Activity Template

Subject Area(s): Science and Technology

Activity Title: What's In a Name?

Header

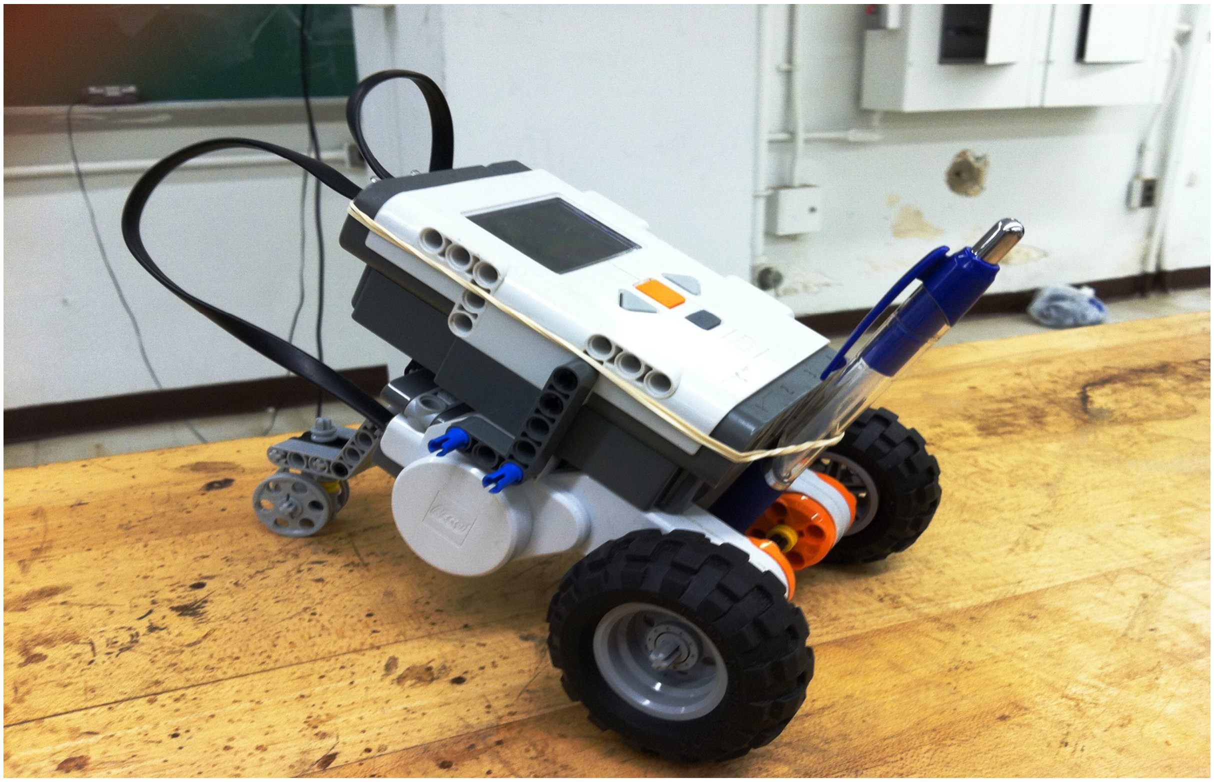

Image 1

ADA Description: Picture of a rover with attached pen for writing while performing program.

Caption: Rover with attached pen

Image file: IMG_0278.jpg

Grade Level: 9-12

Time Required: 45 minutes

Group Size: 4 students

Expendable Cost per Group: US$0 (Lego Mindstorms NXT Kit)

Summary: This programming activity teaches students the different kinds of turns that a multi-wheel robot can perform. Each group is asked to program their robot to write the name of their team on a piece of paper. The activity emphasizes the difference in path taken along with the required programming for

each kind of turn. All programming is done in RobotC language used in Lego Mindstorms NXTs. As a method of explanation, students also encounter geometry concepts used for wheel radii.

Engineering Connection: Many machines and vehicles depend on wheels as a method of locomotion. Often times these machines turn and maneuver around obstacles. Being able to predict how a turn will be executed is of utmost importance for safety concerns.

Engineering Category = #1

1. Relating science and/or math concept(s) to engineering

Keywords: Point Turn, Programming, Radius, RobotC, Robot, Swing Turn

Educational Standards

G.R.1 Use physical objects, diagrams, charts, tables, graphs, symbols, equations, or objects created using technology as representations of mathematical concepts
G.R.6 Use mathematics to show and understand physical phenomena (e.g., determine the number of gallons of water in a fish tank)

Pre-Requisite Knowledge: Students should be familiar with RobotC programming for the Lego MindStorms NXT.

Learning Objectives

After this activity, students should be able to:

- Program a Robot to follow a desired path
- Understand the application for specific types of turns
- Relate rotation of wheels to a length traveled

Materials List

Each group needs:

- One three wheel robot with two motors (one for each wheel)
- Large piece of paper to draw on
- Marker
- Computer (for programming)

Introduction / Motivation

Robots are used for many tasks of life. Some robots vacuum our carpets when we are not around. Other robots traverse the surface of Mars, showing us images of canyons and mountains from our neighboring planet. These robots perform tough tasks by maneuvering around obstacles, but how do they do it? Many robots use wheels as a means of motion, take for instance, a car. If the wheels are going forward, then the car goes forward. If the wheels are pointed to the right, the car turns right. Robots can also drive likes tanks with their wheels. A tanks treads, much like wheels, are always pointing forward, meaning they cannot point them in a direction to turn. So how does a tank turn then? What if one wheel was stopped and the other kept going? (Teacher should draw diagram on board) If we look closely at this picture, we can see that the stopped wheel kind of drags the wheel that is still moving. Before we know it, the tank can be facing in a perpendicular direction, backward direction, or even straight forward again. If we trace the path of the moving wheel, we can see that it draws a circle about a point, which is our other wheel. This is one way a tank can turn. It will stop one wheel and keep the other moving. If the right wheel keeps moving, I turn left, and vice versa. We call this type of turn a swing turn. Can you see an example of a swing turn in the classroom? (Teacher points to the door) We call it a swing turn because the tank rotates about a point that is located under one of its wheels. What if we told one wheel to go forward and the other to go backward? (Teacher draws diagram) Are we still turning? The answer is yes, but what is the difference between these turns? Let's look at the point about which we turn. Well now it cannot be under one wheel because both wheels are turning. Look closely at the diagram. (Teacher points to middle of two wheels and rotates them) We notice that middle of the robot always stays in the same spot. We found it! The point at which we rotate is actually right in the middle of our robot. Well what's so great about this turn? Well if we compare the two circles made by both our turns, we actually see that the point turn covers a smaller area. (Teacher points to area of circles) That means that our robot will bump into fewer obstacles that are nearby. Well then what is so good about a swing turn? Sometimes it is not easy to change the direction of a wheel very quickly. It can be bad for the engine. So in some cases, like when a vehicle is going very fast, it is better to just push the break on one wheel, rather make that wheel go completely backward. So both turns have a use in different situations.

Vocabulary / Definitions

Word	Definition
Robot	A multifunctional, reprogrammable manipulator designed to perform a variety of tasks
Swing Turn	A turn in which one wheel is stationary and the other is in motion
Point Turn	A turn in which one wheel is traveling the same speed as the other, but in the opposite direction
Pi	Proportional constant relating diameter to circumference of a circle.
Radius	Half the diameter of a circle
Circumference	Length around the perimeter of a circle
motor[motorA]=	Command to give motorA a desired power
wait1msec()	Command to wait () milliseconds
nMotorEncoder[motorA]=	Command to set initial position of encoder of motorA
nMotorEncoderTarget[motorA]=	Command to set target rotation in degrees of motorA

Procedure

Background

The teacher should be familiar with Lego MindStorms and programming in RobotC. After students are taught the lesson and geometry of the problem, the teacher will need to demonstrate how to turn these movements into actions of the robot via programming commands.

Before the Activity

- Make two or more three wheel robots to give to each group
- Attach markers directly under between the two wheels.
- Tape large sheets of papers to the floor so robots have room to draw.

With the Students

1. Lecture students on geometry of turns
2. Relate radius and circumference to distance between the wheels and arc length traveled, respectively
3. Show number of wheel rotations needed as a function of arc length and circumference of wheel.
4. Explain the function of encoder
5. Provide sample code for each turn
6. Divide classroom into at least two groups
7. Have groups come up with a name (do not tell them why)
8. Give robots to students and have them program robots to draw name
9. Have robots draw on paper

Image 2

ADA Description: Two students planning the movements in order to write their team name with the rover

Caption: Two students with rover

Image file: IMG_0280.jpg

Assessment

Pre-Activity Assessment
Descriptive Title: Pre-Survey Questionnaire

Activity Embedded Assessment
Descriptive Title: Ask Questions
While students decide how to approach drawing their team name, ask the students what kind of shapes do they see in their letter? How many half-circles? Full circles? At what points do lines of a letter intersect? Can the students describe the transition into different lines as turns of a robot?

Post-Activity Assessment
Descriptive Title: Post-Survey Questionnaire

Activity Scaling

- For lower grades, do not use motor encoder commands.
- For upper grades, perhaps have students draw an entire detailed picture.

Supporting Program: This lesson has been made possible by the National Science Foundation (NSF) funded GK-12 programs Applying Mechatronics to Promote Science (AMPS) and Central Brooklyn Robotics Initiative (CBRI).

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