Sensors

EE468/CE468: Mobile Robotics

Dr. Basit Memon

Electrical and Computer Engineering
Habib University

September 13, 2023

Table of Contents

Table of Contents

The plan for today is:

- Form a group of 2-3.
- Choose a sensor from list.
- Research the sensor.
- Present to the rest.

Sensor list

- Wheel Encoders
- Gyroscope
- Compass
- Accelerometer
- Ultrasonic Rangefinder
- Laser Rangefinder (Lidar)
- Cameras

Research your sensor for 20 minutes and put it up online.

- What does it measure?
- What is its working principle? Any equations?
- How is it used in robotics?
- Advantages? Under what conditions does it perform well?
- Disadvantages? Under what conditions does it fail?
- Examples of already-built robots using this sensor.

Share here

Pair up with another group and share with each other.

Table of Contents

Proprioceptive vs Exteroceptive

- **Proprioceptive:** Internal sensors. The sensor measures values internal to the system (robot), e.g. temperature, motor speed, joint angles, battery voltage, etc.
- **Exteroceptive:** Sensors acquire information from robot's environment, e.g. distance measurements, light intensity, sound amplitude, etc.

Active or Passive

- **Passive:** Passive sensors measure ambient environmental energy entering the sensors, e.g. temperature probe, microphone, camera.
- **Active:** Emit energy into the environment and then measure environmental reaction, e.g. ultrasonic sensors. There are risks of active sensing:

Active or Passive

- **Passive:** Passive sensors measure ambient environmental energy entering the sensors, e.g. temperature probe, microphone, camera.
- **Active:** Emit energy into the environment and then measure environmental reaction, e.g. ultrasonic sensors. There are risks of active sensing:
  - Outbound energy may affect the quantity being measured.

Active or Passive

- **Passive:** Passive sensors measure ambient environmental energy entering the sensors, e.g. temperature probe, microphone, camera.
- **Active:** Emit energy into the environment and then measure environmental reaction, e.g. ultrasonic sensors. There are risks of active sensing:
  - Outbound energy may affect the quantity being measured.
  - Sensor may suffer from interference from other sources, and be a source of interference for others.

Table of Contents

Performance in real-world is different from lab.

- **Dynamic Range:** Spread between lower and upper limits of input values to sensor while maintaining normal sensor operation.
- **Resolution:** Minimum difference between two values that can be measured by sensor.
- **Bandwidth or Frequency:** Rate at which sensor can provide stream of readings.

Lab performance can be extrapolated to real-world.

- **Sensitivity:** DRatio of output change to input change.
- **Cross-Sensitivity:** Sensitivity to environmental parameters that are orthogonal to the target parameters for sensor.
- **Accuracy:** Degree of closeness of sensor reading to true measurement.

$$\text{Accuracy} = 1 - \frac{|\text{Measured Value} - \text{True Value}|}{|\text{True Value}|}$$

Lab performance can be extrapolated to real-world.

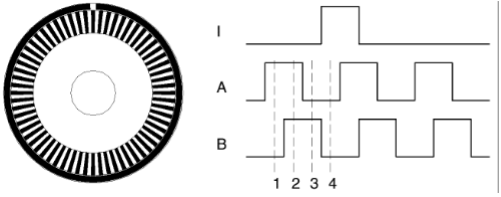
- **Precision:** Reproducibility or repeatability of sensor results.

$$\text{Precision} = \frac{\text{Range}}{\sigma},$$

where σ is standard deviation of random errors of sensor.

Table of Contents

Wheel Encoders



State	Ch A	Ch B
s_1	high	low
s_2	high	high
s_3	low	high
s_4	low	low

Figure: Quadrature Optical Wheel Encoder

Table of Contents

[1] **Roland Siegwart, Illah R Nourbakhsh, and Davide Scaramuzza. Autonomous mobile robots, volume 15. MIT press, 2011.**