Name: ______________________________

Class: _______________________________

Module 2: Connected Vehicles
Lesson 1: Connected Vehicles Demonstration
Connected Vehicle (Sphero) Programming Activity
Grade: 9 - 12

Connected Vehicles

Connected vehicles can communicate with infrastructure (i.e. traffic lights) and other vehicles. One way vehicle-to-vehicle communication could be utilized is crash prevention where one vehicle communicates to the other their speed, position and heading. In this activity you will work with your partner to navigate a Sphero through an intersection by programming the Sphero.

Observations

What happens when two Spheros are approaching an intersection from perpendicular directions at the same distance and the same speed? What about parallel directions?

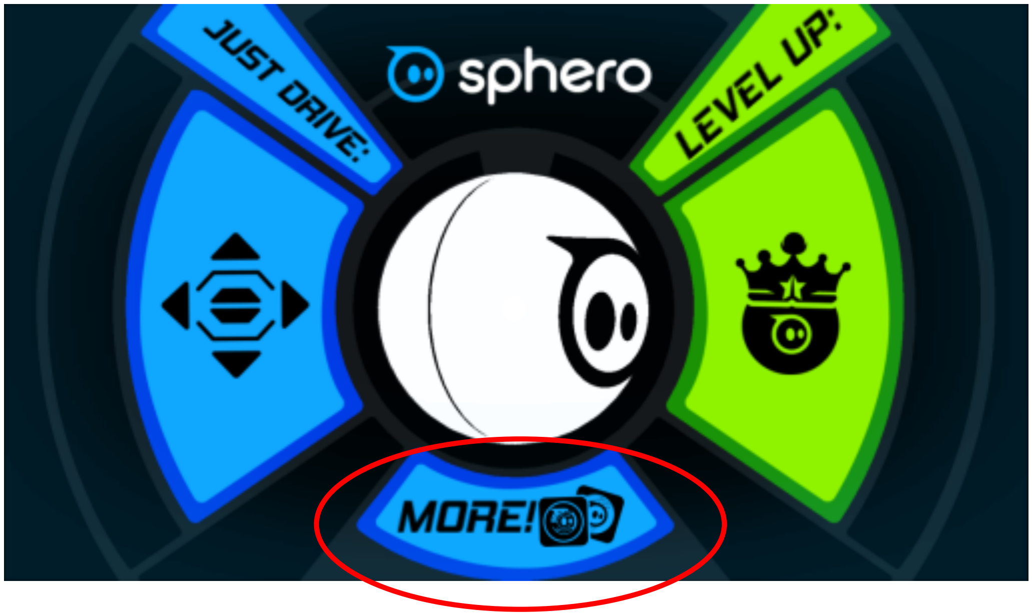
Hypothesis

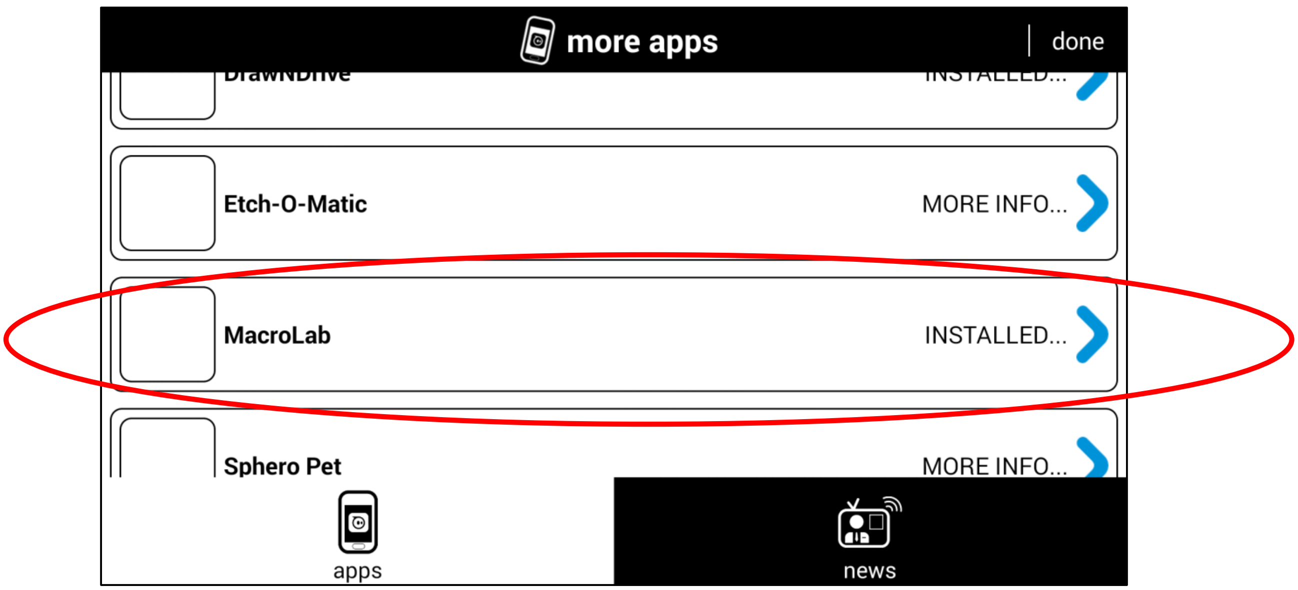
Hypothesize actions that can be programmed to avoid a collision from the perpendicular scenario above.

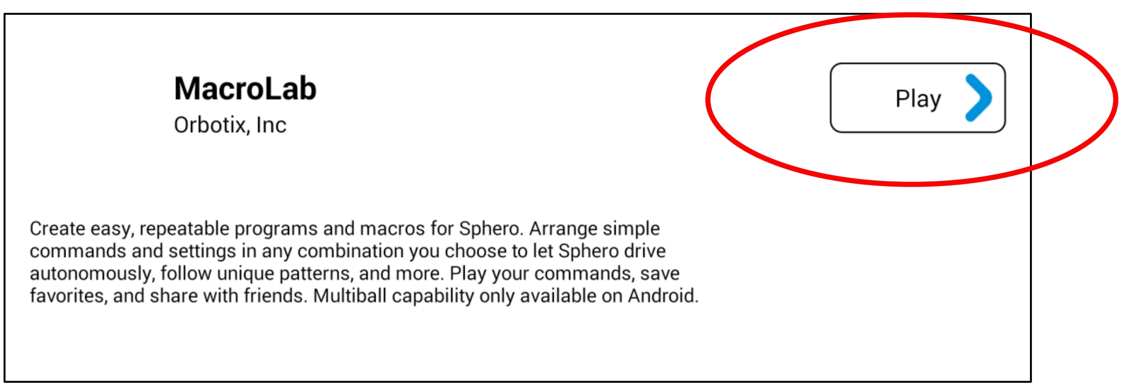
Materials & Procedure

Part 1: Speed Determination

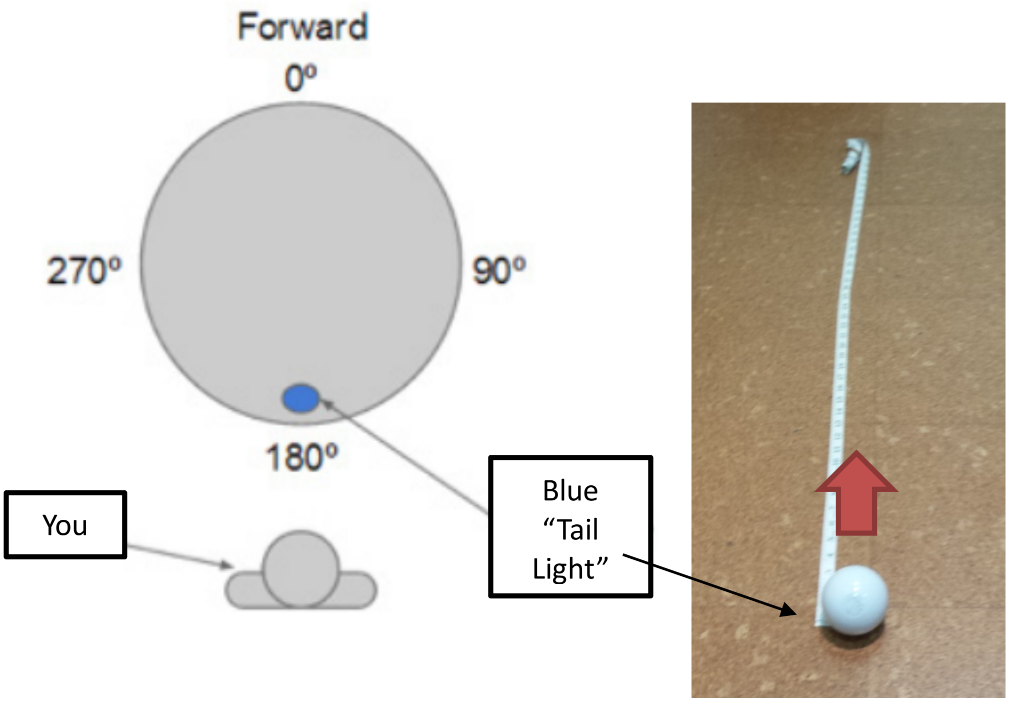
1. Acquire a tablet, Sphero and measuring tape.
2. Turn on the Sphero and the tablet. Open the Sphero application on the tablet. Ensure that the tablet and the Sphero are communicating. Through the Sphero application, open MacroLab as shown below.


JUST DRIVE:
sphero
LEVEL UP:
MORE!

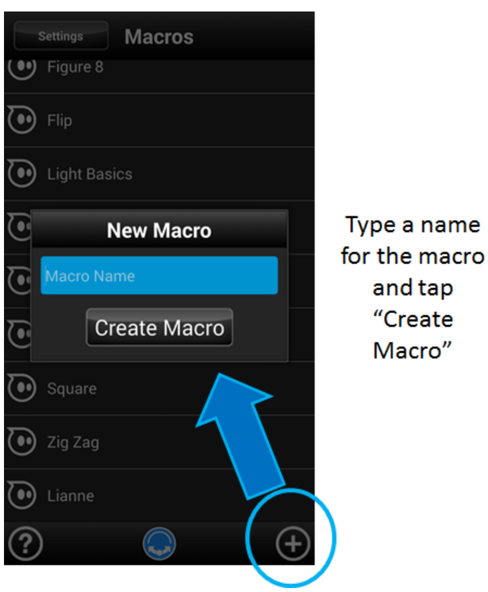

more apps
done
Etch-O-Matic
MORE INFO...
MacroLab
INSTALLED...
Sphero Pet
MORE INFO...
apps
news

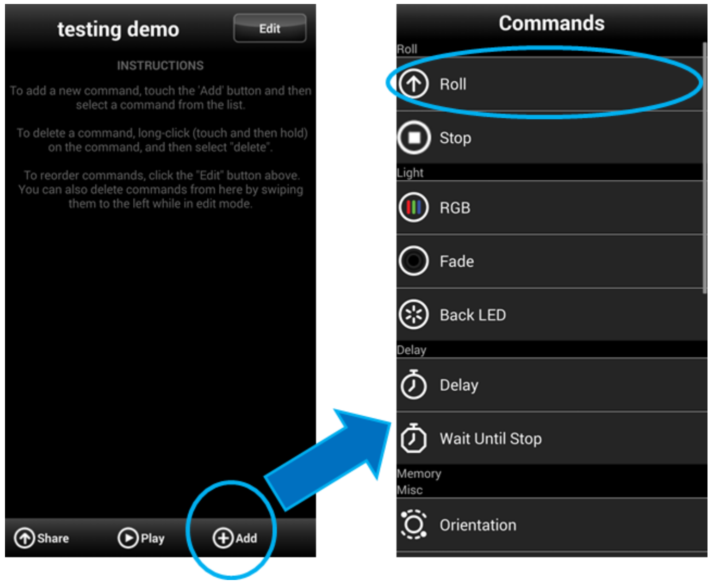

MacroLab
Orbotix, Inc
Play
Create easy, repeatable programs and macros for Sphero. Arrange simple commands and settings in any combination you choose to let Sphero drive autonomously, follow unique patterns, and more. Play your commands, save favorites, and share with friends. Multiball capability only available on Android.

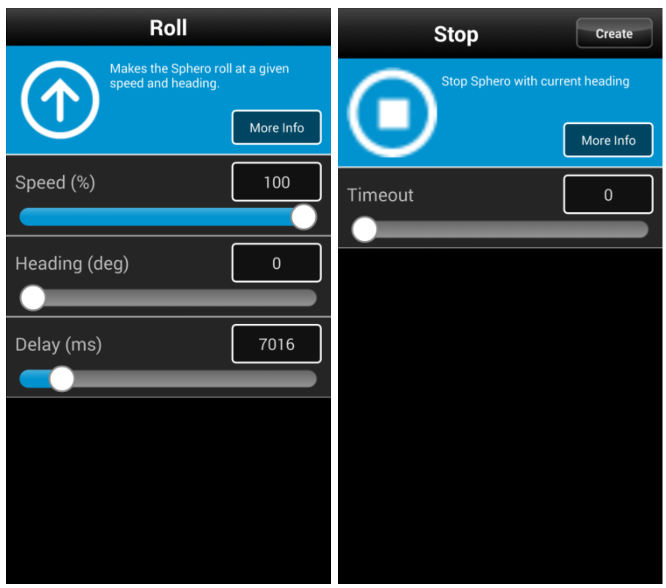
3. Next, lay out the measuring tape in front of you. Align the heading of the Sphero so that the "tail light" is facing you and opposite the direction you want the Sphero to roll as shown below. The measuring tape should lie in front of the Sphero in the direction it will roll as shown below.



4. Create a new macro with a roll and a stop step. You are going to fill in the data table below, to determine an average speed that the Sphero rolls at 100% and 50% output speeds. The first trials will be with the speed at 100% output for a time of 1000 milliseconds.







5. Execute the macro with the table and measure how far the Sphero rolled. Record the distance on the data table.
6. Repeat taking turns with your partner, and changing variables to fill in the data table.
7. Calculate the average Sphero speed at 100% and 50% with the data table and formula below. (In order to convert milliseconds to seconds, divide the number of milliseconds by 1000.)

Data table

Fill in the table below during your experiments – or use the tablet to make the following table and record your measurements.

100% Speed	Length rolled (m)	Time (milli-seconds)	Speed (m/s)	50% Speed	Length rolled (m)	Time (milli-seconds)	Speed (m/s)
Trial 1		1000		**Trial 5**		1000	
Trial 2		1000		**Trial 6**		1000	
Trial 3		2000		**Trial 7**		2000	
Trial 4		2000		**Trial 8**		2000	
Average				**Average**			

In order to calculate speed, the following formula is used:

$$Speed = \frac{Distance}{Time}$$

Where:

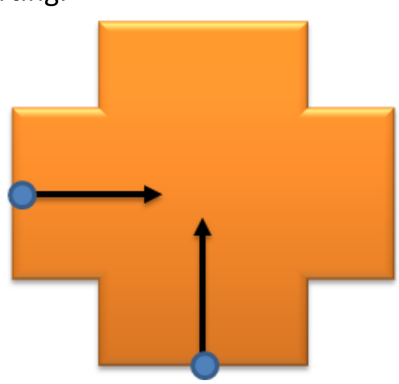
$Speed$ = the speed that the Sphero rolls at 100% output

$Time$ = the amount of time (in seconds)

d = distance ball rolled (in meters)

Part 2: Collision Avoidance

1. Map out the intersection with your partner using the measuring tape. Draw the intersection on a piece of paper. (Or use an application on the tablet to do so.)
2. Program the Sphero to travel through the intersection at a given speed. Calculate how long the Sphero needs to roll to travel through the intersection completely at the speed you've chosen.
3. Find another group that is ready to roll their Sphero. Set up your Sphero to roll through the intersection, have the other group set up their Sphero to roll perpendicular to yours through the intersection as shown. Your Sphero and the other group's should be the same distance from the intersection before starting.



4. At the same time the other group and your group will execute your macro’s to observe what happens.
5. If the Sphero’s collide, or come close to colliding – collaborate with the other team to ensure that collision does not occur when you repeat step 4.

Part 3: Maze Navigation

In this part of the activity, your instructor will extend the intersection to a maze. You will map the maze and then the maze will be covered up. Your challenge should you choose to accept it is to program the Sphero to navigate through the maze without hitting any walls. The team to complete this activity with the fewest wall bumps can declare victory!

Conclusion

Based on the results, form a conclusion as to whether your hypothesis was supported or rejected and explain.

Analysis questions

1. Was the speed of the Sphero at 50% half of the speed of the Sphero at 100%?
2. Does that mean that the relationship between the speed settings is linear?
3. List three ways to avoid a collision.
4. How did your discussion with other team mimic vehicle-to-vehicle communication?
5. Name one thing that you learned about programming that you did not previously know.
6. How can vehicle-to-vehicle communication help to prevent crashes, aside from speed?

Closure

In the real world vehicles are not programmed (yet). However, the devices that allow connected vehicles to communicate with each other require a large amount of programming.