Module 2 : Robots mechanisms

Lecture 5 : Manipulators Mechanisms-I

Objectives

In this lecture we will learn about

- Degrees of freedom
- Parallel Manipulators
- “Teaching” the manipulator

Degrees Of Freedom

It is required to find DOF for a manipulator which in turn decides the number of actuators required. The task is relatively straightforward for open chains –serial manipulators. In most of these, the chain is composed of links connected through revolute or prismatic pairs. The degrees of freedom simply turn out to be the number of moving links in the open chain - and the number of actuators will equal the degrees of freedom. The word “axis” is often used instead of degrees of freedom. Thus a manipulator with six moving links and as many revolute pairs is called a 6-axis manipulator. Note that the actuator used to power the gripper (open and close fingers etc) is not counted as an “axis” – since the function of the actuator on the gripper is solely to open and close the fingers. Also, the actuator for the gripper does not contribute to the positioning and orienting capability of the end-effector.

Closed chains.

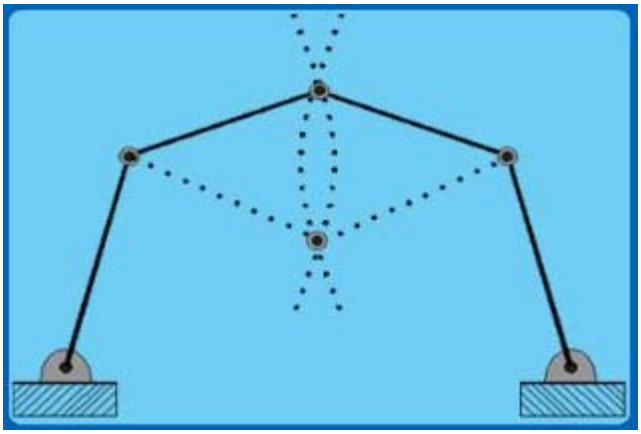

Figure 5.1.1

To find the DOF of mechanism in robot, Gubler's formula for closed chains or given set of n links is applied.

1. For the 5R mechanism shown above Figure 5.1.1, let
   Jr- no of revolute joints; Jp – no of prismatic joints
   Then Gublers formula states that DOF=3(n-1)-2Jr-2Jp
   For above mechanism of 5R; DOF=3(5-1)-2x5=2

2. For 4RP mechanism, n=5, Jr=4, Jp=1 therefore DOF= 3(5-1)-2x4-2x1=2

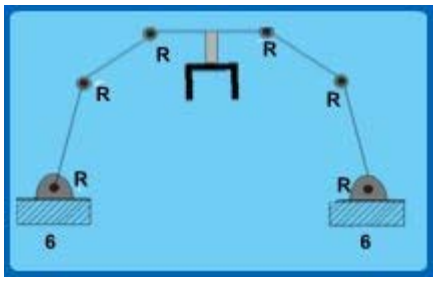

Figure 5.1.2

3. Figure 5.1.2 for 6R bar planer mechanism n=6, Jr= 6, Jp=0
Therefore Mechanism DOF = 3(6-1)-2x6=15-12=3

Work space of closed chains will be less than that of open chains.

Parallel Chains

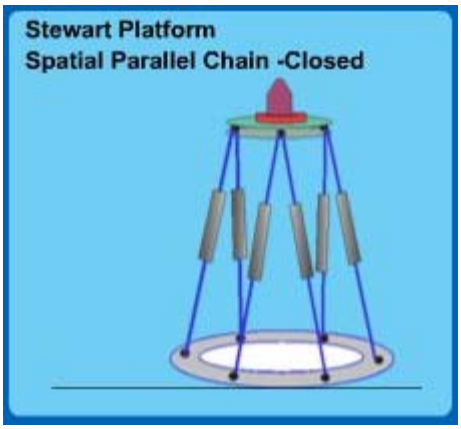

Figure5.2.1

1) Stewart platform: Here 2 rings top & bottom are connected together through prismatic links and having ball & socket joint at bottom and hooks joint at top. Figure 5.2.1 beside. Stewart platform finds application in aircraft simulator where pilots are trained

Applying Grublers criterion for closed chains,

N=no of links=1

Js=no of spherical joints=6

Jh= no of hook's joint=6

Jr= no of revolute joint=0

Jp= no of prismatic joints=6

DOF = F=6(l-n-1) + S fi

Where l= no. of links

N= no of joints

fi = DOF with ith joint

Therefore, F = 6(14-18-1) + 36 = 6

Teaching and Measurement

Manipulators may be used as measuring tools as shown in figure 5.3.1. With link lengths and joint angles known we can determine position &

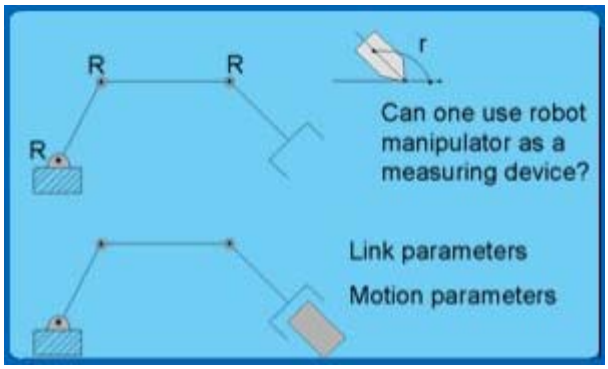

Figure 5.3.1

orientation of end effector. This technique is used for “teaching”.

Recap

In this course you have learnt the following

- Gublers criterion for mechanism analysis
- Spatial robot of Stewart Platform and its DOF
- Application of robots for inspection purposes

Congratulations, you have finished Lecture 5. To view the next lecture select it from the left hand side menu of the page