Autonomous Kitting Robot (Project Collie)

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I. INTRODUCTION

We propose to implement an autonomous kitting robot, code-named *"Project Collie"* in ROS2 and Gazebo inspired by the mail sorting scene in a popular movie from 2002, *"Men In Black 2"* [1] as shown in figure 1 where an alien quickly sorts the mail by reading the address on them. While employing an alien which can do the task can be almost impossible, we can achieve the task using a robot.

Fig. 1. Alien kitting mail at post office [1]

Robotic Kitting is the creation of product assortments, most often for retail sale. High speed picking robots are well adapted to this task. Using robot vision, autonomous kitting robots identify individual products and assemble the assortment [2].

The robot system consists of a stationary overhead camera and 7-DOF Panda Robotic Arm acting as the manipulator, which can pick and place various objects as needed. The objective of the system is to use color as a criteria for kitting where each kit consists of a known assortment of colored objects. Having identified the items to kit, the robot picks the object up sequentially and moves them into their respective bins. The primary application for color based kitting is for candies and sweets kitted based on holidays, but this application can be generalized further to allow implementation in various industries to automated their assembly chain. One such example can be kitting at Amazon warehouses to send multiple order items made by the same customer in a single package.

II. PROJECT ORGANIZATION

Product development shall be done using the Agile Iterative Process where tasks will be tracked using a backlog table.All the tasks will be outlined and backlog tables for each iteration will also be maintained. The entire project will split into two sprints. Team members shall follow the pair programming method for development, where the roles of navigator and driver will be interchanged every sprint. The project will undergo a series of unit tests for each module designed to ensure complete code coverage.

III. TECHNICAL OVERVIEW

We will be using ROS2 (and ROS1 if needed) as our networking framework and the Gazebo [3] as our simulation environment to build and demonstrate the robotic manipulator to perform the sorting task. C++14 will be our choice of programming language to develop the nodes and services essential to perform the task of sorting and robot manipulation. The manipulator will be a 7-DOF Panda robotic arm [4] that is capable of performing the required pick and place task. The robot has an additional DOF to allow for greater dexterity. The robot will be controlled using the Move-it 2 [5] package provided by Picnik [6], which holds a BSD 3-Clause License allowing us to implement it in the final product for commercial use.

Apart from the robotic stack, a vision stack needs to be developed to allow the robot to see and understand the environment it is in. OpenCV [7] is used to implement this vision stack, with an Apache 2.0 license it too can be used in the final product for commercial use. The vision stack would be responsible for isolating the workpieces and transmitting their position and color information to the robotic controller. All the resources for the project will be document and version-controlled using Github and continuous integration will also be handled using GithubCI [8]. Coveralls [9] will bed used to visualize the unit test results.

The architecture for the proposed project is shown in the figure 2 below:

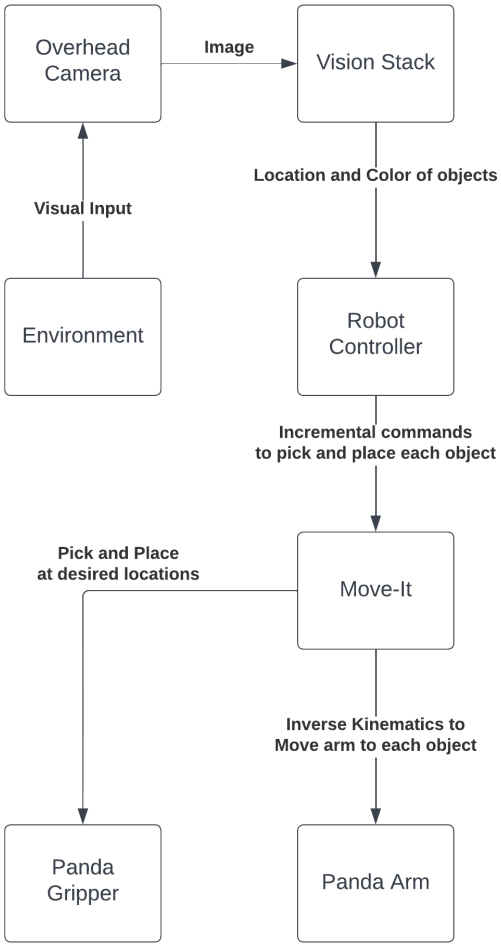

Fig. 2. Project Architecture

IV. RISK AND MITIGATION

The aim of the team is to create a quality product with no bugs. Risk mitigation for the autonomous kitting robot will be performed by extensive unit testing of each module using gtest. Since the node will be operating in a real-world robot which can be of potential physical risk to nearby humans in case of a failure, a mitigation plan of implementing a kill-switch is in place, if the robot becomes unresponsive.

V. DELIVERABLE

The deliverables of the project are as follows. A code repository on GitHub with a detailed README and commit history. Several launch files used to demonstrate the functionality of the project in various scenarios. A technical presentation with slides to the CTO of ACME detailing the merits of the system. A UML diagram that describes the internal structure of the project on a node level. Unit tests results of each node/service using rostest. Results of Cppcheck to demonstrate static code coherence and cpplint to ensure Google c++ style compliance

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