MEAM 520 Project Proposal:
Path Planning for Lynx Robots on ROS/Gazebo

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1 Introduction

In the course we have learned how to derive the forwards and inverse kinematics and also studied multiple planning methods to generate paths that can be tested on the simulation in Matlab. In order to combines two lab assignments and test on the platform that have not been discussed in class, our group aims to realize the simulation on ROS/Gazebo platform while trying more efficient path planning methods on the simulation we implement.

2 Goals

Our project can be divided into two main parts. In the first part, we will focus on implementing the simulation of the Lynxmotion robot from MATLAB to the ROS and Gazebo platform. This will allow simulation with high scalability to add different packages for vision or dynamic obstacles.

In the second part, we will implement several path planning methods other than the one we did in lab2. We will do this in MATLAB to get a proof of concept first and move to the simulation environment we create in part one later. Performances of different approaches will be compared in different scenarios for insights on their advantages and disadvantages. For the baseline project, we will use static obstacles for simulation analysis. In lab3, the end-effector is replaced with LIDAR sensors to detect dynamic obstacles in the environment. Furthermore, in order to achieve this part, we can consider the LIDAR sensors or even the vision based Camera for object detection if time permits.

3 Approach

3.1 ROS/Gazebo Simultion

This part is more about the study of ROS and implementation of our model on the ROS/Gazebo platform. We will use Gazebo to build Lynx arms based on the parameters of the robot provided and create a ROS module that includes the basic rostopic of the robot positions and kinematics, the locomotion, the map, also the control part of the robots. We will mainly implement our node via python for the path planing that generate waypoints for our robots and then use control thread to achieve the movement. Furthermore, we can give some simple tasks such as move from one position to another in the simulation to test our module can really work on the actual robot arms.

3.2 Path Planning

For the path planning part, we have learned and achieve RRT algorithm for lab2 and applied artificial potential field for lab3. Both are related to how to generate the steps and make paths for robots. We have found algorithms for 3D planning[1] such as other mathematics model based algorithms or heuristic algorithms. About the sampled based algorithms as we study in the course, there are a lot of improvements such as stable sparse RRT and SST star in [2] that we are interested and would like to implement in our project. In addition, after completing the lab3, we have a deeper understanding of artificial potential field that move robots in desired direction in order to get the real-time path with dynamic obstacles. we can also add artificial potential field method in order to search tree extension stage of RRT or use other prior path for the motion planning.

In lab2, what we have done to check collision is using the linear interpolation for the robot motion between points, which is not smooth for robot to generate natural paths. To improve this part of path planning, we will also add some smoothing algorithms for collision checking and the robots trajectories. Also the simulation code in lab2 just divide the paths into 20 pieces and then plot the position of the robots. In our simulation, we will melioration this motion also to get better effect.

4 Relation to the course

In the labs assignments, we use the simulator provided about Lynx Robot to conduct relevant topics including forward/inverse kinematics and different path planning methods introduced in the course. First of all, our team focus on the simulation of Lynx robots and considering the virtual situation of the labs, we would like to build this Lynx robots on Gazebo/ROS platform in order to better understand the whole process of the robot motion.

5 Timeline

5.1 Week 1:

1. Build the Lynx model on gazebo;
2. Implement the SST planner on matlab

5.2 Week 2:

1. Build ROS package, run our simulation based on ROS;
2. Covert the path planning to ROS package

5.3 Week 3:

1. Improve the trajectory planning if time permits;
2. Organize the data and finish the report

6 Extra Credit

Ani's fun fact 2: Stegosaurus, from Greek meaning roofed lizard; lived in the late Jurrasic period.

7 Reference

1. Liang Yang, Juntong Qi, Dalei Song, Jizhong Xiao, Jianda Han, and Yong Xia. 2016. Survey of Robot 3D Path Planning Algorithms. J. Control Sci. Eng. 2016 (March 2016), 5.DOI:https://doi.org /10.1155/2016/7426913

2. Li, Y., Littlefield, Z., Bekris, K. E. (2016). Asymptotically optimal sampling-based kinodynamic planning. The International Journal of Robotics Research, 35(5), 528–564. https://doi.org/10.1177 /0278364915614386

3. J. Amiryan and M. Jamzad, "Adaptive motion planning with artificial potential fields using a prior path," 2015 3rd RSI International Conference on Robotics and Mechatronics (ICROM), Tehran, 2015, pp. 731-736.