Robotic Curriculum: "Parking Space - Controlling Movement of the Robot"
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Hands-on activities can be used to help students understand programming concepts. *Parking Space* is a sample lesson demonstrating the difference between using a simple timing program and a more sophisticated method. Students build a simple robot and write programs to move it from a garage to a parking space without hitting obstacles or running over the curb. Two or more students may work together on the activity. My student team was made of four students.

Most beginning robotic students start out writing programs that use the simple forward and speed commands while controlling the distance moved by timing alone. This involves a great deal of guessing and adjusting to get the robot to move an exact distance. The sleep command is also effected by the battery power and as the day goes on, the robot's timing changes. Changing the program to use move to relative position (mrp) allows more control. Using simple math to figure the circumference of the wheels and the number of ticks needed for the wheel to complete one rotation allows for controlling the movement of the robot with more precision.

Parking Space gives the students opportunity to test programs, evaluate the results, and make appropriate adjustments while requiring only simple programming skills. The extensions allow for more complex programming and creativity on the students' part.

The Story: You are a new employee of KIPR. You've been given an autonomous vehicle to drive to work each day.

The Task: Program your new vehicle to drive from your home garage to your assigned parking space at KIPR.

Remember: KIPR is counting on you to take good care of their new autonomous vehicle so be careful not to hit anything or run over the curbs. Dr. Miller will be watching. Fortunately, for right now, you live directly across the street and your garage faces the parking lot.

A group of my students from several different schools tested the lesson out. See page 6. They built a small robot as you can see in Figure 1, programmed it, ran trials, and evaluated their results. Katie and Zach are from John Glenn Middle School, Michelle is a student at Palm Desert Charter, and Kristal goes to Desert Hot Springs Middle School. The team is shown in Figure 2. Their results are displayed in Figures 3, 4, and 5. The robot managed to both hit a parked car and run over the curb. Sorry Dr. Miller. But finally after several attempts and programming adjustments the robot made it safely to the parking space. Success! Hopefully your students will be able to replicate the lesson and discover their own success.

Robotic Curriculum

Parking Space

Controlling Movement of the Robot

Drive Your Robot From Your Garage to Your Assigned Parking Space

Story:

You are a new employee of KIPR. You've been given an autonomous vehicle to drive to work each day.

Task:

Program your new vehicle to drive from your home garage to your assigned parking space at KIPR.

Remember:

KIPR is counting on you to take good care of their new autonomous vehicle so be careful not to hit anything or run over the curbs. Dr. Miller will be watching. Fortunately, for right now, you live right across the street and your garage faces the parking lot.

The Robot:

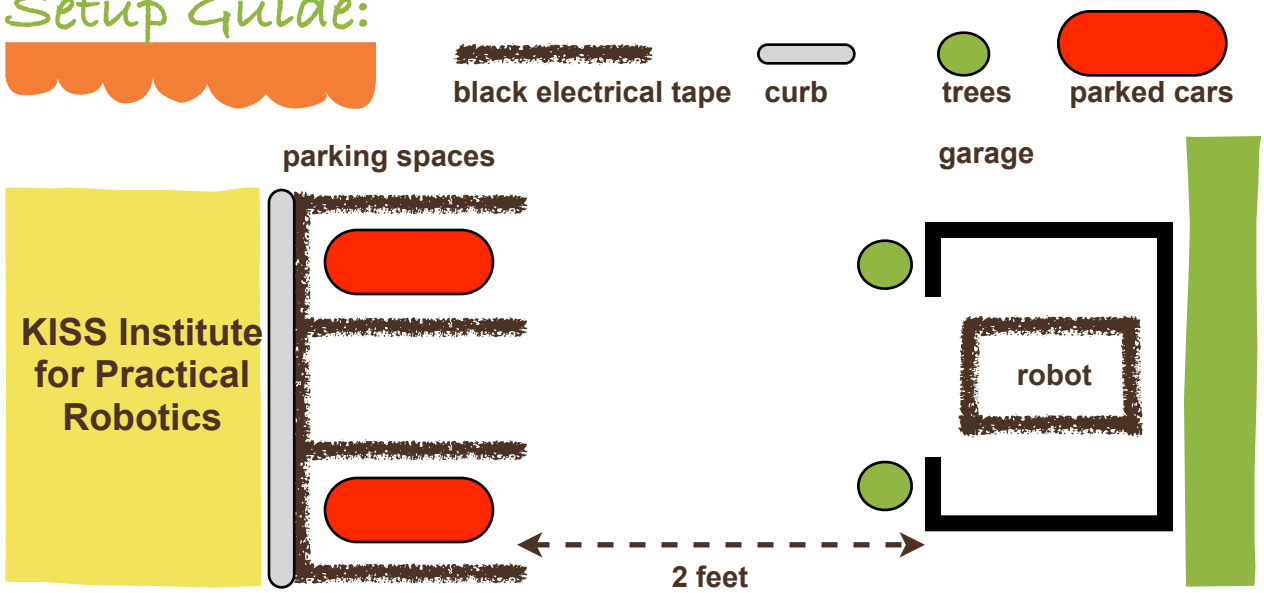
Build a very simple robotic vehicle. The robot needs two wheels in the back each attached directly to a motor. Put skids in the front, not wheels. Make sure that you can change the wheel size from large to small. Mount the CBC so the robot is as balanced as possible.

Setup:

Create 3 parking spaces next to each other using black electrical tape. Build a free moving curb at the end of the spaces. The parking spaces should be 1 inch wider and 1 inch longer than your robot. Place a vehicle (box, lego, etc.) in each of the outer spaces. Your goal is to park your vehicle in the middle space not touching any of the lines or moving/touching/running over the curb, trees, or other vehicles.

Make the garage two feet away and directly in line with the parking spaces. Build it out of whatever you like. Make the door 2 inches wider than your robot. Put your vehicle in the garage and place tape at the back, front and sides to outline the exact starting spot for the robot.

Setup Guide:



Program the Robot:

1. Write a KISS C program to move your robot forward and stop in the parking space using the fd, sleep, and ao commands to control your robot. Estimate the time needed to move the correct distance. Run the program and record the results. Make adjustments until the program can successfully park your robot. Record all the results for each trial run. Make sure you set the robot in the exact place each time.

2. Change the size of the wheels on your robot. Run your final program. Record the results.

3. Write a KISS C program to move your robot forward and stop in the parking space using the mrp, bmd, and ao commands to control your robot. Use the estimate of 1100 ticks per wheel rotation. Figure out the circumference of the wheels and use the information to move the correct distance. Run the program and record the results. Make adjustments until the program can successfully park your robot. Record all the results for each trial run.

4. Change the size of the wheels on your robot. Use the circumference of the new wheels to change the program. Run your program. Record the results.

5. Evaluate:

   Which program was the most accurate? Why?
   How did changing the size of the wheels effect your program? Why?
   Which program would you use? Explain why?

Parking Space

Trial Record

Trial #	Distance Traveled	# of Objects Hit/ Moved	Parked? Yes	Parked? No	Programming Method Sleep	Programming Method MRP
Average						

Extension #1:

You've found a great new apartment two blocks away from the institute. Make a new set up and program your vehicle to travel to KIPR making at least two turns before parking. Remember Dr. Miller is still watching.

Extension #2:

Develop a method to measure exactly how many ticks it takes to move each wheel precisely 1 rotation. Use this with the mrp command to program your robot to move a precise distance. You will need to know the circumference of the wheels.

Extension #3:

Use a sensor to detect objects (like the curb or parked cars) and avoid them.

Extension #4:

Use the simulator to test your programs.

Trial #	Distance Traveled	# of Objects Hit/ Moved	Parked Yes	Parked No	Programming Method Sleep	Programming Method MRP
1	Distance: cm, mm, in	How many objects were hit or moved - list them, ex: 2, curb and parked car on right	√		Seconds used in the sleep command. Ex. 5 seconds	Ticks used in the mrp command. Ex. 23,034 ticks

Sample Record: (Using fd command)

Trial #	Distance Traveled		# of Objects Hit/ Moved	Parked? Yes	Parked? No	Programming Method Sleep		Programming Method MRP
1	30	in	1		√	6.0	Sec.	
2	20	in	1		√	4.0	Sec.	
3	24	in	0	√		4.5	Sec.	
Average	25	in				4.8		

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Results:

Katie, Michelle, Kristal, and Zach

Demonstrate the Parking Space Lesson

Our Robot

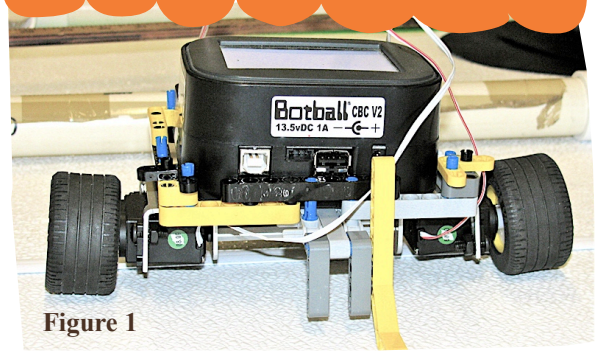

Figure 1

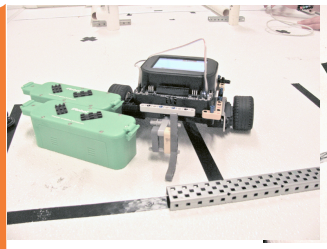

Figure 3
Hit the parked cars!

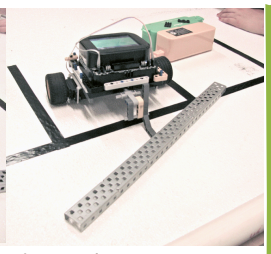

Figure 4
Ran into the curb!

Our Team

Figure 2 Kristal, Zach, Michelle, Katie

Figure 5 and 6

SUCCESS!!!

Sample Programs

Parking Space Fd

```
int main()
{
        fd(0);    // Move forward full speed
        fd(3);
        sleep(3);  // Wait for 3 seconds
        ao();   // Turn off all motors
}
```

Parking Space MRP

```
int main()
{
        mrp(0,100,1100); // Forward for 1 rotation
        mrp(2,100,1100);
        bmd(0);  // Wait for motor to finish task
        ao();   //Turn all motors off
}
```