Using infrared proximity sensors for close 2D localization and object size recognition

Richard Berglind
Neonode
Outline

• Overview of sensor types
• IR proximity sensors and their drawbacks
• Principles of a distributed sensor
• Robot implementation
Sensor types
Sensor types

- Camera
- LIDAR
- Time of flight
- Ultrasound
- IR proximity
Camera

- 2D image of the surrounding environment
- Stereo vision or structured light to help determine distance and object shape
- Image processing required
- Camera FOV limits the minimum sensor to object distance
LIDAR

- Scans a series of light pulses to generate a “point cloud” of the surrounding environment
- Distance based on return time of pulses
- Suitable for long range applications
- Expensive
Time of flight

• Phase shift method
• 2D-chip generates 3D image
• Requires calibration
• Temperature sensitive
• Accuracy ~1 cm
• Improve accuracy at the expense of frame rate
• Difficult to measure very short distances
Ultrasound

• Speed of sound ~340 m/s
• Round trip 50 cm distance ~3ms
• Sensor array: tradeoff between frame rate and resolution
IR proximity
Basic proximity components

Emitter (LED/laser)

Receiver (PD)

Light blocker

Field of view

Emitted light
Diffuse object scatters light in all directions
A fraction of the scattered light is detected
Detector signal decreases with distance
What about the reflectivity (bright/dark objects)?
Object shape recognition
Object shape recognition – striped objects
Distributed sensor
Distributed sensor concept

- Alternating emitters and receivers
- Collimating optics
- Receiver field of view at an angle toward the emitters
- Each sequentially scanned emitter is used in combination with several receivers
- Object position is determined based on *relative* signal levels and *geometry*
- Independent of material reflectivity
Emitter (laser/LED)
Receiver field of view
Multiple emitters
Emitter-receiver maxima for one receiver
Emitter-receiver maxima for multiple receivers
Two viewing directions for every receiver
Full set of emitter-receiver maxima
Short distance
Long distance
Lateral resolution – signal ratio between emitters
Distance resolution – signal ratio between receivers
Specifications

Accuracy: < 5 mm
Resolution: 0.1 mm
Maximum scanning frequency: ~900 Hz
Typical power consumption: 45-110 mW
Shape recognition

- Each emitter generates a distance value
- Distance values for multiple emitters can be translated into an object shape with the same resolution as the distance between the emitters (7.2 mm)
Shape recognition – different shapes
Shape recognition – striped objects
Robot implementation
Roboteam Twente

• Multidisciplinary team of students from the University of Twente, Netherlands
• Autonomous robot soccer team with eight robot players
• Computer controlled during games
• Cameras above the field track general positions of ball and robots
• Rapid and precise 2D-localization of the ball relative the robot is required for good ball handling
Roboteam Twente – soccer playing robot

Courtesy of Roboteam Twente
Roboteam Twente – soccer playing robot

Courtesy of Roboteam Twente
Roboteam Twente – robot response

Courtesy of Roboteam Twente
Summary

- Ordinary IR proximity sensor generates ambiguous and possibly erroneous data
- Distributed sensor overcomes this by using a geometric approach
- Fast, accurate 2D-localization and shape recognition
- Well suited for robot applications