CS 6334.001 Virtual Reality Homework 4

Professor Yu Xiang

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Problem 1

(2 points)

Convolutional Layers.

Suppose the input of a convolutional layer is a tensor with height $h = 16$, width $w = 64$ and channel $c = 3$. We can say the shape of the input tensor is $h \times w \times c$. The convolutional layer has 32 filters with shape $5 \times 5 \times 3$ with padding 2 and stride 3.

(1) What is the shape of the output tensor for this convolutional layer?

(2) What is the total number of parameters in this layer?

Problem 2

(2 points)

Forward Kinematics.

Figure 1(a) shows a two-link planner arm in 2D. Link 1 has length a_1 and Link 2 has length a_2. The coordinate frame (x_0, y_0) denote the base frame, i.e., world frame of the arm.

Figure 1(b) also shows the local coordinate frames of the two links with joint angles θ_1 and θ_2.

Compute the coordinates of the gripper center (see the blue dot in Figure 1(a)) in the base frame using forward kinematics.

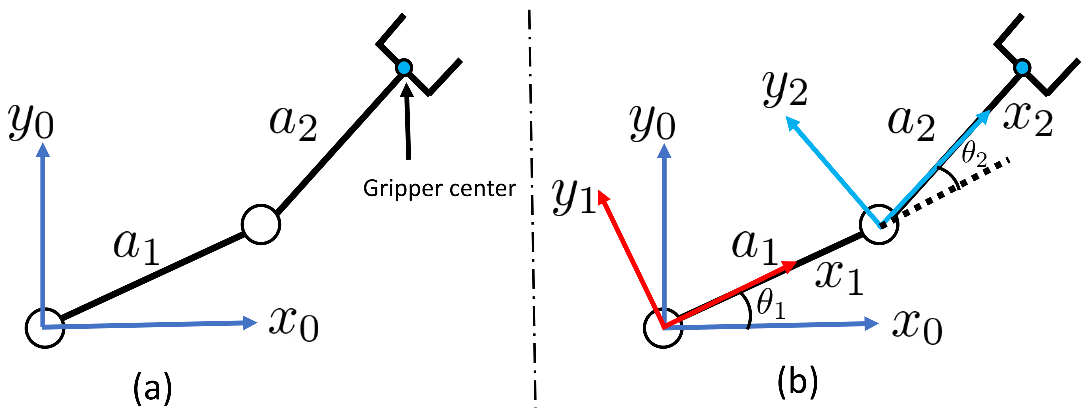

Figure 1: Illustration of a two-link planner arm in 2D

Problem 3

(2 points)

Transfer Function.

Let $y(t)$ be a continuous-time signal. The Laplace transform of $y(t)$ is defined as

$$Y(s) = \int_{-\infty}^{\infty} y(t)e^{-st}dt. \tag{3.1}$$

Now, let's assume that the signal $y(t)$ is generated by convolution:

$$y(t) = \int_{-\infty}^{\infty} u(\tau)h(t-\tau)d\tau, \tag{3.2}$$

where we can interpret $u(t)$ as an input signal, and $h(t)$ is a filter applied to $u(t)$.

Apply Laplace transform to Eq. (3.2) and show that $Y(s) = U(s)H(s)$, where $U(s)$ and $H(s)$ are the Laplace transform of $u(t)$ and $h(t)$, respectively.

(Hint) Consider changing variable by $t - \tau = \eta$ in integral.

Problem 4

(4 points)

RANSAC.

Download the homework4_programming.zip file from eLearning, Assignments, Homework 4. Implement the ransac() function in ransac.py for estimating the parameters of a 2D line given a set of data samples.

After your implementation, run the ransac.py in Python. Figure 2 shows an example of running the script. Submit your script to eLearning, and TA will run your script to verify it.

Here are some useful resources:

- Python basics `https://pythonbasics.org/`
- Numpy `https://numpy.org/doc/stable/user/basics.html`

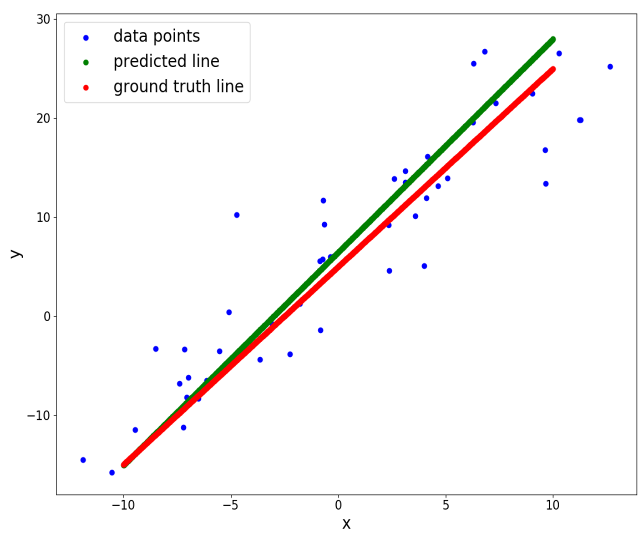

Figure 2: Example of running of the ransac.py script