Worksheet 8 – Preventive maintenance using thermal imagery

In this worksheet we will simulate a mobile robot that operates on an assembly environment. The task of this robot is preventive maintenance, where it needs to find parts that are not functioning at the normal operating temperature. Consequently, it is equipped with a thermal imagery camera that allows it to survey the different parts. After identifying the part it needs to obtain the pose of the part that needs replacement in order to grasp it. The robot is also equipped with a laser scanner and RGB camera that will possibly aid it in this task.

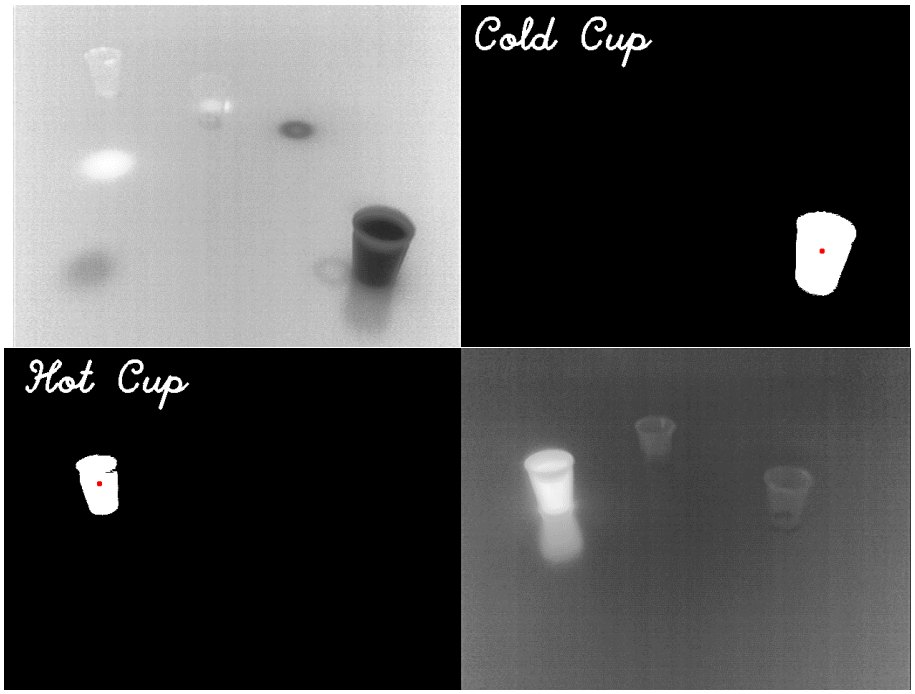

Figure 1- Implementation example

The scenario in the worksheet is simplified and ideal, here we will only have the parts we need to scan without any other distractors in the scene. There will be only 3 cups present and only one cup will be at a different temperature. Additionally, each cup will always be inside one of three pre-defined zones. The zones are all equal and divide the field of view of the thermal camera (see Figure 2)

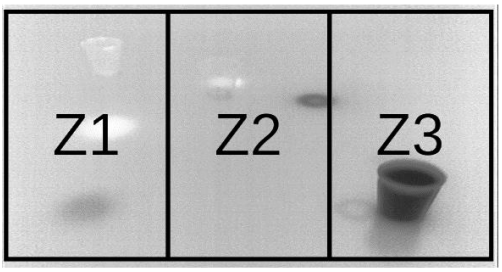

Figure 2-Predefined zones

Implementation

This worksheet is to be performed in groups of two. First you should download the provided bags of the different runs to familiarize yourself with data available to detect the failing part. Each bag will have thermal imagery, RGB data, laser scanner data and TF. Also a URDF description of the equipment used is available for download.

First you should envision the steps needed to obtain the pose of the desired part, at the end of the first class an initial draft should be presented and approved by the teachers. A final diagram, similar to Figure 1's, with a description on how you solved the problem should be included in the submission of the worksheet.

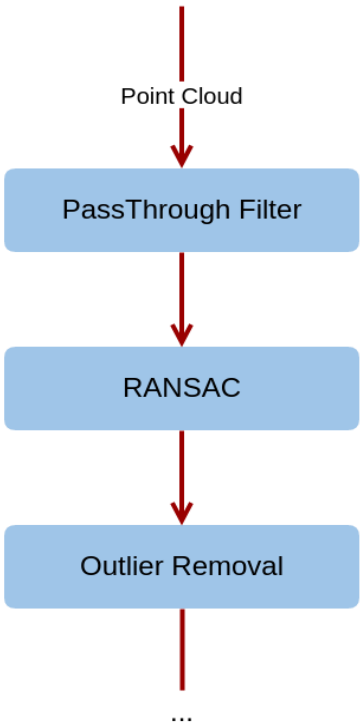

Figure 3- Diagram example

There are no restrictions on how to identify the part or how to get its position. Creative ideas are welcome as long as they do not cheat.

Your work will be tested in the in the 4 bags provided and in 2 additional ones that will not be available to you. In these the parts themselves will be disposed differently. So be advised to make your solution as broad and versatile as possible. All the bags will have the same conditions and information as the ones available to you.

The output of your node should be an ROS message custom type named ***cup_info*** published in the topic ***/selected_cup*** with the following structure:

- *Header* ***std_msgs/Header***
- *Group_number* ***std_msgs/Int16***
- *Object_position* ***geometry_msgs/Point***
- *Bag_name* ***std_msgs/String***

- *Thermal_label* ***std_msgs/Int8***

During the duration of the bag the node should be continuously publishing the message above with the most likely pose of the desired part. Also a TF to each of the 3 parts should also be continuously published. (**Note: The TF should be between *sensors_frame -> partX*)**

Work Units & Grading System

Work Unit I – Modelling the Problem (2 grade points)

This initial step regards the envisioned plan of work mentioned above in which you should state, through a diagram, the steps leading to your solution. Here you will be rewarded for clarity and creativity. You should also write short paragraphs, explaining each step.

Work Unit II – Prepare the ROS Node (6 grade points)

Preparing a ROS implementation to subscribe each available topic your solution may need, and to publish the desired output message. This means setting your ROS code with all message callback functions, even though no processing over the incoming information is required at this stage. Also you should publish the target messages, setting their correct type and filling their header properly.

Work Unit III – X,Y coordinates and hot/cold label(2 grade points each)

The next step is to estimate the X and Y coordinates of the failing part (cup). For the correct coordinates you will receive 2 points. And to identify if the cup is hot or cold for additional 2 points.

Work Unit V – TF of each of the 3 cups (3 grade points)

Next you should publish a TF to each of the cups with the parent being the ***sensors_frame***.

Work Unit IV – Z coordinate (2 grade points)

In the final work unit you should estimate the Z coordinate of the failing part (cup) and publish the complete message (***thermal marker***).

Optimization and Creativity (3 grade points)

Correct use of ROS and creativity in solving the problem at hand.