ROBOT VIRTUAL PENDANT

Introduction and Familiarization

UNIT OBJECTIVE

Familiarization with the Lab-Volt robot system, Model 5150. You will be able to identify each axis using the industry name. You will be able to identify the control(s) used to move each the robot axes.

DISCUSSION OF FUNDAMENTALS

Introduction

In the early 1920's, the word robot, derived from the Czechoslovakian word ***robotnik***, meaning slave, first appeared in a play about a mad scientist who invents artificial people to do the world's work. Although today's robots are not biological creations, science fiction has had a tremendous influence on what, today, has become science fact.

The robots used today come in many configurations and many of them are analogous to humans, which is termed ***anthropomorphic***, and defined as having human-like characteristics. For instance, the Lab-Volt model 5150 robot has a shoulder, an upper arm, an elbow, a forearm, a wrist, and a gripper (hand) used as fingers.

As robots become more advanced and less expensive, they are utilized more frequently in industrial situation where working conditions are dangerous or repetitive. Examples of applications are: undersea and space exploration, pharmaceutical manufacturing, surgery, bomb disposal, the replacement of fuel rods in nuclear power plant, the cleaning of contaminated areas, the placement of electronic components on printed circuit boards, car painting, and welding.

Robots can be built to lift or move much more weight than humans. They can work almost nonstop, and they do not require food or rest / restroom breaks. Most often, a robot will perform tasks more accurately than humans.

This lesson was created by Daniel M. Sherry on November 14, 2017 as part of a collaborative effort between Texas A&M, College Station, Texas and Alamo Colleges District, San Antonio, Texas, using portions of the Lab-Volt Robot, Model 5150, student curriculum and modified for the RVP project requirements. This project is sponsored by the National Science Foundation (NSF).

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Nowadays, engineers are working on designing prototypes capable of walking, thinking (to some extent…), as well as talking, based on our current knowledge of the relationships between the thinking and talking processes.

Overview of the Lab-Volt Robot System

The Lab-Volt Robot System, Model 5150, consists of a robot controlled by using a Teach Pendant (TP) and in this lesson the RVP.

The Robot Arm

Figure 1-1 shows the robot arm of the training system. This robot is of the manipulator type, also called an ***articulated type***. It consist of a series of segments that are linked by rotary joints to form articulations. This robot has five ***axes of freedom*** because the base will rotate the shoulder (and the entire unit), the shoulder moves the upper arm, the elbow moves the forearm, and the wrist can rotate or pivot. This robot has 5 axes of freedom, which means it is able to accomplish 5 basic movements. The gripper is known as the ***End of Arm Tooling*** which is sometimes referred to as the ***EOAT***. The EOAT is changeable and might use grippers, such as the one on the robot arm, suction cup application, welding tool, paint tool, and many other EOAT applications.

The articulations are controlled, using the TP or in this lesson the RVP, to grasp and move objects.

- The robot arm is mounted on a ***base (waist).*** The base houses a motor used to make the ***shoulder*** rotate in a left or right (clockwise or counter-clockwise) direction.
- The shoulder rotates on the base. It houses five motors associated with the various mechanical systems which includes: gears, belts, and rope/pulley systems that move the other sections of the arm.

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- The lower end of the ***upper arm*** carries the gears and pulleys that drive the forearm, wrist, and gripper. One end of the ***forearm*** is attached to the upper arm, while the other end is attached to the wrist.

  The structure of the forearm allows the block of the gripper puller, housed in the forearm, to move back and forth, opening or closing the gripper. The upper arm and forearm can perform upward and downward, ***pitch***, motions.
- The wrist and the gripper (hand/fingers) work together to pick up items and move them to desired locations. The wrist moves upward and downward to control the tow-finger gripper. The wrist can also rotate, ***roll***, in a 360 degree clockwise or counter-clockwise direction. The fingers of the gripper move in an "open" or "close" motion.

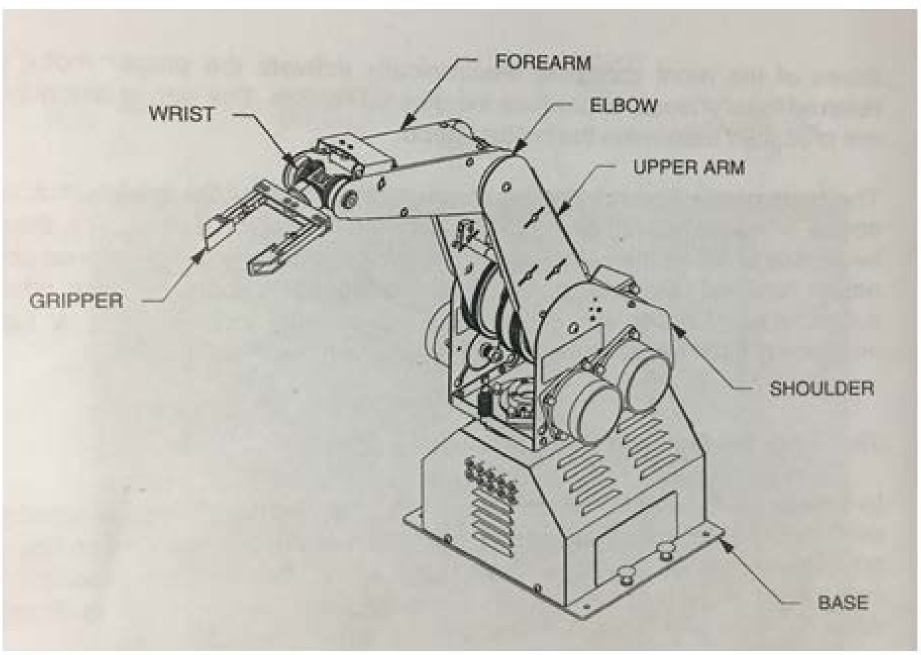

Figure 1-1. The robot joints and segments form articulations used to grasp and move objects.

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The Robot Virtual Pendant and Control of the Axes

Control of the various axes of the robot system is accomplished using the RVP, shown in Figure 1-2. Each axis of the robot system has an associated control that allows manual control of the axes to move the various joints specified direction or movement.

MAJOR AXES

- BASE + and BASE -, allows the shoulder, and the entire robot arm, to be rotated in a clockwise or counter clockwise direction.
- SHDR + (Shoulder) and SHDR -, allows articulation at the shoulder causing the upper arm to move up and down, and to some degree in and out.
- ARM + and ARM -, allows articulation at the elbow causing the forearm to move up and down.

MINOR AXES

- GRIP + and GRIP -, allow the fingers of the gripper to be opened or closed.
- ROLL + and ROLL -, allow the gripper or hand to rotate in a 360 degree clockwise or counter-clockwise rotation.
- PITCH + and PITCH -, allow the gripper hand to move up and down

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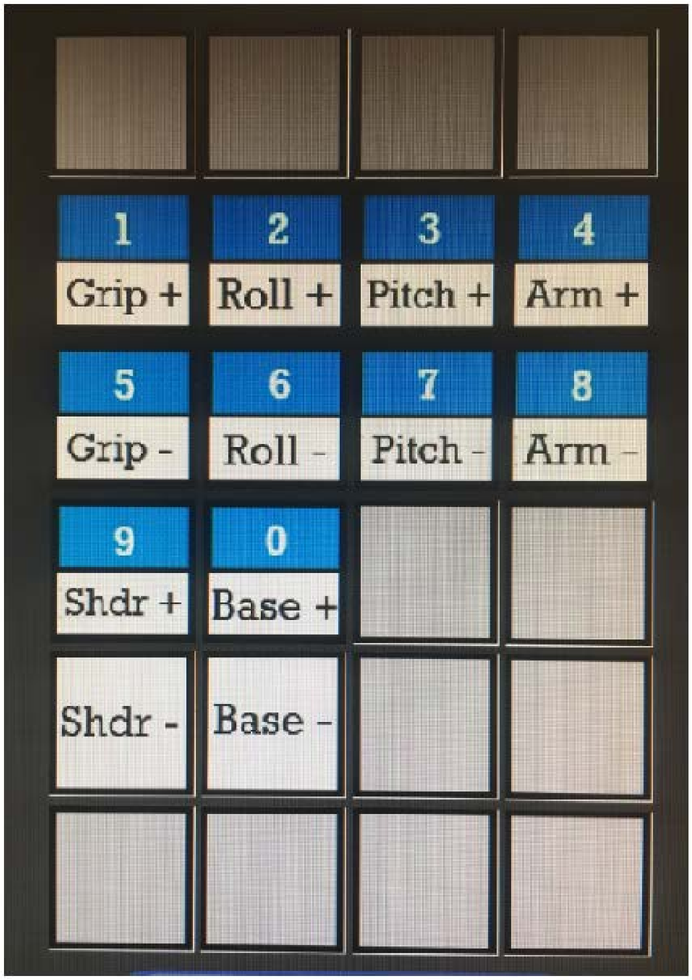

Figure 1-2. The Robot Virtual Pendant (RVP) used to control the robot arm.

The robot stepper motors

Stepper motors are the ***primary movers*** of the robot axes and they are used to actuate the joints of the Lab-Volt robot arm. Stepper motors are very popular in industrial applications where accurate position is the norm. They can rotate in either direction, start and stop at various mechanical positions, and move their rotor in precise angular increments, called the ***step angle***. The step angle is the number of degrees the motor moves in one step. The number of steps per revolution and step for typical stepper motors, is indicated in Table 1-1.

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STEPS PER REVOLUTION	STEP ANGLE (DEGREES PER STEP)
240	1.5°
200	1.8°
180	2.0°
144	2.5°
72	5.0°
48	7.5°
24	15°
12	30°

Table 1-1. Typical steps per revolution and step angle for typical stepper motors.

The stepper motors of the Lab-Volt robot perform a complete revolution each 200 steps, providing a precision of 1.8 degrees per step. The robot controller monitors the movement of each articulation by sending direction and step signals to the drive associated with the motors involved with this movement. To do so, the drives of the robot controller electronically activate the proper motor windings, referred to as phases, to produce the desired motion. The rate at which these steps are produced determine the motor speed.

The movement will be accomplished accurately, provide the maximum acceleration speed, or torque are not exceeded at any time. If this situation occurs, the motor will be unable to follow the commands from the controller, and the desired position will not be reached. Since all positions are calculated relative to each other, all the subsequent positions will be altered. To correct the situation, a ***hard home*** positioning must be performed and the program modified. Additionally, the learner must insure that any obvious cause of the over speed or over torque condition has been removed. For instance, a jammed part might be causing an over torque condition.

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END OF LESSON

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