Object recognition while mapping for an autonomous robot vehicle

University of BRISTOL

Marios Georgiou

Supervisor: Dr Walterio Mayol-Cuevas

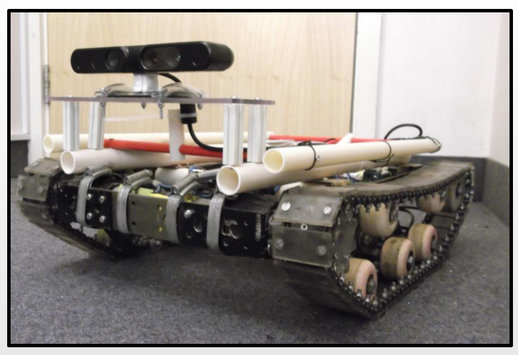
Department of Computer Science

Abstract: The aim of the thesis is to produce a set of algorithms based on an RGB-D camera sensor and build a robot that uses these algorithms.

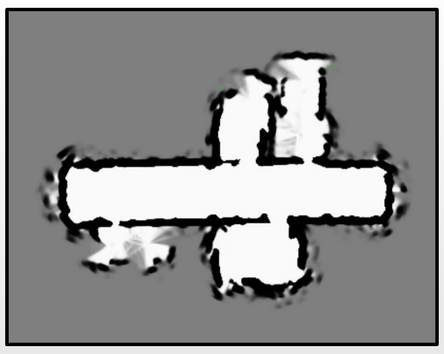
Tasks:

+ Environment mapping
+ 3D object recognition
+ Path planning
+ Supporting algorithms for running the robot.

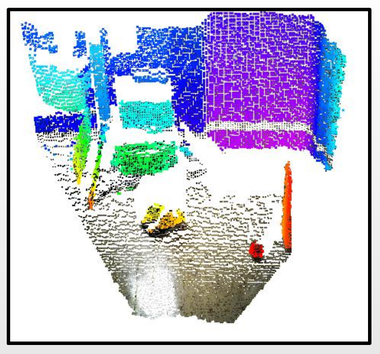
Overview



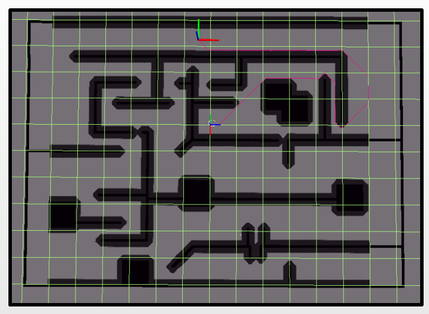
+ Custom tracked robot
+ 30A drivers, drill motors
+ Lexan polycarbonate pads
+ Bicycle chain tracks



Mapping of the environment using vision

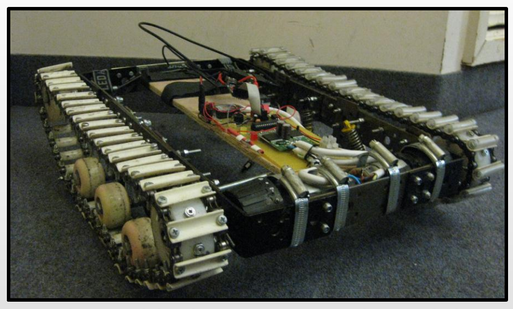


3D object recognition

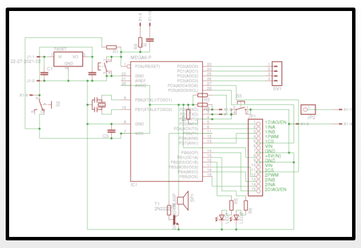


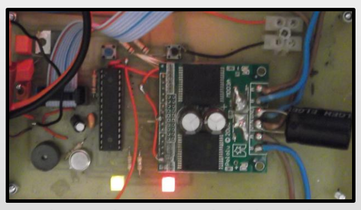
Path planning using the Flood fill algorithm

Robot design

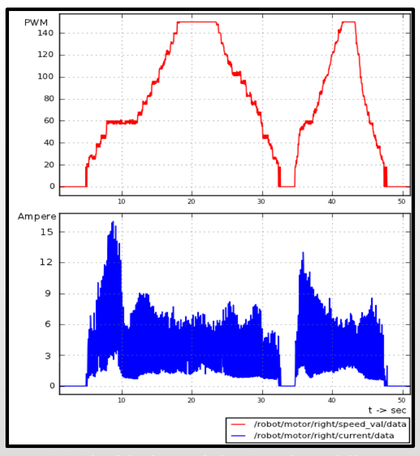


Robot with the PVC version of the track pads





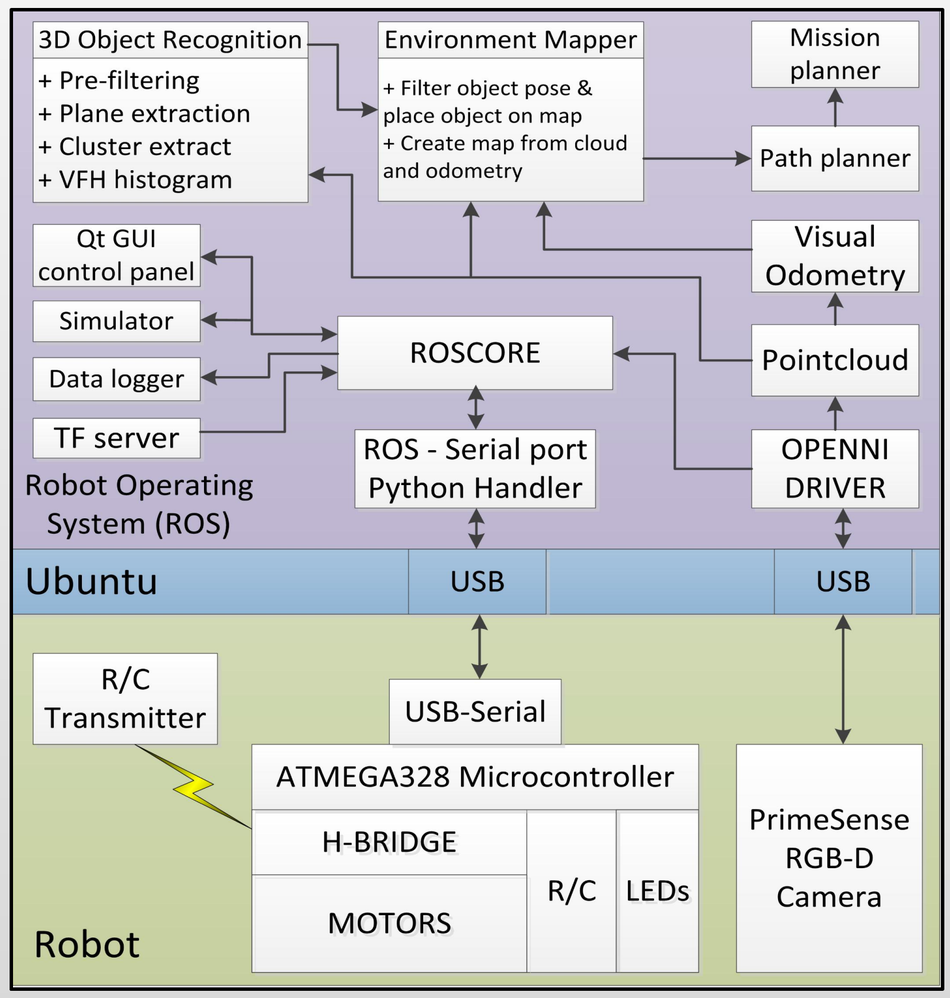
Schematic & board of the robot



Static friction of the tracks while manually varying the PWM duty cycle.

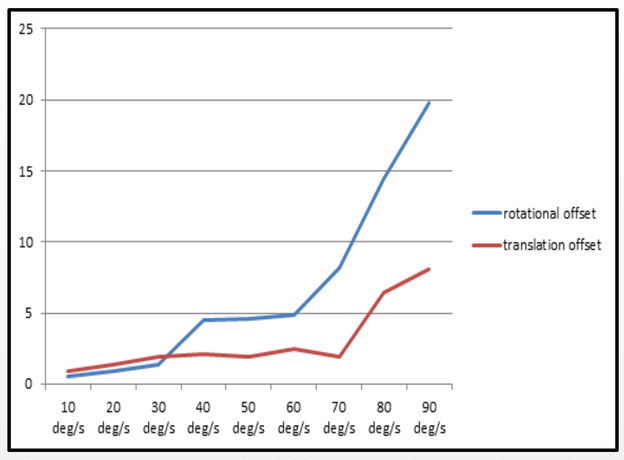
System architecture

The architecture of the system follows a network-centric, message passing model. This allows for all the modules of the robot to be integrated seamlessly. The benefit of running all the algorithms as nodes is that it promotes easier debugging and increased scalability.



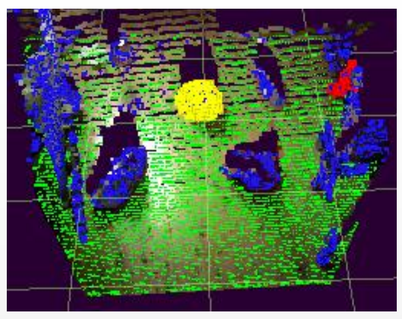
Environment mapping

Map of a 10 x 10m area (with furniture)

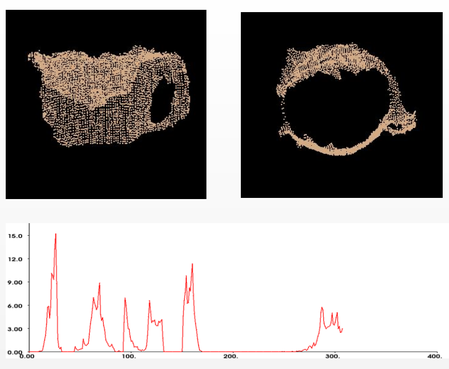


Angular velocity vs. offset (deg) in rotation and translation

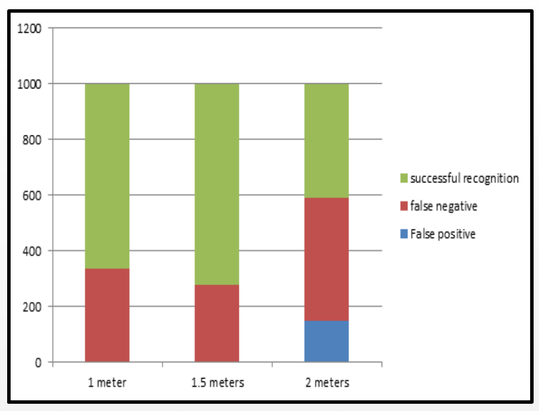
3D Object recognition



Green: Extracted planes
Blue: Points not in a plane
Red: Cluster currently in scope
Yellow: Identified, spherical object

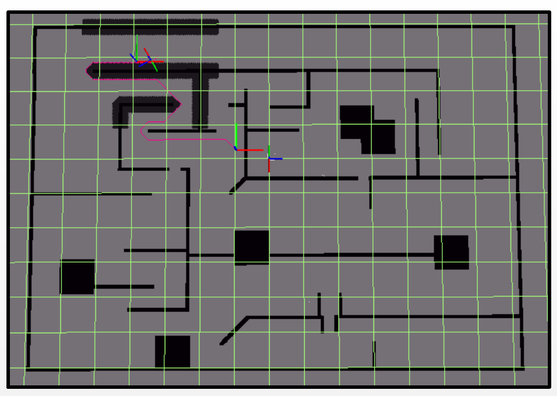


Object signature extraction of a mug

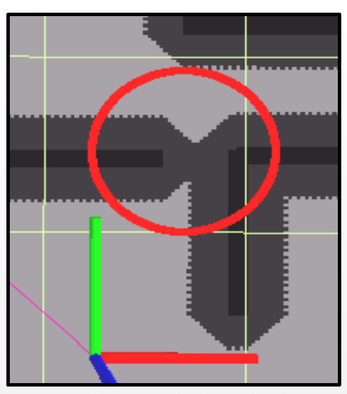


Performance of comparison of a specific object in different distances

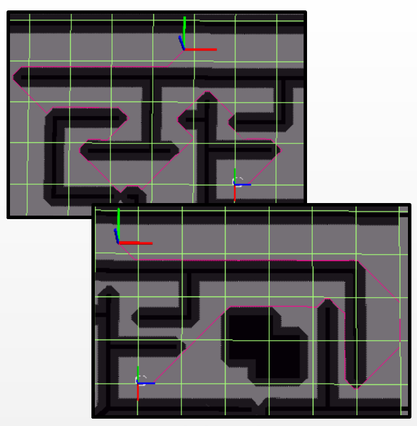
Path planning



Dynamic inflation of obstacles & faster path calculation



A smaller path is ruled out



Straights than turns (adds cost on turns)

Conclusions

The described algorithms were successfully integrated into a coherent system. Each task was successfully carried out according to the specification.

+ The robot is able to support enough payload for it to operate completely untethered (20kg).

+ The mapping algorithm can produce a map using only visual odometry. The mapping consistency was heavily dependant on the viewing angle of the sensor and the complexity of the environment layout.

+ Object recognition using pointcloud data also resulted in high rates of success given that the object's signature was pre-recorded.

+ The path planning and tracing algorithm was tested in simulation and with the robot with success. Mapping and planning simultaneously is also possible but carries a high risk of map distortion due to vibration.