Probabilistic Robotics Course

Robots and Sensors
MARRTino & Orazio

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Outline

- Robot Devices
  - Overview of Typical sensors and Actuators
- Mobile Bases
- MARRTino/Orazio
  - Hardware
  - Firmware

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

Measuring the Environment

Perception of the environment

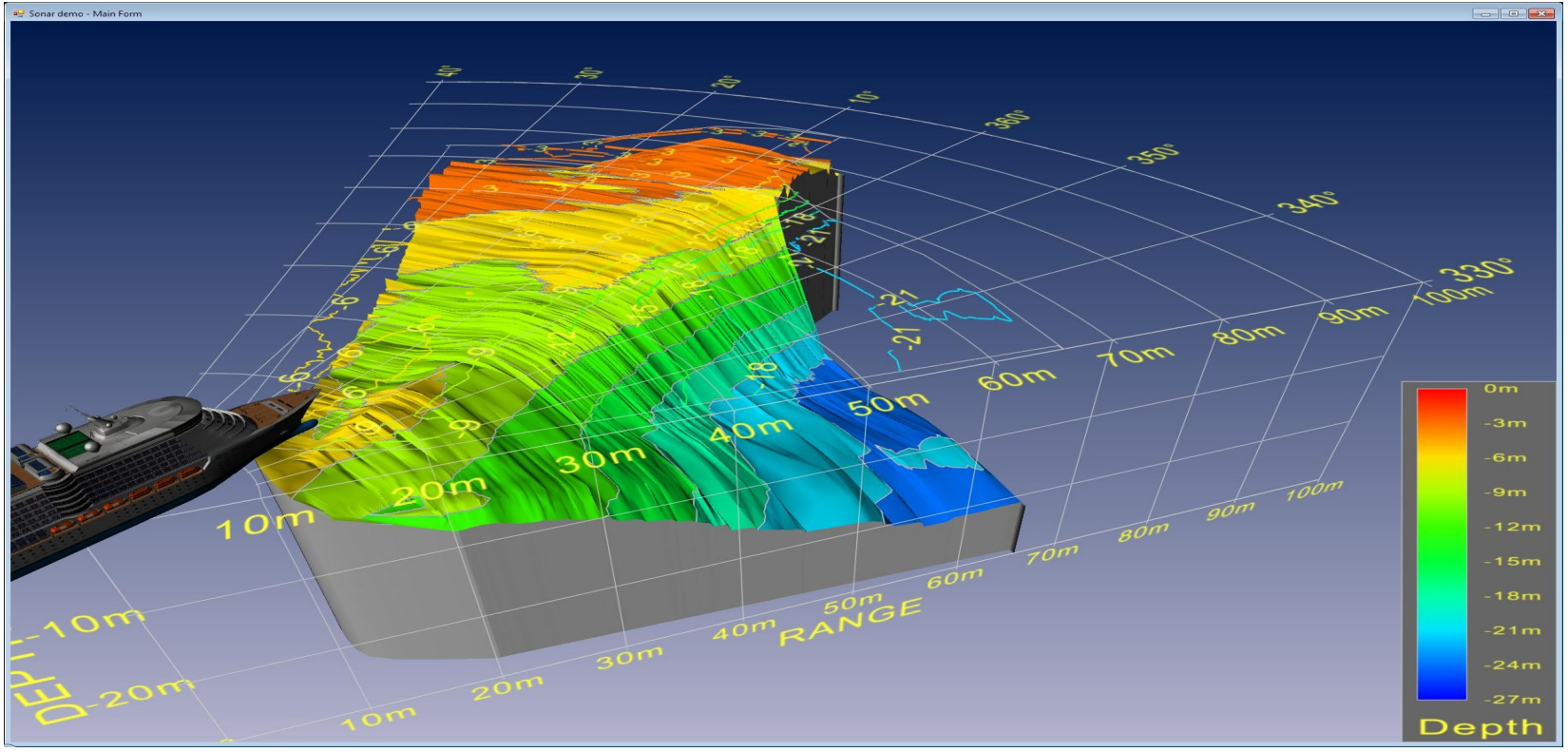
Active:

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

Passive:

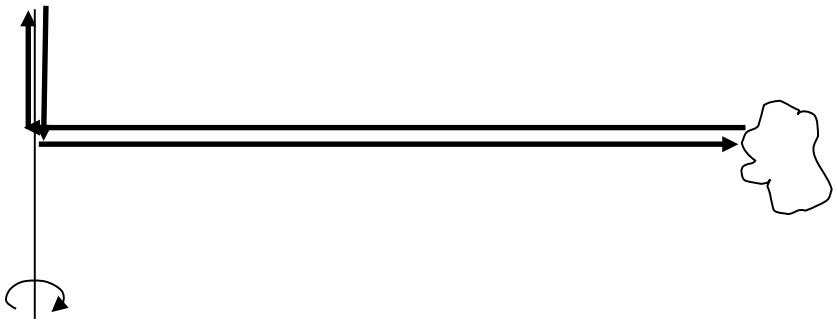
- RGB Cameras
- Tactiles

Sonars
(SOund Navigation And Ranging)



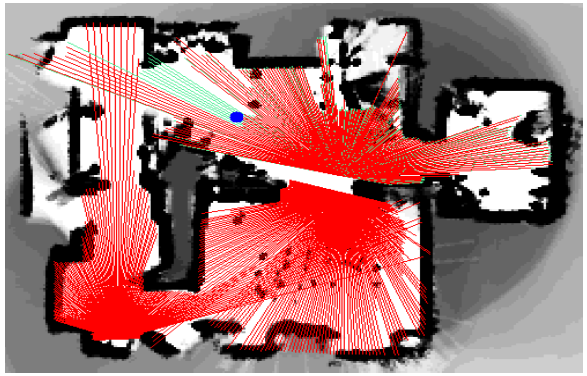
- Extensive FOV

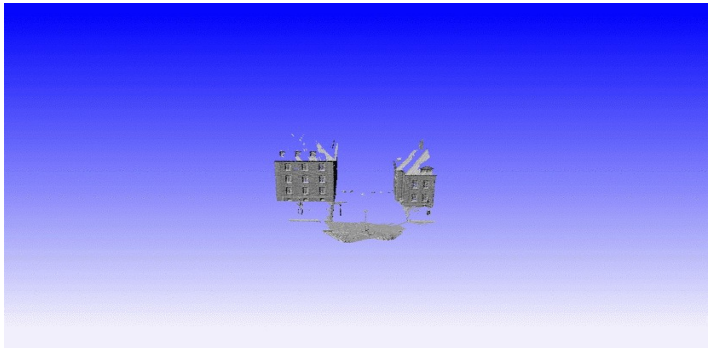
Laser Scanner

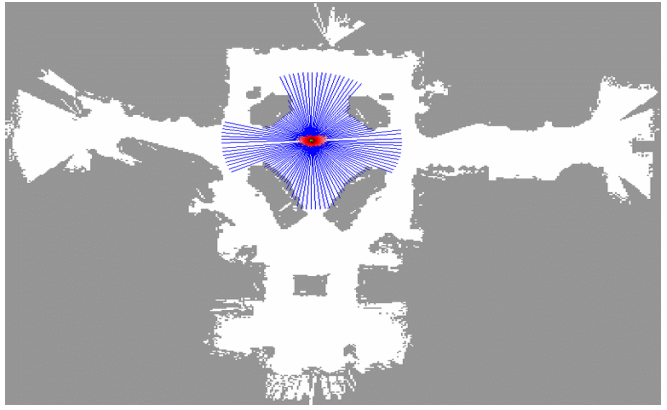


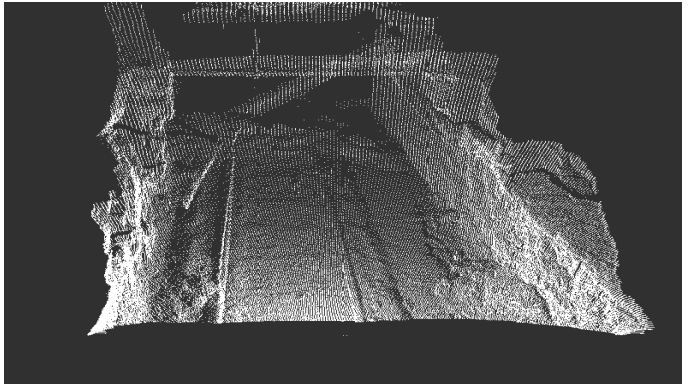
- Wide FOV
- Highly Accurate
- Approved security for collision detection

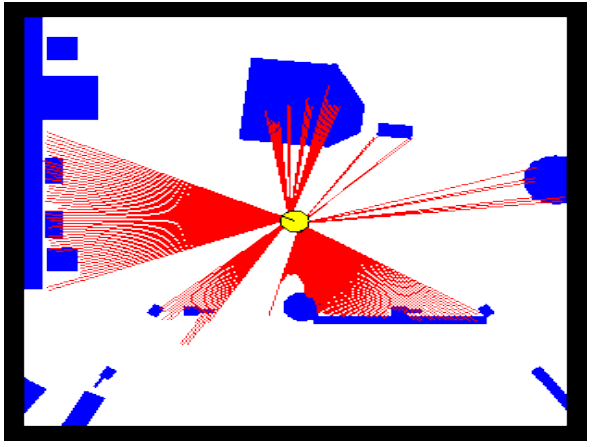
Typical Scans



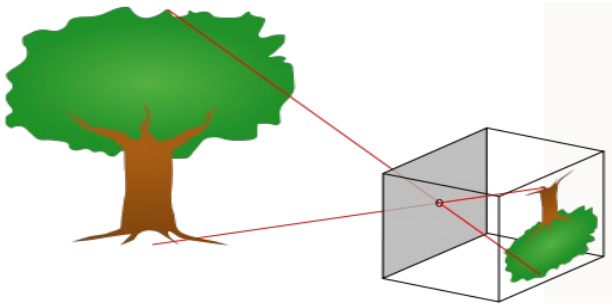


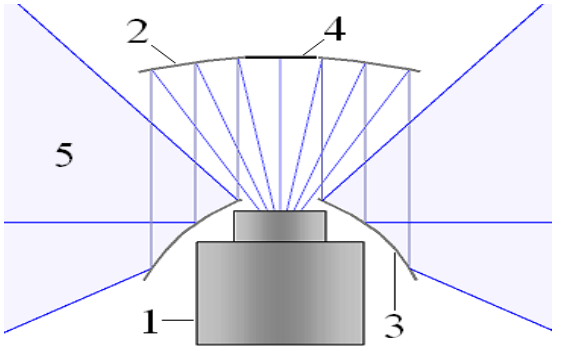






RGB Monocular Camera

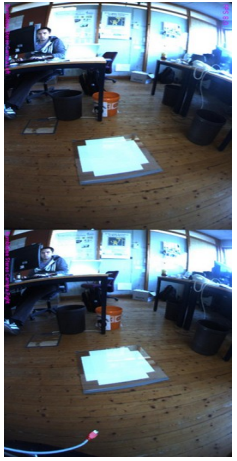


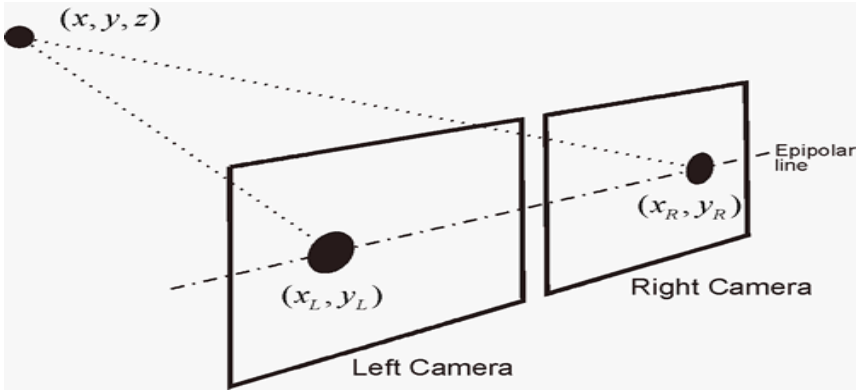


RGB Monocular Camera

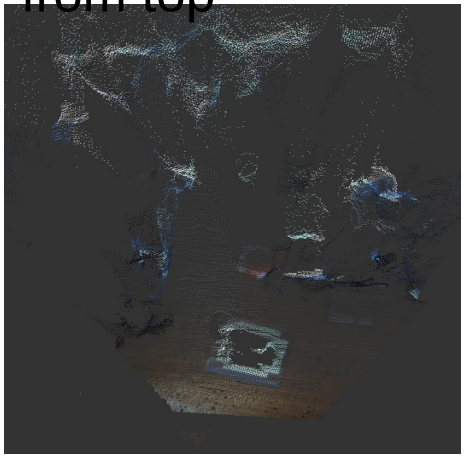
- Cameras measure the intensity of the light projected onto a (typically planar) ccd through a system of lenses and/or mirrors
- Provide a lot of information
- Project 3D onto 2D, which results in the unobservability of the depth
- The scene can be reconstructed by multiple images (see SfM)

RGB Stereo Camera





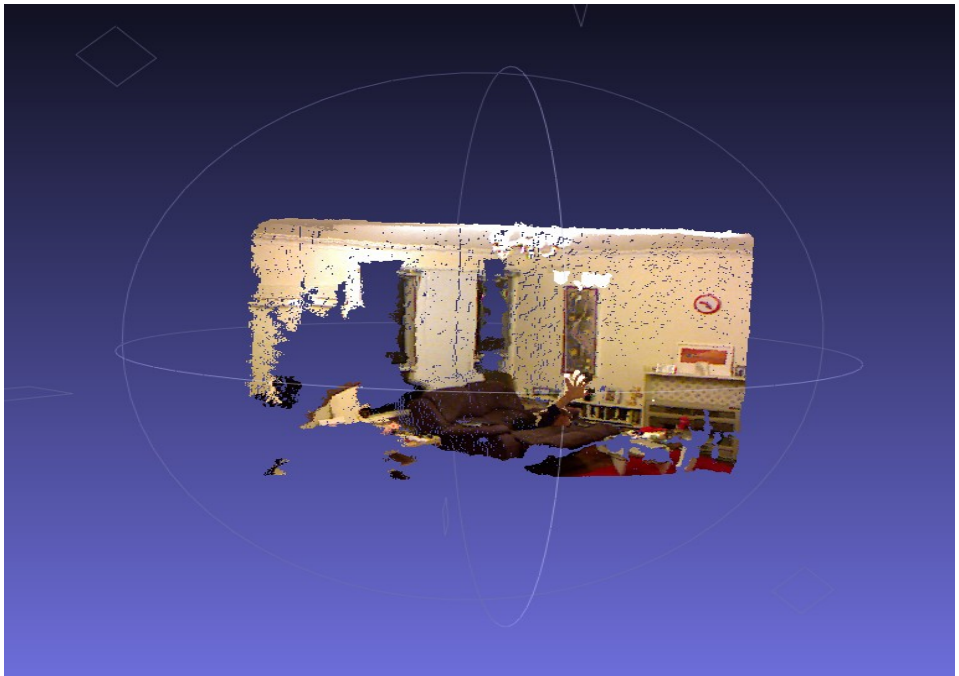
reconstruction from top



- 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

RGB-D Cameras

- Cameras that are able to sense the color and the depth even with poor/no texture
- Use an active light source and retrieve the depth either
  - via stereo triangulation (emitter and source are in different positions)
  - Time of flight (emitter and source are in the same position)
- Environment conditions should allow to sense the emitted light.
- Typically OK indoors

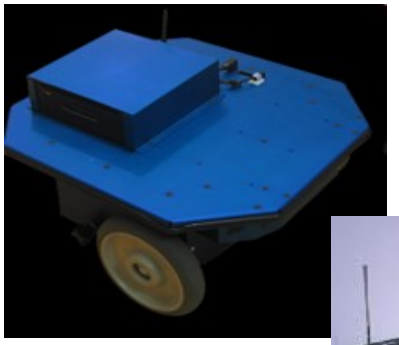


Mobile Base

- 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).



MARRtino

- Is a simple but complete mobile base designed to be used in the MARR course.
- The cost of the parts is around 300 euro
- It is entirely open source
- It is integrated in ROS through a simple node that publishes/subscribes standard topics

https://www.marrtino.org/

Orazio

- Is a simplified yet complete redesign of MARRtino, with the goals of
  - Using easy-to-find hardware (Arduino)
  - Reducing the assembly time (2 hours for non skilled users)
- It is entirely open source
- It is integrated in ROS through a simple node that publishes/subscribes standard topics

Firmware at **`https://gitlab.com/srrg-software/srrg2_orazio`**