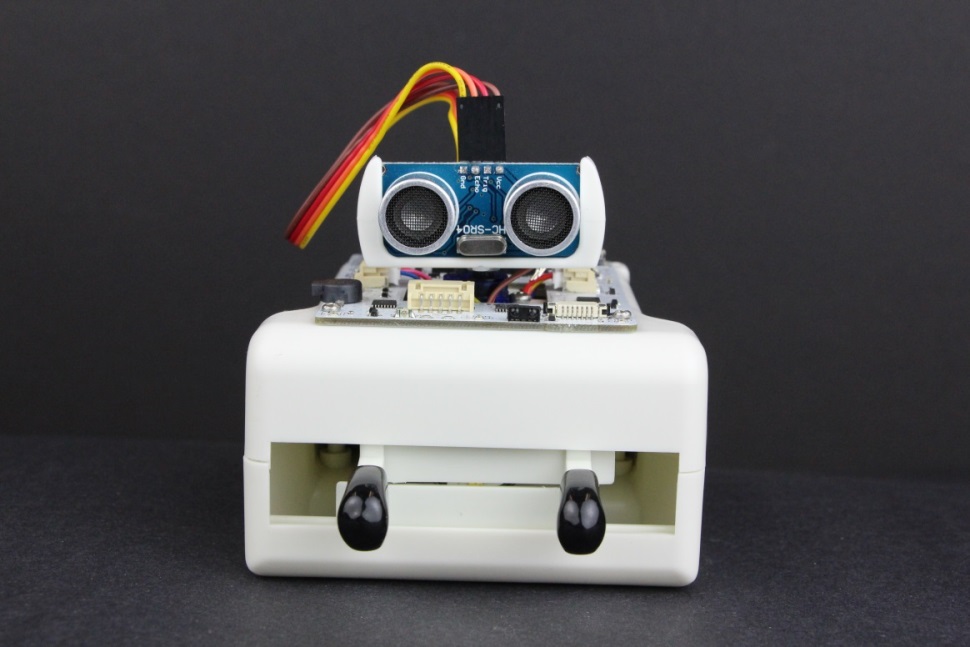
Sparki has an ultrasonic sensor that can be used to determine Sparki’s distance from objects and a servomotor that lets it turn its “eyes” from side to side and scan for objects. Can you use this to decide which of two objects is closer? Can you use it to make Sparki find a follow your hand?

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**Background (Sensor):** The ultrasonic sensor lets Sparki finds objects using sonar, just like a submarine does. The sensor has

* A speaker that emits a sound wave; and
* A microphone that can detect when that sound wave is reflected back.

If we know how fast the sound wave is moving (the speed of sound, in air, is roughly 340 m/s), and we know how long it took between emission and detection, we can use some simple math to determine where objects are.

*Example: There is an object directly in front of Sparki. If the ultrasonic sensor emits a sound and then detects the reflection .012 seconds later, how far away is the object?*

* *Speed of sound in air: 340 m/s*
* *Time to object: .006 seconds (the wave travels to the object in half the total time of flight)*

Note that the ultrasonic sensor is a very simple sensor whose limitations include the following:

* The sensor cannot distinguish between individual objects, other than to indicate their distances from Sparki;
* The sensor is less effective with objects that are far away from Sparki; and
* The sensor does not accurately detect very soft objects (like foam) that can absorb (rather than reflect) the sound wave.

**Tutorial (Sensor):** The following flowchart and code will get Sparki’s “eyes” up and running. Set up a few objects at various distances from Sparki, and use the Serial Output Monitor to see how the output of the sensor changes as you point Sparki at the different objects. Determine how accurate the sensor is, and see what type of objects will confuse Sparki.

Output to Serial Monitor

Read Ultrasonic Sensor

//Use the ultrasonic sensor and the serial output monitor to   
//determine the distance to various objects  
//The University of Texas at Austin 5/2014

#include <Sparki.h> // include the robot library

void **setup**()

{

**Serial**.begin(9600); //Start the Serial Output Monitor

}

void **loop**()

{

int cm = sparki.ping(); // measures the distance with Sparki's “eyes”

**Serial**.print("Distance: ");

**Serial**.print(cm); //prints the distance that Sparki measured

**Serial**.println(" cm");

delay(100); // wait 0.1 seconds (100 milliseconds)

}

**Background (Servomotor):** A servomotor is a special type of motor that can rotate to a specific angular position. The servomotor for Sparki’s “eyes” can rotate from -90° (left) to +90° (right). If you combine moving the servomotor and using the ultrasonic sensor, you can scan a room to make sure Sparki never bumps into anything.

**Tutorial (Servomotor):** The following flowchart and code will make Sparki’s head turn from the center toward the left, then toward the right, and then back to the center:

Turn Head to Left

Center Head

Turn Head to Right

Center Head

#include <Sparki.h> // include the robot library

void **setup**()

{

sparki.servo(SERVO\_CENTER);

delay(500);

sparki.servo(-90); // turn head from center toward the left

delay(500);

sparki.servo(90); // turn head from the left toward the right

delay(500);

sparki.servo(0); // turn head from the right to center

delay(500);

}

void **loop**()

{

}

Now you are ready to solve the two mini-challenges of this handout.

**Mini-Challenge # 1:** Combine the information in the two tutorials above to have Sparki measure its distance to two separate objects – one in front of the robot, and one to the left of the robot – and signal which object is closer.

**Step 1:** In your engineering notebook, create a flowchart for the program that will accomplish the mini-challenge. You may want to build on the flowcharts provided in the tutorial.

**Step 2:** Write the program that corresponds to your flowchart. Note that:

* You will need to understand how to make Sparki measure distance.
* You will need to understand how to make Sparki move the servo motor.
* You will need to use conditional programming (if/then).
* You will need to signal with light or sound.
* You will need elements from the sample code in the tutorial above, including #include <Sparki.h> and the variables.

**Step 3:** Upload your program to Sparki and demonstrate that your code works.

**Mini-Challenge # 2:** Make your robot constantly look for and follow your hand, like a well-trained pet. You can use the head, controlled by a servomotor; the wheels, controlled by stepper motors; and the ultrasonic sensor to complete the challenge.

**Step 1:** In your engineering notebook, create a flowchart for the program that will accomplish the mini-challenge. **This example flowchart is only part of the solution; what is missing?**

**…**

Move ahead 10cm

Read ultrasonic sensor

Center head to 0°

See the hand?

yes

no

**Step 2:** Write the program that corresponds to your flowchart. Note that:

* You will need to understand how to make Sparki measure distance.
* You will need to understand how to make Sparki move the servo motor.
* You will need to use conditional programming (if/then).
* You will need elements from the sample code in the tutorial above, including #include <Sparki.h> and the variables.

**Step 3:** Upload your program to Sparki and demonstrate that your code works.