Supervisor: Dr. Khalid Wassif

Abstract

The 21st century is a century for robotics. Robots have long borne the potential to bridge the gap between the cybernetic world (the internet of things) and the physical world. Robotics is set to play an ever increasingly important role in society for its influence in every aspect of life, including medicine and healthcare, building services, manufacturing, food production, logistics and transportation.

This project tackles the pick and place robot arm problem. Our robot is a vision powered robot arm where it applies computer vision methodologies on the robot camera feed, then by passing the feed to a machine learning model that was trained in advance, we are able to classify each object. Moreover, we use path planning algorithms and calculate the needed kinematics equations to be able to pick and place successfully. Applying this combined approach, therefore, we will be able to have an active robot to be used in several industrial needs as sorting items, packaging ...etc.

Introduction

Robots are the future of industries and any labor job even housework, Robots will clean, cook, organize things, maybe fetch something when it's asked to and many more tasks.

Obviously robots aren't intended to solve one problem or do one task and robots vary in their shape, components and the tasks that they are intended to do, However there are some tasks that most of the robots are doing not to solve the main task but to solve some sub-tasks to reach the final goal. In this project these sub-tasks are what we are intended to solve which are how to recognize different objects, build a collision map and finally to be able to pick and place objects.

Conclusion

Robots major task are the pick and place, What we were trying to tackle is to make robots perform this task as a sub-problem, what we did was adding to the robot RGB-D camera, used computer vision to detect items in the scene, used machine learning model to identify each item, then we performed the pick and place by calculating the path plan, forward and inverse kinematics.

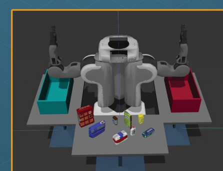
What we tried to achieve is to make the robot self-dependent and doesn't need any human supervision and that's what we achieved, of course further improvement is still needed as we lacked the computational power which affected the performance of the robot.

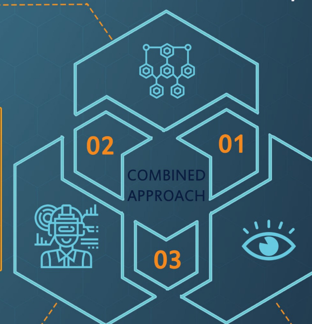
Primarily Techniques

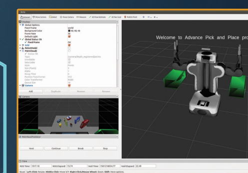
In the current project we are using combined approach to achieve our purpose.

ROS framework

combined with python scripts as ROS contains a set of tools, libraries and conventions that aim to create a more robust robot behavior for complex systems due to it utilizing a peer to peer message passing architecture that contains nodes and topics.







Gazebo

which is a 3D simulator for our robot, PR2. It allows us to focus on the controlling aspect of the robot without worrying about mechanical problems occurring while also providing simulation for environmental noise and other aspects that drive the simulation closer to reality allowing for minimal code refactoring when shifting to the real world.

RVIS

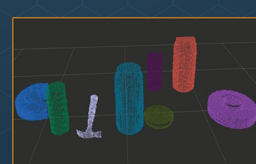
It is a 3D visualization environment tool allowing us to know what the robot is seeing, thinking and doing. Rviz under-stands sensor state information like laser scans, point clouds and coordinate frames. There are also visualization markers to send primitives like cubes, arrows and lines. It also shows all the details for the path planning, goals, object detection and calibration.

Methods

To achive the goal of a vision powered pick and place robot, our course of action followed these FOUR combined methods.

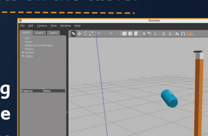
Computer Vision

1.Removing Noise
2.Clustering Object
3.Pose Estimation



Machine Learning

After training our ML Model using Support vector machine, we are able to classify the objects on the table.



During the Process

Result (output)

Path Planning

1.Acquiring gripper initial position.
2.Generating collision map and free state.
3.Taking in consideration joint constraints.
4.Traversing free states using tree-based planner to reach goal.

Kinematics

1.Forward Kinematics to find gripper position

2.Inverse Kinematics to move to position goal.