Human Assistance For Robot Arm (HAFRA)

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CSE Senior Design

Executive Summary

- The problem of inefficient machinery in industries affects overall production and can cause significant errors.
- Creating a robot that can mimic and perform human tasks efficiently and correctly and can be a great benefit to industries.
- The UR5 robot increases performance and can achieve a success rate of nearly 100% through human assistance.
- Can get rid of potential risks while still having a consistent worker.
- A profitable idea by replacing the cost of paying a human worker constantly to only a one-time investment.

Background

We are using UR5 robot for our project. The UR5 is a lightweight adaptable industrial robot which is used to pick and organize items up to 11 lbs and has a reach of 850 mm. To increase the efficiency of the robot, we decided to introduce human assistance.

The Human Assistance For Robot Arm (HAFRA) project consists of:

- Universal Robot - UR5
- Intel RealSense depth camera
- Software Application
  - Python programming
  - Robot Operating System (ROS)

Figure 1. UR5 Robot

Experimental Setup

- Computer vision program:
  - Detects center of fiducial (ArUco tag)
    - Pixel Coordinate
  - Sends position
- Movement program:
  - Receives coordinate
  - Moves the robot to perform its task of picking up envelopes and placing them into a bin
- Human assistance portion:
  - Allow human to select a coordinate and assist the robot to be able to continue picking.
- Constraints:
  - Final prototype demonstration must be completed by May 6, 2022
  - CSE department budget is $800

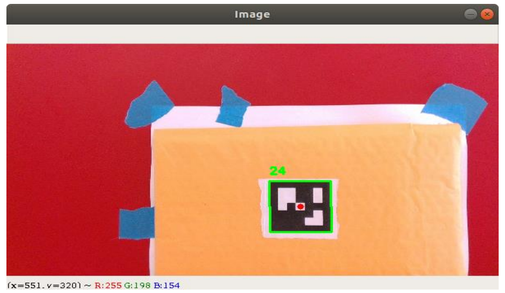

Figure 2. Center Pixel Coordinate

Experimental Plan

Robot Operating System-software libraries

- ROS Communication
  - Publisher node
  - Subscriber node
- ROS Visualization (RViz)
  - virtual objects for boundaries
  - backwall, ceiling, floor, suction gripper (tool)

Python

- OpenCV (cv2)
- Rospy
- pyrealsense

Human Assistance

- System should provide a software solution for remote picking by a human operator.
- Will oversee and fix any mistakes the robot has made.
  - Can type a coordinate in terminal
  - Program converts pixel coordinate to real-word coordinate based on robot's perspective

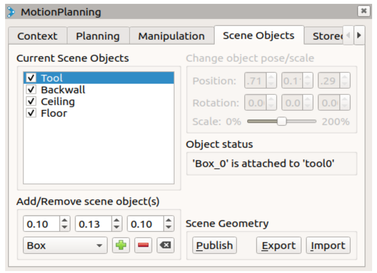

Figure 3. Scene Objects

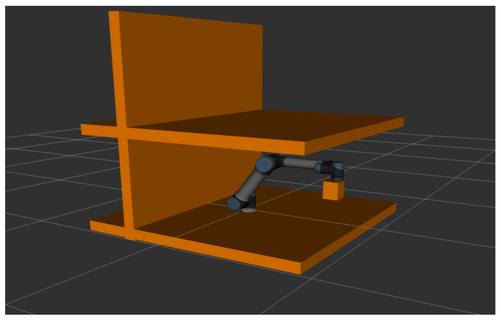

Figure 4. RViz Environment with Scene Objects

Experimental Results

- Vision program detects center of ArUco Tag on envelope
- Obtains pixel coordinates and converts it to x,y position
- If it cannot detect a tag, it will send the image to human assistance program
- If it does, it will send coordinates to movement program and robot will move to pick up envelope and drop it off at the bin
- We had a small error of about 10 pixels while detecting the ArUco tag, but it is too small to affect the program.

Figure 5. ArUco Tag on Envelope

Conclusions

- Client's original goal was to provide a software solution to allow human to assist robot remotely
  - Implementing human assistance for the UR5 robot has increased the efficiency of the robot
    - Success rate of nearly 100%
- Has also opened the possibility of artificial intelligence and machine learning for the UR5 robot in the future
- Possibility of Universal Robots replacing humans in the industry in future
- A special thanks to Dr. McMurrough, Minh Tram, and the CSE department for sponsoring the project and giving us this wonderful opportunity.

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