# HMI

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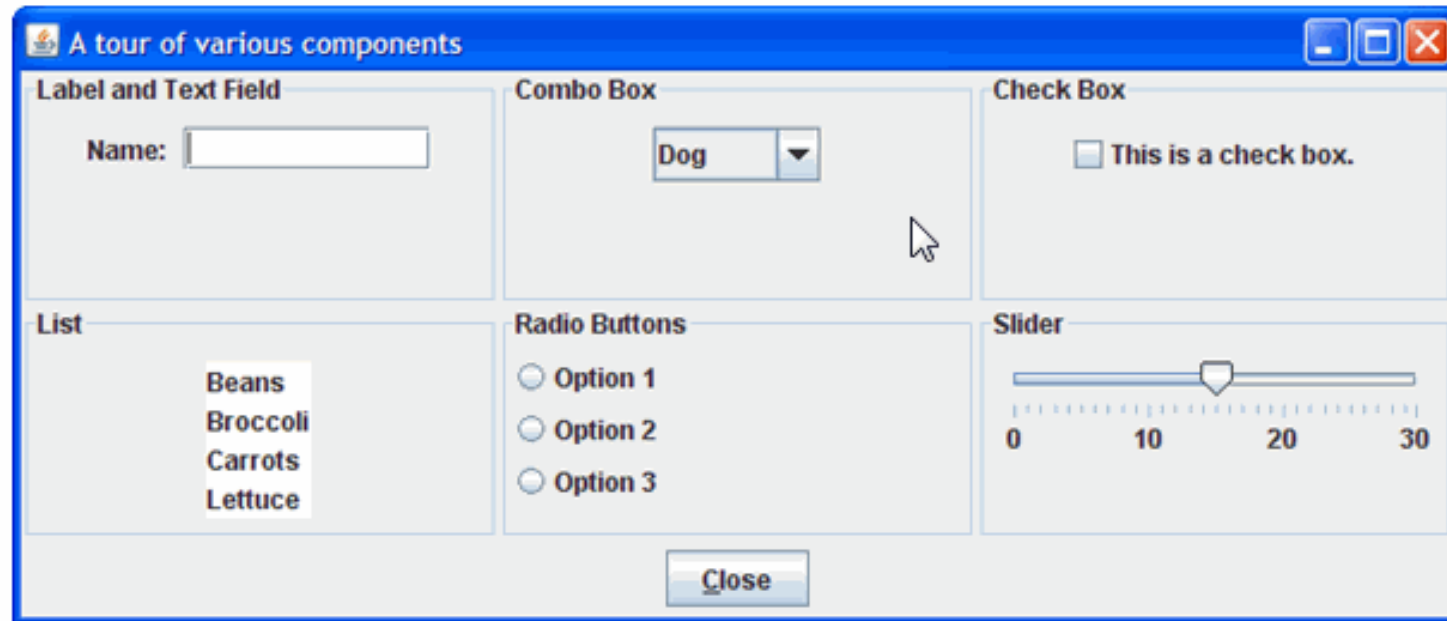
# Human-Machine Interface (HMI)

- The space where interactions between humans and machines occur.

- Allow <u>effective operation and control of the machine</u> from the human end, whilst the machine simultaneously feeds back information that aids the operators' decision making process.

- Similar words: user-interface (UI), man-machine interface (MMI), human-machine interaction, human-robot interaction (HRI), human-computer interaction.
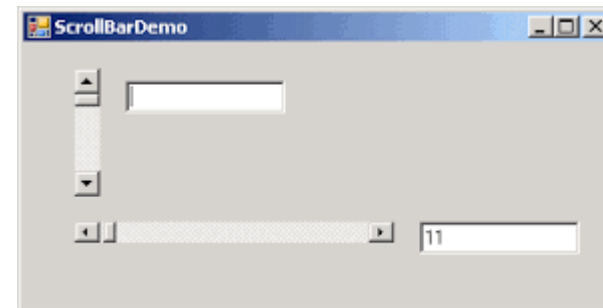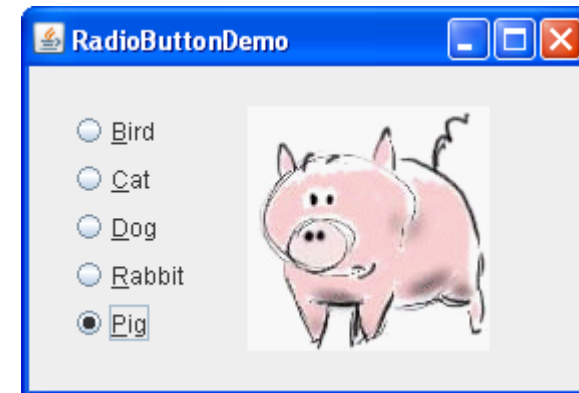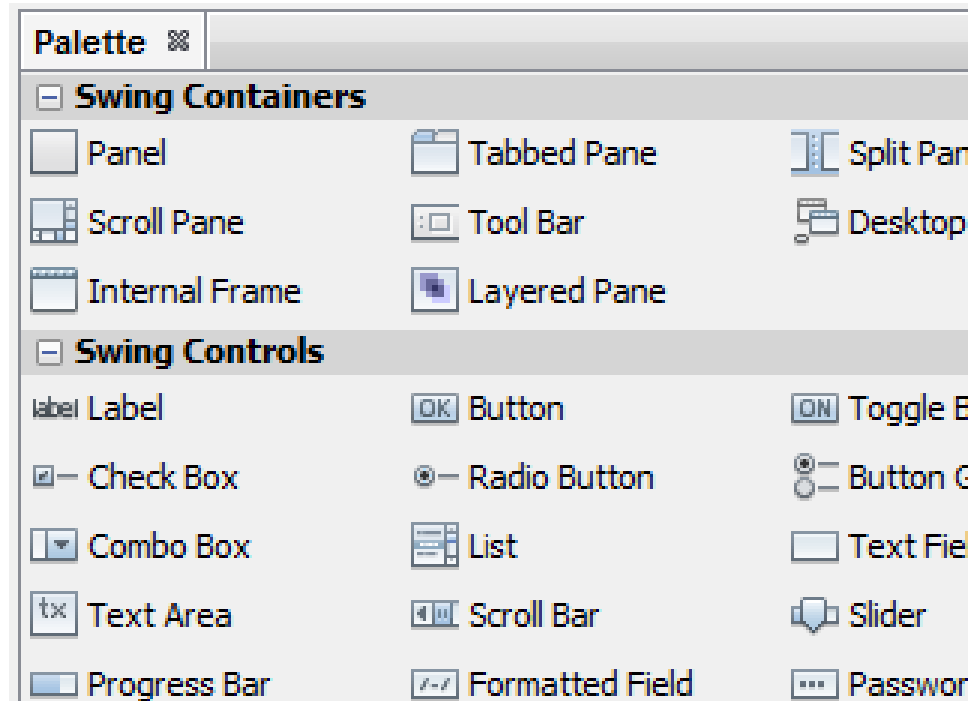
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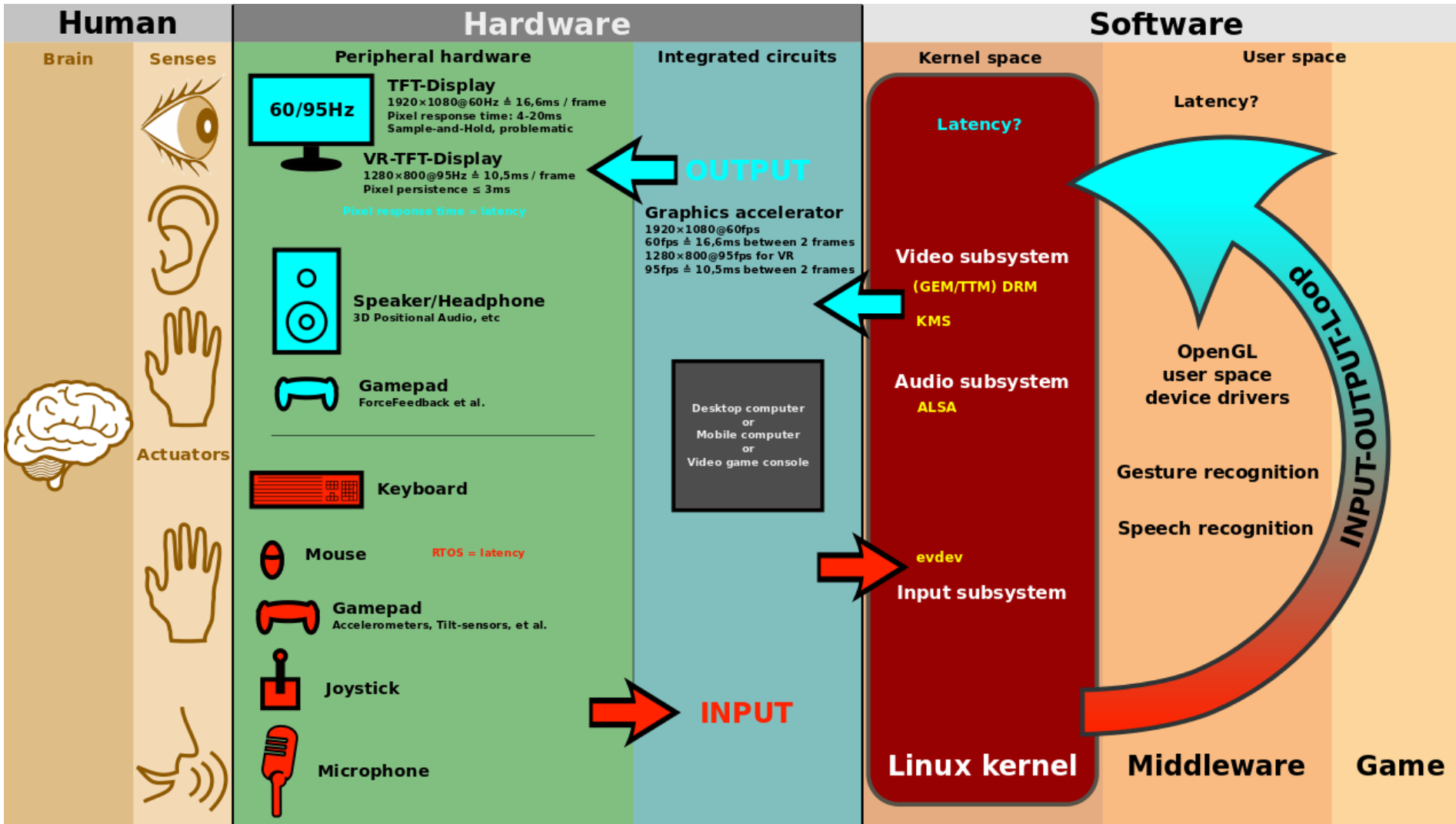
# Graphical User Interface

Graphical User Interfaces (GUIs) use a graphical **window** or windows that provide interaction with the user.

# GUI Components
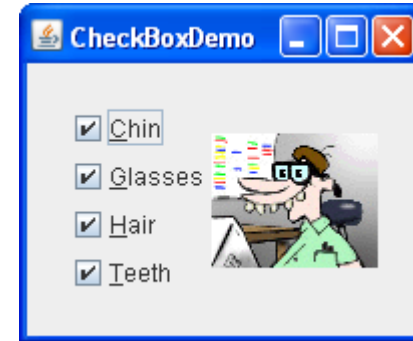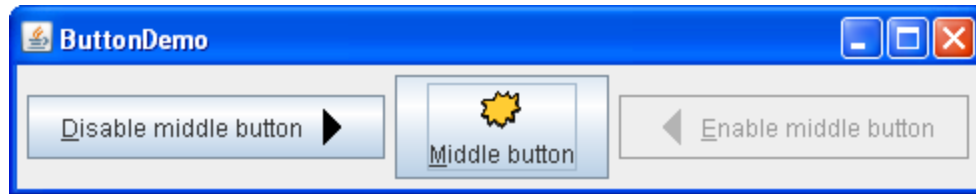
# Goal of HMI

Produce a user interface which makes it

• Easy (self-explanatory),

• Efficient, and

• Enjoyable (user-friendly)

to operate a machine in the way which produces the desired result.

Operator needs to provide minimal input to achieve the desired output with minimal knowledge, and also that the machine minimizes undesired outputs to the human.

# Level of Autonomy



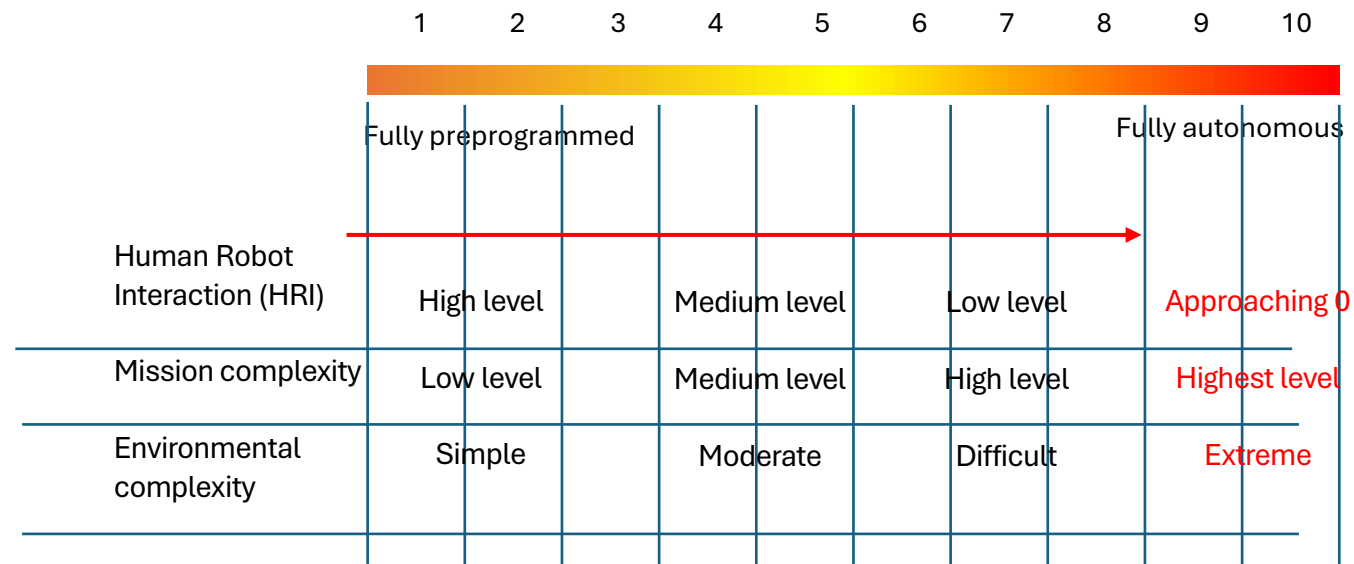|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
|  | Fully preprogrammed |  |  |  |  |  |  | Fully autonomous |  |  |
| Human Robot Interaction (HRI) | High level |  | Medium level |  | Low level |  |  | Approaching 0 |  |  |
| Mission complexity | Low level |  | Medium level |  | High level |  |  | Highest level |  |  |
| Environmental complexity | Simple |  | Moderate |  | Difficult |  |  | Extreme |  |  |

# Level of Driving Automation

| SAE level | Name | Narrative Definition | Execution of Steering and Acceleration/ Deceleration | Monitoring of Driving Environment | Fallback Performance of Dynamic Driving Task | System Capability (Driving Modes) |
|---|---|---|---|---|---|---|
| **Human driver monitors the driving environment** | | | | | | |
| 0 | No Automation | the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems | Human driver | Human driver | Human driver | n/a |
| 1 | Driver Assistance | the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task* | Human driver and system | Human driver | Human driver | Some driving modes |
| 2 | Partial Automation | the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task* | **System** | Human driver | Human driver | Some driving modes |
| **Automated driving system ("system") monitors the driving environment** | | | | | | |
| 3 | Conditional Automation | the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene* | System | **System** | Human driver | Some driving modes |
| 4 | High Automation | the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene* | System | System | **System** | Some driving modes |
| 5 | Full Automation | the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver* | System | System | System | **All driving modes** |

Level of driving automation （SAE International, 2014）

# ROS Packages for HMI

- Graphical User Interface (GUI)
  - RQT: http://wiki.ros.org/rqt
- Visualization
  - RVIZ: http://wiki.ros.org/rviz
  - Gazebo: http://wiki.ros.org/gazebo_ros_pkgs
- Joystick
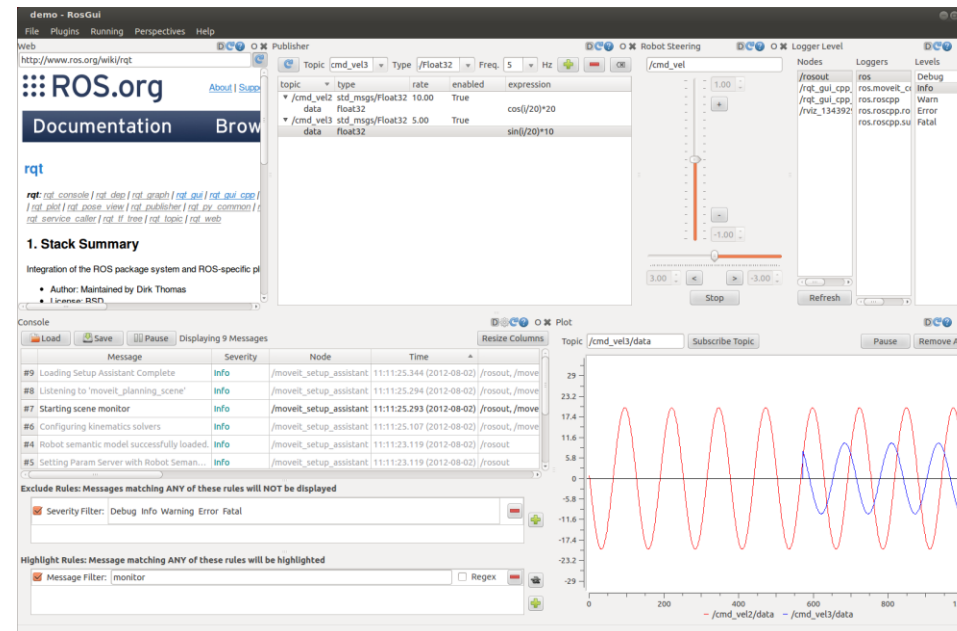  - Joy: http://wiki.ros.org/joy

# RQT

Software framework of ROS that implements various GUI tools in the form of plugins.
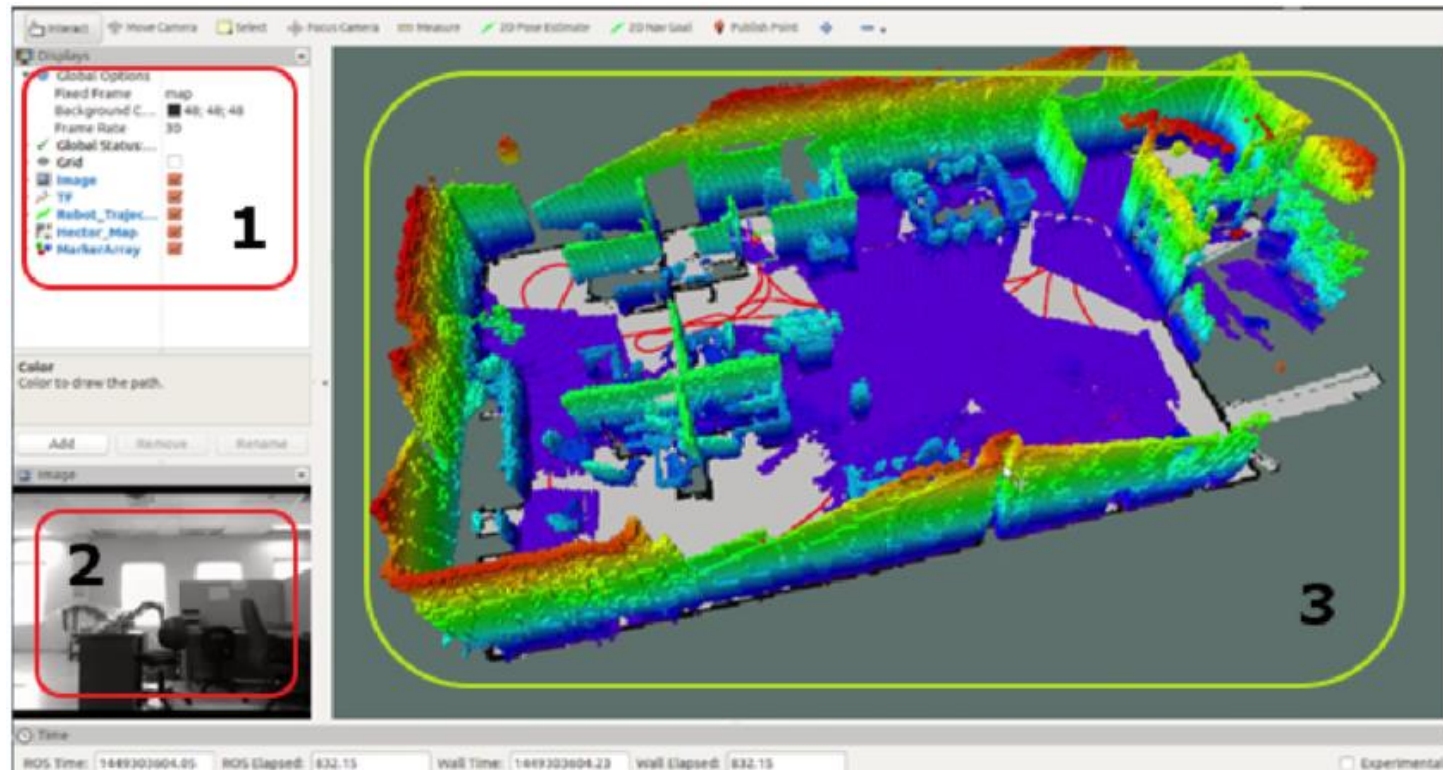
**rqt**: Core modules

**rqt_common_plugins**: ROS backend tools suite that can be used on/off robot runtime

**rqt_robot_plugins**: Tools for interacting robots during their runtime

# RVIZ

Shows what the robot sees.  Users can select information to see.

# Exercise

1.  Mount a USB camera onto the pan/tilt unit.

2.  Connect a USB camera to your PC.

3.  Show video images on Rviz.

4.  Design a joypad.

5.  Control the pan/tilt unit (**one servo for online students**) using the joypad.

# Homework

This is an individual assignment.

- Take a picture of the pan/tilt camera you integrated and submit it as a png file.

- Complete the in-class exercise and submit a short video (mp4) showing camera streaming on Rviz and the actual pan/tilt motion using the joypad.