ISSN: 2321-8169
106 - 108

Development of 3 DOF Kinematics

[1] Shubham N. Vinode,
student,Department of Electronics,
AISSMS COE, PUNE, India
vinode.shubham3@gmail.com

[3] Rohan R. Lunavat
, student,Department of Electronics,
AISSMS COE, PUNE, India
rlunavat02@gmail.com

[2] Shubham M. Kakade,
student,Department of Electronics,
AISSMS COE, PUNE, India
shubham.kakade012@gmail.com

[4] Prof. S.B. Dhekale[4]
, professor, Department of Electronics,
AISSMS COE, PUNE, India
sbdhekale@aissmscoe.com

Abstract-:In today's society, robots are used in various areas especially in those where high precision is required. Robots have improved life standards and we are upgrading their performances in order to make our lives easier and more comfortable. Many applications in the field of medicine and industry use different kind of motor-based systems such as robots because of their wide-range of sufficient characteristics like the fact that they can be used as constant power devices with accurate positioning and fast response. This project describes implementation of the proposed control of the stepper motor and robotic arm by development of suitable transfer function. In this work a motorized robot arm with a 3 degree of freedom is designed. For this design control algorithm will be developed using MATLAB software which is widely used in controlling application.

Keywords - *Forward and inverse kinematics, DOF (degree of freedom), transformation, DH convention, Robotic Arm.*

*****

1. Introduction:

The accurate control of motion is a fundamental concern in mechatronics applications, where placing an object in the exact desired location with the exact possible amount of force and torque at the correct exact time is essential for efficient system operation. The ultimate goal of this project addresses design, modeling, simulation and control issues for robotic arm, particularly, to design a robot arm control, select and apply appropriate transfer function, so that an applied input voltage with a range of 0 - 12 volts corresponds linearly to an output arm angle of 0 to 180.The designed systemshould respond to the applied input with an overshoot less than 5%, a settling time less 2 second and a zero-steady state error. To simplify and accelerate the process of robot and control design and analysis, 3 DOF kinematics is developed as due to this the robot arm can have access to 3 axis (x, y, z) hence improving the work ability of the arm. In this paper a basic introduction of the position and orientation analysis of a serial manipulator is given. Degree of freedom (DOF) is a joint on robot arm, where arm can rotate or translate, each DOF requires an actuator.

2. Kinematics:

Kinematics is the branch of mechanics that deals with the motion of the bodies and system without considering the force. And the robot kinematics applies geometry to the study movement of multi DOF kinematic chains that form the structure of robot manipulator. Robot kinematic studies the relationship between the linkages of robot with the position, orientation and acceleration. And the robotic kinematic analysis is divided into two types.

3. Forward kinematic:

This specified the joint parameter and kinematic equation is used to compute the position of end effector from specified value for each joint parameter. Or Calculation of the position and orientation of the robotic manipulator in terms of the joint variable is called forward kinematic.

4. Inverse kinematic:

This is opposite to the Forward kinematics and specified the position of end effectors and kinematics equation is used to compute the joint angle from specified position of end effector. The angle of each joint need to be obtain.

5. Literature:

We have studied many previous works done in this field by different researchers.There are many approaches that were followed by different researchers like forwardkinematics,inverse kinematics, Fuzzy Logic, Genetic Algorithm, system modeling, etc. Some of the previous works are given belowF.B.W. (Frank) Brenden in his paper hasapplied GeometricJacobian to calculate the

ISSN: 2321-8169
106 - 108

velocity of a frame as a function of joint velocities.Therefore,the Jacobian is a powerful tool to describe the motion of a multi-body system. The first step in designing the robotic arm is designing the desired kinematic structure. This structuredefines the degrees of freedom and where the axes of rotation/translations take place. The axis is free tochoose; however, the torque at each link should be considered and the robot must be able to reach the desired space. For a start and design ability the robot base will be a rotating base in Z direction.

6. Forward kinematic analysis:

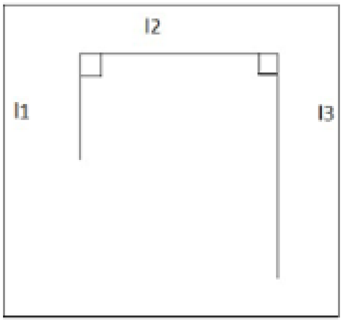


Fig. a

The forward kinematics problem is to solve Cartesian points of the end effector given from the actuated angles.

By considering fig. a. following relations are readily derived:

X1=l1sinθ1;

Z1=l1-cosθ1

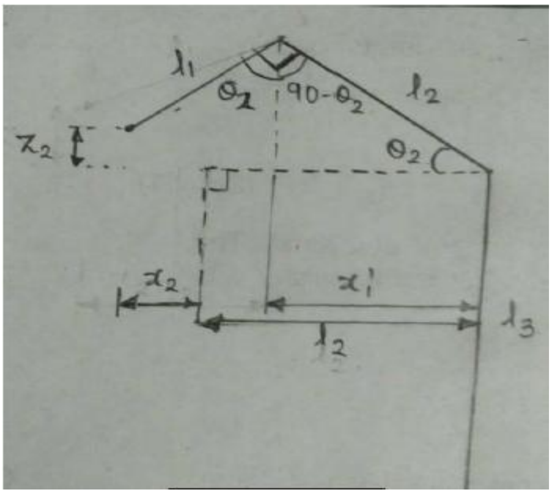


Fig. b

Individually:

By considering following fig. c. following parameters are directly derived.

X2=l2cosθ2 + l1sinθ1 – l2;

Z2=l2sinθ2 + l1- l1cosθ2;

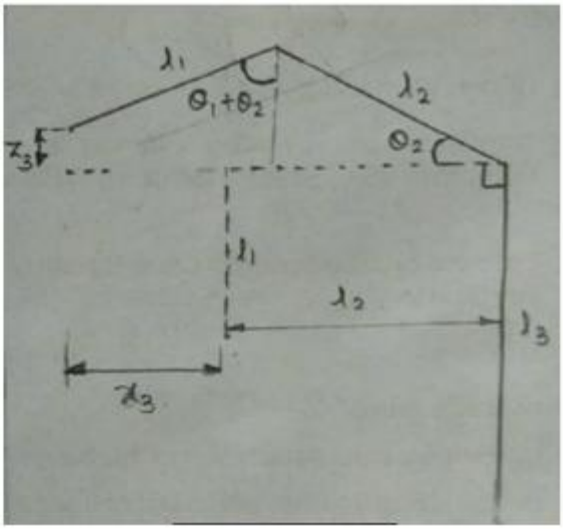


Fig. c

SIMULTANEOUSLY:

Considering fig.d. following parameters are directly derived:

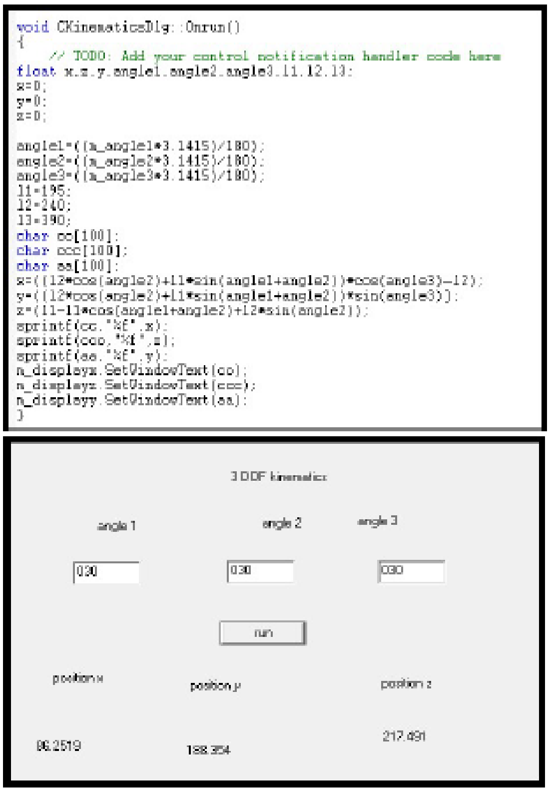
X3=l2cosθ2 +l1sin(θ1+θ2)-l2;

Z3=l1-l1cos(θ1+θ2) +l2sinθ2;

X= (l2cosθ2+l1*sin(θ1+θ2)) cosθ3-l2;

Y= (l2cosθ2+l1*sin(θ1+θ2)) sinθ3;

Z=(l1-l1cos(θ1+θ2) +l2sinθ2);



```
void CKinematicsDlg::Onrun()
{
    // TODO: Add your control notification handler code here
float x,z,y,angle1,angle2,angle3,l1,l2,l3;
x=0;
y=0;
z=0;

angle1=((m_angle1*3.1415)/180);
angle2=((m_angle2*3.1415)/180);
angle3=((m_angle3*3.1415)/180);
l1=195;
l2=240;
l3=390;
char cc[100];
char ccc[100];
char aa[100];
x=((l2*cos(angle2)+l1*sin(angle1+angle2))*cos(angle3)-l2);
y=((l2*cos(angle2)+l1*sin(angle1+angle2))*sin(angle3));
z=(l1-l1*cos(angle1+angle2)+l2*sin(angle2));
sprintf(cc,"%f",x);
sprintf(ccc,"%f",z);
sprintf(aa,"%f",y);
m_displayx.SetWindowText(cc);
m_displayz.SetWindowText(ccc);
m_displayy.SetWindowText(aa);
}
```


Fig. d

The motion controller is being used to carry out the functions of 3 DOF robotic arm and software gives command to the controller.

7. Reverse kinematics:

Reverse kinematics is to determine actuated joint angles (θ1, θ2, θ3) by given cartesian coordinates(x,y,z).

For θ1, individually,

θ'1(x)=sin^ (-1) (x1/l1);

θ'1(z) = cos^ (-1) ((l1-z1)/l1);

For θ2, individually we have used fuzzy logic.

For θ3,

θ'3=tan^ (-1) (y/(x+l2)).

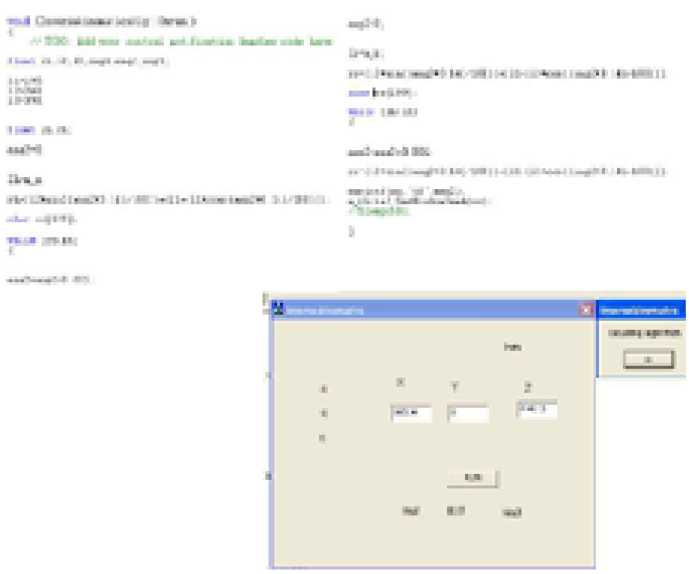


Fig. e

8. The future scope

1) Further testing and improvement of the algorithm for more complex robots and also tasks incorporating the real constraints by making use of dynamics
of robot manipulator can be considered.

2) The present work open ways to further study the more complex architectures of robotic manipulators.

3) More complex trajectories can also be attempted to find accuracy of robot manipulator.

9. Conclusion

The work presented in this report has been tried to provide a single platform for analytical 3DOF robotic arms, simulation and experimental methods for multi-DOF robotics manipulators. Forward kinematic architecture has been successively developed and tested on CATIA software. It produced accurate results. Reverse developed in this work gives individual values.

10. References

[1]. Paul, Richard (1981). Robot manipulators: mathematics, programming, and control: the computer control of robot manipulators. MIT Press, Cambridge, MA. ISBN 978-0-262-16082-7.

[2]. Gan J.Q., Oyama E., Rosales E.M. and Hu, H. A complete analytical solution to the inverse kinematics of the Pioneer 2 robotic arm, Robotica, Cambridge University Press. 23(2005): pp. 123–129.

[3]. inverse kinematics, forward kinematics and working space determination of 3dof parallel manipulator with s-p-r joint structure periodica POLYTECHNICA SER. MECH. ENG. VOL. 49, NO. 1, PP. 39–61 (2005) March 30, 2004.

a. http://www.southampton.ac.uk/~rmc1/robotics/arkinematics.htm.

[4]. Design and Development of Inverse kinematics Based 6 DoF Robotic Arm Using ROS Volume 118 No. 18 2018, 2597-2603 ISSN: 1311-8080 (printed version); ISSN: 1314-3395 (on-line version) url: http://www.ijpam.eu.

[5]. SSRG international journal of mechanical engineering"design and analysis of robotic arm using matlab and anysys" volume4 issue4 year 2017.

[6]. "control of robotic arm" by M.R de gier. Year of publication 2015, ref .

[7]. Kinematic analysis and simulation of a 3-DOF robotic manipulator Computational Intelligence & Communication Technology (CICT), 2017 3rd International Conference on**Date of Conference:** 9-10 Feb. 2017

[8]. Development of robotic arm suitable for practicing control algorithm taught in course morden robotics by F.B.W (Frank) berndsen, date of publication: 2007, IEEE doi.1109/tmech/2007.905720.

[9]. https://en.wikipedia.org/wiki/Degrees_of_freedom_(mechanics).