Introduction to Mobile Robotics
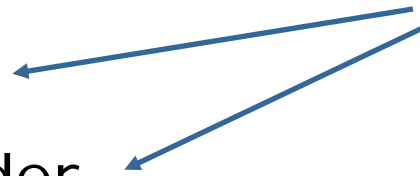
Proximity Sensors

Daniel Büscher

Sensors of Mobile Robots

Perception of the environment

Active:

- Ultrasound
- Laser range finder
- Infrared
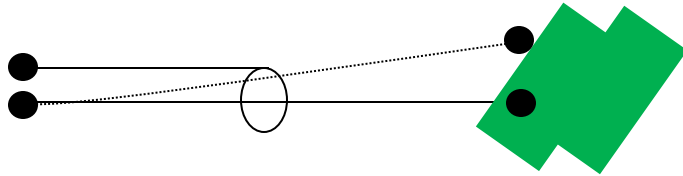
Time of flight

Phase shift
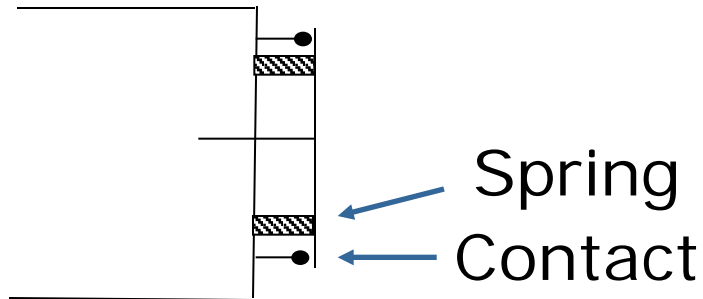
Passive:

- Cameras
- Tactiles

Intensity-based

Tactile Sensors

Measure contact with objects

Touch sensor

Spring
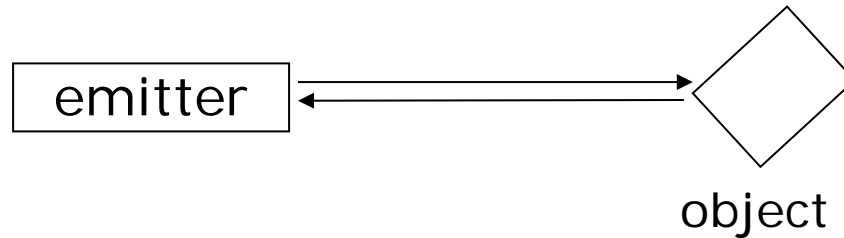
Bumper sensor

Contact

Ultrasound Sensors

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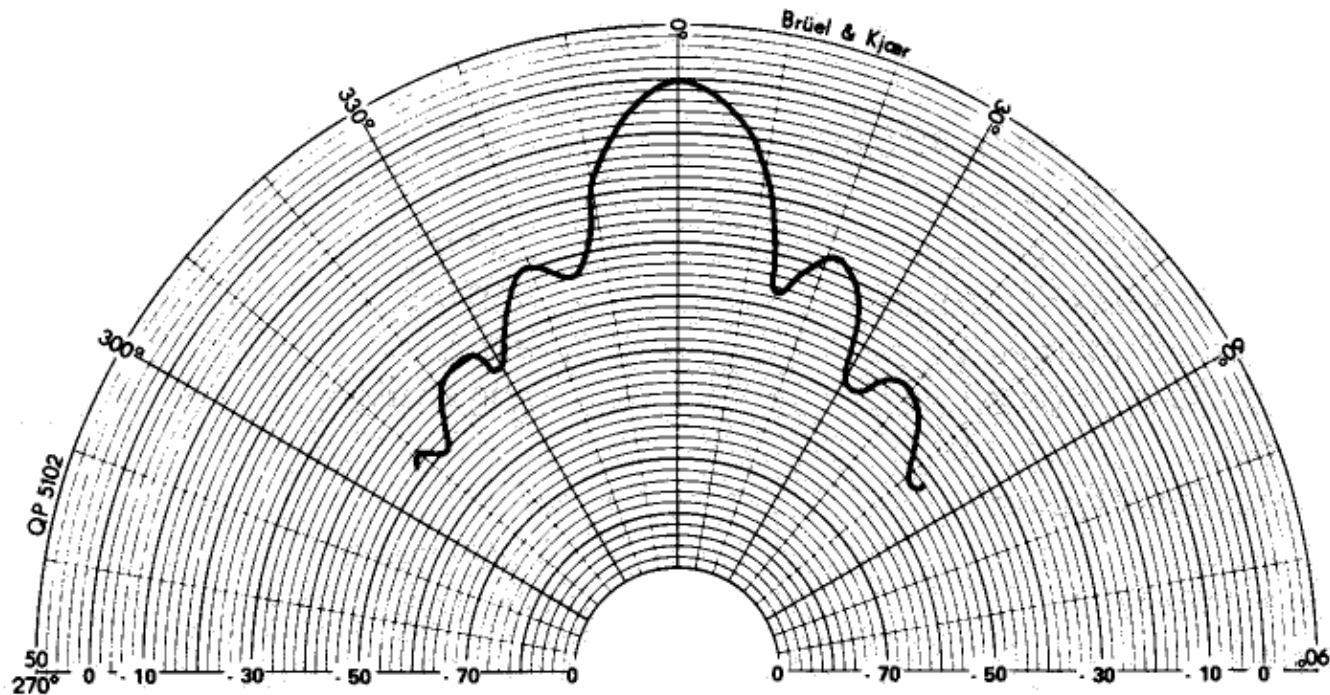- Time of flight sensor

Polaroid 6500

Time of Flight Sensors

$$d = v \times t / 2$$

v: speed of the signal

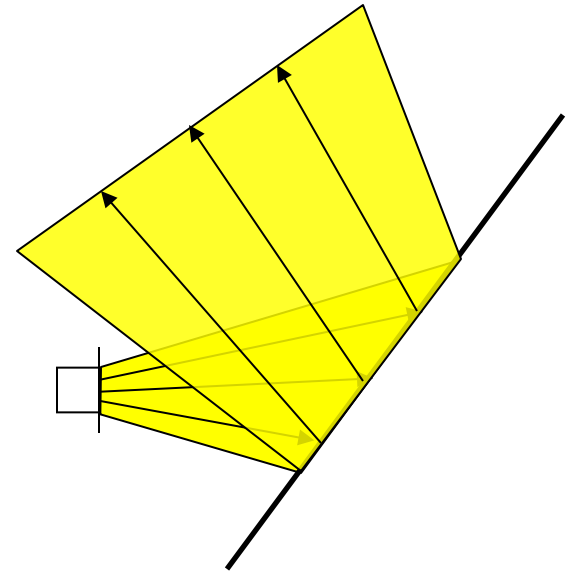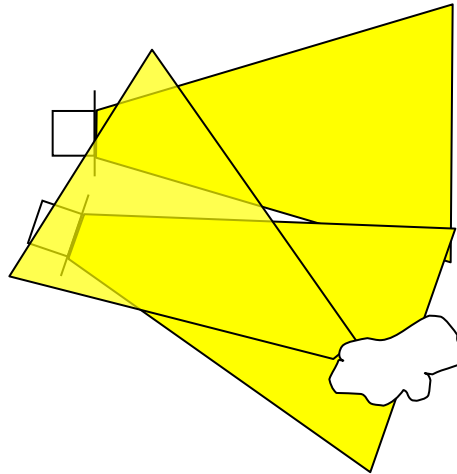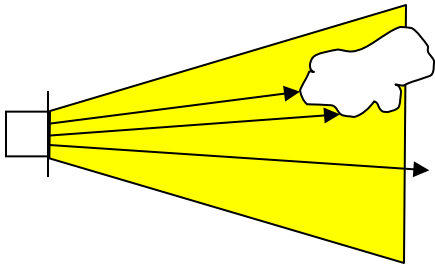t: time elapsed between broadcast of signal and reception of the echo.

Properties of Ultrasounds
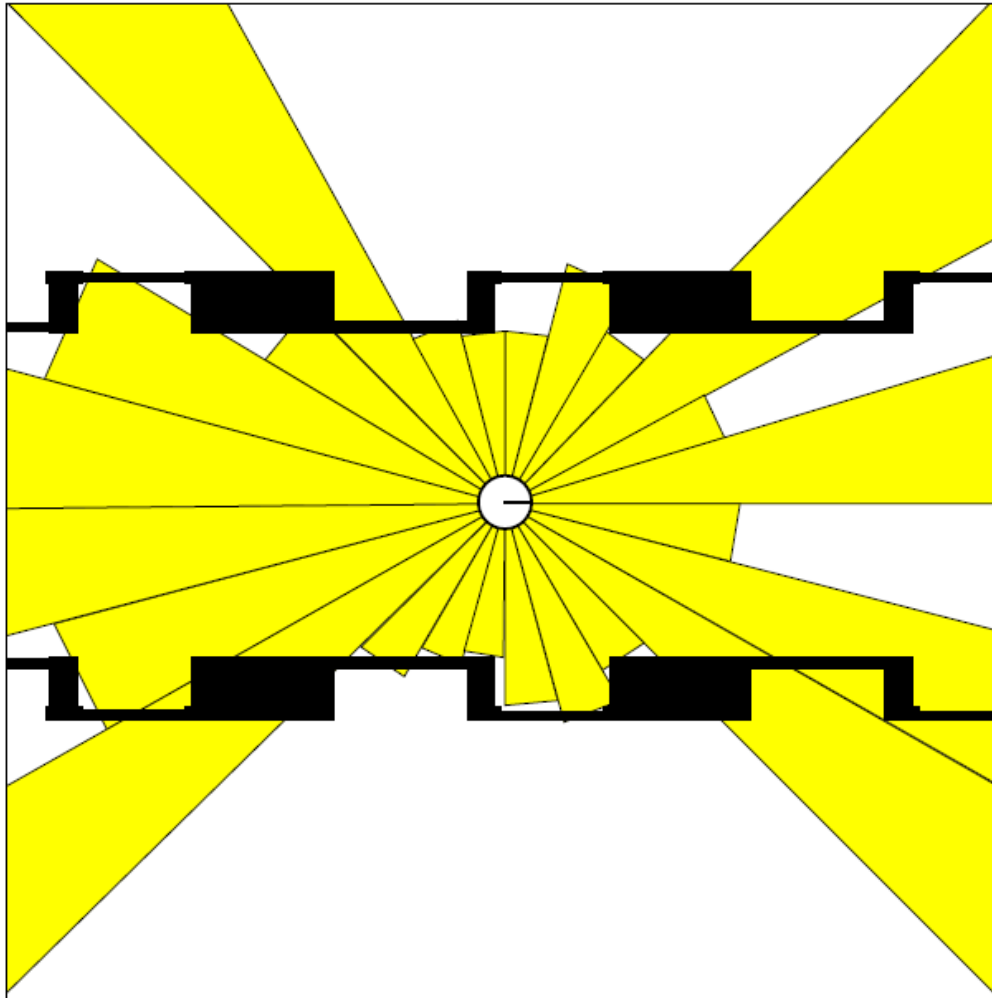
- Signal profile (Polaroid)

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
  $t = 2 * 10 \text{ m} / (330 \text{ m/s}) = 0.06 \text{ s}$

- Complete scan: $24 * 0.06 \text{ s} = 1.45 \text{ s}$

- 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)
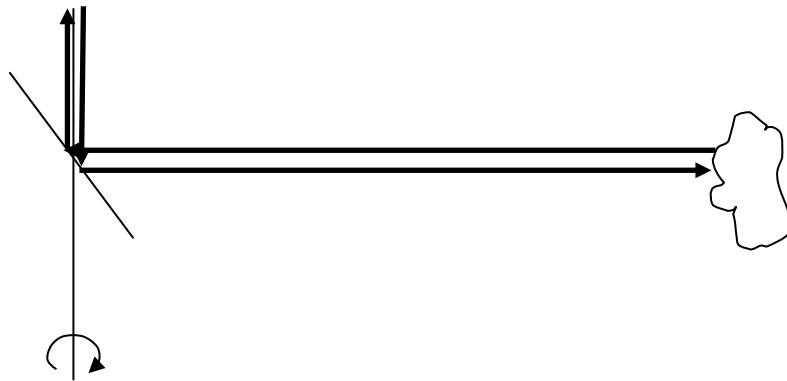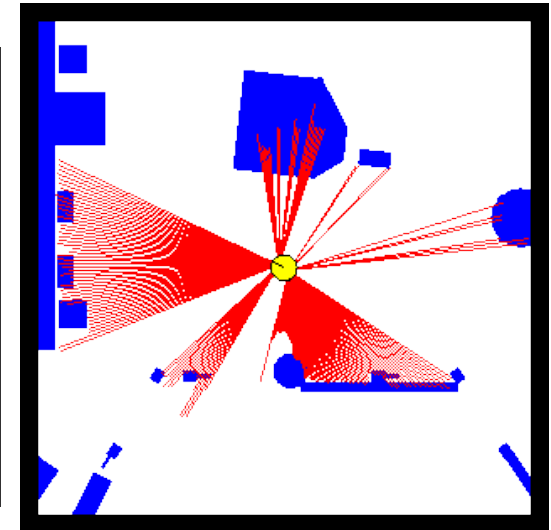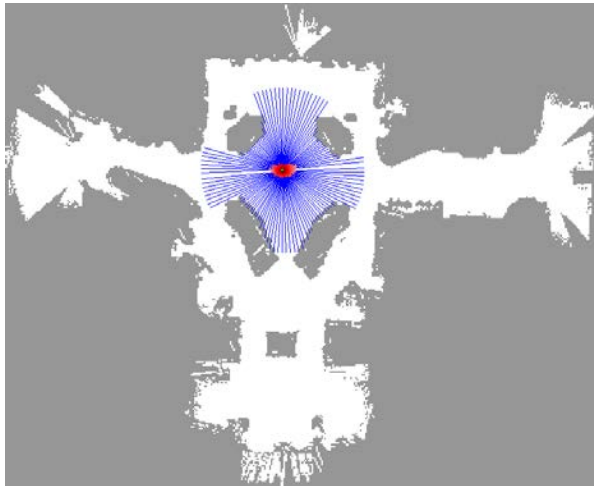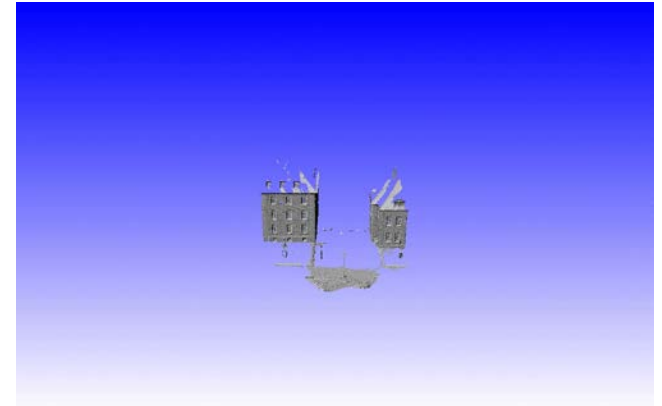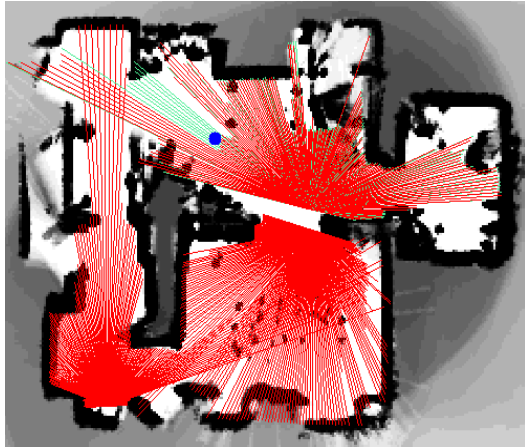
Computing the End Points

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
- $(x, y) = r * (\cos a, \sin a)$
- Typical question: Where are the end points in an external coordinate system?
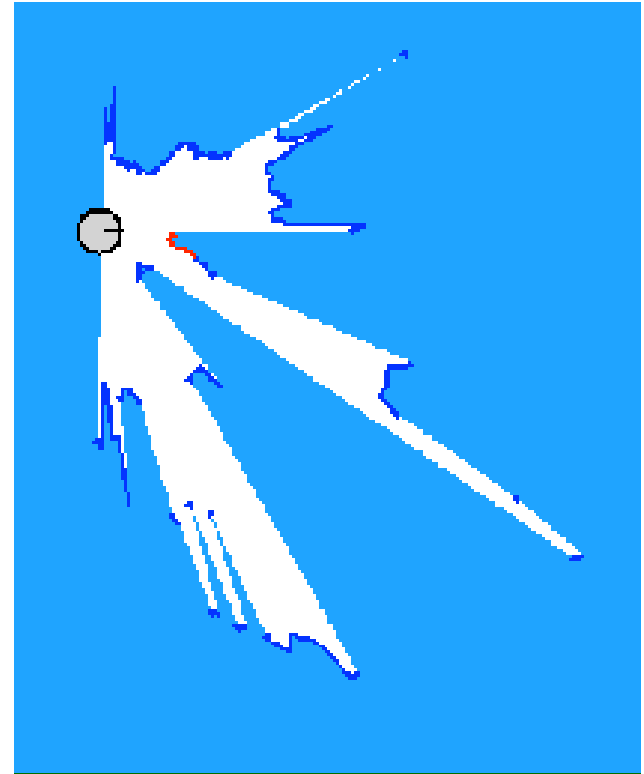
Robots Equipped with Laser Scanners

Typical Scans

3D Kamera (Kinect)

Questions?