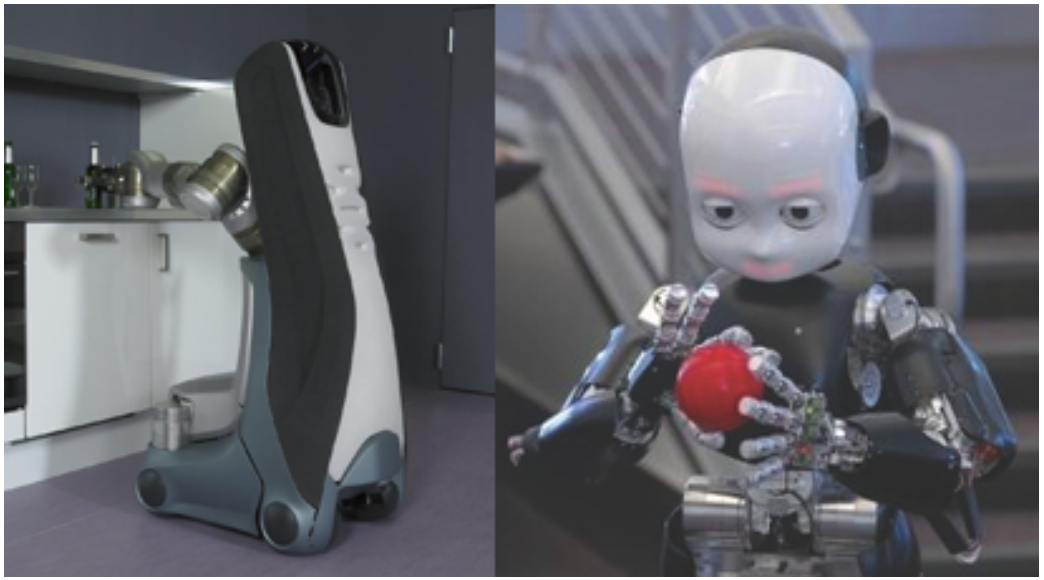
Review

- Three Ds
- Environments
- Locomotion
- Types of sensor states
- Do sensors provide state?

How can robots perceive?



Perception

- An autonomous systems must acquire ***knowledge*** about its ***environment***
- Perception assists ***interaction*** with environments, operators, and people
- ***Modeling*** (e.g. parts, buildings, caves)

- ***Monitoring*** (e.g. quality, invasive environments)
- ***Surveillance*** (e.g., banks, parking lots)

Sensors

- Obtain raw *measurements* of environment properties
- Perception assists ***interaction*** with environments, operators, and people
- ***Modeling*** (e.g. parts, buildings, caves)

- ***Monitoring*** (e.g. quality, invasive environments)
- ***Surveillance*** (e.g., banks, parking lots) ... and more

Sensors

- A robot's window to the world (environment)
- Based on conversion of energy from one for one form. (transduction)
- Measure a physical quantity, do not provide state

Sensors Classification

- Classified using two functional axes
  - (Proprioceptive / Exteroceptive) & (Passive / Active)

- *Proprioceptive*: (“sense of self”)
  - Measures value internal to the system, (e.g. battery level, wheel position).

- *Exteroceptive*:
  - Observations of robot’s external environment, objects in it. e.g. distance measurements, light intensity)

- Active: **emits** energy, (e.g. radar)

- Passive: passively **receives** energy, (e.g., camera, microphone)

Mobile robotics sensors (common)

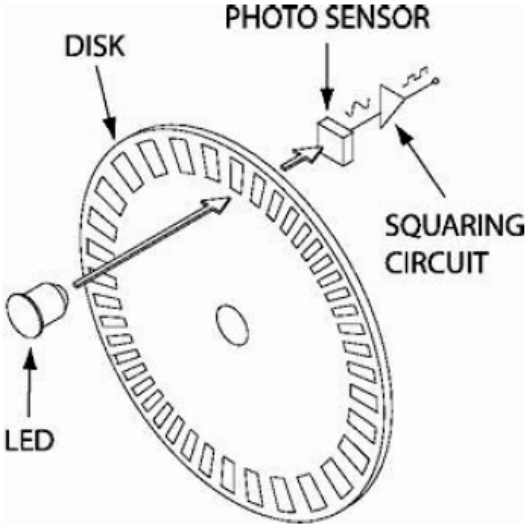
Proprioceptive	Exteroceptive
• Gyroscope • Accelerometer	• Contact switch • Bumpers • Compass • GPS • Radar • Cameras

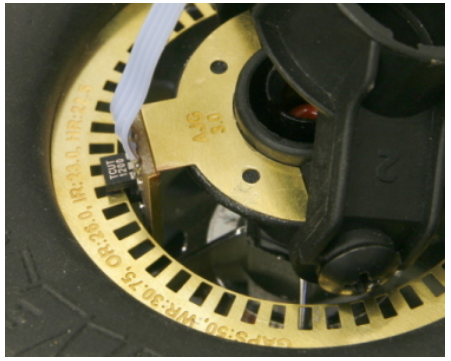
Mobile robotics sensors (common)

Active	Passive
• GPS • Radar • Reflectivity sensors	• Contact switch • Bumpers • Compass • Gyroscope • Cameras

Wheel/motor Sensors

- Measures internal state and dynamics of a mobile robot
- **Optical encoders** are commonly used to measure speed and position associated with wheels/motors
- **Incremental (Quadrature) encoders** are commonly used in mobile robotics.
- **Odometry** – Wheel movement can be used to estimate the robots position





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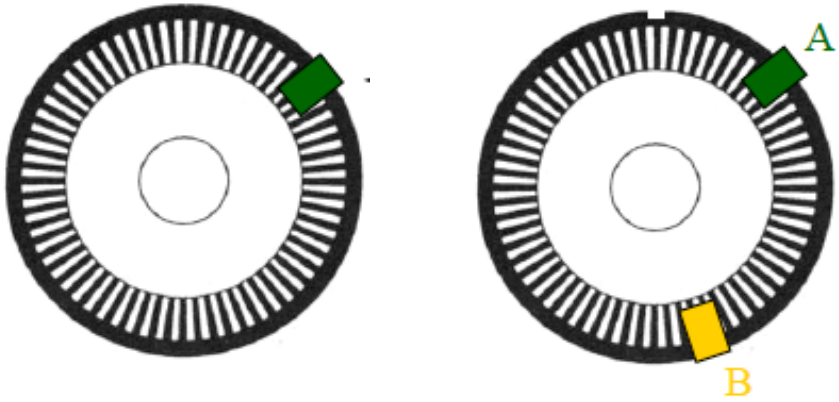

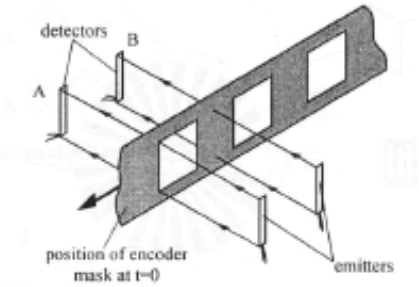

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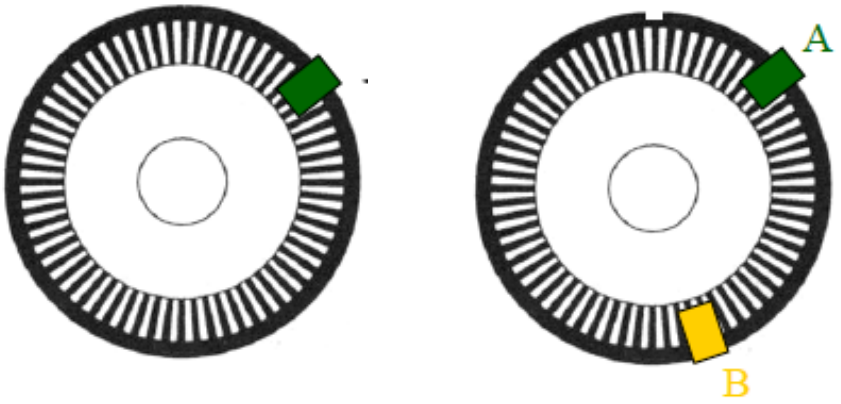

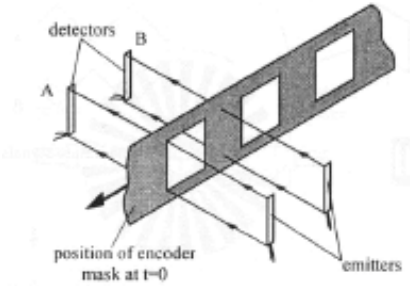

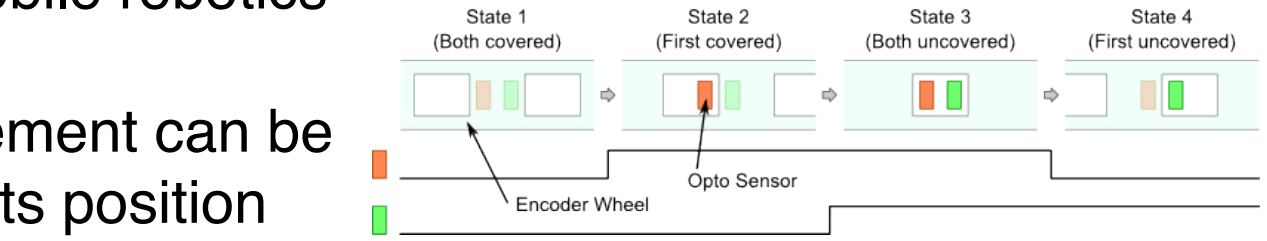

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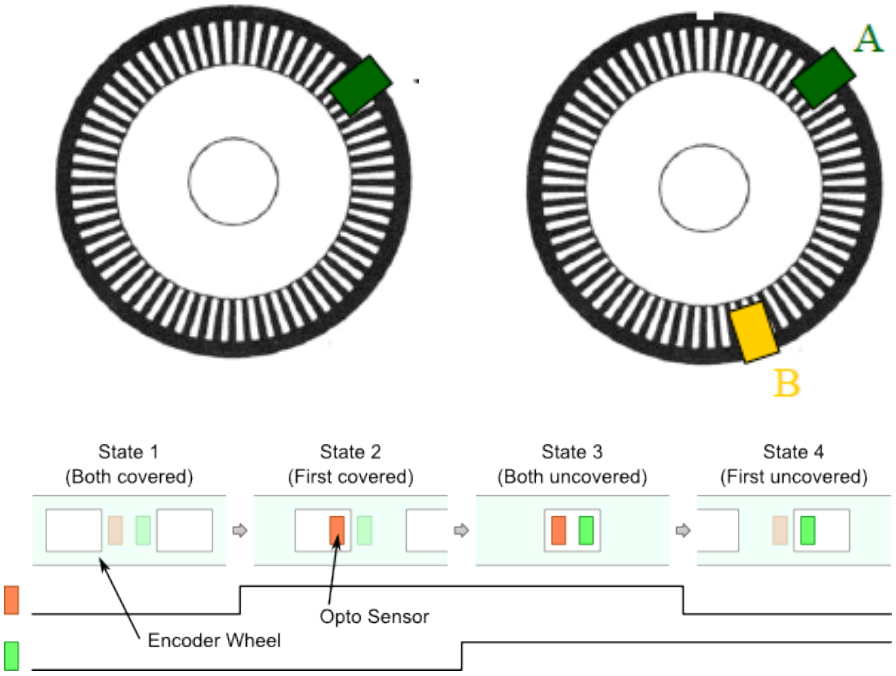


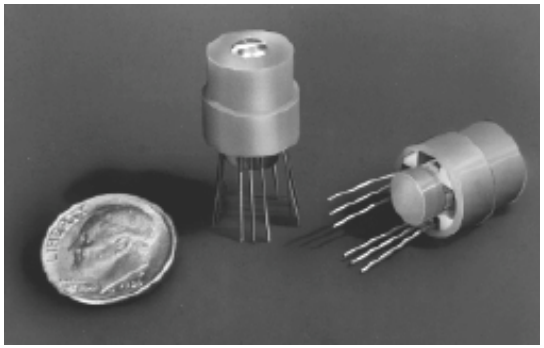
State	Ch A	Ch B
S_1	High	Low
S_2	High	High
S_3	Low	High
S_4	Low	Low

Heading Sensors

- Heading sensors can be **proprioceptive** (gyroscope) or **exteroceptive** (compass)
- Commonly used to determine a robot's **orientation**.
- Together with **velocity** information it can give us information about movement to a **position** (estimate). **Dead reckoning** (ship navigation).

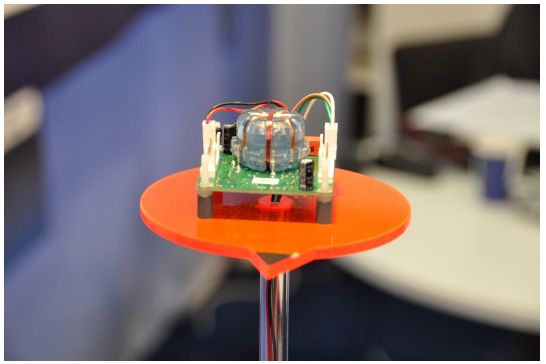
Heading Sensors: Hall-Effect Compass

- Measures orientation using the Earth's magnetic field.
- Two common types of sensors used to measure direction of magnetic field: **Hall effect** and **flux gate** compasses.
- **Hall effect:**
  - **Small** and **inexpensive**
  - Poor resolution
  - **Slow**



Heading Sensors: Flux gate Compass

- Measures orientation using the Earth's magnetic field.
- Two common types of sensors used to measure direction of magnetic field: **Hall effect** and **flux gate** compasses.
- **Flux gate:**
  - Higher **resolution** and **accuracy**
  - **Larger** and more **expensive** than hall-effect compass

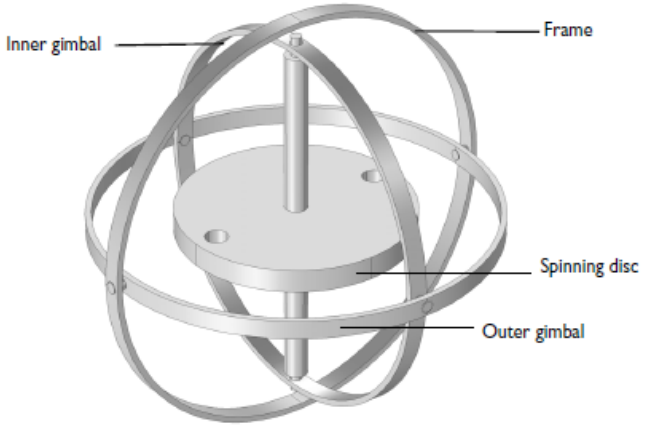


Heading Sensors: Magnetic Compass

- Using Earth's magnetic field has drawbacks
  - Disturbances caused by other magnetic objects
  - Vibration
  - Often avoided in indoor environments

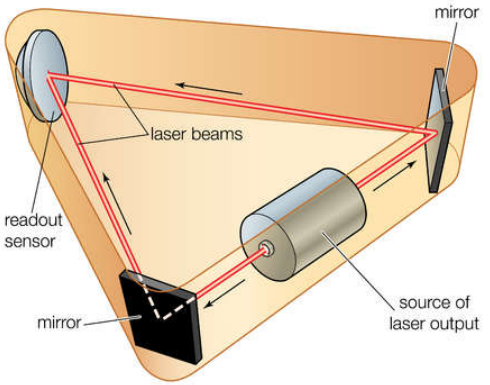
Heading Sensors: Mechanical Gyroscopes

- Heading sensors that preserve orientation to a fixed reference frame
- Provides absolute measure for heading
- Angular momentum associated within a spinning wheel keeps the axis stable
  - This allows measurement of a system relative to where it started



Heading Sensors: Optical Gyroscopes

- First commercially used in early 1980s in airplanes to measure angular speed.
- Two laser beams shot from same source (clockwise and counterclockwise)
- Laser beam traveling in direction of rotation has slightly shorter path (higher frequency)
- Difference in frequency of two beams is proportional to angular velocity



HW 1: Sensors