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3D Vision and Lobster Picking

Introduction

The objective of this project is to develop a 3D vision system that can identify lobsters from a bin to allow for a 6-axis robotic arm to pick them out and place them onto a conveyor belt.

Design Requirements

- Must use a Time-of-Flight variant with RGB imaging capabilities
- 3D Camera must be capable of operating under adverse conditions (ie. Shine from lobster shell)
- System must operate in conjunction with the Motoman GP-12 robotic arm onsite at Enginuity Inc.
- Communication between components must be done through the Robot Operating System (ROS)

Project Deliverables

At the conclusion of this project, Group 14 will be delivering the following to Enginuity Inc.:

- Chosen 3D Camera
- ROS2 YRC1000 Driver
- 3D Lobster Localization Algorithm

Design Process

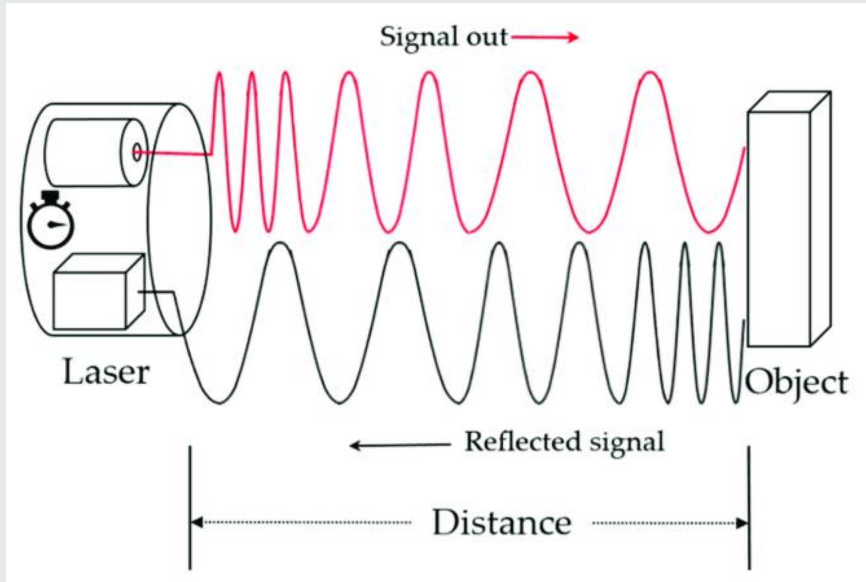
3-Step Approach:

1. Determine the best 3-D vision camera solution to use with the system.
    - Comparison of 8 different 3D cameras based on type, resolution, FPS, capture time, cost, and supportability
2. Development of an AI/Machine Learning solution to identify lobsters and their key points.
3. Creation of communication system between the robotic arm, 3D camera, and a host PC.
    - Using ROS2 to take information from 3D depth images, determine the best path to pick up lobster, and create MoveIt packages to feed the robotic arm the appropriate movements

Details of Design

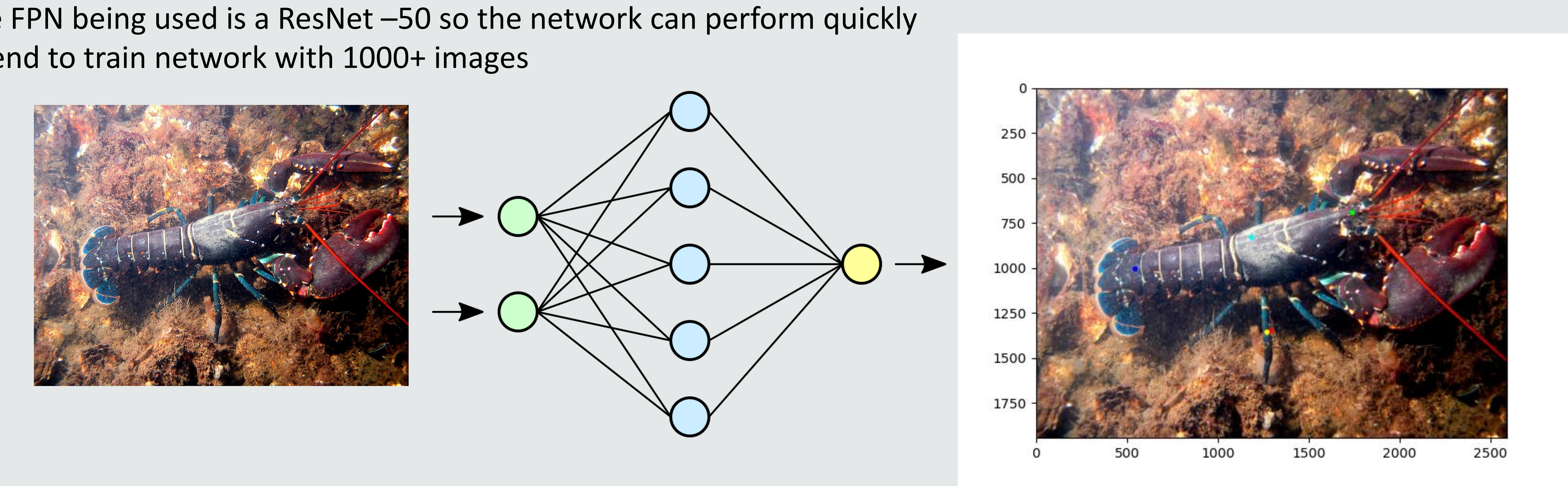
3D Camera

- Chosen camera is the Intel RealSense L515
- TOF camera with RGB imaging capabilities
- Will take depth image of lobster and pass to localization algorithm



Localization

- The network architecture being used is the Pytorch key-point RCNN detector
- The FPN being used is a ResNet –50 so the network can perform quickly
- Intend to train network with 1000+ images

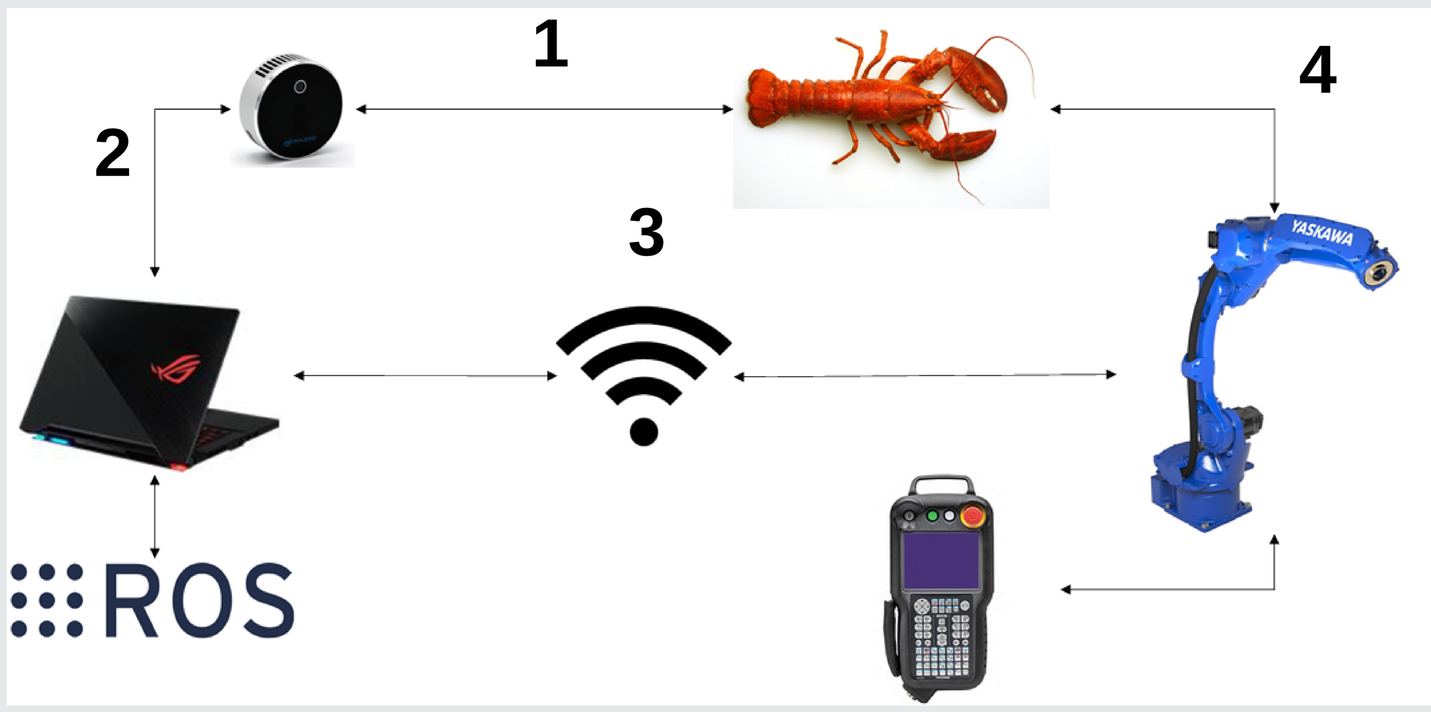


Driver Development

- The driver for the Motoman GP12 was updated to work with ROS2. Due to new development several improvements were needed to be made. These included:
- Trajectory Streaming
    - The trajectory streamer takes the points generated from the MoveIt2 package
- State Translator
    - Converts TCP packets with joint positions, publishes packets to '/joint_states' topic, and completes feed-back loop of control
- IO Control Server
    - Responsible for controlling digital IO useful for actuating pneumatic grippers
- These components come together to create the new driver for ROS2 that allows motion of the arm.

System Architecture

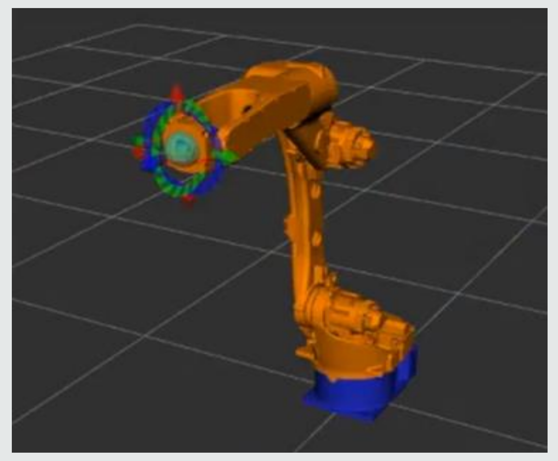
1. 3D Camera takes image of lobster in bin
2. Lobster location is determined and MoveIt pipeline plans a path
3. MoveIt plan is shared over the network to the robotic arm
4. Robotic arm receives movements and picks up lobster



Verification Plan

- Proof of Concept Testing
    - Using a modified Xbox Kinect to test early concepts
    - Testing of initial localization algorithm

- Simulation Testing
    - Using Rviz to simulate and test ROS code
    - Prior to on-site testing, the created ROS2 drivers will undergo robust testing



- In-Person Testing
    - On-site testing with Motoman GP-12 at Enginuity Inc.

Conclusions & Future Work

- Current system satisfies all client requirements and is on track for successful delivery at the conclusion of the Fall 2021 semester
- Need to increase current data set of training images to 1000
- Integration of all three major components to be done in Fall 2021
- Additional research on making current developed driver more robust

References

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- https://moveit.ros.org/