Introduction to Mobile Robotics

Proximity Sensors

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Sensors of Wheeled Robots

Perception of the environment

Active:
- Ultrasound
- Laser range finder
- Infrared

Passive:
- Cameras
- Tactiles

Methods:
- Time of flight
- Phase shift
- Intensity-based
Tactile Sensors

Measure contact with objects

Touch sensor

Spring

Bumper sensor

Contact
Ultrasound Sensors

- Emit an ultrasound signal
- Wait until they receive the echo
- Time of flight sensor

Polaroyd 6500
**Time of Flight Sensors**

\[ d = v \times \frac{t}{2} \]

- \( v \): speed of the signal
- \( t \): time elapsed between broadcast of signal and reception of the echo.
Properties of Ultrasounds

- Signal profile [Polaroid]
Sources of Error

- Opening angle
- Crosstalk
- Specular reflection
Typical Ultrasound Scan
Parallel Operation

- Given a 15 degrees opening angle, 24 sensors are needed to cover the whole 360 degrees area around the robot.
- Let the maximum range we are interested in be 10m.
- The time of flight then is $2\times10/330 \text{ s}=0.06 \text{ s}$
- A complete scan requires 1.45 s
- To allow frequent updates (necessary for high speed) the sensors have to be fired in parallel.
- This increases the risk of crosstalk
Laser Range Scanner
Properties

- High precision
- Wide field of view
- Some laser scanners are security approved for emergency stops (collision detection)
Computing the End Points

- Laser data comes as an array or range readings, e.g. [1; 1.2; 1.5; 0.1; 81.9; ...]
- Assume an field of view of 180 deg
- First beams starts at -½ of the fov
- Maximum range: ~80 m (SICK LMS)
Computing the End Points

- Laser data comes as an array or range readings, e.g. [1; 1.2; 1.5; 0.1; 91.9; ...]
- Assume an field of view of 180 deg
- First beams starts at $-\frac{1}{2}$ of the fov

Blackboard:

- Where are the end points relative to the sensor location?
- Where are the end points in an external coordinate system?
Robots Equipped with Laser Scanners
Typical Scans
Another Range Sensor (Kinect)
Wolfram in 3D