Developing an Autonomous Robot Packaging System

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Abstract

A lot of tasks nowadays can be much more precise and complicated than before. Tasks such as microscale surgery or car assembling cannot be done by human easily without errors. We need robots to autonomously complete these jobs for us. We use the Manipulator – H robot from ROBOTIS, which contains 6 joints and 5 links, as the experiment subject. We use ROS – Robot Operating System to implement robot path planning algorithms such as sampling-based algorithms like Rapidly-Exploring Random Trees (RRT) as well as computer vision techniques. As a result, we developed a system which will automatically detect goal objects and follow the shortest path to the object. It is possible to apply robot systems to industries such as car assembling and product packaging. This is important because being able to find the shortest path can save a lot of time when it comes to car assembling or auto-packaging.

Motivation

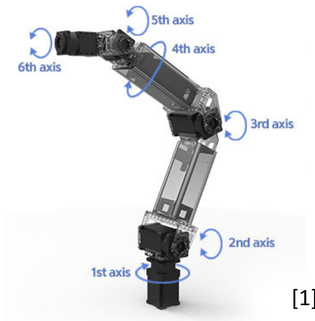
- As the rapid growth of industries such as car factory and delivery service occurs, human power is not sufficient to handle the huge amount of packages.
- A high efficiency of process packages is needed in order to process the huge amount of incoming packages.
- Auto detection and path calculation is desired in order to make the robot works more efficient.

Materials and Experiment Object

The Manipulator-H robot manipulator from ROBOTIS is used in this project.

Information about Manipulator-H:

- 6 degrees of freedom
- Weight: 14.33 lbs
- Joint speed:180 deg/sec
- Reach length: 645mm

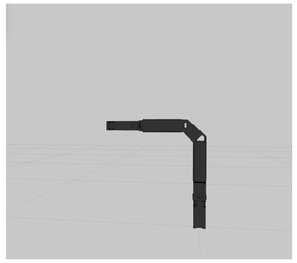


[1]

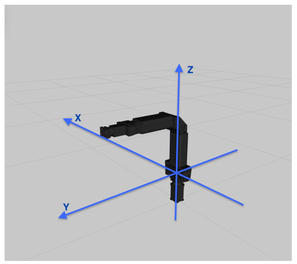
Methodology

We use the ROS (Robot Operating System) system to Control different joints to move the end of manipulator (hand side) to a desired location. [2]

To navigate the manipulator to a desired location, we first need a reference. We use the base of first joint as the origin and expand a 3D Cartesian coordinate system.
To best avoid the damage to the manipulator, we first apply our algorithm on the rviz or gazebo simulator and then use the real manipulator.



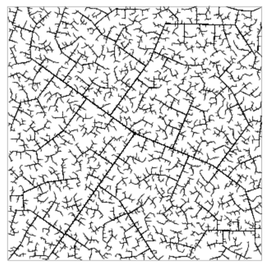
Manipulator-H in rviz



Coordinate System of Manipulator-H

Manipulator-H in lab

We use Rapidly-Exploring Random Trees (RRT), which is an that can efficiently search a collision-free path in high-dimensional spaces by randomly building a space-filling tree. It is a randomly constructed, sampling based path search method which could navigate our robot from current location to goal location despite the path may not be optimal.

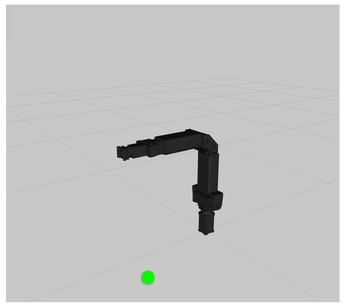


[3]

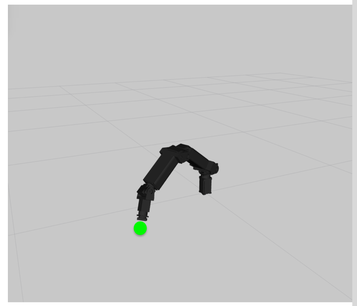
RRT in 2D

Results

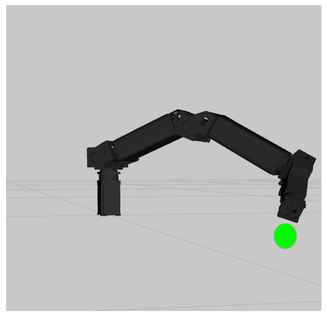
Given a goal position coordinate, the robot manipulator can calculate a serious of joints moves in order to get to the goal configuration



Initial configuration



Result configuration



Goal reaching with obstacle avoidance

Result configuration in lab

Directions for Future Research

- Incorporate computer vision part to let the robot detect objects automatically and pass the goal coordinate to search algorithm.
- Enhance the collision avoidance algorithm to make the robot manipulator find the best collision-free path or report task is impossible automatically.

References

[1] Figure of Manipulator-H from http://www.robotis.us/robotis-manipulator-h/
[2] Figure of ROS logo from http://www.ros.org/
[3] Figure of RRT in 2D from http://planning.cs.uiuc.edu/node231.html

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