Introduction to robotics - HW 1

Part 1

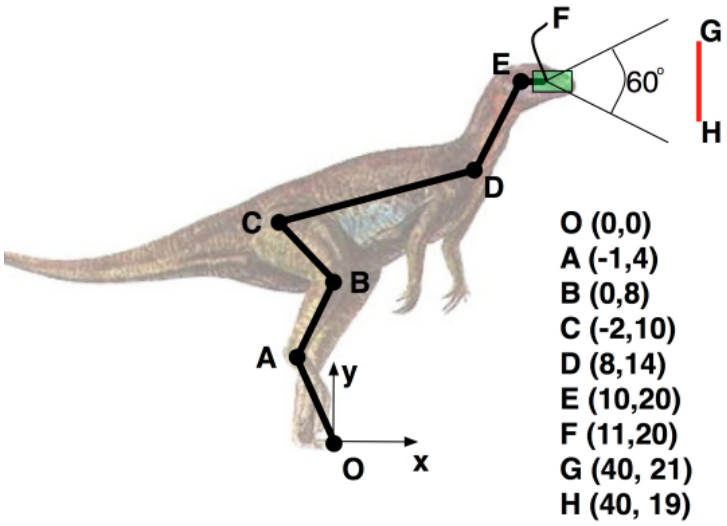
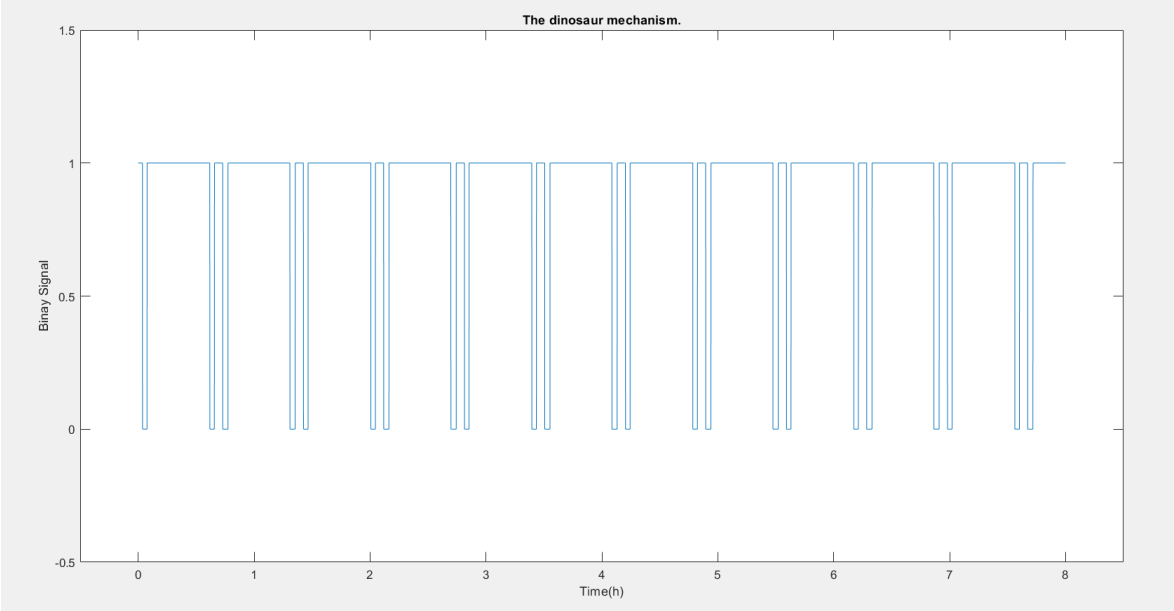


Figure 1: The dinosaur mechanism.

Generate a plot, Time vs output, Where output is 1 when any part of the Window GH is inside the FOV of camera at point F, Otherwise 0.

Solution:

Result Graph:

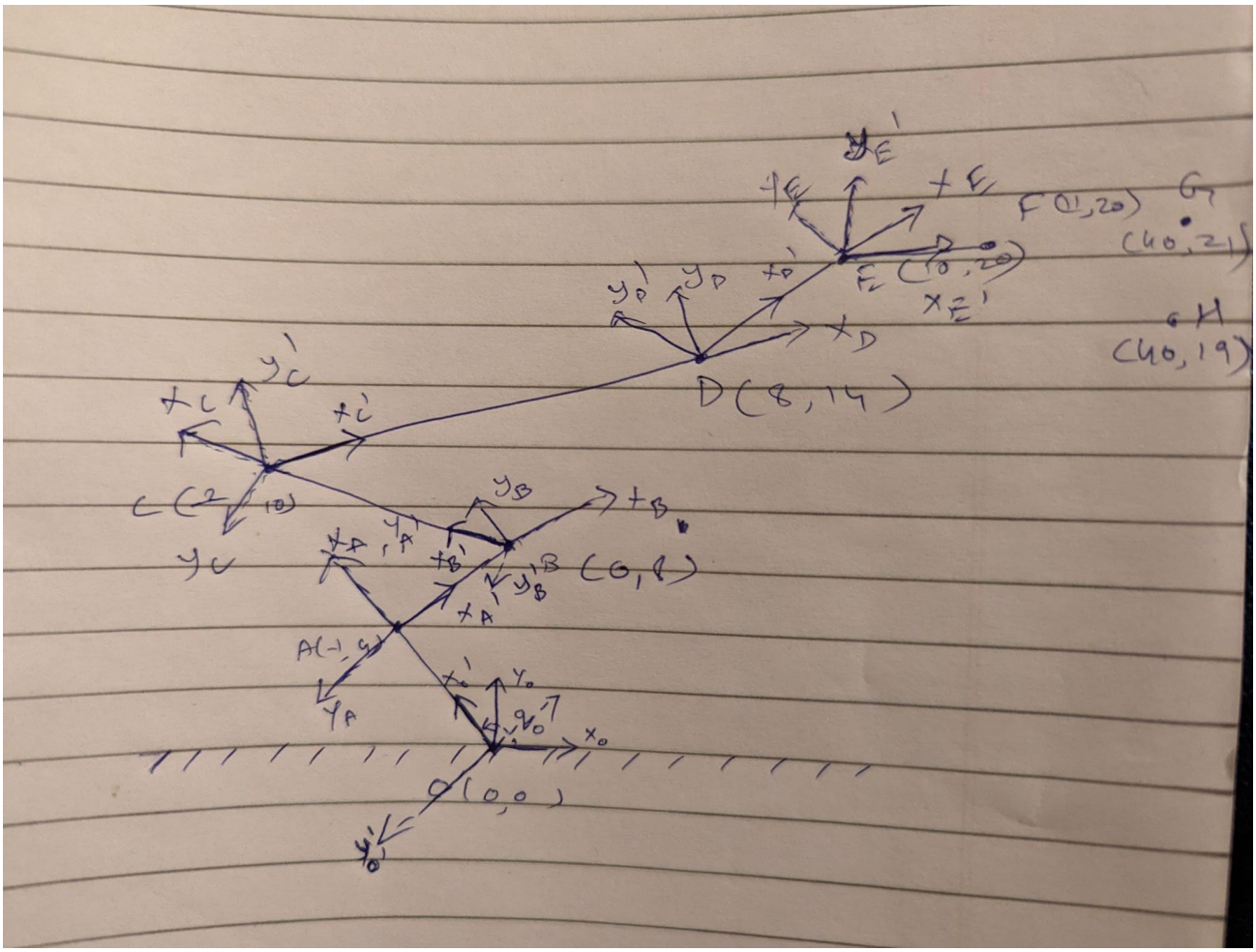


Theory:

Using Homogeneous Transformations, Generate the position of all the joints based on the encoder values given by the .txt file. Using the transformation, reach to the position of the joint, and generate the current position by multiplying with the position of joint with respect to the joint frame. After computing the position of all the joints at all times, Generate 2 lines that have an angle difference of 60 degrees (FOV of the camera). And when position the lines on point F, To check whether the window lines inside the lines or not by comparing the Y coordinate of the lines and Y coordinate of G and H.

Steps:

1. Read the Encoder text file to get encoder values of all the joints for a duration of 8 hrs
2. Calculate the position of point F at all times.
    a. Using Homogeneous Transformation and following the reference frames in the below image. Translate and rotate from point o to point f.



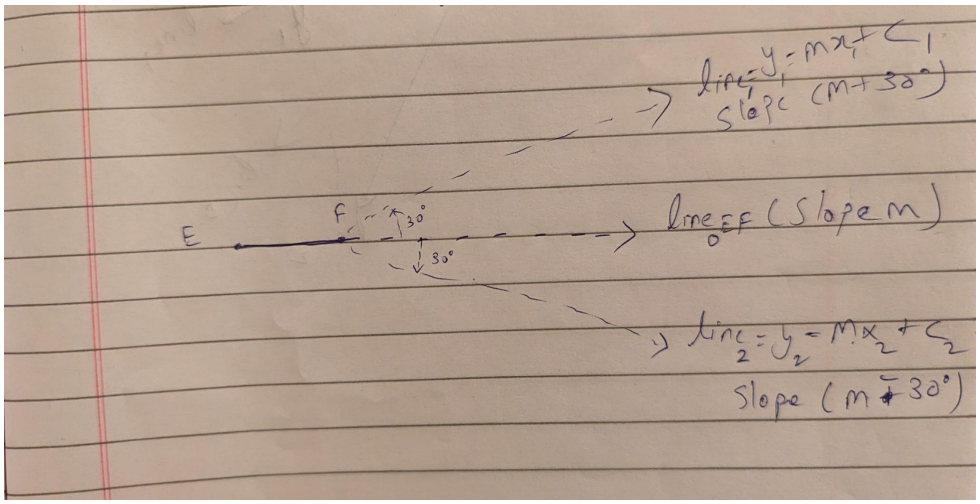
b. Based on the above reference frames, To calculate the position of point F we use the below formula

pf = Tooe*Toea*Taae*Taeb*Tbbe*Tbec*Tcce*Tced*Tdde*Tdee*Teee*Teef*Pf{f}

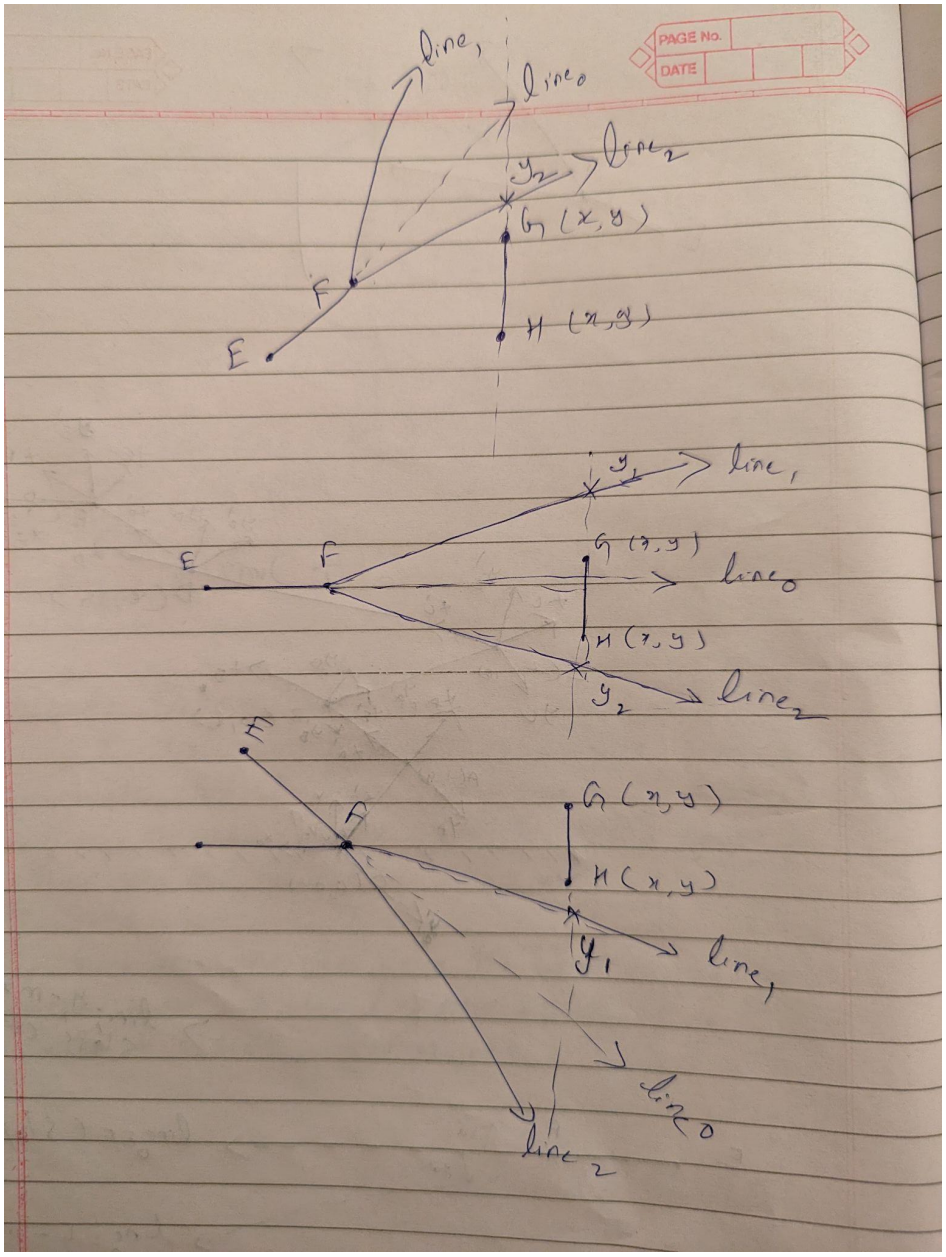
c. To calculate the pose of point A → We rotate the reference frame from o to oe: and then translate with distance oa(Length of the link OA) and reach the reference frame A. To get the current pose after the rotation of joint o by the encoder data and the offset angle q0, the pose can be calculated by the following equation.

pa = Tooe*Toea*Pa{a}

d. Repeat the same steps to get the pose of all joints.



3. To generate the FOV of the camera at point F, We calculate the slope of line EF, and add an offset of 30 Degree each side to generate a FOV of 60 Degree.
4. Using the equation of Line, using the point F, Pass the X and Y coordinates of point F in equation Y = mX + C, We calculate the intercept C of a line with slope m and passing through point F
5. Repeat the step for -30 degree line and generate two lines with slope m1 and m2 and passing through point F and are at an angle of 60 degree from each other.



6. We consider the above 2 lines as infinite lines and calculate the Y parameter, when the X coordinate of point G satisfies the line and repeat for point H .
7. To check if the Line GH is in the FOV or not, When the Y parameter of -30 degree line is greater than Y coordinate of point G ‘OR’ Y parameter of + 30 degree line is less than the Y coordinate of the point H. The Line is outside the FOV of the camera and the output is 0; Otherwise it's Inside the camera FOV and the output is 1.

Part 2
Minimum Distance of the point F from the window GH

Solution:

Minimum Distance of Point F from Window GH is : 26.103618

Theory:

To calculate the Minimum distance between point F and line GH, Calculate the distance between the points F and G, H and Midpoint of GH and store the values in an array. Use the min function to pick the minimum value from the 3 arrays. Now we have the Minimum distance between Point F wrt point G, H and midpoint of GH. Pick the minimum distance from the 3 values to calculate the least distance of point F from window GH.

Steps:

1. Calculate the distance between point F and point G
2. Calculate the distance between point F and point H
3. Calculate the distance between point F and Midpoint of the window GH
4. Calculate the Min of the above arrays and Pick the least value of the 3 minimum values.