Path Analysis of Scorboter V plus End Effectors Using Lab View

S Anand[1], Navish Kumar[2], Ajithkumar MS[3]
Assistant professor, [1,2,3]Karpagam Institute of Technology

Abstract : *In this paper, a novel technique has been used for analyzing the path of Scorboter V Plus TCP (tool centre point) for various sets of joint parameters within the predetermined workspace boundaries to analyze the movement of the end effectors. In this approach, besides the D-H Parameters, Joint variables are the only decision variables within the workspace. The algorithm has been tested in LabVIEW simulation, displayed in graphical form which yielded exact results, and also has been compared and validated with ROBOCELL 3D graphic software. The proposed system has been modeled using LabVIEW2011.*

Keywords: *D-H model, DOF, TCP, Lab View. Developing Path Analysis Model*

INTRODUCTION

Path and workspace analysis are used to analyze the possible path of travel of TCP and to develop inverse kinematics model in Stage IV. The modification done in the FKM to do the analysis. The results are obtained graphically using LabVIEW and AutoCAD model. The path analysis is done in three major starting positions. They are 1.Minimum position, 2.Home position, and 3.Maximum position. The workspace analysis is done considering four Rotations. They are 1.Base, 2.Shoulder, 3.Elbow and 4.Wrist.

Modifications in FKM for getting Reachability Model

The following modifications are done in the block diagram used in FKM to do Reachability analysis.
In the block diagram the following inclusions are made. Combined signal is obtained by merge the three inputs taken from the FKM. The path and workspace graphically expressed in 3D parametric surface graph and 3D scatter graph.

Figure Modification in the block diagram of FKM

List Programme for Workspace Analysis Model

The results obtained from reachability analysis FKM are imported to an XL file and using LISP in AutoCAD the Workspace analysis is done. The procedure is explained in the section 6.3. The 3D graphical representation of the model provides the complete data about the working space of the SCORBOT ER V Plus.

Path Analysis

Path analysis of the SCORBOT ER V Plus is done by using the developed PAM. At three different positions various rotations are recorded. The procedure developed in this stage is given below. The path analysis is done considering three possible positions for each rotation. They are 1.Minimum position, 2.Home position, and 3.Maximum position.

With Base Rotation

The results obtained from experiments one, five and nine of the previous stage (STAGE II) are combined to analyse the path of the TCP.

Minimum

All the joint parameters with their minimum range are assumed. $\theta_2 = -35$, $\theta_3 = -130$, $\theta_4 = -130$ and $\theta_5 = -570$ are kept constant and θ_1 (± 155) is variable. (Refer Table 5.1)

Home Position

All the joint parameters with their minimum range are assumed. $\theta_2 = -120.27$ $\theta_3 = 95.03$ $\theta_4 = 88.81$ and $\theta_5 = 0$ are kept constant and θ_1 (± 155) is variable. (Refer Table 5.5)

Maximum Position

All the joint parameters with their minimum range are assumed. $\theta_2 = 130$, $\theta_3 = 130$, $\theta_4 = 130$ and $\theta_5 = 570$ are kept constant and θ_1 (± 155) is variable. (Refer Table 5.9)

Figure Path analysis with base rotation (Scatter Plot)

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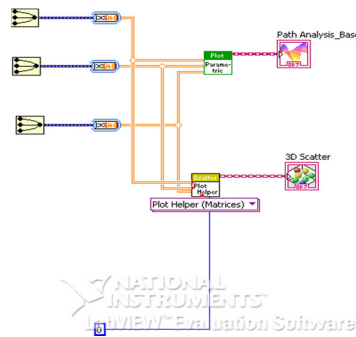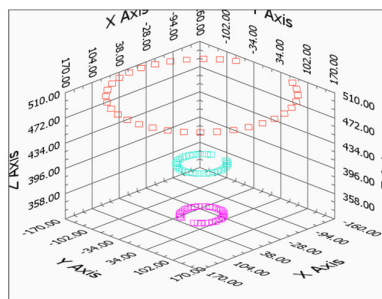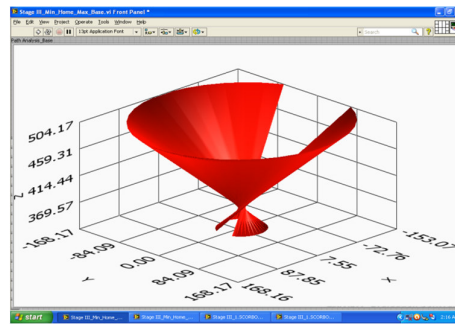
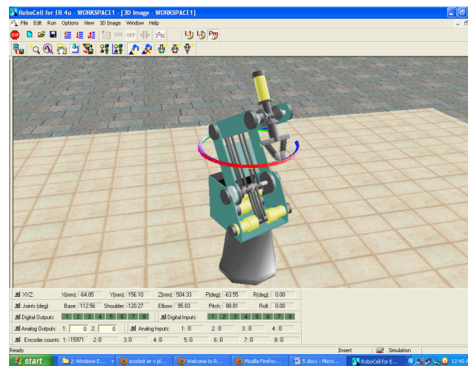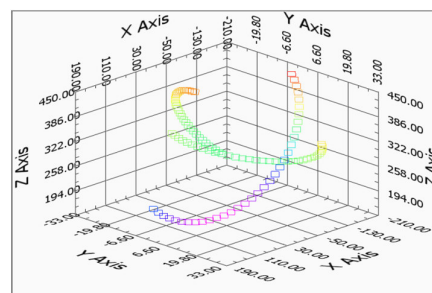Figure Path analysis with base rotation (Parametric Surface Graph)

Figure Path of TCP using ROBOCELL (base rotation)

With Shoulder Rotation

The results obtained from the experiments two, six and ten of STAGE II are combined to analyse the path of the TCP.

Minimum Position

All the joint parameters with their minimum range are assumed. θ_1 =-155, θ_3 = -130, θ_4 =-130 and θ_5 =-570 are kept constant and θ_2 (-35 to +130) is variable. (Refer Table 5.2)

Home Position

All the joint parameters with their minimum range are assumed. θ_1 =0, θ_3 = 95.03, θ_4 =88.81 and θ_5 =0 are kept constant and θ_2 (-35 to +130) is variable.(Refer Table 5.6)

Maximum Position

All the joint parameters with their minimum range are assumed. θ_1 =155, θ_3 = 130, θ_4 =130 and θ_5 =570 are kept constant and θ_2 (-35 to +130) is variable. (Refer Table 5.10)

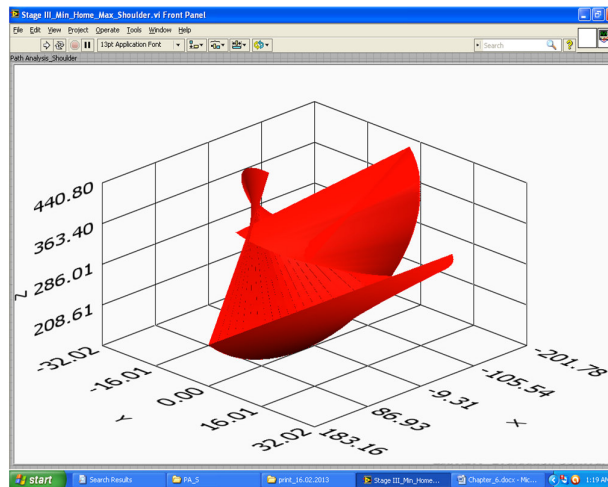Figure Path analysis with shoulder rotation (Scatter Plot)

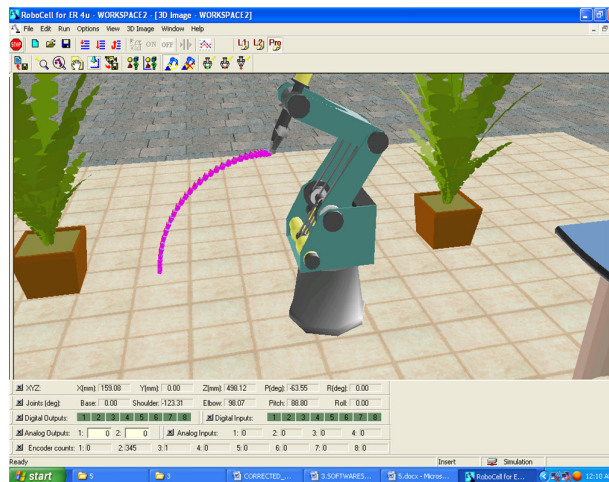Figure Path analysis with shoulder rotation (Parametric Surface Graph)

Figure Path of TCP using ROBOCELL (shoulder rotation)

With Elbow Rotation

The results obtained from the experiments three, seven and eleven of STAGE II are combined to analyse the path of the TCP.

Minimum Position

All the joint parameters with their minimum range are assumed. θ_1 =-155, θ_2 = -35, θ_4 =-130 and θ_5 =-570 are kept constant and θ_3 (-130 to +130) is variable. (Refer Table 5.3)

Home Position

All the joint parameters with their minimum range are assumed. θ_1= 0, θ_2 = -120.27, θ_4 =88.81 and θ_5 =0 are kept constant and θ_3 (-130 to +130) is variable. (Refer Table 5.7)

Maximum Position

All the joint parameters with their minimum range are assumed. θ_1 =155, θ_2 = 130, θ_4 =130 and θ_5 =570 are kept constant and θ_3 (-130 to +130) is variable. (Refer Table 5.11)
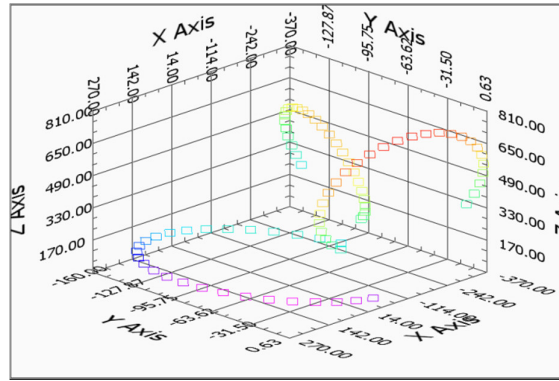
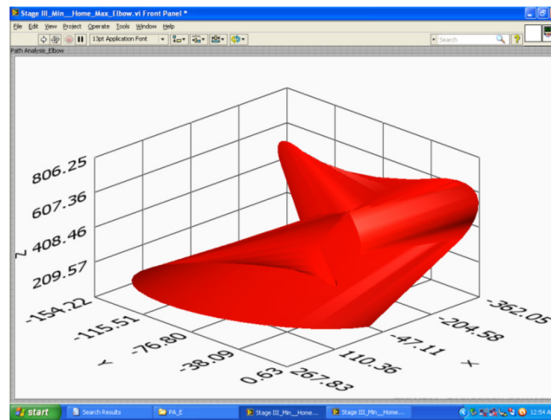Figure Path analysis with elbow rotation (Scatter Plot)

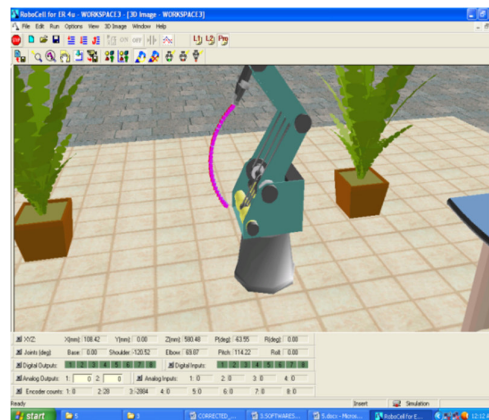Figure Path analysis with elbow rotation (Parametric Surface Graph)

Figure Path of TCP using ROBOCELL (elbow rotation)

With Wrist Rotation

The results obtained from the experiments four, eight and twelve of STAGE II are combined to analyse the path of the TCP.

Minimum Position

All the joint parameters with their minimum range are assumed. θ_1 =-155, θ_2 = -35, θ_3 =-130 and θ_5 =-570 are kept constant and θ_4 (-130 to +130) is variable. (Refer Table 5.4)

Home Position

All the joint parameters with their minimum range are assumed. $\theta_1 = 0$, $\theta_2 = -120.27$, $\theta_3 = 95.03$ and $\theta_5 = 0$ are kept constant and θ_4 (-130 to +130) is variable.(Refer Table 5.8)

Maximum Position

All the joint parameters with their minimum range are assumed. $\theta_1 = 155$, $\theta_2 = 130$, $\theta_3 = 130$ and $\theta_5 = 570$ are kept constant and θ_4 (-130 to +130) is variable. (Refer Table 5.12)
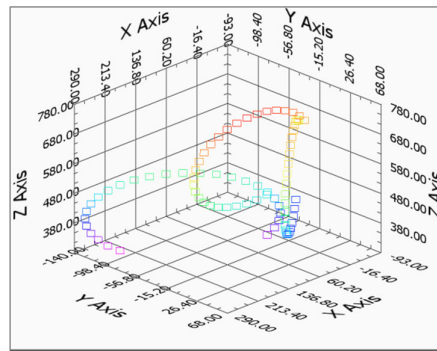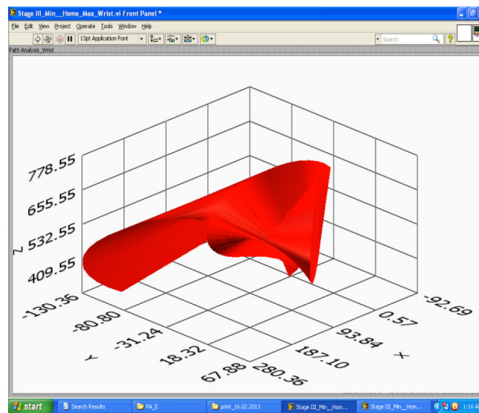

Figure Path analysis with wrist rotation (Scatter Plot)

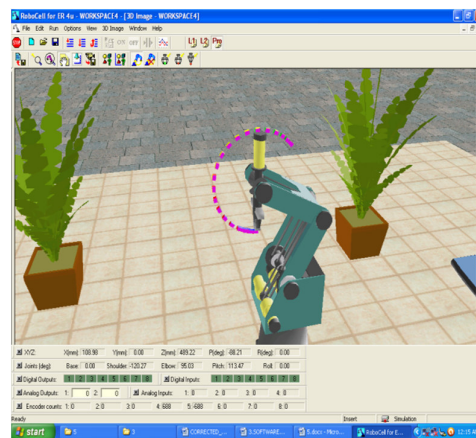Figure Path analysis with wrist rotation (Parametric Surface Graph)

Figure Path of TCP using ROBOCELL (wrist rotation)

Conclusion

A complete path analysis of SCORBOT ER-V plus TCP (tool centre point) for various sets of joint parameters within the predetermined workspace boundaries to analyze the movement of the end effector using a novel technique has been presented. In this approach, besides the D-H Parameters, Joint variables are the only decision variables within the workspace. This method is more effective and can also be applied to serial manipulators having any number of degrees of freedom. This technology can easily be extended to other robot control such as, optimal routing, error compensation control and other such aspects. It also simplifies the design process and shortens the design cycle, reduce development costs and improve product quality. The future work includes further testing and improving the algorithm for more complex robots, task incorporating the real constraints and making use of dynamics of robot manipulator as well.

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