Independent Study Project Proposal, Spring ‘20

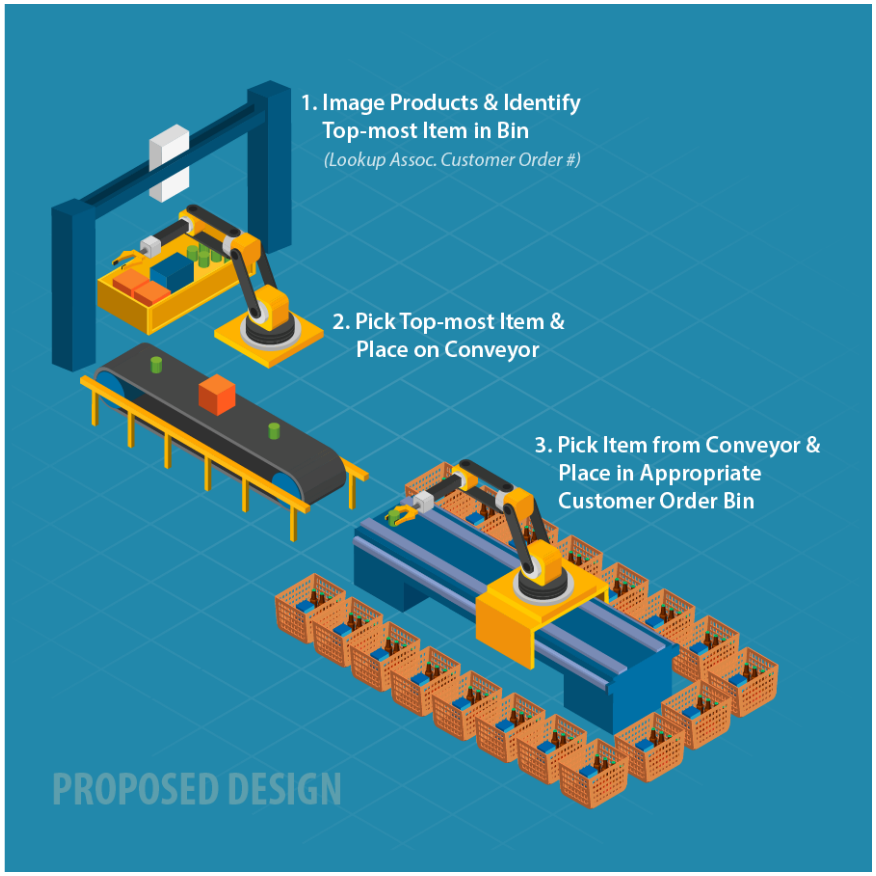
Brief Summary

To design a collaborative, multi-robot system incorporating computer vision, robot operating system (ROS), and multi-robot control to demonstrate skills needed to pursue a career as a robotics software engineer.

Abstract

Many major retailers and grocery stores today offer “curbside” pickup or local delivery of orders placed online. This process frequently involves human “pickers” picking products from retail shelves order-by-order to fulfill these requests, then repackaging these orders appropriately for pickup or delivery. Why not introduce some automation to speed the work of the human and potentially increase the order throughput, while also keeping retail workers on the retail floor where they can also be available to help customers?

My idea is to combine multiple orders into a single pick-list that the human retail worker uses to efficiently grab products moving aisle-by-aisle methodically, simply tossing all picked products into a single bin. Then the worker can wheel that bin to a back room where automation takes over.



The automated system would use an RGB+depth camera to identify the top-most product in the bin, use the depth information provided by the camera to determine the product’s shape and dimensions, and use those attributes to quickly identify the product from a database of known SKUs via image matching. The system would then convey the coordinates of the top-most item to a robot arm to remove that item and place it on a short conveyor belt. While the arm is moving the product, the system will determine which of several orders the product belongs to, sending that information to a second arm at the other end of the conveyor. The second arm will pick-up the product as it arrives and place it in one of several smaller bins (or final packaging) that is specific to an individual customer’s order. And repeat. By allowing the human worker to focus on the robot-challenging task of identifying products and picking them off shelves and the robots to focus on the easy, but repetitive work of sorting products into proper orders, we may be able to increase

system throughput while also improving customer service by keeping friendly retail faces on the floor to help customers while also picking orders.

Goals

- Develop Efficient Computer-Vision based feature extraction algorithms:
  - Utilize **OpenCV** for image feature selection and description
- Data Management:
  - Utilize segmented file-based database of extracted image features for efficient querying
  - Utilize open source **MySQL database** to store product data and image metadata
- Embedded System and Robotics:
  - Utilize **Intel RealSense D415** module for image capture
  - Utilize **ROS** for control of the robot arms
  - Design system with **Python** and migrate to **C++** for final demo (“production”)
  - Deploy two **6-DOF robots arm(s**) for moving a chosen product

Relevant Skills / Courses

- Previous IT career provides extensive base knowledge and experience:
  - C, C++, Python, and C# coding
  - Database design and implementation
  - System design and integration
- Relevant BU Courses: Circuits, EC413, EC444
- Vision system design and implementation in EC601

Proposed Robot Arm(s) to Use

Mirobot, 6-axis Mini Industrial Robot Arm

Preorder available now on Indiegogo for January delivery.

Interested in the “Production Line” kit:

- 2x arms with grippers
- Pneumatic end-effectors
- Sliding rail (to mount 1 arm on)
- Conveyor belt
- $1999