IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 14, Issue 5 Ver. I (Sep. - Oct. 2017), PP 50-53
www.iosrjournals.org

MATLAB GUIDE Development for SCARA Robot

Suyash Shrivastava[1]
[1](*Mechanical Department, Medi caps College Indore, India)*
Corresponding Author: Suyash Shrivastava

Abstract: *The research work is focused on developing MATLAB GUIDE Graphical User Interface to calculate forward and inverse kinematics of 4 Degree of Freedom SCARA robot. In this research work two different GUI windows were developed for calculations of forward kinematics of SCARA robot and inverse kinematics of SCARA robot. The forward kinematics position*

Keywords: *Forward or Direct Kinematics, GUIDE, Inverse kinematics, MATLAB, SCARA.*

Date of Submission: 30-08-2017 Date of acceptance: 08-09-2017

I. Introduction

The research work focused on solving problem related to calculation of forward and inverse kinematics of SCARA robot. The equations of position matrices of SCARA robot are complicated and complex it will be problem for researcher to calculate the position matrices. The research work is focused on developing a user friendly Graphical User Interface with the help of MATLAB GUIDE software to minimize time and labor of researcher in calculating position matrices of 4 DOF SCARA robots.

In the forward kinematics of robot position and orientations were calculate with the help of link length and joint angles on the other hand inverse kinematics of robot joint angle were calculated with the help of link length and position matrices. This can be explained with the help of diagram of forward and inverse kinematics which is shown in fig.1.

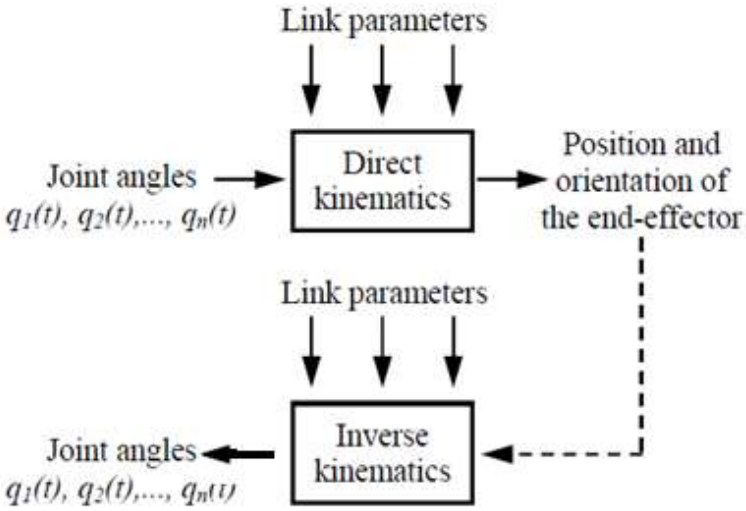

Fig. 1 Forward and Inverse Kinematics

II. Literature Review

The Author (Mariappan and Veerabathiram 2016) has done modeling and simulation of multi spindle drilling redundant SCARA robot PRRP (prismatic -revolute -revolute -prismatic) which is used to drill multiple holes in printed circuit board and sheet metal, modeling is done using solidworks CAD software and to study dynamic 3D CAD model of robot is converted in Sim-mechanics block diagram by exporting into MATLAB/Sim-mechanics utilizing its motion sensing capability the dynamic parameter velocity and torque of the manipulator are studied and necessary improvement in design of robot is performed. [1]

The Analysts (Chinmayi, et al. 2016) have performed analysis the kinematic of SCARA robot for the application of deburring rectangular path, modeling motion simulation kinematic analysis is done in NX, mathematical analysis is performed in MATLAB, comparison is performed between CAD NX motion simulation kinematics analysis and MATLAB mathematical analysis it is observed there is variation in the time it is because of the change in the direction of movement which can be reduced by providing offset at the point where there is change in the direction. [2]

The Researchers (Venkata Rao, Raju and Subhashini 2014) has performed analysis of SCARA robot for deburring circular profile mathematical model for kinematics and equations are derived from Denavit-Hartenberg notation, kinematic parameter include joint angle, position, and velocities are calculated by modeling and simulation analysis in CAD software and compare with result obtained from MATLAB, it is observed that result match fairly. [3]

The Analysts (Fang and Li 2013) had modeled four degree of freedom SCARA robot simulation and analysis is done by using robotic toolbox in MATLAB. Robot kinematic simulations include both forward kinematics and inverse kinematics, operator has to provide joint angle to the software and robot reach the space coordinate. [4] The Author (Elaikh, et al. 2013) has studied vibration and kinematics characteristic of SCARA robot structure using simulation with the help of MATLAB software. [5]

The Researcher (Shanmugasundar and Sivaramakrishnana 2012) enhanced analytical approach of inverse kinematic SCARA robot by applying mathematical model's linear integration of the parameters by least square method to Adaptive Neuro Fuzzy Network (ANFIS) and the approximation error is back propagated. Matlab is used to simulate the codes and finally ANFIS gives acceptable solution. [6]

The Researcher (Jamali and Shirazi 2012) had modeled, simulated, and optimized virtual prototype of a three degree of freedom SCARA robot by using CAD software solidworks and for multivariable control process and genetic algorithm MATLAB simmechanics is used. [7]

The Author (Jasim 2011) has performed calculation of complex inverse kinematics of four axes SCARA robot by using neuro fuzzy network ANFIS. The reason of using adaptive neuro fuzzy network was, it is easy to operate and errors are in acceptable limit and simulation is quit fast. [8]

The Researcher (Isaksson, et al. 2010) studied kinematic parallel structure of robot to enhance working of SCARA robot, comparison were performed between parallel structure and SCARA robot. [9] The Researcher (Tempea, Neacsa and Livadariu 2009) designed a double SCARA mechanism using CAD software CATIA V5, there are two types of five-bar mechanisms model that have been normalized and reduced, in which the distance between the joints from the frame is zero. In the second case, it offers a new acting solution of active couples, making it easier to build the system. This solution also goes into a simplified forward and inverse kinetametics and simple control system. [10]

III. Matrices And Equations

The SCARA robot of 4 degree of freedom has four matrices each matrices represents the individual motion or orientations of robotic arm. By multiplying the matrices of the robotic arm equations of orientations and positions were obtained. But research work is focused on position of robotic arm for forward kinematics so equations for position matrices were shown.

$$\left[A_0^1\right] = \begin{bmatrix} c_1 & -s_1 & 0 & a_1 c_1 \\ s_1 & c_1 & 0 & a_1 s_1 \\ 0 & 0 & 1 & d_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}; \left[A_1^2\right] = \begin{bmatrix} c_2 & -s_2 & 0 & a_2 c_2 \\ s_2 & c_2 & 0 & a_2 s_2 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}; \left[A_2^3\right] = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & -d_3 \\ 0 & 0 & 0 & 1 \end{bmatrix};$$

$$\left[A_3^4\right] = \begin{bmatrix} c_4 & -s_4 & 0 & 0 \\ s_4 & c_4 & 0 & 0 \\ 0 & 0 & 1 & -d_4 \\ 0 & 0 & 0 & 1 \end{bmatrix};$$

$P_x = a_1 C_1 + a_2 C_{12}$

$P_y = a_1 S_1 + a_2 S_{12}$

$P_Z = d_1 - d_3 - d_4$

The following are the equations for inverse kinematics of SCARA robot.

$$\theta_2 = a\cos\left(\frac{P_x^2 + P_y^2 - a_1^2 - a_2^2}{2 a_1 a_2}\right)$$

$$\theta_1 = a\sin\left(\frac{P_y^2[a_1 + C_2 a_2] - P_x^2 S_2 a_2}{P_x^2 + P_y^2}\right)$$

IV. MATLAB GUIDE

The MATLAB is powerful tool used in calculating complex and sophisticated problems. In this research work two different windows were developed by help of MATLAB GUIDE to calculate position matrices in forward kinematics and joint angles in inverse kinematics.

In fig. 2 forward kinematics calculation of SCARA robot is shown and in fig.3 inverse kinematics calculation for SCARA robot is shown.

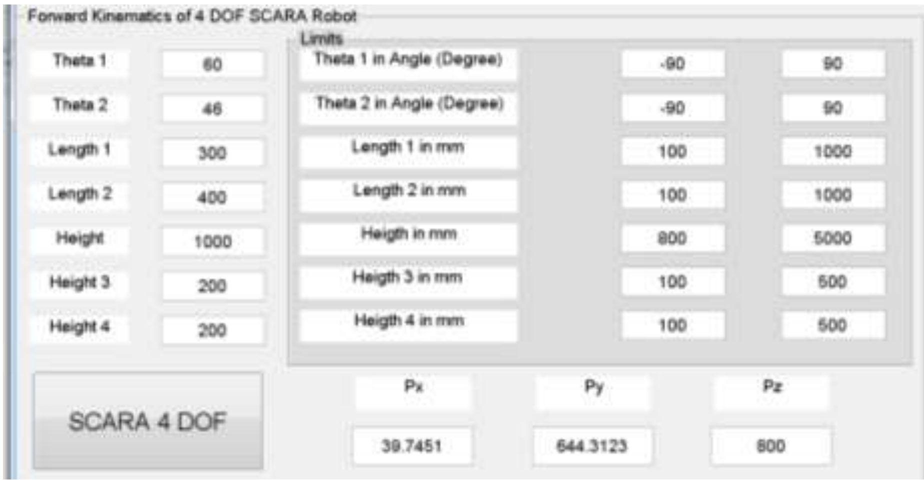

Fig. 2 MATLAB GUIDE Window for 4 DOF SCARA Robot

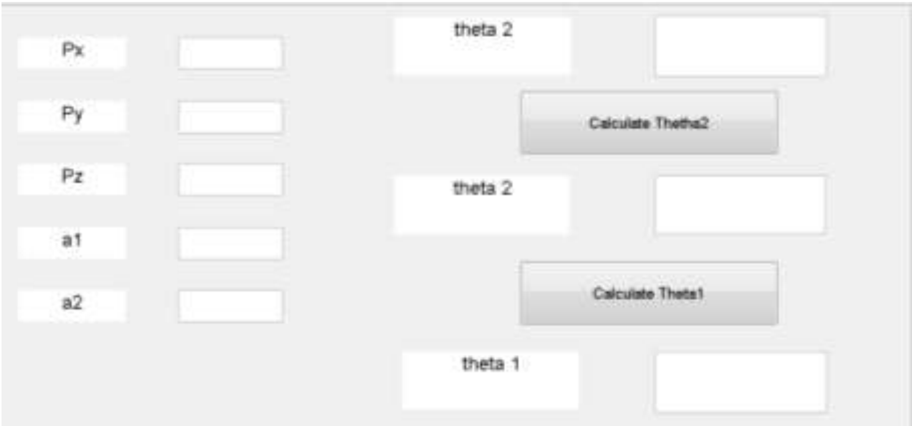

Fig. 3 MATLAB GUIDE Window for 4 DOF SCARA Robot

V. Observation Tables

The observations were taken for forward and inverse kinematics. The TABLE I shown the observations of forward kinematics of 4 DOF SCARA robots, in this TABLE I the position matrices were calculate by the help of link length and joint angle. The TABLE II shows the observations of inverse kinematics of 4 DOF SCARA robots, in this TABLE II the joint angles were calculate by the help of link length and position matrices.

TABLE I Forward Kinematics of SCARA 4 DOF Robot

SN	α1	α2	a1	a2	d1	d3	d4
1	30	20	500	500	1000	300	200
2	35	25	700	700	1200	300	200
3	45	45	1000	1000	2000	500	300
4	70	80	1000	1000	2000	500	300
5	90	90	1500	1500	5000	1000	500

TABLE I Inverse Kinematics of SCARA 4 DOF Robot

SN	Px	Py	Pz	a1	a2	α1	α2
1	754.4065	633.0222	500	500	500	30	20
2	923.4064	1007.7213	700	700	700	35	25
3	707.1068	1707.1068	1200	1000	1000	45	45
4	-524.0053	1439.6926	1200	1000	1000	70	80
5	-1500	1500	3500	1500	1500	90	90

VI. Conclusion

MATLAB GUIDE developed for easy and simple calculations of forward and inverse kinematics of 4 DOF SCARA robots. The TABLE I and TABLE II show the observation and one can see that the result were perfectly matched. In the TABLE I Forward Kinematics of SCARA 4 DOF Robot, positions matrices were calculated with the help of link length and joint angles. In the TABLE II Inverse Kinematics of SCARA 4 DOF Robot, joint angles were calculated with the help of link length and position matrices.

References

[1]. Mariappan, Saravana Mohan, and Anbumalar Veerabathiram. "Modelling and Simulation of Multi Spindle Drilling Redundant SCARA Robot using Solidworks and MATLAB/ SimMechanics." *Facult of Engineering, University of Antioquia* (ResearchGate), December 2016: 63-72.

[2]. Chinmayi, k, PVS Subhashini, G Venkata Rao, and NVS Raju. "Kinematic Aanlysis of a SCARA robot for Deburring of Rectangular Paths." *International Journal of Scientific & Engineering Research* 7, no. 6 (June 2016): 57-62.

[3]. Venkata Rao, G, NVS Raju, and PVS Subhashini. "Modelling Simulation and Analysis of a SCARA Robot for Deburring of Circular Components." *APRN Journal of Engineering and Applied Sciences* 9, no. 4 (April 2014): 398-404.

[4]. Fang, Jian, and Wei Li. "Four Degree of Freedom SCARA Robot Kinematics Modeling and Simulation Analysis." *International Journal of Computer Consumer and Control* 2, no. 4 (2013): 20-27.

[5]. Elaikh, Talib EH, Haider J Abed, Kadhim M Abed, Salah M Swadi, and Kadhim Karim M. "Vibration and Kinematic Analysis of SCARA Robot Structure." *Diyal Joural of Engineering Sciences* 6, no. 3 (September 2013): 127-143.

[6]. Shanmugasundar, G, and R Sivaramakrishnana. "Software Development for an Inverse Kinematics of Seven degree of Freedom Newly Designed Articulated Inspection Robot." *International Journal of Computer Application* 58, no. 18 (November 2012): 29-36.

[7]. Jamali, Pouya, and Kourosh H Shirazi. "Robot Manipulators Modeling Simulation and Optimal Multi Variable Control." *Trans Tech Publications* , 2012: 1-5.

[8]. Jasim, Wesam Mohammed. "Solution of inverse kinematics for Scara Manipulator using Adaptive Neuro Fuzzy Network." *International Journal on Soft Computing* 2, no. 4 (November 2011): 59-66.

[9]. Isaksson, Mats, Torgny Torgardh, Ivan Lundberg, and Saeid Nahavandi. "Improving the Kinematic Performance of the SCARA Tau PKM." *IEEE International Conference on Robotics and Automation*, May 2010: 4683-4690.

[10]. Tempea, Iosif, Marin Neacsa, and Adriana Livadariu. "A New Acting Solution of a Double SCARA Robot." *The 3rd International Conference on "Computational Mechanics and Virtual Engineering"* , October 2009: 765-770.

Suyash Shrivastava. “MATLAB GUIDE Development for SCARA Robot .” IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , vol. 50, no. 53, 2017, pp. 50–53.