Individual Lab Report – 5

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Team D: CuBi

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11th April 2019

Individual Progress

Perception – Research

Laavanye has been working on classical approach to vision in order to get bounding boxes on toys. To mitigate the risk of obtaining high false positives in that method, I started looking at deep learning approaches. CuBi has to perform object detection in real time so a fast neural network has to be deployed. RNN which is widely used is a two-stage architecture neural net. While it gives higher accuracy, it is slower than single stage neural net. These one-stage neural nets do not give as much accuracy as two-stage except for RetinaNet. Reading the paper, I found that by employing a novel focal loss this architecture performs as good as two-stage detectors while having the speed of single stage neural net. This seemed a good fit for our application without compromising on accuracy. YOLO Mini could also be used for our application since we do not have to classify many objects. I stopped from implementing them since Laavanye was getting better results in his approach and I had other pressing tasks to complete.

Base Mobility

I wrote a ROS package that moves the robot to pre-defined waypoint. Overall the task was to detect an apriltag in the environment and move the base to that pose. Apriltag detection and obtaining of pose was already done by team members. We were using Intel NUC before and Bobby swapped it for Nvidia Jetson TX2 since our vision system needs higher computation power. After installing the Jetson on CuBi we are facing issues in integrating the camera with the system. So, we are currently unable to obtain the pose of the apriltags.

Without the apriltag pose, I wrote a node that makes CuBi go to a hard-coded pose. But a key factor is to be modular so that I can integrate my code when the vision system is up and running. From the apriltag node, we get the relative pose from the robot for every frame. So, my node subscribes to a topic that publishes relative pose of the desired point every instant. When the target pose is above a certain threshold, I publish velocity to the wheel motors. CuBi moves at a constant velocity until it reaches the target pose. Given a point CuBi's movement is as follows: rotate such that robot is aligned to the target position and move forward till it reaches the target.

In order to mimic the apriltags output, I wrote a sample node that publishes a target position relative to the robot. This had its own sets of issues while implementing since our transforms were off which led to wrong relative transformation. This node is just for testing and will be replaced once our system integration is complete. For now, CuBi can go to absolute hardcoded positions which can be validated by subscribing to the odometry topic.

Challenges

Integration of system is proving to be a challenge as we move forward in this project. We need to integrate vision to our system that will let us do local planning and mobility. Another big challenge is the gripper design. There had been cases which causes the toys to get stuck in the gripper while gripper closes. This is one of our primary risk. Another challenge is our vision. If it doesn't provide reliable results, we can use deep learning methods to get better results. Another challenge is fixing the network issue in Jetson TX2. The internet keeps crashing which causes insurmountable delays.

Teamwork

Jorge helped me with the mobility. We had discussions on how to implement and how to write a scalable code. He had also worked with Bobby on fixing the different manipulator configurations. Previously, the manipulator was stretching forward while moving, which caused the robot to topple due to the extra torque applied on it. Now the gripper has a more compact configuration while moving due to their joint work. Bobby had disassembled the entire robot and put it together in such a way that balances the weight while it moves. Paulo had designed the mount for LiDAR and made a couple of iterations of gripper design for better grasping. Laavanye had been working to improve the vision system to reduce the number of bounding box false positives. Paulo had created a package for detecting apriltags and he helped him on that.

Figures

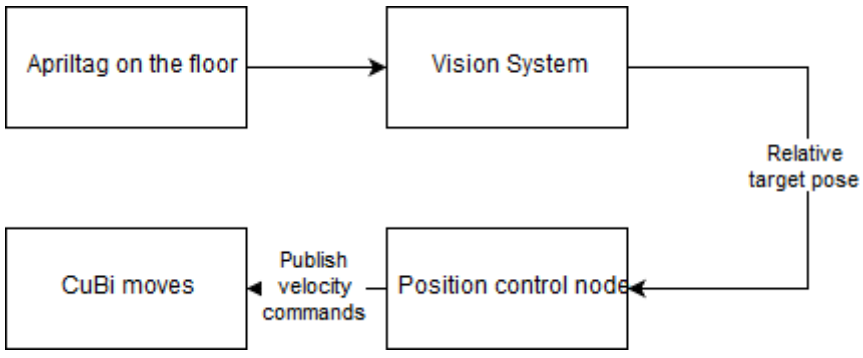

Fig1. Overview of target pose detection and movement

Plans

As soon as the vision is integrated into the system, I have to write a planning algorithm to be able to go to the position of toys. In addition to this, I need to work on localization of CuBi with odometry and IMU readings. This would set us up in a good position to

perform SLAM in the future. As a team, we need to finalize the gripper design, get reliable results from vision, and integrate the entire system.