Introduction to Mobile Robotics

Proximity Sensors

Wolfram Burgard
Sensors of Wheeled 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

- Spring
- Contact
Ultrasound Sensors

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

Polaroyd 6500
Time of Flight Sensors

\[ d = \nu \times t / 2 \]

\( \nu \): 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*10m divided by the speed of sound (330m/sec) which leads to 0.06sec
- A complete scan thus requires 24*0.06=1.45sec
- 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. \[1; 1.2; 1.5; 0.1; 91.9; \ldots\]
- Assume an field of view of 180 deg
- First beams starts at \(-\frac{1}{2}\) of the fov

Typical problems to be solved:
- 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