

CS558 Computer Vision: Homework #1

Due March 6, 2015 6:00pm

Problem #1: Orthographic v.s. Perspective Cameras (4 points)

Figure 1 shows two pictures taken by two different cameras. Answer the following questions:

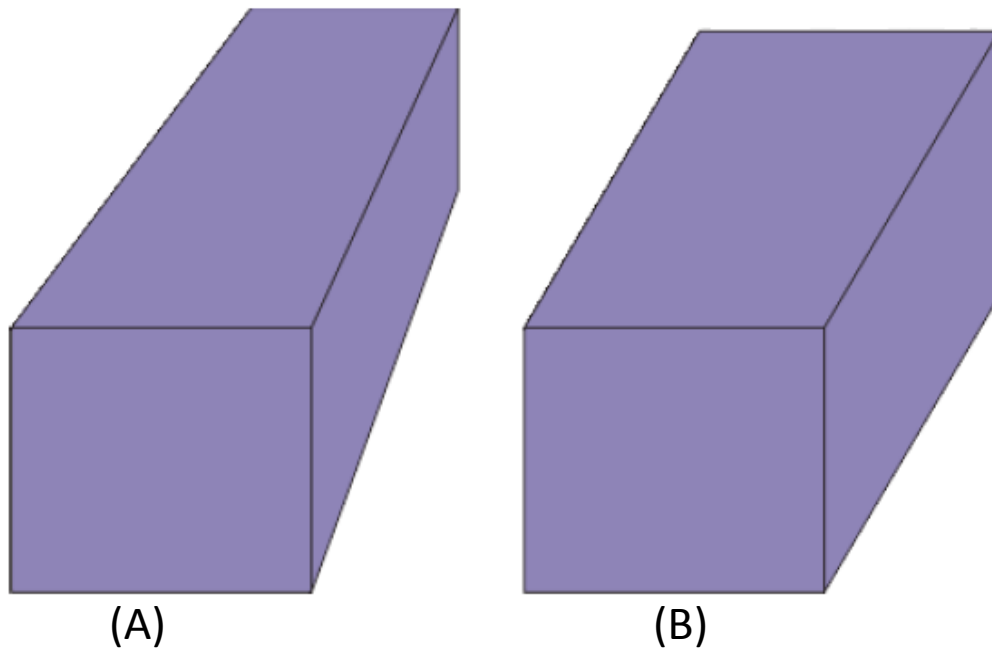


Figure 1: Two pictures taken by two different cameras.

- (1) For the two pictures shown in Figure 1, which one is taken with a perspective camera and which one is taken with an orthographic camera? (1 point)
- (2) What is the camera projection matrix for a perspective camera? What is the camera projection matrix for an orthographic camera? Why an orthographic camera can be considered as a special perspective camera? In your own language, discuss their differences. (2 points)
- (3) Identify a set of lines in either picture A or picture B that are intersecting in a vanishing point with a finite coordinates. (1 point)

Problem #2: 2D Geometry (3 points)

Here are the homogeneous coordinates of two 2D points

$$y_1 = [1 \ 1 \ 2], y_2 = [2 \ 3 \ 1].$$

Here are the dual homogeneous coordinates of some 2D lines

$$l1=[2 \ 3 \ 3], l2=[1 \ -1 \ 2].$$

- (1) What are the coordinates of y_1 and y_2 in the 2D coordinate system (*i.e.*, Euclidean coordinates)? (1 point)
- (2) Determine the intersection points of line $l1$ and $l2$, in the form of both homogenous and Euclidean coordinates. (2 point)

Problem 3: 3D Geometry (3 points)

Here are the homogeneous coordinates of some 3D points

$$x1=[1 \ 2 \ 3 \ 4], x2=[4 \ 3 \ 2 \ 1].$$

Here are the dual homogeneous coordinates of a 3D plane

$$p1=[1 \ -1 \ 2 \ -1].$$

- (1) Which 3D points do the homogeneous coordinates represent? (1 point)
- (2) What are the normal vector and the distance to the origin for the plane? (2 points)

Problem 4: Linear Regression (10 points)

You are given a fully labeled training dataset of 4,649 data samples with 256 dimensions. In this dataset, each sample takes a discrete label from `1', `2', ..., `10'. You are required to build regularized linear regression from the 256-dimensional data to the discrete labels. The task is to predict the labels for a test dataset of 4,649 samples. Note that the test data is completely disjoint to the training data.

Data link http://www.ee.columbia.edu/~wliu/linear_regression.zip

All data information is wrapped into a `linear_regression.mat' file in Matlab. Separate data information, including `trainX.txt' (training data samples, each row represents a sample), `trainY.txt' (training data labels in the order of training samples), and `testX.txt' (test data samples, each row represents a sample), are also provided.

Describe your method for this multi-class classification task. Please output **your predicted labels** (in 1 to 10) in the same order as that of the test samples into a `testY.txt' file.

(**Hint:** multiple linear regressors are needed, each of which accounts for a single discrete label. The regularization parameter needs to be tuned on the training dataset. A two-fold cross validation can be tried.)

What to turn in?

You should make your answers in a PDF file and name it as:

[yourfirstname]_[yourlastname]_HW1.pdf

For Problem 4, also send your 'textY.txt' file.

Please submit your PDF and txt files to TA (Xin Li, li.xin.cv@gmail.com).

Late submission policy applies universally with no exception.

If you have a compelling excuse, you must inform me at least 2 days before the due date. I don't accept excuses such as "**I am overloaded by other courses**".