Robot Programming

Sensors
MARRtino

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Outline

- Robot Devices
  - Overview of Typical sensors and Actuators
  - Operating Devices in ROS
- Mobile Bases
- MARRTino
  - Hardware
  - Firmware

Mobile Base

- A mobile platform is a device capable of moving in the environment and carrying a certain load (sensors and actuators)

- At low level the inputs are the desired velocities of the joints, and the output is the state of the joints

- At high level it can be controlled with linear/angular velocity, and provides the relative position of the mobiel base w.r.t. an initial instant, obtained by integrating the joint's states (odometry).

Proprioceptive Sensors for Ego-Motion

- Wheel encoders mounted on the wheels
- IMU:
  - Accelerometers
  - Gyros

- The estimate of ego-motion is obtained by *integrating* the sensor measurements of these devices. This results in an accumulated drift due to the noise affecting the measurement
- In absence of an external reference there is *no way* to recover from these errors

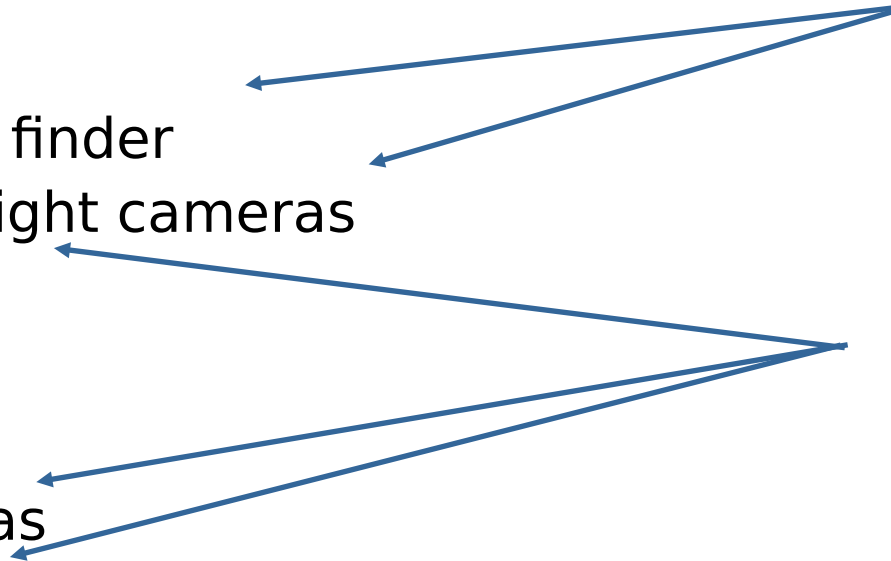# Exteroceptive Sensors

Perception of the environment

Active:
- Ultrasound
- Laser range finder
- Structured-light cameras
- Infrared

Passive:
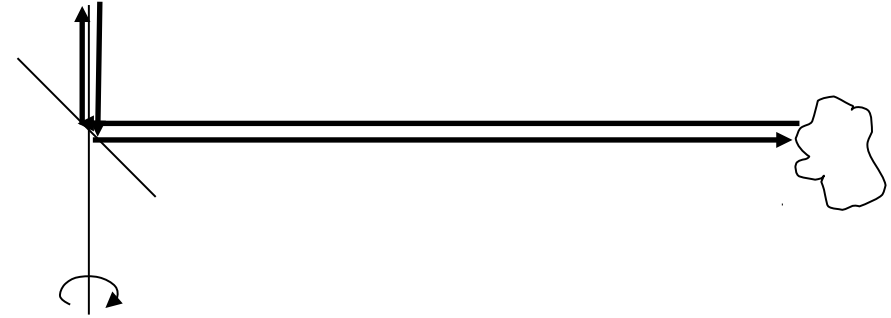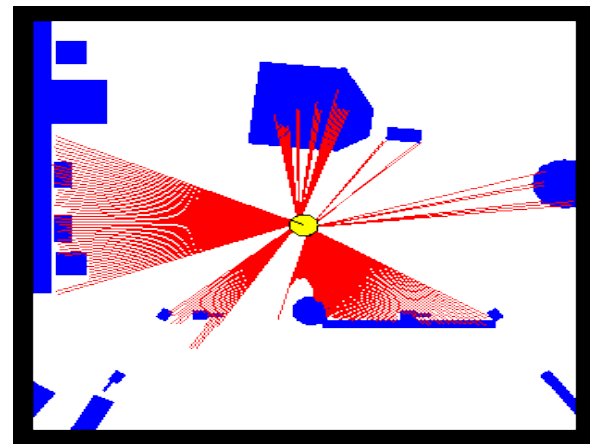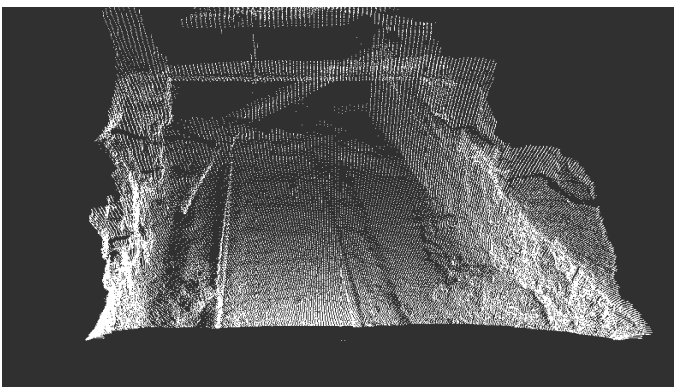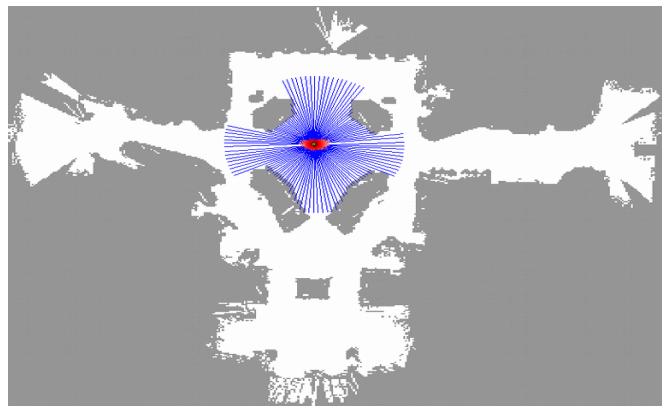- RGB Cameras
- Tactiles
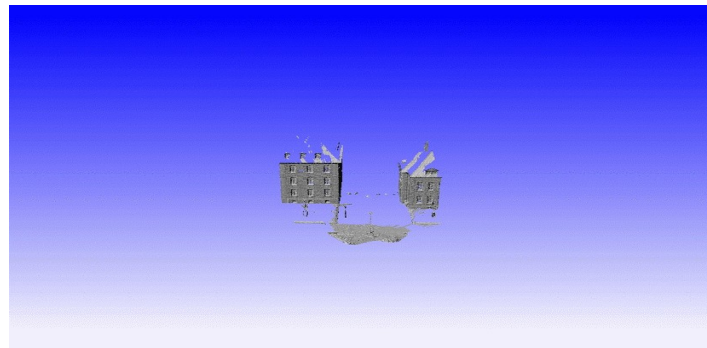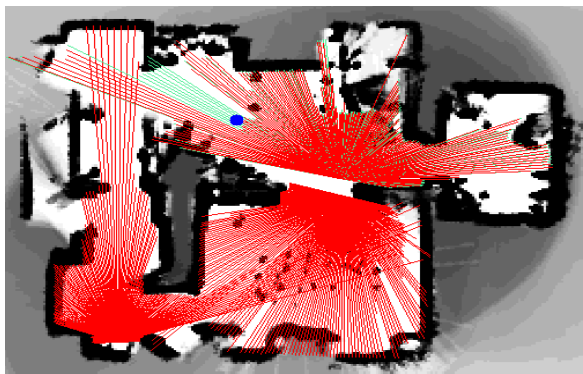
Time of flight

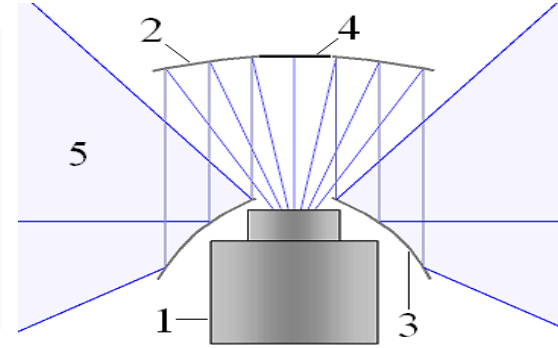Intensity-based

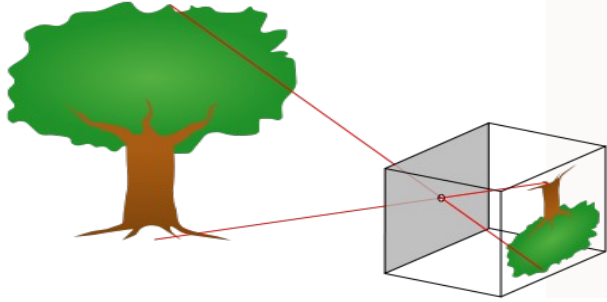# Laser Range Scanner

Properties

- High precision
- Wide field of view
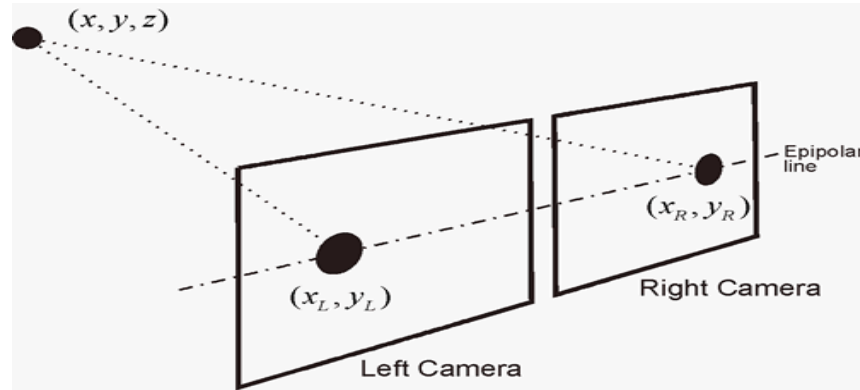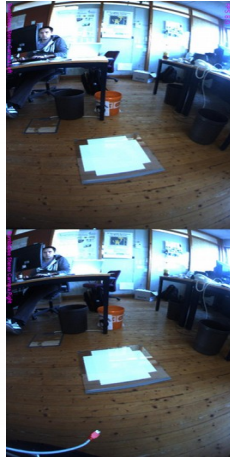- Approved security for collision detection
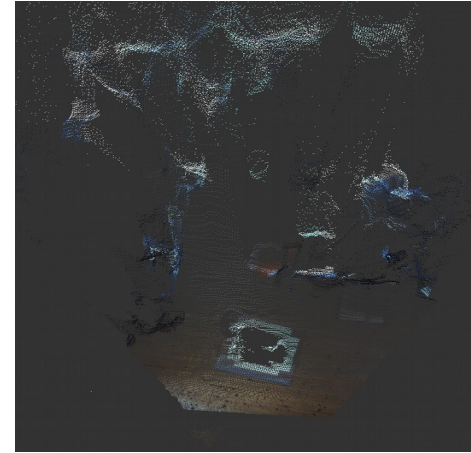
Typical Scans

RGB Monocular Camera

RGB Monocular Camera

- Cameras measure the intensity of the light projected onto a (typically planar) ccd through a system of lenses and/or mirrors
- Provide a lot of information
- Project 3D onto 2D, which results in the unobservability of the depth
- The scene can eb reconstructed by multiple images (see SfM)

Stereo Camera

reconstruction from top

- Stereo cameras are combination of 2 monocular cameras that allow triangulation, given a known geometry.
- If the corresponding points in the images are known, we can reconstruct the 3D scene.
- Error in the depth depends on the distance!
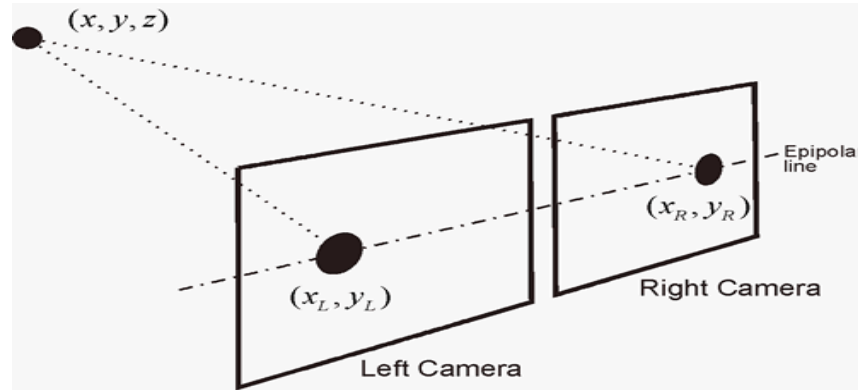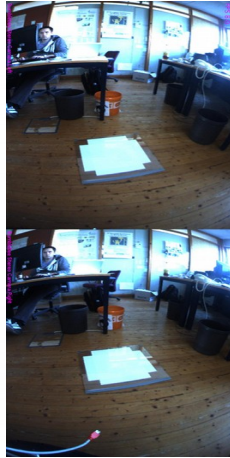- Sensible to lack of texture
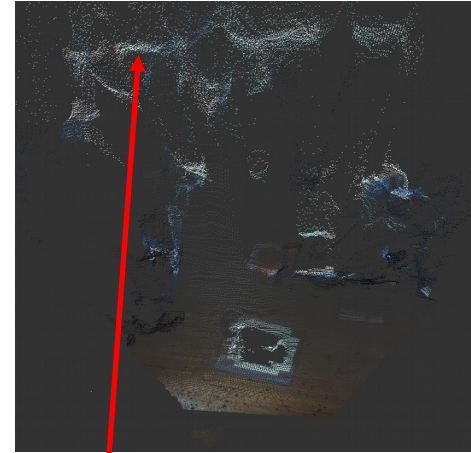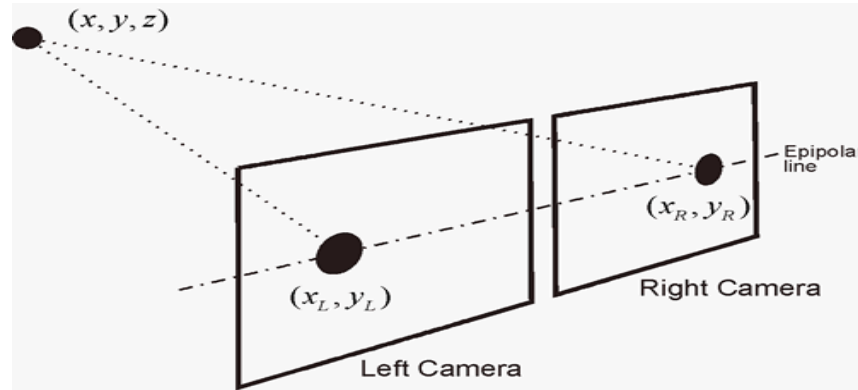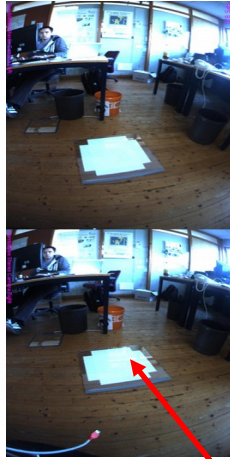
Stereo Camera

reconstruction from top

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- If the corresponding points in the images are known, we can reconstruct the 3D scene.
- Error in the depth depends on the distance!
- Sensible to lack of texture

Stereo Camera

reconstruction from top

(x, y, z)

(x_R, y_R) — Epipolar line
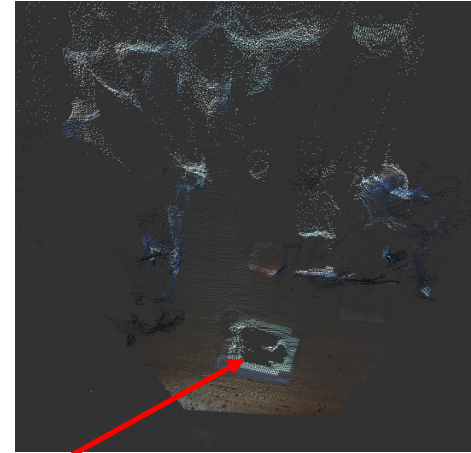
(x_L, y_L)

Right Camera

Left Camera

- Stereo cameras are combination of 2 monocular cameras that allow triangulation, given a known geometry.
- If the corresponding points in the images are known, we can reconstruct the 3D scene.
- Error in the depth depends on the distance!
- Sensible to lack of texture

How to access a Device in ROS?

- Each device is a node
- The input topics are the commands that the device can output
- The output topics are the feedback given by the device.

- In sensor_msgs/ many messages for the common sensors are defined.
- Use rosmsg show <message_name> to see the format of a message.

- To start a device it is sufficient to start the corresponding node and to give it the necessary configuration parameters. These include
  - Specific devices parameters (e.g. which serial port/usb device , the resolution of an image, and so on..)
  - The **name** of the **reference frame** in the sensor