Automation in Material Inspection and Handling

Hersch Nathan, Maggie Fontaine, Adam Garsha | E-3: Automation, Robotics, & Controls

Goal

The system demonstrates how robotics can be used to automate handling and inspection labor at the lab. Increasing the automation in laboratory system will also aid in increasing the lab's potential output.

Hardware

For the purposes of this project, a Clearpath Robotics Ridgeback platform robot was fitted with a Universal Robotics arm. The combination of a platform and arm allows the robot to move between task areas and manipulate objects.

RIDGEBACK

The Ridgeback robot uses four mecanum wheels to move in any planar direction. The ridgeback provides the ability of the system to move between task regions, simulating a real work environment where materials may be placed in different work areas.

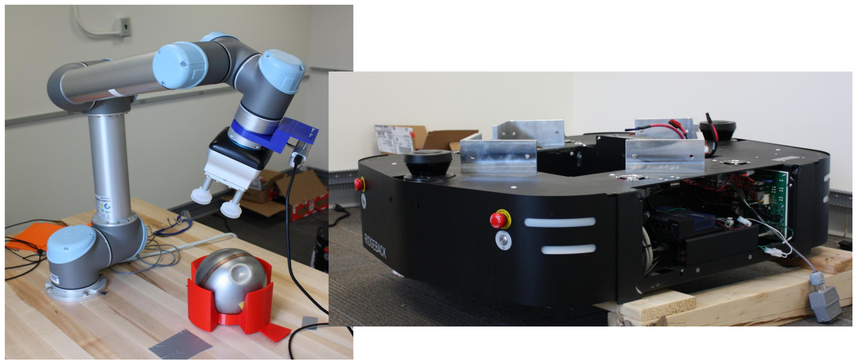

Figure 1. UR5 Arm (Left) and Ridgeback (Right)

UNIVERAL ROBOTICS (UR5) ARM

The UR5 arm has 6 movement axes, allowing it to manipulate its end effector along all three positional and rotational coordinates. A quick changing attachment at the end of the arm allows various end effectors to be attached, giving the arm various object handling capabilities.

End Effector

For this demonstration, a VGC-10 vacuum gripper was used to collect objects and move them around for inspection and hauling tasks.

Camera

An Intel Realsense Camera with depth cloud data is used to determine the position of AprilTags and determine the locations of objects so that the UR5 arm can collect them.

Electrical and Safety Updates

In order for this multi robotic system to work safely the two systems had to be integrated together. Safety wise the emergency stops were wired together such that if one stops both stop. To power the UR5 we tapped the batteries of the Ridgeback and upgraded the UR5's power supplies to handle the battery input.

Taking two different types of commercial robots and altering them to fit one another and lab specific requirements

3 Part Demonstration

For this demonstration, metal spheres were used as objects to inspect.

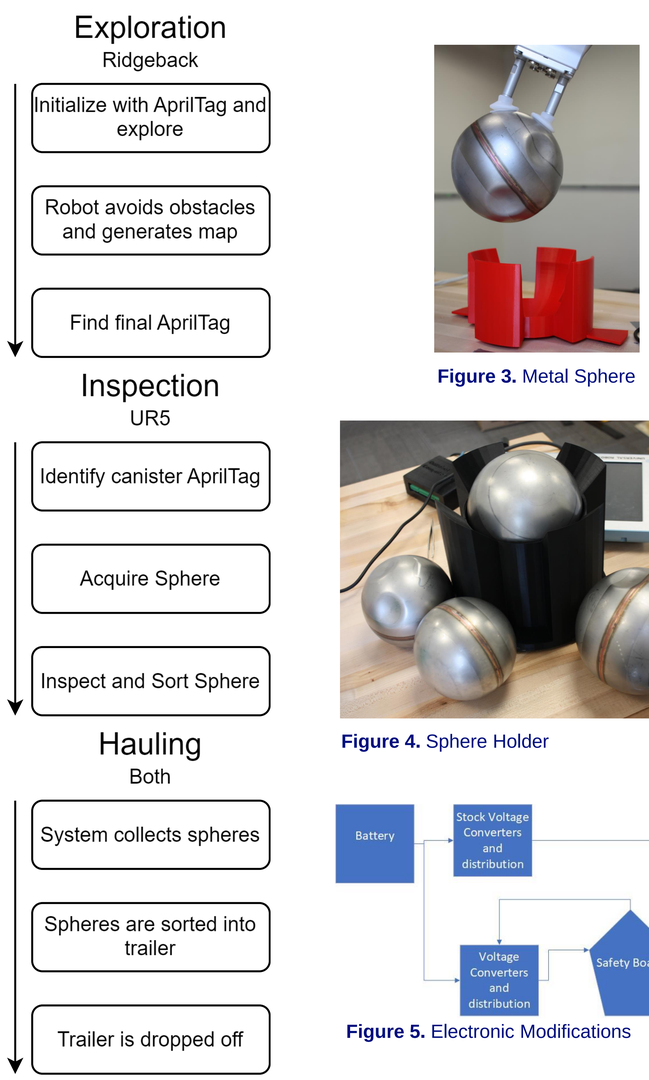

Figure 2. Demo Diagram

Figure 3. Metal Sphere

Figure 4. Sphere Holder

Figure 5. Electronic Modifications

Software

ROBOTIC OPERATING SYSTEM

ROS is a set of tools for controlling a network of robots and systems using topics and services. Existing ROS packages were complemented with custom code to control the UR5, Ridgeback, camera, and other components.

POLYSCOPE

In addition to ROS, the UR5 arm works with PolyScope, which provides path planning and other features. PolyScope integrates with ROS, which was used to control the UR5 arm.

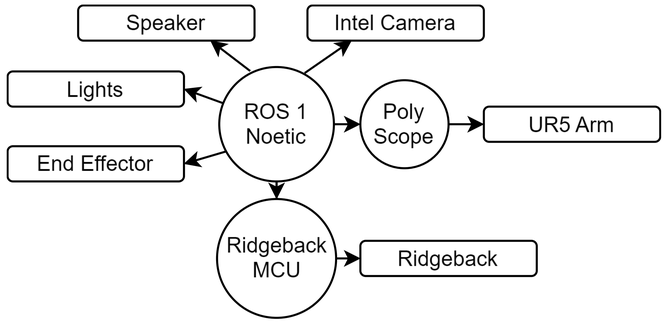

Figure 6 Software Diagram

APRILTAG

In addition to the packages required by, ROS packages were installed to read AprilTags. AprilTags act like QR codes that provide positioning information for the robot.

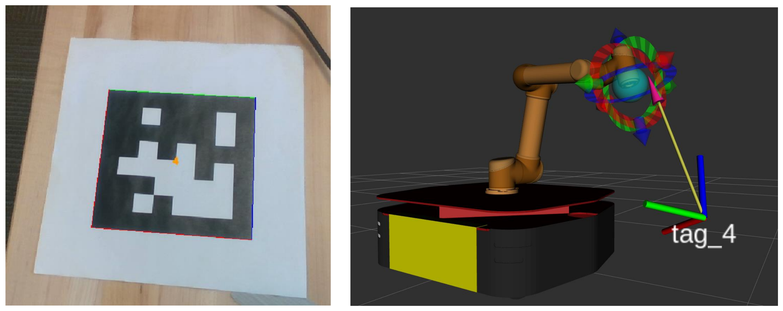

Figure 7. AprilTag (:eft) and AprilTag Transformation (Right)

AI / ML Vision Model

A machine learning vision model determines the damage present on the metal spheres and sorts them accordingly. We use CNNS and transfer learning to identify the damage.

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