Robot augmented reality

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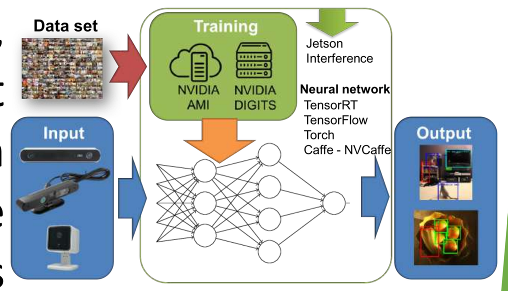
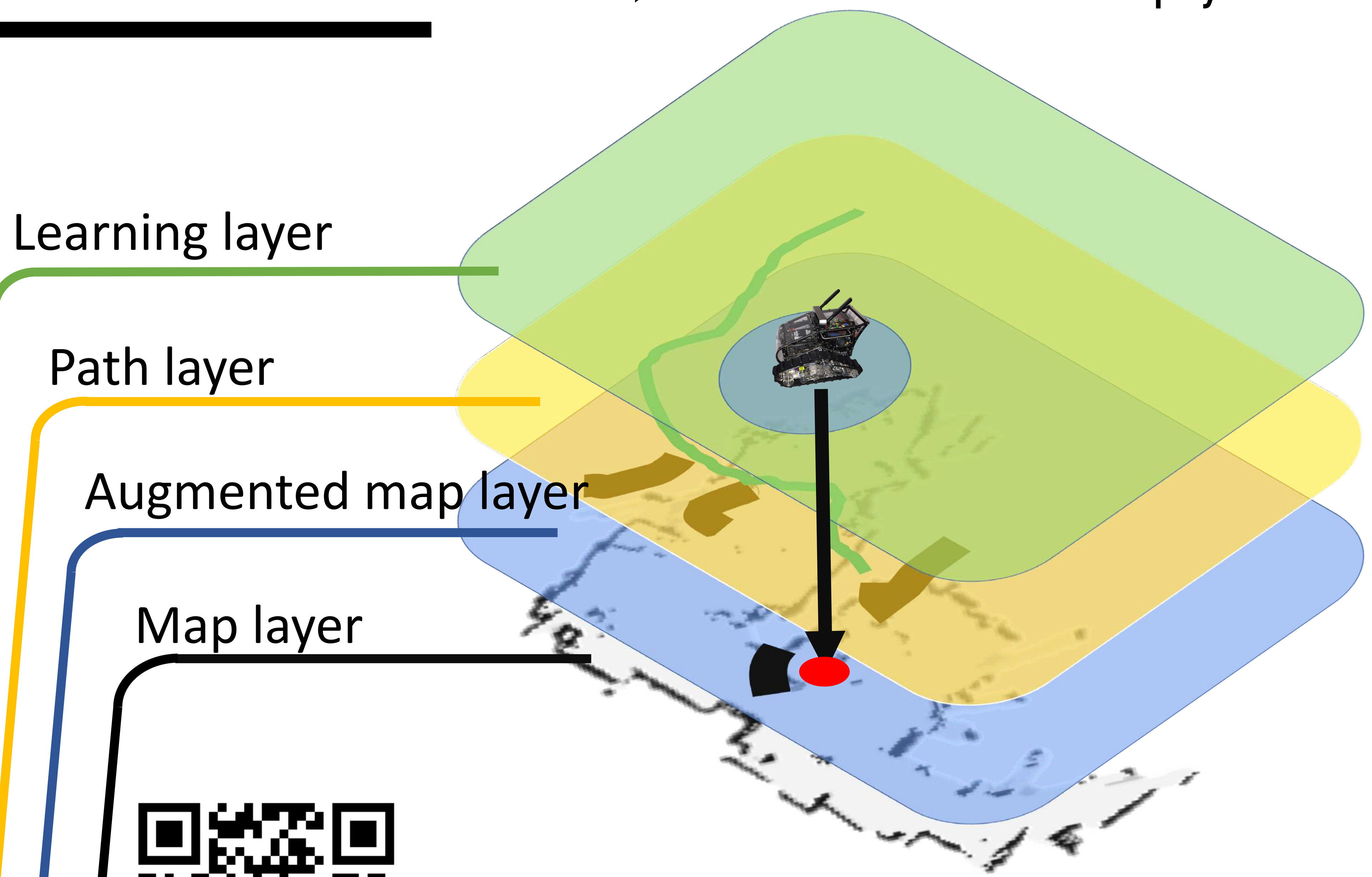
Allow the robot to interact with obstacles that are not really present in the environment, but have been drawn by an external operator. The path planner is capable of recognize both real and virtual obstacles, building a trajectory that treats both of them in the same way.
This technique giving the opportunity to try to drive a robot in hard "virtual" environments, drawn on the basis of real physic environments.

Learning & obstacle avoidance

When the robot is moving inside the environment, it is driven by two control algorithms: a "static" path planner that keeps the robot on a pre-planned path, a "dynamic" potential field obstacles avoidance algorithm that allows to detect moving obstacles, reacting immediately to them. Meanwhile with the Jetson Inference the robot recognizes the objects and save the coordinates inside the map. The unknown obstacles are stored in a database and the objects recognized (books) are pinned in the map and listed in the webpage.
When the robot approaches the goal, the planner checks to have completed the full path, it stops the robot and the user can read the information about the path, the objects detected and the status of the machine.





Dude

Characteristics

- Size: 20x30x15 (cm)
- Weight: 1.5 kg
- Type: Wheeled
- Board: Jetson TK1
- Motor Control: unav
- Sensors:
  - XTION
  - IMU
  - Odometry

Panther

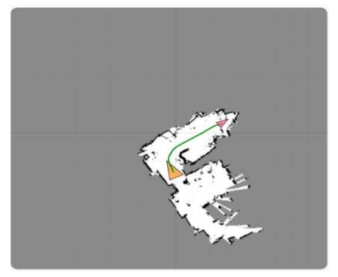
Characteristics

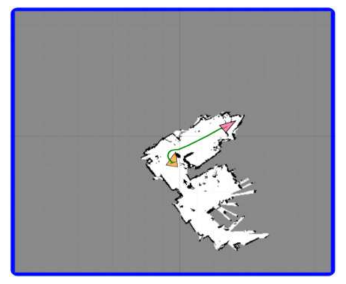
- Size: 42x40x30 (cm)
- Ground clearance: 7cm
- Weight: 11 kg
- Type: Tracked
- Board: Jetson TX2
- Motor Control: unav
- Sensors:
  - ZED
  - LIDAR
  - IMU
  - Odometry

Path planner

The robots use the ROS mobile base controller [2] to control all tasks during the navigation. The global path planner designs the path and checks if the robot does not have any obstacle on the way. Before to start the planner generates a local path and solves the moving constraint issue, the robot can change the trajectory to avoid unplanned obstacles during the trip. The idea is to link the trajectory of the vehicle according to available spaces and bounds on the speed. This is an evolution from [1] and integrates an optimal nonlinear discrete planner. The mobile robots, Dude and Panther, can be represented with same kinematic model with an approximation of a unicycle (non-holonomic). (The nonlinear discrete controller requires another internal loop to compensate the dynamic components)

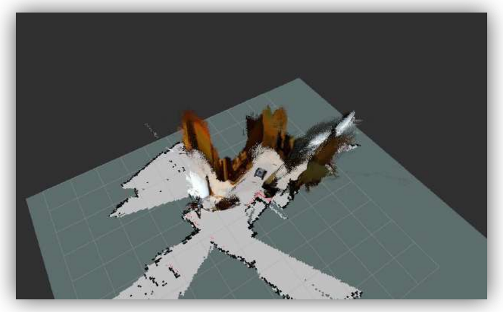
Augmented reality & human interaction





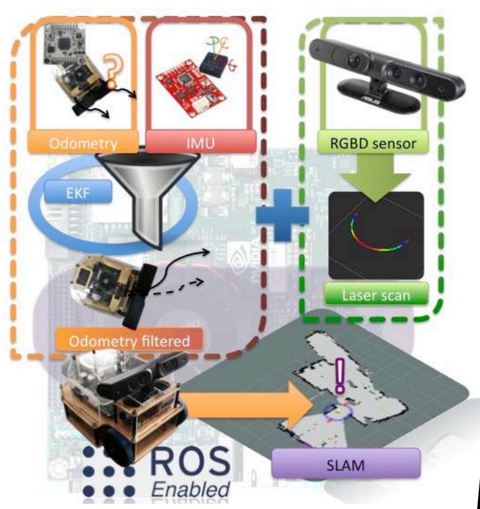
The augmented reality is an interaction between a real world (information extrapolated from other sensors) and virtualized space.
With this technique, the behavior of the robot change when approach a particular obstacle drawn in the web page and it is moving avoid the fake obstacle and the approached real obstacle. To solve this issue is required an interaction between "drawn map" and "real map". The "real map" is built with the Simultaneous Localization and Mapping (SLAM) and build a 3D map [5]. The web interface controller (major details in the green box) can be modify the map bitmap in real time and save in a local database the combined information.

Video



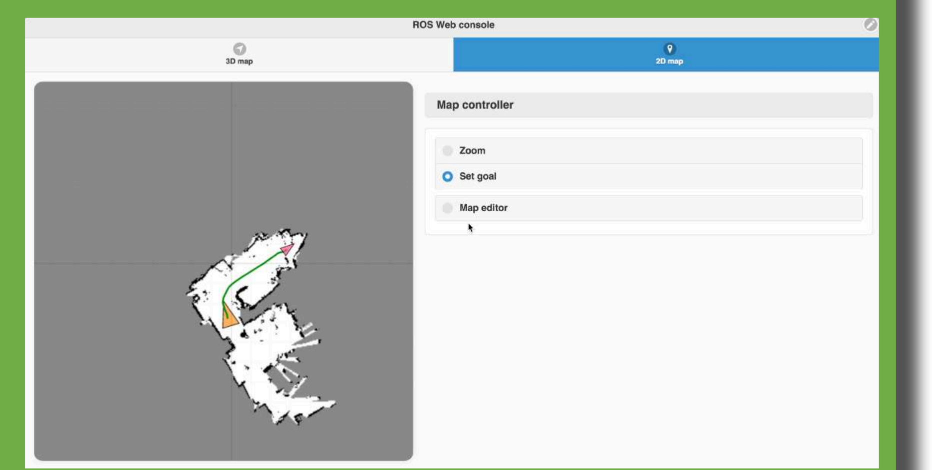
Map & localization

With the Extended Kalman Filter (EKF) implemented in ROS [3], the localization from motor odometer, visual odometer (ZED stereo camera) and from an IMU are fused and used to localize the robot in the real world. The EKF keeps track of an estimate the robot position.
The EKF information are combined with the SLAM. It processes consists of a number of steps and the goal of the process is to use different feature of the environment to localize the robot inside the real-time built map and update the localization of the robot. In addition, Panther use the data from the LIDAR to fix and increase the performance of the robot [5].



Web interface controller

With ROS the telemetry information are bridged in a web interface via "robotwebtools" [4]. The web page shows real time the 2D map generated real-time from the SLAM and with an editor has possible to draw inside 2D map and show the update from the path planner to avoid real and virtual obstacles.
The new obstacle is drawn in black, the free space in drawn in white and the unknown environment in grey. In the same time, it is possible to modify the map and you can add or remove obstacle recognize previously. (in figure, a screenshot from the web interface)



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