Robotics Lab 03 Report

Nimra Sohail **Areeb Adnan**

Task 3.1 Understanding functioning of system (10 points)

(a) [*] Identify and list all the sensors and actuators in our complete robotic system illustrated in Figure 3.1.

(b) [*] Figure 3.3 suggests that a potentiometer is being used as the shaft position sensor. Research and describe how can a potentiometer be used for this purpose.

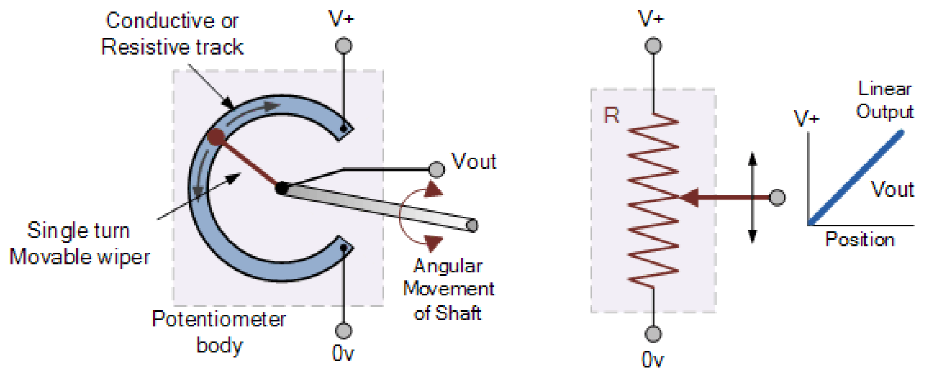
(a)

There are two sensors: camera and a position sensor(for servo motor).
The camera senses the environment and is used to get an image of object to find its position.
In servo motors, a position sensor is used to measure the current angular position of the motor's rotor. It provides feedback to the control circuit, allowing the motor to accurately maintain its position in response to a control signal.

The actuator is the servo motor that helps in the motion of the robotic arm.

(b)

The most widely used position sensor is the potentiometer. In the rotational potentiometer construction shown in figure below the output voltage Vout is measured from the movement of wiper as it moves along the resistive track. Correspondingly, this voltage is proportional to the movement of the angular shaft.
The potentiometer can be used to detect how much voltage is being produced by the movement of the motor and resultantly we can determine the position of the motor.



Task 3.2 Motor Specifications (10 points)

This task is about familiarizing ourselves with the Dynamixel reference manual (`https://emanual.robotis.com/docs/en/dxl/ax/ax-12a/`) and some relevant specifications included in it.

(a) Find the angle rotation limits, resolution (see the definition below), speed limit, and torque limit[a] of AX-12A servo.

(b) [*] Will this motor resolution limit the possible Cartesian resolution of the end-effector? If yes, why?

The Angle rotation limits of the AX-12A servo motor as seen from the datasheet is from 0 to 300 (degree). The figure is attached below for further information.

The Resolution of the AX-12A servo motor as seen from the datasheet is 0.29 (degree).

The Speed Limit of the AX-12A servo motor as seen from the datasheet is 0 ~ 1,023(0x3FF), and the unit is about 0.111rpm. If it is set to 0, it means the maximum rpm of the motor is used without controlling the speed. If it is 1023, it is about 114rpm.

The torque limit of the AX-12A servo motor is 1.5 [N.m] (at 12 [V], 1.5 [A]). The stall torque is maximum torque the motor is capable of generating. This is the torque required to hold the load/weight connected to the motor shaft in position.

b). Yes, the end effector's potential Cartesian resolution may be constrained by the motor's resolution. The precision of the end effector's movement in Cartesian space is directly impacted by the motor resolution, which is the smallest movement increment a motor is capable of producing. The end effector may not be able to move with enough accuracy to achieve the specified Cartesian coordinates if the motor resolution is poor, resulting in a lower Cartesian resolution.

Task 3.4 Image Manipulation in MATLAB (60 points)

Complete at least modules 1-4 of the 'Image Processing OnRamp' (`https://matlabacademy.mathworks.com/details/image-processing-onramp/imageprocessing`) and provide your 'Progress Report' as submission for this task.

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Progress Report

Name: Nimra Sohail
Course: Image Processing Onramp
Progress: **70%** complete (as of 29 January 2023)

Chapters

1. Introduction **100%**
2. Images in MATLAB **100%**
3. Image Segmentation **100%**
4. Preprocessing and Postprocessing Techniques **100%**
5. Classification and Batch Processing **0%**
6. Conclusion **0%**

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Progress Report

Name: Areeb Adnan Khan
Course: Image Processing Onramp
Progress: **70%** complete (as of 29 January 2023)

Chapters

1. Introduction **100%**
2. Images in MATLAB **100%**
3. Image Segmentation **100%**
4. Preprocessing and Postprocessing Techniques **100%**
5. Classification and Batch Processing **0%**
6. Conclusion **0%**

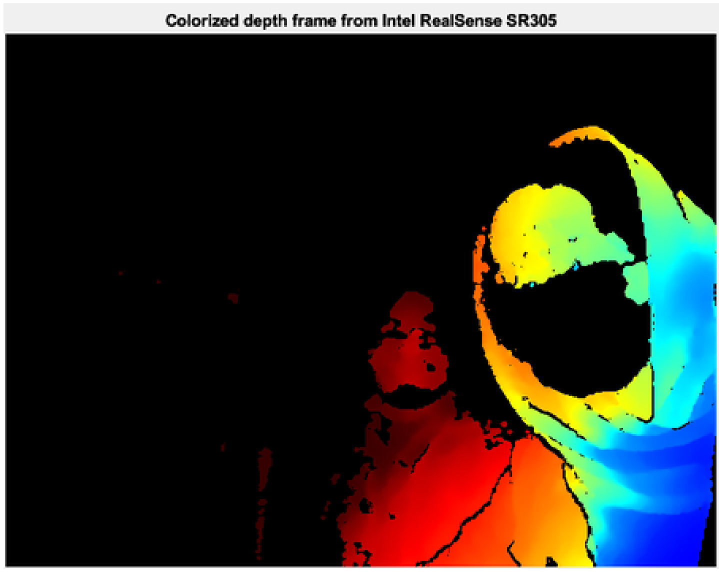
Release: R2022b | Language: English

Task 3.5 Extract color and depth images (10 points)

The MATLAB function `depth_example()`, located in the folder where the SDK is installed, provides the code to extract a depth image. Verify that the code works and make sense of the provided code.

Modify this code so that it also extracts a color frame and displays it. You can do so by using the function `get_color_frame()`. Don't forget to reference the appropriate class instance and format the received frame before displaying.

Code:




```
function depth_example()
    % Make Pipeline object to manage streaming
    pipe = realsense.pipeline();
    % Make Colorizer object to prettify depth output
    colorizer = realsense.colorizer();

    % Start streaming on an arbitrary
%camera with default settings
    profile = pipe.start();

    % Get streaming device's name
    dev = profile.get_device();
    name = dev.get_info(realsense.camera_info.name);

    % Get frames. We discard the first couple to allow% the camera time to settlefor i = 1:5
        fs = pipe.wait_for_frames();
    end% Stop streamingpipe.stop();

    % Select depth frame
    depth = fs.get_depth_frame();
    % Colorize depth frame
    color = colorizer.colorize(depth);

    % Get actual data and convert into a format imshow can use% (Color data arrives as [R, G, B,
R, G, B, ...] vector)
    data = color.get_data();
    img = permute(reshape(data',[3,color.get_width(),color.get_height()]),[3 2 1]);

    % Display imageimshow(img);
    title(sprintf("Colorized depth frame from %s", name));
end
```

Code:

```
function depth_example()
   % Make Pipeline object to manage streaming
   pipe = realsense.pipeline();
   % Make Colorizer object to
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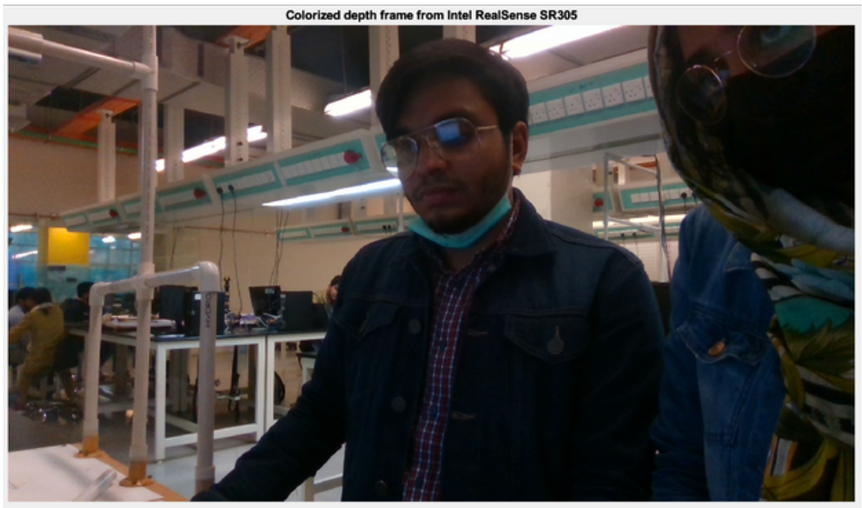

Task 3.6 Reflection (10 points)

> Based on your experiences with the robot arm in the current and previous session, write a brief note outlining your takeaways and any unanswered questions about the vision-based pick and place robotic system that we intend to develop as our first project.

From our previous sessions, we have observed how what we learned in theory was getting applied to our robotic arm in lab. The analysis of joints and links and the understanding of the kinematic chain helped visualize the concepts better.

At start everything/every concept looked very confusing. Understanding the concepts in air using hands was confusing until this lab which helped visualize better how the frames are assigned to the joints/links. However, for the vision-based pick and place system, we are still curious how the camera sensing can be applied to tell the robot to pick an object from a certain location. Also how can the real time picking of object be optimized.

We think that the position sensor(potentiometer) should have a better sensing mechanism to enhance overall accuracy of the robotic arm. We are curious to know how high accuracy robots would operate and do we have any high accuracy robotic arms in the university.

We had the question in mind does different orientations/shapes of the object being picked affects the accuracy and repeatability of teh robotuc arm.

Task 3.7 Bonus (10 points)

According to the manufacturer's provided heuristic [2], the load on any motor should not exceed 1/5 of the stall torque. Keeping this heuristic, motor specifications, mass measurements in Figure 3.10, and physical principles outlined in Section 3.3.1, verify the wrist lift strength specified by the manufacturer. The wrist lift strength is the load that the wrist joint can support.

We are going to use the following equation to find torque:

τ=MgL+mgL/2

where:

M=250g=0.25kgwrist left strength(as provided by manufacturer)

g=9.81m/s

L=90mm=0.09m

m=106g=0.106g

τ=(0.25)*(9.81)*(0.09)+(0.106)*(9.81)*(0.09/2)=0.2675Nm

As said in the task, the load on ay motor should not exceed 1/5 of stall torque and we know stall torque is 1.5Nm, 1/5(1.5) =0.3Nm

Concludingly, we can see that the given wrist lift strength gives the approximately right stall torque as the task suggested hence it's verified that the wrist lift strength is correct.