ECE 472 Robotics and Vision
Prof. K. Dana
Homework 3: 3D Imaging using Camera Matrix, Camera Calibration

1. Create a 3D wireframe model of a simply polygonal house. Write a python program to create a virtual tour where the camera "flies" around the house creating several views. The wireframe house is described by a list of 3D vertices and a list of edges (vertex pairs) in world coordinates (pts). Choose an intrinsic parameter matrix (K), and **five** camera views (rotation and translation). Use the intrinsic parameter matrix and the camera view to project the 3D world points pts to 2D points. The projections should be handled by using the camera matrix (image formation pipeline) discussed in class. Create a function drawmyobject in python to draw 2d lines between 2d vertices. Do not use plot3 or any 3d plotting commands. . Allow your camera to rotate around the house to create a sequence of **five** views around the house. Accept the "n" button to move to the next view.

2. Consider an articulated robot arm as shown in Figure 1 and 2. This robot arm is a 3-link planar arm with revolute joints. We start by defining a reference frame, Frame0. It is fixed to the base and aligns with Frame1 when the first joint variable θ_1 is zero. (See Figure 3.6) For this arm, all $\hat{z}$ axes are oriented perpendicular to the plane of the arm. Since all joints are rotational, when the joint angle is zero degrees, all $\hat{x}$ axes align. Let $L1 = 10$, $L2 = 10$, and $L3 = 3$ units. Let $\theta_1 = 45, \theta_2 = 30, \theta_3 = 22.5$.

   (a) Write a python program to do the following: Prompt the user for angles for each degree of freedom. Your program should compute and output the transformation from matrices ${}^0T_1$,${}^1T_2$,${}^2T_3$ and ${}^0T_3$ for a specific selection of joint angles. Your program should also output "The location of the wrist with respect to the reference coordinate frame is ...". for the specified set of joint angles.

   (b) Submit a pdf describing the derivation of each coordinate frame transformation and the solution to the wrist location when (Let $\theta_1 = 45, \theta_2 = 30, \theta_3 = 22.5$.).

3. **Graduate Students Only ECE561:** Devise a 4 joint manipulator whose rotations are confined to one plane. Sketch the robot as in the figures for the previous question. Provide the transformation matrix between all joints and the transformation from the last joint to the reference frame. Give an example of calculation to transform a point given with respect to the final frame to the reference frame.

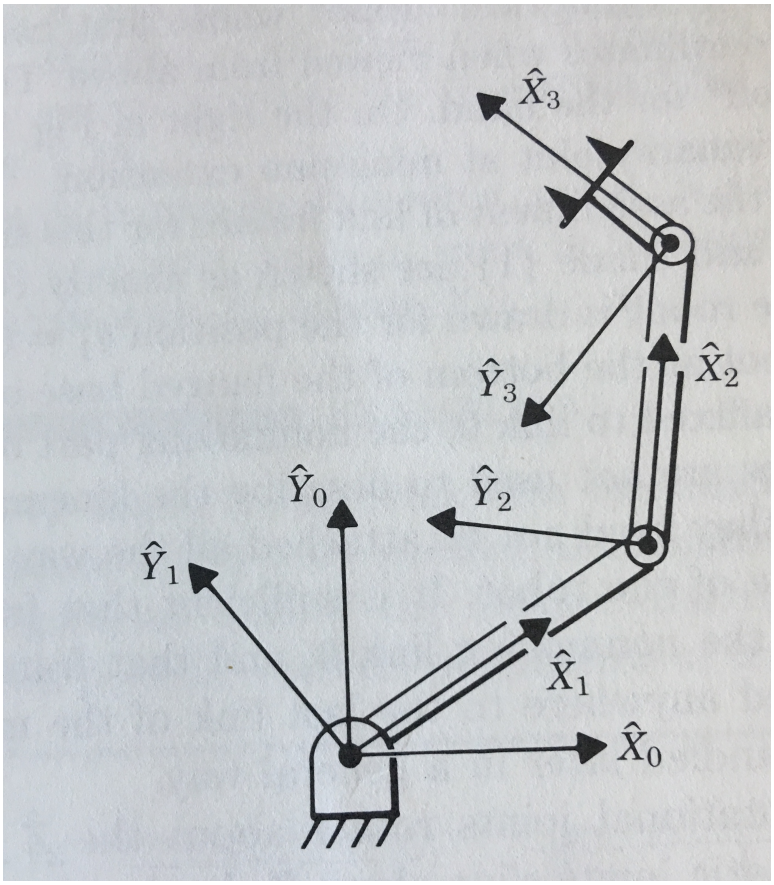

Figure 1:

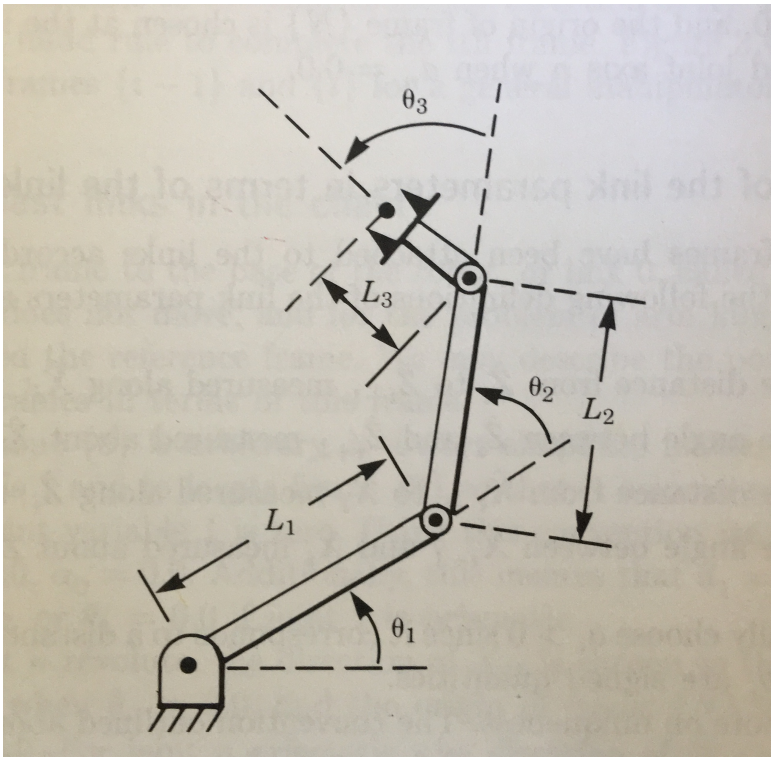

Figure 2: