KULLIYYAH OF ENGINEERING

الجامعة الإسلامية العالمية ماليزيا

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

ROBOTICS

MCTE 4352

SECTION 1

SEM 2 2020/2021

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Final project

- **Objectives**

  - To create a 3 dof planar robot that can draw my last name ‘DINI’ in Brush Script MT font (On an A4 paper) using RTBtool box and using pen & paper and excel.

- **Methodology**

1. Get points positions of the letters:

   By typing the name ‘DINI’ in word in word, a screenshot had been taken and uploaded on WebPlotDigitizer to get the points of the letter. A number of 67 point have been taken.

Transformation points (x,y,z):

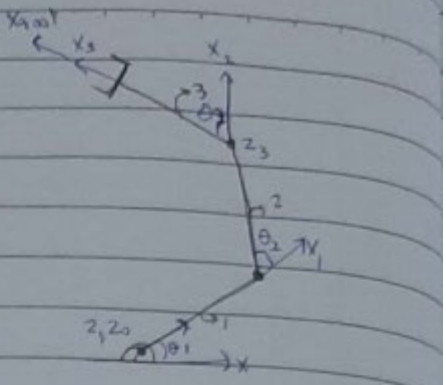
1. 0.3791 2.3889 0;
2. 0.5764 0.9949 0;
3. 0.6565 2.5717 0;
4. 0.7071 1.4491 0;
5. 0.8642 0.9377 0;
6. 0.8376 1.7230 0;
7. 0.9569 2.6921 0;
8. 1.0323 2.0430 0;
9. 1.1983 1.0232 0;
10. 1.2688 2.7401 0;
11. 1.2537 2.3263 0;
12. 1.5102 1.1335 0;
13. 1.5807 2.8039 0;
14. 1.8221 1.3023 0;
15. 1.8926 2.7768 0;
16. 2.1189 1.5473 0;
17. 2.1788 2.6935 0;
18. 2.3682 2.4279 0;
19. 2.3585 1.8455 0;
20. 2.5300 2.1283 0;
21. 2.8875 2.0775 0;
22. 3.1101 2.4846 0;
23. 3.1401 2.0201 0;
24. 3.2405 0.9884 0;
25. 3.4017 2.6937 0;
26. 3.4692 1.3422 0;
27. 3.6482 1.6827 0;
28. 3.6882 2.8591 0;
29. 3.8167 2.0097 0;
30. 3.9752 2.3161 0;
31. 3.9953 2.8838 0;
32. 4.0777 2.5274 0;
33. 4.3676 2.6191 0;
34. 4.4085 1.1339 0;
35. 4.6553 1.4352 0;
36. 4.6795 2.7207 0;
37. 4.8505 1.7483 0;
38. 4.9914 2.8229 0;
39. 5.0333 1.9902 0;
40. 5.2042 2.3084 0;
41. 5.3043 2.9045 0;
42. 5.2127 2.6768 0;
43. 5.3360 0.9087 0;
44. 5.3519 2.1408 0;
45. 5.4776 1.2877 0;
46. 5.6400 2.4089 0;
47. 5.6367 1.6705 0;
48. 5.6289 0.8888 0;

49. 5.8298 1.9590 0;
50. 5.9729 2.5736 0;
51. 5.9472 1.1276 0;
52. 6.0489 2.2107 0;
53. 6.2351 2.6586 0;
54. 6.3000 2.2920 0;
55. 6.1383 1.2984 0;
56. 6.4252 2.0597 0;
57. 6.6649 2.4642 0;
58. 6.6816 2.0089 0;
59. 6.8022 0.9890 0;
60. 6.9633 2.6942 0;
61. 7.0308 1.3436 0;
62. 7.2098 1.6849 0;
63. 7.2499 2.8591 0;
64. 7.3784 2.0111 0;
65. 7.4966 2.3106 0;
66. 7.5570 2.8857 0;
67. 7.5620 2.5891 0;

2. Next, we need to get the DH values for 3 DoF planar robot in order to insert these values in matlab.

1) For the 3R planar robot,
Find
(i) DH Parameter
(ii) $^{0}_{Tool}[T]$

$L_1 \rightarrow [0, 1]$
$L_2 \rightarrow [1, 2]$



DH Table

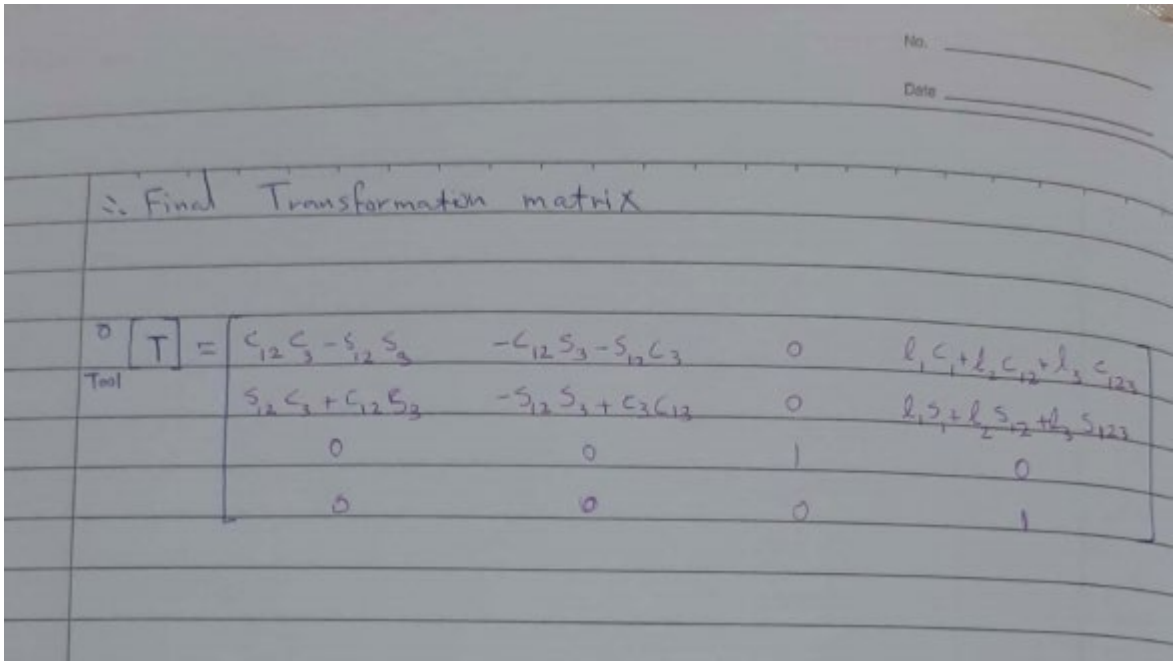
		θ (Z)	d (Z)	a (X)	α (X)
(0→1)	L1	$+\theta_1$	0	0	0
(1→2)	L2	$+\theta_2$	0	l_1	0
(2→3)	L3	$+\theta_3$	0	l_2	0

* Z axis is assumed out of paper so $\alpha = 0$

$$^{0}_{1}[T] = \begin{bmatrix} C_1 & -S_1 & 0 & 0 \\ S_1 & C_1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad ^{1}_{2}[T] = \begin{bmatrix} C_2 & -S_2 & 0 & l_1 \\ S_2 & C_2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$^{2}_{3}[T] = \begin{bmatrix} 1 & 0 & 0 & l_2 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad ^{3}_{Tool}[T] = \begin{bmatrix} 1 & 0 & 0 & l_3 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

* From 3 → tool, It can clearly be seen that there is only one translation movement along X-axis.



- **Forward Kinematic equation:**

x=l1c1+ l2c12+l3c123

y=l1S1+ l2S12+l3S123

Φ=θ1+θ2+θ3

- **Inverse Kinematic equation:**

θ2 = atan2(sinθ2,cosθ2)

θ1 = atan2((k1yn −k2xn),(k1xn −k2yn)

θ3 = ϕ −(θ1 +θ2)

Where,

k1=l1+l2cosθ2=10-10cosθ2

k2=l2=10

sinθ2cosθ2=x2+y2-2l22l2=x2+y2-200200

sinθ2=±(1-cos2θ2)

Xn=x-l3cosΦ=x-10cos

yn=y-l3sin=y-10sin

3. Next, we used rtbtoolbox and insert it the value for links and DH table parameters that we found through the calculations, the initial values for theta assumed to be zero:
   dh= [
   0 0 0 0
   0 0 L1 0
   0 0 L2 0
   0 0 L3 0];
   In addition, a 67x3 matrix has been created to store the points,
4. After that, the transformation matrix for all points has been calculated using the command:

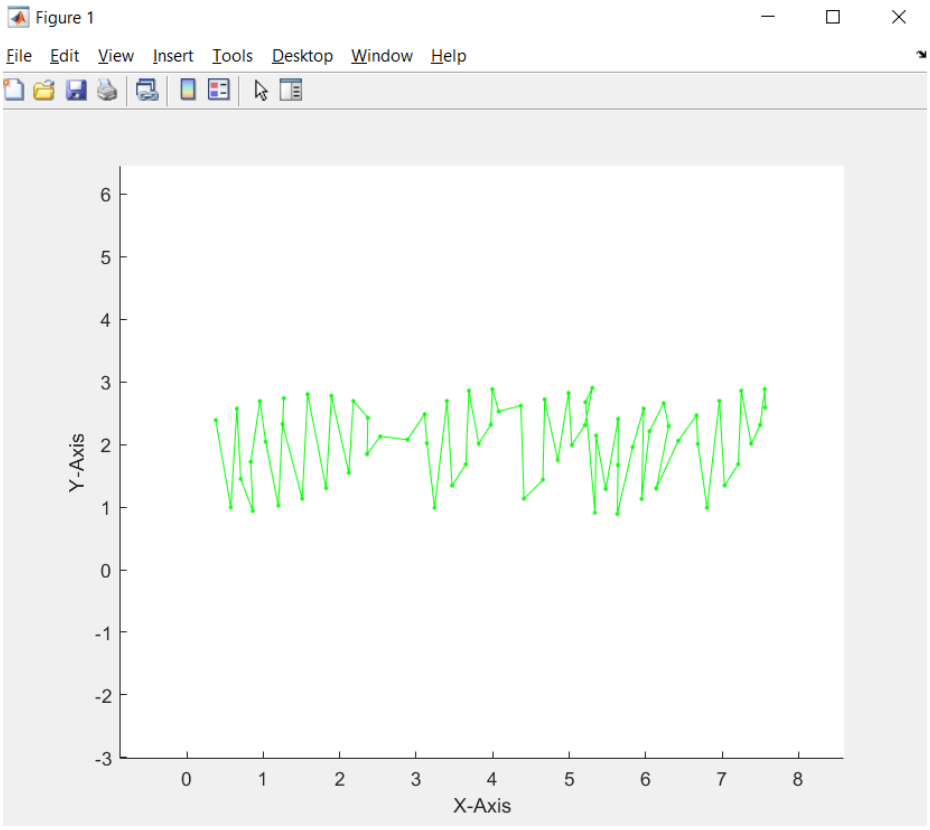
   Pn = transl(matrix(n,1), matrix(n,2), matrix(n,3));

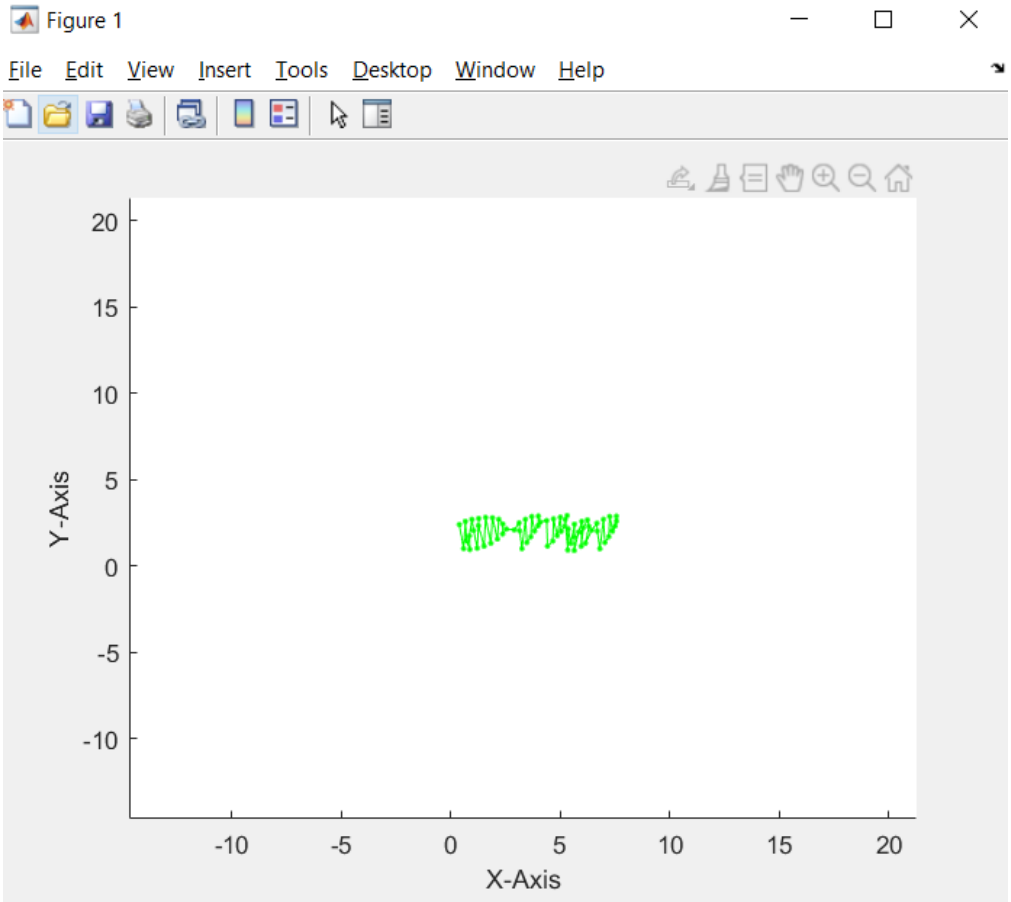
   where n is the number of the point.
5. From trasformation matrix, we can obtain IK by using this command:

   qn = diniproject.ikine(Pn,q0,[1,1,1,0,0,0]);
6. Next, from inverse kinematics, we can get forward kinematics by using this command:

   qn_Pn = Rob.fkine(qn);
7. Lastly, Since we everything needed now, we need to move the 3 dof planar in way so it can follow the points. First, we using trajectory to set up all the point position, then by using 'for' loop, we can move the robot across the point to write the name 'DINI'.

- **RESULT**





- **Discussion**

  Looking at the graph created by MATLAB, it can be seen that the drawing is not clear enough, this is due the low numbers of points that has been taken. However, it still represents the letters of the name shows it drew all the points.

- **Conclusion**

  - There are so many modern simulation tools in robotics that can ease work and solve complicated robot designs.