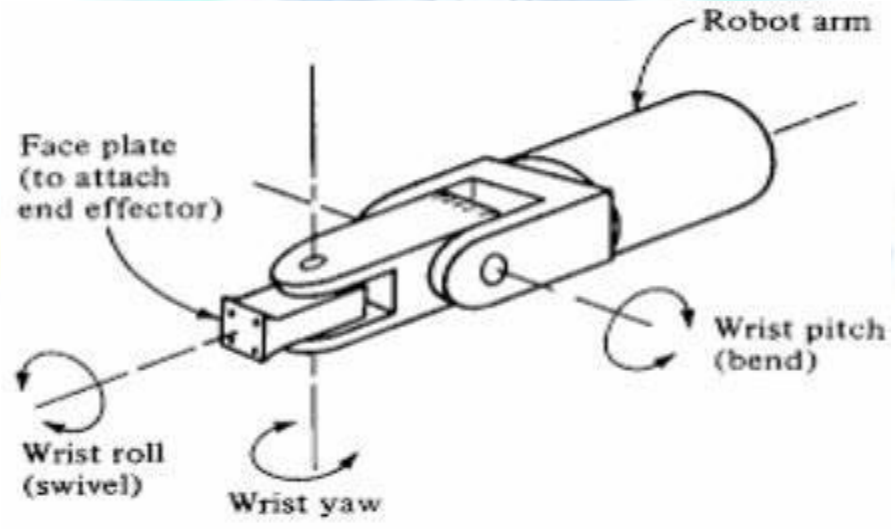
1.7 PITCH, ROLL, YAW:

In robotics, Pitch, Roll, and Yaw are used to describe the orientation of a robot's end effector (e.g. gripper, tool or sensor). These are essential for controlling how a robot interacts with its environment, especially the tasks like welding, assembling, picking, placing and inspection.

Term	Axis of Rotation	Motion	Common use in Robotics
Pitch	Rotation around the x-axis	Tilts up and down	A robot arm tilting a camera or tool up or down
Yaw	Rotation around the Y-axis	Turns left or right (like shaking head)	A robot turning to face a new direction
Roll	Rotation around the Z-axis	Rotates sideways (like rolling)	Twisting a screwdriver or rotating gripper

WRIST CONFIGURATION OF ROBOT:



Wrist movement is designed to enable the robot to orient the end effector properly with respect to the task being performed. To solve the orientation problem, the wrist is provided with up to three degrees of freedom.

ROLL- This is also called wrist swivel, this involves rotation of the wrist mechanism about the arm axis.

PITCH- It involves up and down rotation of the wrist. This is also called as wrist bend.

Yaw- It involves right or left rotation of the wrist.

JOINT NOTATION SCHEME:

A robot joint is a mechanism that permits relative movement between parts of a robot arm. The joints of a robot are designed to enable the robot to move its end-effector along a path from one position to another as desired.

The basic movements required for a desired motion of most industrial robots are:

1.ROTATIONAL MOVEMENT: This is the rotation of the arm about the vertical axis.

2.RADIAL MOVEMENT: This involves the in or out movement of the arm from the vertical center of robot.

3.VERTICAL MOVEMENT: This is the capability to move the wrist up or down to provide the desired vertical attitude.

These degrees of freedom, independently or in combination with others, define the complete motion of the end-effectors. These motions are accomplished by movements of individual joints of the robot arm. The joint movements are basically the same as relative motion of adjoining links. Depending on the nature of this relative motion, the joints are classified as prismatic or revolute.

PRISMATIC JOINTS:

Prismatic joints are also known as sliding as well as linear joints. They are called prismatic because the cross section of the joint is considered as a generalized prism. They permit links to move in a linear relationship.

Revolute joints permit only angular motion between links (body move through the same angle, along circular path around a fixed point).

Their variations include:

- ROTATIONAL JOINT (R)
- TWISTING JOINT (T)
- REVOLVING JOINT (V)
- LINEAR JOINT (L)

A ROTATIONAL JOINT (R):

It is identified by its motion, rotation about an axis perpendicular to the adjoining links. Here, the lengths of adjoining links do not change but the relative position of the links with respect to one another changes as the rotation takes place.

A TWISTING JOINT (T)**:** It is also a rotational joint, where the rotation takes place about an axis that is parallel to both adjoining links.

A REVOLVING JOINT (V): It is another rotational joint, where the rotation takes place about an axis that is parallel to one of the adjoining links. Usually, the links are aligned perpendicular to one another at this kind of joint. The rotation involves revolution of one link about another.

A LINEAR JOINT(L): Linear joints enable robots to move in a straight line. These joints typically consist of a movable element that slides or glides along a set of rails or guides.

AN ORTHOGONAL JOINT(O): The orthogonal joints are also popularly referred to as the type O-joints. They feature a relative movement taken by the input link and output link. This kind of motion involved in the Orthogonal joints is a translational sliding motion. However unlike the linear joints arrangement, with the Orthogonal joint, the output link is perpendicular to the input link.