A Versitile Method to Design a Three Fingered Robotic Arm using Cad and Matlab Technique

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Abstract: : The main objective of the paper is to design a versatile Robotic Arm that has the capability to mimic the motion of a snake such that work space of the robotic arm is maximized. Design is made to achieve maximum mobility of the Robotic Arm such that it can pick up things and placed in very complex scenarios. The design is able to give degrees of freedom to the robot so that it becomes more versatile. It has a kinematic redundancy, like that of a human arm that enables us to place objects in various orientations. This Robotic arm is equipped with a three fingered gripper that provides for efficient grasping. The paper also provides design details of three fingered gripper that is suitable to hold cylindrical objects such as bolts, cable connectors etc. Autodesk Fusion 360 has been used to make cad model of arm and grippers. The 3D arm and gripper are assembled with revolute joints. The robot is tested for its mobility by performing Kinematic Analysis.

Keywords : Forward kinematics; Autodesk fusion 360;MATLAB; Dh-convention,versitile

I. INTRODUCTION

Robotics is a mixture of geometric transformations and a real-time operating system. Robot is a reprogrammable and multifunctional manipulator designed to move materials / pieces from one place to another through different movements programmed to perform a series of tasks and the robot can also be classified according to its application method as a way of control, operating parameters, environmental conditions, structural design, structure materials, technology level. The robot path can be continuous or point-to-point. The volume of the work space of a robot can be articulated in a rectangular, cylindrical, spherical or spherical shape. A Versatile Robotic Arm means the robot able to turn, revolve and move in a space with a capable of grasping objects for variety of tasks.

In this paper one such a Robotic Arm is designed along with Three Fingered Gripper The main objective of new design of Robot is to reach any point in a 3D workspace without singularities.

The paper is organized in the following manner. section(2) gives the design and modeling aspects of Robotic Arm. where as section(3) focuses gripper design and modeling. Kinematic Analysis is carried out to specify the path of gripper to reach desired point in a space is elaborated in section(4). Results & discussion and Conclusion are given in section (5) and(6) respectively.

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II. ARM DESIGN:

The Robotic arm is designed by making use of C-channels that are shown in Fig 1 . The Dimensions of C-channel are given as 20*20*3cm.

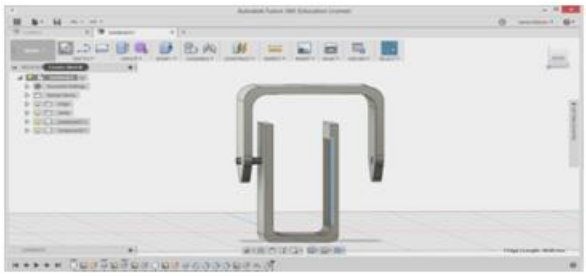

Fig.1. External and Internal C channels

Two C-channels have been joined together with help of pins as shown Fig 2.The joint between two C-channels permits 180 degrees Rotation with respect to one another. By using several C-channels, the Robotic Arm is built up as shown in Fig 3.

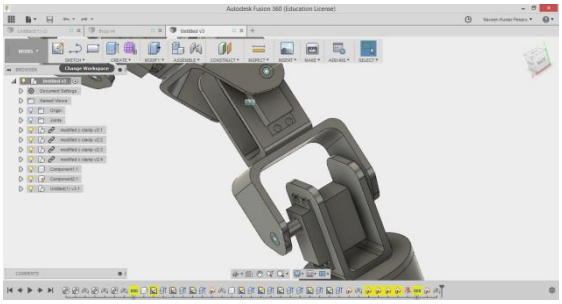

Fig.2. Attaching the clamps using pin joint

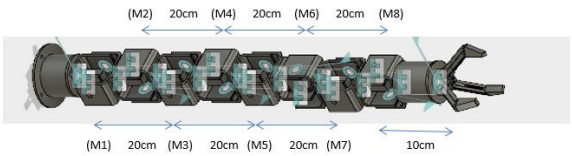

Fig.3. Arm and Gripper Assembly.

The Joint torque calculations are worked out as given here under:
Weight that has to be handled by the arm: 1.5kg ; Weight of each link in arm: 300gr (0.3kg)
Torque of Joint 1 (M1) = (20*0.3) + (40*0,3) + (60*0.3) + (10*0.3) + (30*0.3) + (50*0.3) + (70*0.3) + (80*2)
= 244 kg-cm = (M1)= 24.4 N-m
Similarly, a torque calculations required for reaming joints are calculated and their values are given here under:.
(M2) = 203 kg-cm, (M3) = 165 kg-cm, (M4) = 130 Kg-cm, (M5) = 98 Kg-cm, (M6) = 69 Kg-cm, (M7) = 43 kg-cm, (M8) = 20 kg-cm.

III. THREE FINGERED GRIPPER DESIGN:

The three finger gripper works on screw operation. with the Rotation of screw the Three fingers moves closer when Screw Rotates clock wise direction and moves away when screw rotates counter clockwise directions. The assembly of screw operated gripper is shown in Fig4.

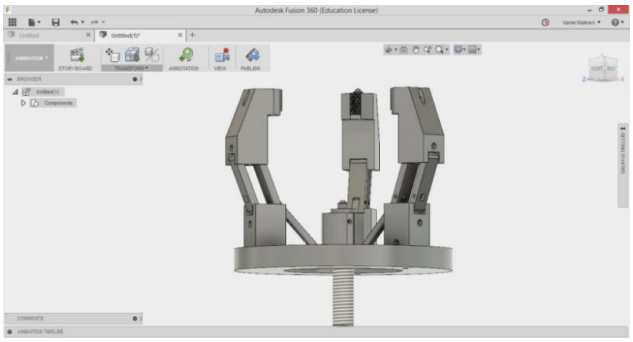

Fig.4 Screw operated Gripper

An under-actuated gripper using screw, circular frames and links have been designed . Each finger consists of two links, a support groove block placed on circular platform. The lower link of finger is operated and attached to an internally threaded center circular platform frame (nut) that slide across a screw. Note that one of the ends of link 1 is rigidly connected on a central circular frame and other end pinned to lower limb (link2) of finger.

IV. KINEMATIC ANALYSIS:

The kinematic analysis of robotic arm is worked on in this section. The kinematic analysis ensure the end effector path travel in a 3D space when joint motors are rotated. DH method as being adopted to develop the kinematic Transformation matrices between two successive joints of Robotic Arm. The eight channelled Robotic Arm with four turning joints is taken and DH method is adapted to derive kinematical transformation relations. The kinematic relations have been implemented in MATLAB programming to work out the end effector path in 3D space. The figures 5,6, and 7 indicate the path travel of gripper, when joint 1,2,3 and 4 rotate simultaneously with different angels in a given period of time.

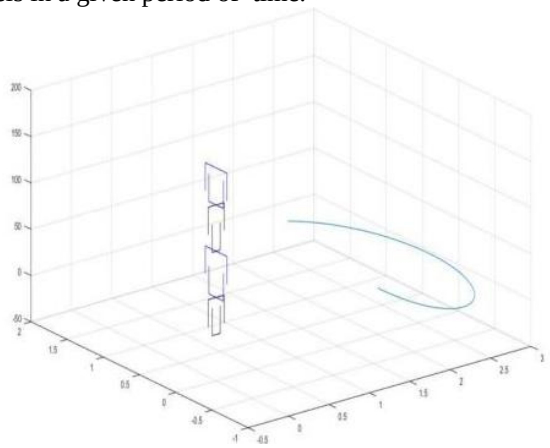

Fig.5 Gripper quarter circle path when t1=(0,-pi/8), t2=(-pi/2,-pi/4), t3=(-pi/2,-pi/4), t4=t(-pi/2,3pi/4).

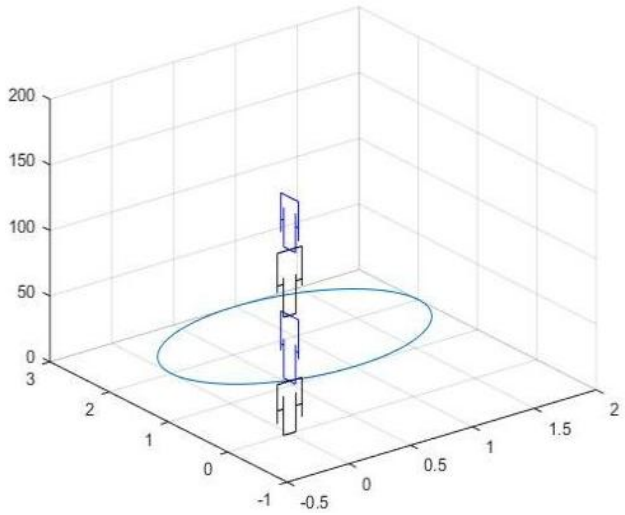

Fig.6. Gripper circular path when t1=(0,0),t2=(0,0),t3=(0,0),t4=t(0,2pi).

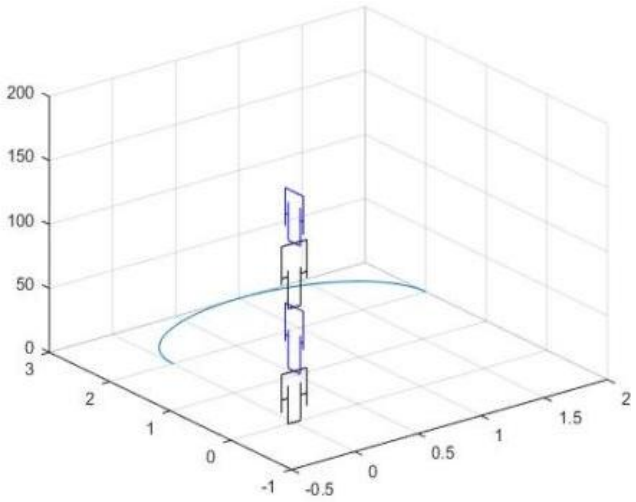

Fig.7 Semicircle path of Gripper

Figure5 shows the space path taken by end effectors link when four joints 1,2,3 and 4 rotates simultaneously as follows:

Joint1: Rotation (from 0^0 to -22.5^o) ;Joint2:Rotation (from -90^0 to -45^0) ; Joint3(from 90^0 to -45^0); Rotation (from -90^0 to -135^o) .

V. RESULTS AND DISCUSSION:

The assembly of cad model of arm and gripper is shown in Fig 8. The developed structure of robot will enhance the move ability in any direction in a 3D space. With this robot it is possible for picking up and placing of objects from any points in the work space. The maximum reach of arm is 450mm along the vertical axis of robotic arm. The model of the robot developed here avoid jam of various joints.

The proposed gripper is able to pickup cylindrical objects having maximum weights 1500 grams is easily. The advantage of this gripper is its flexibility and needs only one single motor to run the screw. These type of gripper design enable to grasp even smooth cylindrical object without slippage.

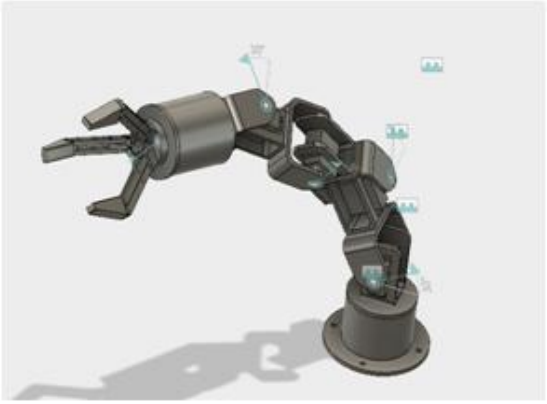

Fig.8 Shows the final position of robotic arm.

VI. CONCLUSIONS:

The robotic arm design presented in this paper is similar to snake like Robotic arm.The Robotic Arm is designed to carry a payload of 1.5Kg through the three fingered gripper and able to maneuver through various points in 3D space by avoiding obstacles without damaging the environment. In this paper the three fingered grippers is presented to pick up cylindrical objects easily and without slippage. The kinematic analysis is carried out to identify singularities and reachable points in work volume. The work presented on development of Robot is very much useful to locate to work out assembly works in un reachable places of Machines..

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