SECTION E

THE ROBOT ARM

ACTIVITIES

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ACTIVITY 1: EXPLORING THE SHOULDER

The robot arm has features similar to the human arm, constructed as it is with a shoulder, a forearm, a wrist, and a hand. Examine your own arm and think about how it moves. The robot arm moves in similar ways, but is much slower than a human arm. To make the robot arm do what you want it to, think carefully about how you use your own arm to do the same things.

NOTE: Be sure RB5X's batteries are fully charged before you start these arm movement activities. The robot uses a lot of energy to move its arm around. Begin these activities with RB5X's arm in a full resting position, inside the robot.

New Robot Vocabulary

1. MOVE THE ARM FROM THE SHOULDER (UP,DOWN,IN,OUT) _____ for this many degrees _____

Let's Experiment

Examine the way the arm is located inside the robot. Which direction does the shoulder have to move first as the robot begins extending its arm? DEFINE a task that extends the shoulder to the place where it can use its full range of movement. See if it works.

Let's Experiment Some More

Now you have the arm out of the robot where it can be used fully. EDIT your task to allow the robot to move its shoulder in all possible directions and then fold itself up inside again.

ACTIVITY 2: WHAT IS A ROBOT ELBOW?

A robot elbow is much like a human elbow except it is more flexible. A human elbow can move in and out in only one direction, while a robot elbow can move in and out in two directions. This means that you have to think a little differently about using the robot elbow (or forearm, as it is called in RCL) when deciding how the robot performs certain tasks. How can you use degrees to allow for movement in two directions?

New Robot Vocabulary

1. MOVE THE FOREARM (IN,OUT): ___ for this many degrees: ___

Let's Experiment

Using the task you wrote in Activity 1, "Exploring the Shoulder," EDIT the task to include the new command after the shoulder is fully extended. Try to visualize a movement that would be helpful, and select the direction and number of degrees you think are needed. Load the task to see if you were right. Modify the movement until you are satisfied.

Let's Experiment Some More

You now know enough commands to have RB5X touch the floor and raise its arm in the air. Modify your task to allow the robot to do a few calisthentics before RB5X puts its arm away.

ACTIVITY 3: WRIST WIGGLING

The robot wrist moves in the same way that the human wrist does. As you move your own wrist, think about what humans use this movement for. How will this movement help RB5X perform useful jobs?

New Robot Vocabulary

1. TURN THE WRIST (LEFT,RIGHT): ____ for this many degrees: ____

Let's Experiment

DEFINE a new task. Using the commands you already know, have the robot extend its arm so the wrist is visible. Include the commands that let RB5X wiggle its wrist back and forth several times. Then have the robot put its arm away.

Let's Experiment Some More

EDIT the task where the robot touches the floor and raises its arm. Have RB5X wave hello by using the wrist-wiggling commands. You can decide where in the movements you would like the robot to wave. Maybe you would like it to wave more than once.

ACTIVITY 4: ROBOT GRIPPERS

The robot hand is quite different from the human hand, especially in appearance. It moves much the way the human hand moves when people are picking up little sticks. Notice that there are only three "fingers." This means that the robot cannot do as many things with its hand as people can. As you experiment, you will notice other differences. The robot arm is not as strong as the human arm -- RB5X can only lift between 12 and 16 ounces. The fingers have to be positioned just right to be able to pick up and hold something.

New Robot Vocabulary

1. MOVE THE HAND (OPEN,CLOSE): ____ for this (1-100) %:

Let's Experiment

EDIT your first wrist-wiggling task. Use the new command to have the robot open its hand at some point in the task. Try different percentages to see what each will hold.

Let's Experiment Some More

EDIT your complete arm-movement task. Select some object for RB5X to pick up from the floor. Add the proper commands to allow the robot to grasp and hold the object. (HINT: You may need to add some basic movement commands to allow the robot to get a proper hold on the object.) See how well your task works. Experiment with different objects.

ACTIVITY 5: FIND THE CENTER, FIND THE LIMITS

It is important to know how to teach the robot to find certain places. To do this, we need to know how many degrees or in what direction each part of the robot arm must move to be in a specific relation to other parts of the robot. This way, we know where to tell the robot to put its

arm if it is going to touch something in front of it or off to one side.

Let's Experiment

DEFINE a new task. Using what you have already learned, give the robot instructions that let it extend its arm as far as possible straight in front. Make notes of the degrees you used.

Let's Experiment Some More

From the center position, see how far in each direction you need to move the arm for it to reach the limit of its movement. Make notes of the degrees used. Now experiment to see how many degrees you need to make the arm move half-way between the center and the limit of each direction. Once you have mastered this, you are ready to put the arm to work.

ACTIVITY 6: EGGS IN THE BASKET

Now you understand the basics of arm movement. Let's begin to put these basics to use. In industry, robot arms are often used for "pick-and-place" activities -- where they select a specific object from a group, pick it up, move it to another location, and put it down. The arm is programmed to repeat this movement over and over. Its movements must be accurate enough so that the robot arm does not break or damage anything with which it is working.

Let's Experiment

Think of a simple object that RB5X can pick up and move to another location. It might be blocks or small, light-weight boxes. (You'd better not start with real eggs!)

Find a container for the robot to put these objects in. Decide where the objects will be to start and where you will put the container. Then think about the exact arm movements needed to reach the object and place it in the container. (Remember the Hint in Activity 4 of this section.)

Now DEFINE a task and enter the commands needed to move the arm. Once you have this task working to your satisfaction, try having RB5X "pick and place" other objects.

ACTIVITY 7: A ROBOT ASSEMBLY-LINE HELPER

Since RB5X can use its arm to do pick-and-place types of activities, why not have the robot help you as part of an assembly line? Think how nice it would be if you didn't have to keep reaching for an object before you could do something else with it. You could do routine jobs much faster.

Let's Experiment

Think of some jobs that call for the same movements over and over. Now, decide on a job that has, as a part of it, some movements that RB5X can do while you are doing some other part of the job.

An example might be getting a bushel of fresh corn ready to eat or put in the freezer. You have to reach in the basket, pick up an ear of corn, move it over a container, peel of the husk, and put it in a pot of boiling water. Where could RB5X help you out best in an operation like this? Would you need to change anything about how this job is organized to make it easier for the robot to help?

Once you have decided on the job and the part that RB5X plays, figure out the exact movements and distances RB5X must move its arm. DEFINE a task and write the commands. How does it work? What other jobs could RB5X help you with?

ACTIVITY 8: DRAW A SIMPLE GEOMETRIC FORM

By now you have gotten quite good at programming the arm to move to specific places. Do you think you can teach RB5X to draw?

RB5X can move its arm in all of the proper directions, but you need to figure out how to get the robot to hold on

to a pencil or piece of chalk tight enough to draw continuous lines on paper or a chalkboard. You may even want to design a special board or easel for RB5X to use.

Let's Experiment

Decide on how to have RB5X hold the writing tool. Decide where you are going to place the writing surface (paper or chalkboard). Will it be on the floor, or on a stand in front of RB5X? Vertical or on a slant? You need all of this information before you write the commands.

Now, pick a geometric shape for the robot to draw. Think about the ways in which RB5X can move its arm. What movements are involved in drawing the figure?

DEFINE a task. Write the commands in the proper order. Try out your task. Did RB5X draw what you thought it would? Once RB5X can draw the first figure to your satisfaction, DEFINE tasks for other geometric figures.

ACTIVITY 9: ROBOT ARTIST

RB5X has learned to draw a few basic shapes. Perhaps the robot has the talent to be a real artist. Why not find out?

An artist must decide on the subject for a picture, and on the materials and the medium to be used. For RB5X's first attempt, chalk (or pastels) would be a good choice for medium.

Let's Experiment

Select the materials you need (paper, chalk, etc.). RB5X can use the same positioning as it used in the Activity 8, "Draw a Simple Geometric Form." Decide on the subject for the drawing. You might want to draw some sample pictures yourself so you know exactly what you are going to tell RB5X to do.

Once you know what the drawing will look like and what movements the robot must make to draw it, you are ready to DEFINE the task. Enter the commands in the proper order. If

the robot is going to draw several different objects (such as hills, trees, clouds, buildings, etc.) in one picture, you might want to make each of these a different task so that later RB5X can draw many different pictures.

When your picture task is complete, have RB5X draw. Are you ready to open a "Robot Art" gallery?

ACTIVITY 10: THE WRITING ROBOT

Now RB5X can draw only a few shapes, but pictures as well. The final step is to teach RB5X how to write or print.

Let's Experiment

There are several elements you need to think about before you start to compose this task. You need to decide on the style of the letters RB5X makes. Will the robot write or print? Will the letters be curved or square? Would it be helpful if you made each letter a separate task?

You can use the same approach for writing tool and writing surface you used in the last two activities. Figure out the arm movements that are needed to make each letter. DEFINE a new task (or tasks). Enter the necessary commands that allow RB5X to make the letters. Try out each letter as you go to be sure they are the way you wanted them to be.

If you are using separate tasks for each letter, what could you do to keep the robot from making one letter on top of another? Once you have figured out the answer to this, why not have RB5X write its name? Now, that is one smart robot!