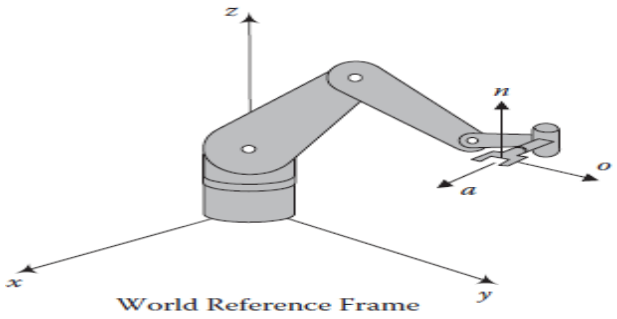
ROBOT REFERENCE FRAMES:

A reference frame (or coordinate frame) is a 3-D coordinate system used to describe the position and orientation of a robot or any point in space.

WORLD REFERENCE FRAME:

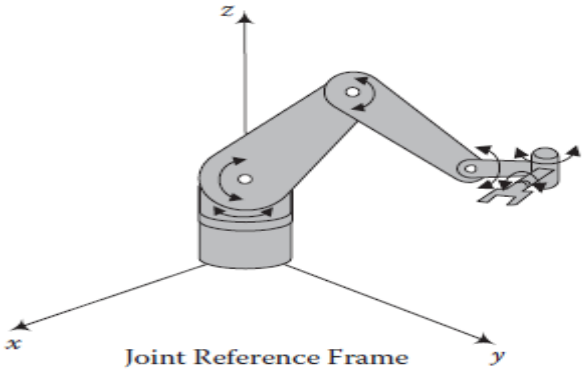
This is a universal coordinate frame, as defined by x-, y-, and z-axes. In this case, the joints of the robot move simultaneously in a coordinated manner to create motions along the three major axes. In this frame, no matter where the arm is, a positive movement along the x-axis is always in the plus direction of the x-axis, and so on.



World Reference Frame

JOINT REFERENCE FRAME

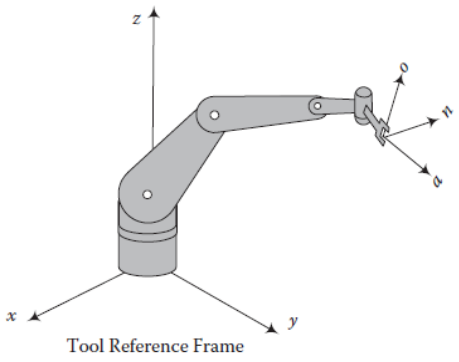
This is used to specify movements of individual joints of the robot. In this case, each joint is accessed and moved individually, and therefore only one joint moves at a time. Depending on the type of joint used (prismatic, revolute, or spherical) the motion of the robot hand is different.



Joint Reference Frame

TOOL REFERENCE FRAME:

Tool reference frame is a moving frame that changes continuously as the robot moves, and the ensuing motions relative to it are also different depending on where the arm is and what direction the Tool frame has. All joints of the robot must move simultaneously to create coordinated motions about the Tool frame.



Tool Reference Frame

PROGRAMMING MODES:

Robots may be programmed in a number of different modes, depending on the robot and how sophisticated it is. The following programming modes are common:

- Physical setup
- Lead-through or teach mode
- Continuous walk-through mode
- Software mode

PHYSICAL SETUP:

In this mode, an operator sets up switches and hard stops that control the motions of the robot. This mode is usually used along with other devices such as programmable logic controllers (PLCs).

LEAD-THROUGH OR TEACH MODE:

In this mode, the robot's joints are moved with a teach pendant. When the desired location and orientation is achieved, the location is entered (taught) into the controller. During playback, the controller moves the joints to the same locations and orientations. This mode is usually point-to-point, and as such, the motion between points is not specified or controlled. Only the points that are taught are guaranteed to be reached.

CONTINUOUS WALK-THROUGH MODE:

In this mode, all robot joints are moved simultaneously, while the motion is continuously sampled and recorded by the controller. During playback, the exact motion that was recorded is executed. The motions are taught by an operator, either through a model, by physically moving the end effector, or by "wearing" the robot arm and moving it through its workspace. Painting robots, for example, may be programmed by skilled painters through this mode.

SOFTWARE MODE:

In this mode, a program is written offline or online and is executed by the controller control the motions. The programming mode is the most sophisticated and versatile mode and can include sensory information, conditional statements (such as if…then statements), and branching. However, it requires a working knowledge of the programming syntax of the robot before any program is written.