Introduction to Mobile Robotics

Proximity Sensors

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Sensors of Mobile Robots

Perception of the environment

Active:
- Ultrasound
- Laser range finder
- Infrared

Passive:
- Cameras
- Tactiles

Time of flight
Phase shift
Intensity-based
Tactile Sensors

Measure contact with objects

Touch sensor

Bumper sensor
Ultrasound Sensors

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

Polaroid 6500
Time of Flight Sensors

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

\( v \): 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 cover 360 degrees

- Let the maximum range be 10m, hence
  \[ t = \frac{2 \times 10 \text{ m}}{(330 \text{ m/s})} = 0.06 \text{ s} \]

- Complete scan: \( 24 \times 0.06 \text{ s} = 1.45 \text{ s} \)

- Too slow for control, hence sensors have to be fired in parallel

- Increases risk of crosstalk
Laser Range Scanner

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

Example: SICK LMS

- Array or range readings [1; 1.2; 1.5; 0.1; 81.9; ...]
- Field of view of 180 deg
- First beams at -90 deg
- Maximum range: ~80 m
- \((x, y) = r \times (\cos a, \sin a)\)
- Typical question: Where are the end points in an external coordinate system?
Robots Equipped with Laser Scanners
Typical Scans
3D Kamera (Kinect)
Questions?