A. Title Page

Final Report for Development of an Indoor Robot for the Study of Simultaneous Localization and Mapping (SLAM) Algorithms

Carlos L. Castillo
Corley Building 114A
964-0877
ccastillo@atu.edu

B. Restatement of problem researched or creative activity

Natural disasters like earthquakes, tornados, landslides, and hurricanes can produce collapsed buildings in which people can be trapped in the rubble. Search and rescue teams are sent to disaster areas to save people. However, sending rescue personnel into collapsed/damaged buildings put them in a great danger. Sending a robot capable of navigate into collapsed building would be extremely desired. Robot navigation relies on two key *competences*[3]: *path planning* and *obstacle avoidance*. There are a great variety of obstacle avoidance approaches that have demonstrated to be competent. Path planning[4] is a strategic problem-solving competence that involves identifying a trajectory that will cause the robot to reach the goal location. This strategic competence needs a map of the environment, the current robot's location and the goal location. Hence, obtaining the robot location and a map of the environment is fundamental to enable robot navigation. Collapsed buildings normally have unpredictable changes in their layouts. Hence, it is necessary to generate a new map of the buildings' interiors to be able to have effective robot navigation. Robot navigation is possible if a map is available and it is possible to locate the robot on it. Generating a map of collapsed buildings and then used it for robot navigation is not a practical task during disaster conditions, because the urgency of rescuing people. Therefore, it is important to develop algorithms that allow the robot to locate itself and build the map of its surroundings simultaneously.

Currently, a very active area of research is the development of algorithms for Simultaneous Localization and Mapping (SLAM) of unstructured and unknown GPS-denied environments. In SLAM algorithms the information provided by a range-finder sensor is combined with the information provided by odometry sensors. The main focus of this research was to develop an Indoors Robot properly equipped for the study of Simultaneous Localization and Mapping (SLAM) algorithms.

C. Brief review of the research procedure utilized

In this proposal an indoor robot was built and equipped to study and implement algorithms for Simultaneous Localization and Mapping (SLAM). One important aspect of building the robot was to obtain an affordable and ready to use robot base. The selected robot base was the Rex-16C which comes equipped with an HP HEDS 5500 two channel optical encoder in each wheel. A Hokuyo URG-04LX-UG01 laser range-finder was acquired. Additional equipment needed was a LeafLabs Maple microcontroller board, a Sabertooth Dual 10A 6V-24V Regenerative Motor Driver board, and the main computer system. The main computer system is a Dual Core PC based on a Mini ITX motherboard. The operating system selected is Ubuntu 11.04 "Natty". The final assembled robot is presented in Figure 1.

The selection of Ubuntu Linux was made mainly because it is the main operating system supported by the Robotics Operating System (ROS). ROS is an open source (BSD) software package that provides libraries and tools to help software developers create robot applications[1].

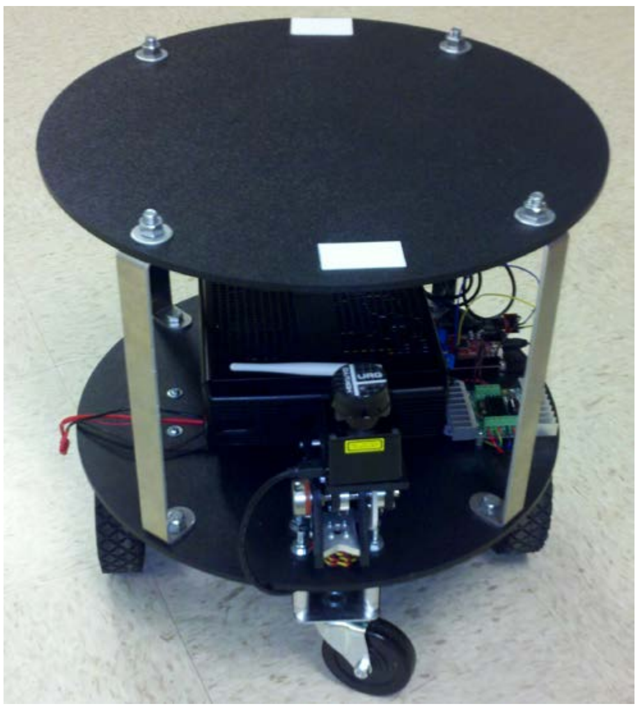

Figure 1. Final Assembled Robot

D. Summary of findings

The ROS navigation stack was configured and tuned to be able to work with the developed robot. The tuning of the navigation stack proved to be a delicate process. Figure 2 shows a setup built to test the SLAM algorithm.

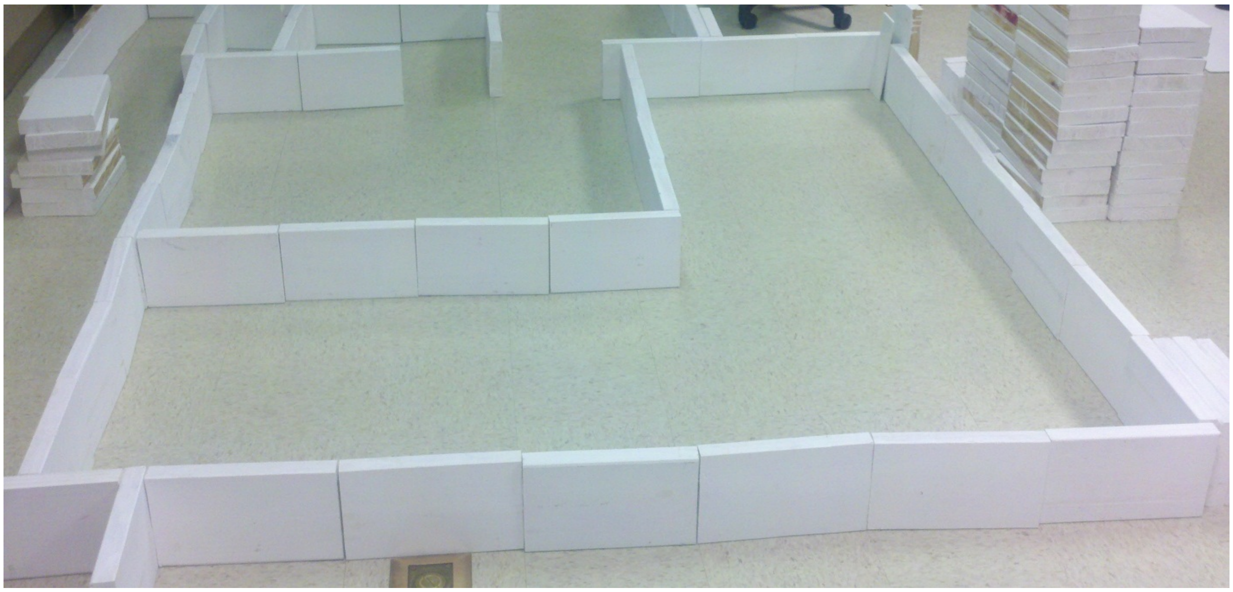

Figure 2 An L corridor used to test the SLAM algorithm

The developed robot successfully produced the map of the L corridor setup and was able to navigate through it. Figure 3 shows an screenshot of RViz which is a 3D visualization environment for robots using ROS[2]. Figure 4 shows a zoom of the map generated by the SLAM algorithm.

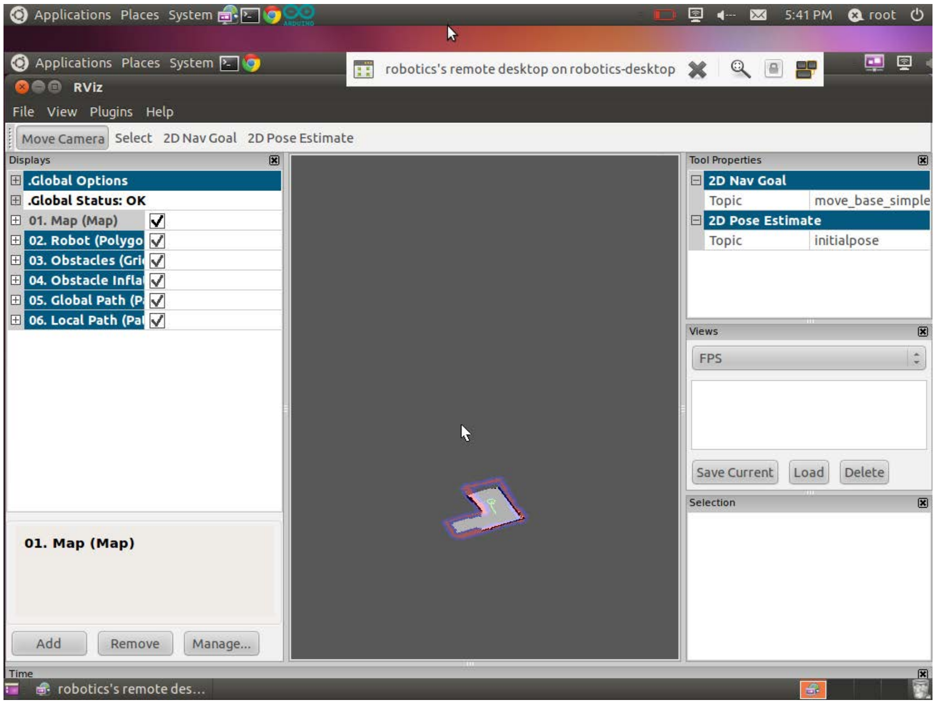

Figure 3 Screenshot of RViz (3D ROS Visualization environment)

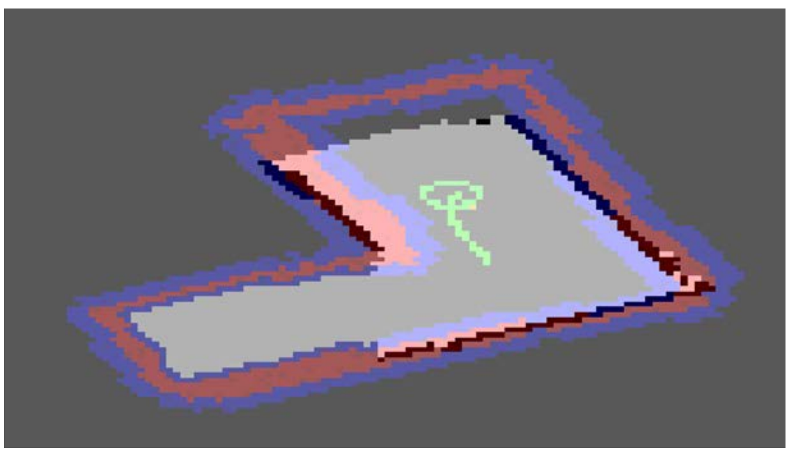

Figure 4 Zoom of the generated map of the L corridor

E. Conclusions and recommendations

In conclusion a robot has been integrated and equipped to perform SLAM. Regarding the fact that ROS has a very steep learning curve, the libraries and tools provided are extremely useful. The development time of an SLAM capable robot is substantially reduced through the use of

ROS. Future research plans includes using additional sensors to try to improve the accuracy of the maps obtained and better robot navigation. The Kinect sensor

REFERENCES

[1] http://www.willowgarage.com/pages/software/ros-platform
[2] http://www.ros.org/wiki/rviz