ENPM808X - Final Project Proposal (Phase 0)
Group 6

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Project Code: FP808XG6

Overview:

Robot manipulators play a crucial role in enhancing efficiency, precision, and safety in industrial environments. These versatile machines, designed to manipulate objects with various degrees of freedom, offer several advantages that contribute to the overall productivity of industrial processes. Inspired by this, in regard to the **collection robot theme**, we plan to build a simulated robotic system to emulate an industrial environment that is capable of determining the required parts from a pool of different available parts and accomplishing the desired task.

We plan to employ the gazebo environment provided by ARIAC [1], an environment that depicts an industrial setting with two robots (floor and ceiling), several bins containing a wide variety of parts, AGVs that are capable of transporting parts from one location to other, and stations designed for specific tasks such as kitting and assembly. Fig. 1 below shows the environment that will be used, please click on the image for more details regarding the environment.

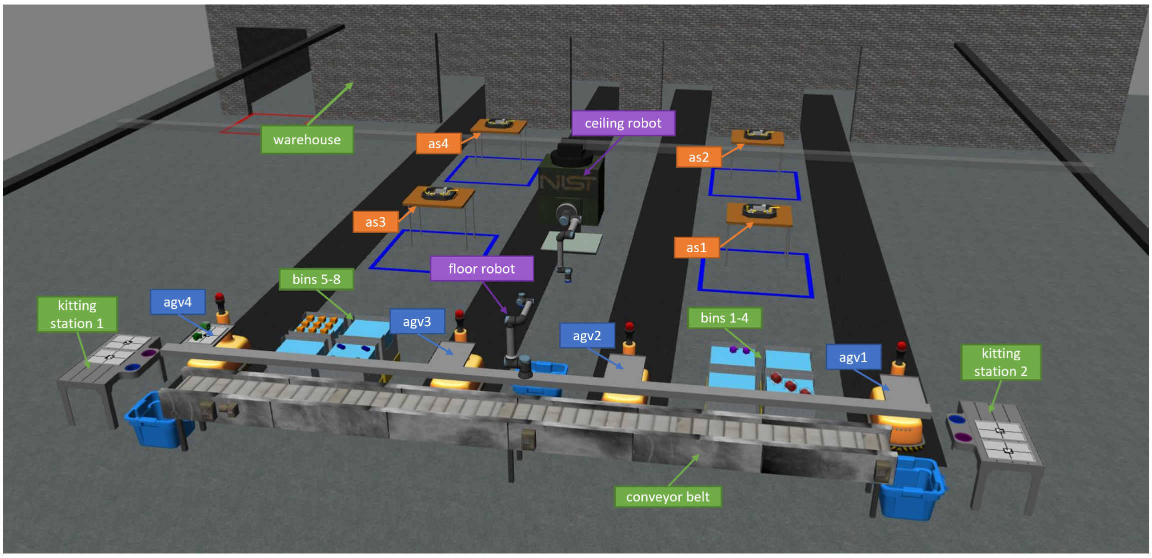

Fig. 1 - ARIAC environment

Design and Implementation:

Given a set of parts (color, type, and quantity) and AGV number, the robotic system should be able to locate the desired parts, pick them, and place them onto their respective AGVs. For identifying the parts, camera sensors present on top of the bins will be used. To control the manipulator, a ROS2 robotic manipulation platform, MoveIt 2 [2] will be employed. Since the ARIAC 2023 environment is built for ROS2 Galactic running on Ubuntu 20.04 (Focal Fossa), we'll be using ROS2 Galactic and our selected programming language is C++. For building the software, we'll utilize the Cmake build system. To identify and address potential memory leaks, we'll employ Valgrind.

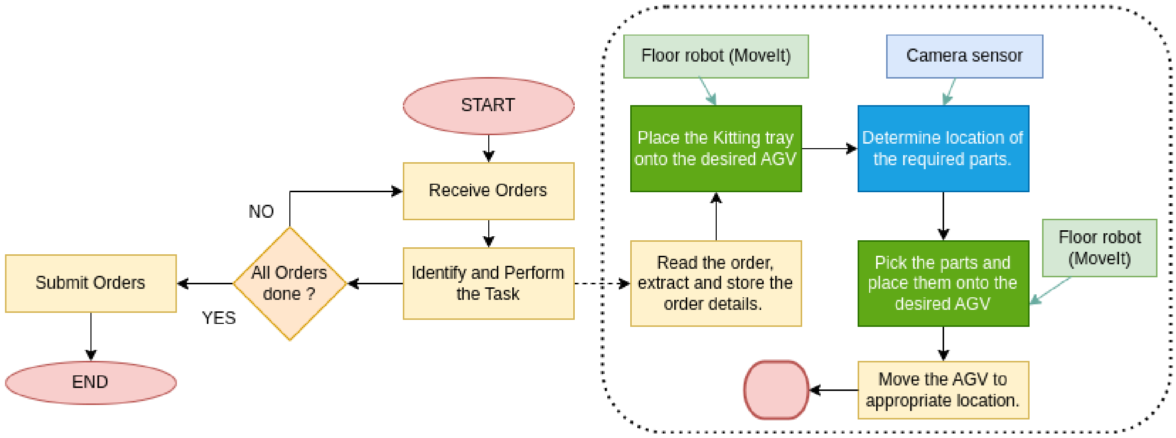

Fig. 2 - Basic Flow Control

Development process:
We are committed to following the Agile Iterative Process (AIP) alongside Test Driven Development (TDD) for our project. Our team will operate in weekly iterations, using a backlog chart to monitor and assess progress. The team, consisting of three members, will assume specific roles as outlined below, and development will be carried out through a pair-programming approach. Our initial focus involves implementing requirements from the backlog, addressing bugs, and introducing new features. Any newly identified requirements will be added to the backlog for subsequent attention. We will utilize Git Version Control to meticulously track our progress. The implementation of unit tests will be a key aspect of verifying code functionality, aligning with TDD principles to minimize errors. Additionally, our emphasis will be on adhering to sound coding practices and maintaining comprehensive documentation for effective project management.

	Phase 1	Phase 2
Kiran S Patil	Driver	Navigator
Surya Chappidi	Navigator	Design Keeper
Vyshnav Achuthan	Design Keeper	Driver

ROS REPs:
We are planning to utilize several ROS Enhancement Proposals (REPs) in our project, including REP-105: Coordinate Frames for Mobile Platforms, REP-103: Standard Units of Measure and Coordinate Conventions, REP-2005: ROS2 Tooling, and REP-120: ROS Messages for Representing State and Status.

Potential Risks and Mitigation:
Collision Avoidance Problems:
    Issue: MoveIt may fail to plan paths due to incorrect collision objects or settings.
    Mitigation: Ensure that the collision objects are defined accurately in the environment.
Kinematics Issues:
    Issue: Incorrect kinematics configurations can lead to planning failures or unrealistic solutions.
    Mitigation: The kinematics solver settings in the MoveIt configuration files match the robot's actual kinematics.

Final Deliverables: A simulation-based robotic system module that is capable of sorting and handling different industrial parts using advanced robotic manipulators and vision systems.

References:

[1] ARIAC Documentation
[2] MoveIt 2 Documentation
[3] Software Engineering: The Current Practice, Vaclav Rajlich. CRC Press, 2011.