e-waste Robotics Solution

by Team RoboTechX Middlesex University Dubai

Robothon Grand Challenge 2022

Background

Dubai has the largest e-waste recycling facility with processing capacity of 100,000 tonnes of total integrated waste per year, of which 39,000 tonnes is e-waste. However, as reported by CNN (https://edition.cnn.com/2021/10/07/middleeast/enviroserve-e-waste-dubai-spc-intl/index.html) some of the process in disassembling the e-waste are still done manually by human.

We aim to automate the disassembling process with robot to save the labor from being exposed to toxic and hazardous materials.

Overview

The solution comprises of two main components, the computer vision system (CVS) and an industrial robot manipulator which is controlled by a program that runs on the same PC as the CVS. When an e-waste is placed on the workspace, the CVS will recognize the orientation of the item and pass the information to manipulator, which in turn will disassemble the item automatically.

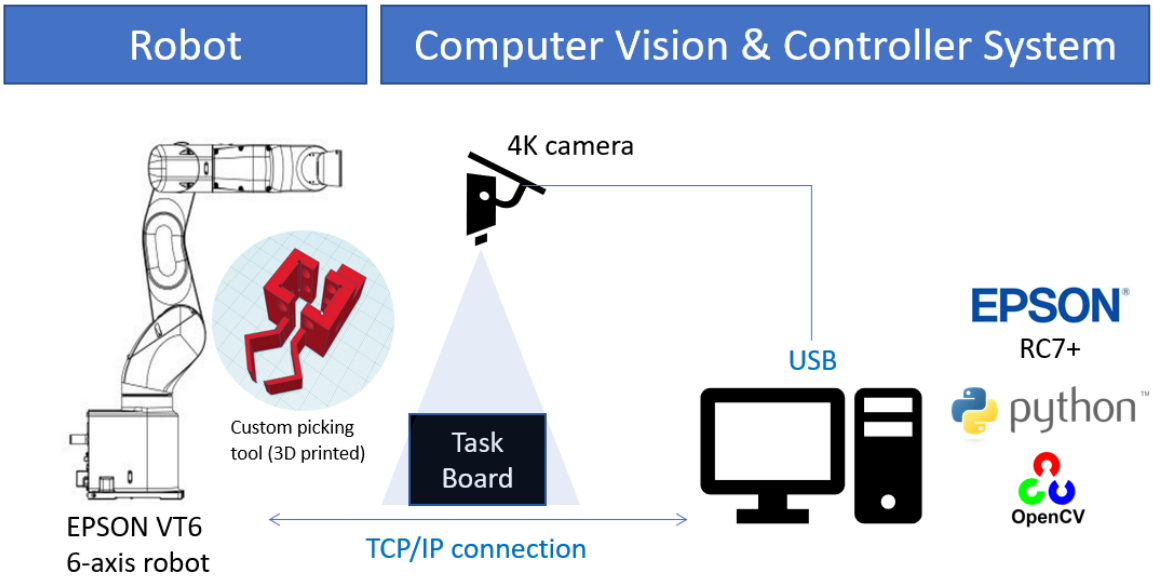

Figure 1: System Setup

Computer Vision System (CVS)

The CVS software is written in Python and utilizes OpenCV, an open source computer vision and machine learning software library. The image of the e-waste item is taken using a camera with 4K resolution, placed directly above the workspace. Based on the image taken, the CVS will calculate the orientation of the e-waste and translates the pixels into real world coordinate to guide the robot manipulator. On the task board given for Robothon Grand Challenge, there are several features on

the board that can be used to mark the position and orientation. The blue button and the ignition keyhole are chosen as the markers as they are unique and far apart.

Once the markers' position is obtained, the values will be passed to the robot via TCP/IP network.

Robot Manipulator

We are using EPSON VT6 manipulator robot with 6 axis, equipped with a pneumatic gripper and attached with custom 3D printed battery picker. The robot is programmed in SPEL RC7 language, which is the default programming language for EPSON robots.

The robot relies on the data sent by CVS at the beginning of the process. The data contains real world coordinates of the markers which will be used to guide the manipulator movement in disassembling the e-waste.

Algorithm

We use pixel mapping to the world coordinates by detecting two reference points on the task board, namely the Blue button and the Keyhole center. These two points are recognized by using circle detection in OpenCV. Once the world coordinates have been calculated, they will be sent to EPSON robot controller which in turn will translate that into local coordinates of the task board.

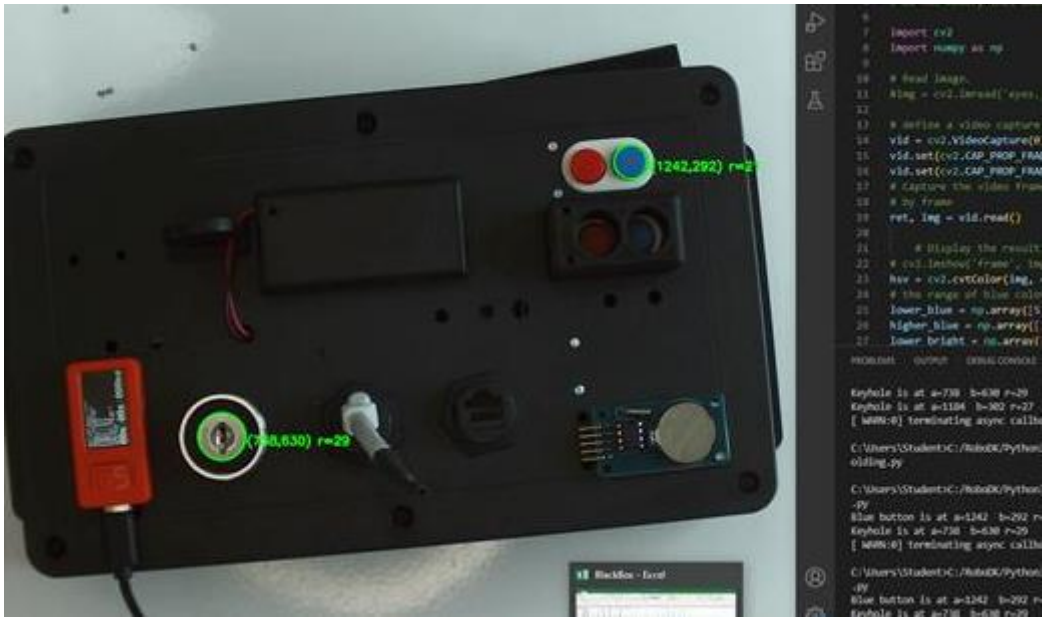

Figure 2 : Reference points

Quick Start Guide

1. Place the e-waste item on the workspace
2. Run the Python program that will capture the image of the e-waste.
3. Start the EPSON robot program and let it standby, awaiting for instruction from CVS.
4. Upon successful image capture and coordinate mapping, the Python program will send the coordinates of Blue button and Keyhole center to the robot via TCP/IP and the robot will start the disassembling process.
5. If for some reason the image detection has failed, repeat from step 2. Please make sure that the workspace is well lit and free from obstruction.

Videos

- Uncut Demonstration Video : https://youtu.be/jE40IqGRikw
- Explanation Video : https://youtu.be/GMilbyAD_ZM

References

- EPSON RC+ 7.0 SPEL+ Language Reference (epson_spel_pl_70_language_reference-r700a_rc90_t(v73r4).pdf)
- OpenCV open source computer vision and machine learning software library (http://opencv.org)
- SolidWorks modeling Computer Aided Design (https://www.solidworks.com)
- Recycling the Middle East's e-waste in Dubai (CNN - https://edition.cnn.com/2021/10/07/middleeast/enviroserve-e-waste-dubai-spc-intl/index.html)
- Worlds Larget e Waste Recycling Facility opens in Dubai (Gulfnews - https://gulfnews.com/uae/worlds-largest-e-waste-recycling-facility-opens-in-dubai-1.62884040)