Arduino BOE kit and Raspibot Board

Class 2: Basics of Arduino Coding





August 8, 2017 Don Wilcher



Presented by:



ROHDE&SCHWARZ

Class 2: Basics of Arduino Coding

Agenda

- Servo Motor Basics
- Attaching Servo Motors to the Parallax Arduino BOE Shield
- Coding with Loops
- Hands-On Labs: Coding Examples





Servo Motor Basics



What is a Servo Motor?

- a) A closed loop servo mechanism
- b) An electromechanical component that uses position feedback to control:
 - i. its motion
 - ii. Final position
- c) input Digital or Analog control signals are use to operate the output shaft appropriately.







Servo Motor Basics...



What is a Servo Motor?

d) Can be control more precisely than DC motorse) They have three wires

- i. Vsupply
- ii. Gnd
- iii. Control









What three attributes that describes a typical servo motor?



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Servo Motor Basics...



What is a Servo Motor?



Servo Motor Basics...

What is a Servo Motor?



Main Parts of Servo Motor: Control Electronics and Mechanicals



Source:

https://www.electrical4u.com/what-is-servo-motor/





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Question 2

What component is not part of a servo motor?

- a) Gear System
- b) Rheostat
- c) DC motor
- d) all parts listed are correct





Servo Motor Basics... What is a Servo Motor?







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Servo Motor Basics...

What is a Servo Motor?





Main Parts of a Servo Motor: Mechanical Parts

Source:

https://www.elprocus.com/difference-dc-motor-servo-motor-stepper-motor/



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Question 3

In slide 9, what signal is produced by the potentiometer?

- a) Feedback signal
- b) Reference Input signal
- c) Reference Output signal
- d) None of the above



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Attaching Servo Motors to Chassis





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Passing Servo Motor wires through Chassis Grommet





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Identifying Servo Motor wires.





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Connecting Servo Motor wires (L&R) to onboard 2x3 male connector (X4).





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Testing the Right Servo Motor

```
* Robotics with the BOE Shield - RightServoTest
 * Right servo turns clockwise three seconds, stops 1 second, then
 * counterclockwise three seconds.
 */
#include <Servo.h>
                                        // Include servo library
Servo servoRight;
                                        // Declare right servo
                                        // Built in initialization block
void setup()
  servoRight.attach(12);
                                        // Attach right signal to pin 12
  servoRight.writeMicroseconds(1300);
                                        // Right wheel clockwise
 delay(3000);
                                        // ...for 3 seconds
  servoRight.writeMicroseconds(1500);
                                        // Stay still
                                        // ...for 3 seconds
  delay(1000);
  servoRight.writeMicroseconds(1700);
                                        // Right wheel counterclockwise
                                        // ...for 3 seconds
  delay(3000);
  servoRight.writeMicroseconds(1500); // Right wheel counterclockwise
```



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What Arduino BOE Shield onboard connector is used to attach the servo motor wires?



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Design Challenge:

Modify the code in the previous slide to test the left servo motor.



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/*	
 Bobotics with the BOE Shield - Right Right serve turns clockwise three seconds. 	ServoTest. sconds, stops 1 second, then
•/	
Anolude Cherve.hb	// Include servo library
Servo servokight;	// Declare right servo
vesit awrop()	// Built in initialization block
serviRight.sttach(12);	// Attach right mignal to P12
serveRight.writeHicroseconds(1300); delay(3030);	// Right wheel clockwise //for 3 peconds
servcRight.writeHioroseconds(1500); delay(1000);	// Stay still //for 3 seconds
serveRight, writeHicroseconds(1700); delay(3000);	<pre>// Right wheel counterclockwise //fog 3 seconds</pre>
servilight.writeHicroseconds(1500);	// Right wheel counterclockwise
1	
vesid loop() (<pre>// Nain loop wate-repeats // Empty, nothing meeds repeating</pre>

Note: We'll be using examples from <u>Robotics with</u> <u>Board of Education Shield for Arduino Book</u> by Andy Lindsay, version 1.0

Source: <u>http://www.robotshop.com/blog/en/how-to-make-a-robot-</u> lesson-4-understanding-microcontrollers-2-3700



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. Bobotics with the BOE Shield - Righth	ervoTert.
* Right serve turns clockwise three sec-	onds, stops 1 second, then
. counterclockwise three seconds.	
•/	
Alsolude (Serve.h)	// Include servo library
Servo servožight;	// Declare right servo
void setup()	// Built in initialization block
t	
serviAight.attAch(12))	// Attach right signal to P12
servoRight.writeNicroseconds(1303);	// Right wheel clockwise
delay(3030);	//for 3 seconds
servicitight.weiteHissomeoonde(1500);	// Stay still
delay(1000);	//for 3 seconds
servellight.weiteMicroseconds(1703);	// Right wheel ocusterclothwise
delay(\$000);	//for 8 seconds
serveRight.writeNicroseconds(1300);	// Right wheel counterclockwise
1	
veld loop()	// Main loop with-repeats
	// Empty, nothing meeds repeating

A for Loop is for Counting

A for loop is typically used to make the statements in a code block repeat a certain number of times. For example, your BOE Shield-Bot will use five different values to make a sensor detect distance, so it needs to repeat a certain code block five times. For this task, we use a for loop. Here is an example that uses a for loop to count from 1 to 10 and display the values in the Serial Monitor.

- Create and save the CountToTen sketch, and run it on your Arduino.
- ✓ Open the Serial Monitor and verify that it counted from one to ten.

```
// Robotics with the BOE Shield - CountToTen
void setup()
{
   Serial.begin(9600);
   for(int i = 1; i <= 10; i++)
   {
      Serial.println(i);
      delay(500);
   }
   Serial.println("All done!");
}
void loop()</pre>
```





IFV0Tert.
nds, stops 1 second, then
// Include servo library
// Declare right servo
// Built in initialization block
// Attach right signal to P12
// Right wheel clockwise
//féz 3 seconds
// Stay still
//for 3 seconds
// Right wheel obusterolockwise
//for 3 seconds
// Right wheel counterclockwise
// Main long with-repeats
// Empty, nothing meeds repeating

Output of "for" loop



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. Bobotics with the BOE Shield - Righth	ervoTers.
. Right serve turns electivize three see	onds, stops 1 second, then
· counterclockwise three seconds.	
•/	
Alsolude (Berwich)	// Include servo library
Servo servožight;	// Declare right servo
void setup()	// Built in initialization block
1	
serviAight.attAch(12))	// Attach right signal to P12
servoRight.writeNicroseconds(1303);	// Right wheel clockwise
delay(1030):	//fee 3 seconds
servoRight.writeHiproseconds(1500))	// Stay still
delay(1000);	//for 3 seconds
servellight.weiteMicroseconds(1703);	// Bight wheel ocusterolockwise
delay(\$000);	//for 8 seconds
serveRight.writeNicroseconds(1300);	// Right wheel counterclockwise
1	
veld loop()	// Main loop with-repeats
	// Depty, nothing needs repeating

How the for Loop Works

The figure below shows the **for** loop from the last example sketch, CountTenTimes. It labels the three elements in the **for** loop's parentheses that control how it counts.



Initialization: the starting value for counting. It's common to declare a local variable for the job as we did here with int i = 1; naming it i for 'index.'

Condition: what the **for** loop checks between each repetition to make sure the condition is still true. If it's true, the loop repeats again. If not, it allows the code to move on to the next







 Bubbiles with the BOE Shield - Rights Right serve turns electwise three seconds. counterclockwise three seconds. 	ervoTest onds, stops 1 second, then
finclude Cherve.ho	// Include servo library
Servo servoRight;	// Declare right servo
void setup()	// Built in initialization block
resvoRight.attach(12)/	// Attach right signal to Piz
serveRight.writeNicroseconds(1303); delay(3030);	<pre>// Right wheel clockwise //for 3 seconds</pre>
servcRight.writeHioroseconds(1500); delay(1000);	// Btay still //for 3 seconds
serveRight.writeHieroseconds(1760); delay(3000);	<pre>// Right wheel orunterolockwise //for 8 seconds</pre>
servcRight.writeNicroseconds(1503);	// Right wheel counterclockwise
1	
vaid loop() (<pre>// Hain loop muto-repeats // Empty, nothing meeds repeating</pre>

A Loop that Repeats While a Condition is True

```
int i = 0;
while(i < 10)
{
    i = i + 1;
    Serial.println(i);
    delay(500);
}</pre>
```





/*	
 Bubbiles with the BOE Shield - Bight Bight pervo turns clockwise three per 	erviTest. onds, stops 1 second, then
•/	
Ausslude (Serve.h)	// Include servo library
Servo servolight;	// Declare right servo
void setup()	// Built in initialization block
servoRight_attach(12))	// Attach right signal to P12
servoRight.writeblicroseconds(1303); delay(3030);	<pre>// Right wheel clockwise //for 3 percends</pre>
servoRight.writeHisroseconds(1500); delay(1000);	// Stay still //fog 3 seconds
serveBight.wriseNicroseconds(1700); delay(\$000);	<pre>// Right wheel ocusterclockwise //for 8 seconds</pre>
servcRight.writeNicroseconds(1500);	// Right wheel counterclockwise
1	
void loop() (<pre>// Hain loop auto-repeats // Empty, nothing meeds repeating</pre>

Condensing code using "++" within the Serial.println (). The variable "i" will increment by 1.

```
int i = 0;
while(i < 10)
{
   Serial.println(++i);
   delay(500);
}</pre>
```





0	
 Bubolics with the BOE Shield - Right Right serve turns electwise three seconds. -/ 	ServeTess. conds, stops 1 second, then
Ainclude (Serve.h)	// Include servo library
Servo servolight;	// Declare right servo
void setup()	// Built in initialization block
f servoAlght.sttach(12);	// Attach right signal to P12
servoRight.writeNicroseconds(1300); delay(3030);	<pre>// Right wheel clockwise //for 3 percends</pre>
servilight.writeHisroseosnie(1500); delay(1000);	// Btay still //for 3 seconds
serveRight.writeRicroseconds(1703); delay(3000);	// Right wheel counterclothwise //for 3 seconds
servtRight.writeHirroseconds(1503);	// Right wheel counterclockwise
1	
vaid loop() (<pre>// Nain loop wito-repeats // Empty, nothing meeds repeating</pre>

A "while" loop keeps repeating as long as the Boolean statement is true. The word "true" is a pre-defined constant.

```
int i = 0;
while(true)
{
   Serial.println(++i);
   delay(500);
}
```



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Write the coding statement that will achieve condensing code when creating program loops.



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 Bubbolos with the BOE Shield - Bight Bight serve turns clockwise three seconds. consterclockwise three seconds. 	JurveTest. conds, stops 1 second, then
Ausslude Chervesho	// Include servo library
Servo servolight;	// Declare right servo
void setup()	// Built in initialization bloc
resvollabt.attech(12))	// Attach right signal to P12
servcRight.writeHicroseconds(1300); delay(3030);	<pre>// Right wheel clockwise //for 3 percents</pre>
servilight.writeHisroseosnis(1500); delay(1000);	// Stay still //for 3 seconds
servedLight.wiiseMicroseconds(1700); delay(3000);	<pre>// Bight wheel counterclothwise //for 3 seconds</pre>
servcRight.writeNicroseconds(1503);	// Right wheel counterclockwise
1	
vaid loop() (<pre>// Hain loop muto-repeats // Empty, nothing meeds repeating</pre>

Constants and Comments

```
/*
Robotics with the BOE Shield - CountToTenDocumented
This sketch displays an up-count from 1 to 10 in the Serial Monitor
 */
                                              // Starting value for counting
const int startVal = 1;
const int endVal = 10;
                                              // Ending value for counting
const int baudRate = 9600;
                                              // For setting baud rate
                                              // Built in initialization block
void setup()
  Serial.begin(baudRate);
                                              // Set data rate to baudRate
  for(int i = startVal; i <= endVal; i++)</pre>
                                             // Count from startVal to endVal
   Serial.println(i);
                                              // Display i in Serial Monitor
   delay(500);
                                              // Pause 0.5 s between values
  Serial.println("All done!");
                                             // Display message when done
void loop()
                                              // Main loop auto-repeats
    Empty, no repeating code.
```

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* Bobonies with the BOE Shield - Rightly	IFV0TeFL
* Right serve turns clockwise three seco	nds, stops 1 second, then
· counterclockwise three seconds.	
•/	
#include (Berwach)	// Include servo library
Servo servolight;	// Declare right servo
void setup()	// Built in initialization block
1	
servoRight.attAch(12))	// Attach right signal to P12
servoRight.writeNicroseconds(1300);	// Right wheel clockwise
delay(3030):	//for 3 seconds
servoRight.writeHipposeconds(1500))	// Stay still
delay(1000);	//for 3 seconds
servellight, writeHieroseconds (1703) /	// Blaht wheel osusterolockwise
delay(\$000);	//for 3 seconds
serveRight.writeMicroseconds(1503);	// Right wheel counterclockwise
3	
weid Loop ()	// Main loss successes.
1	// Passy nothing mania reparting





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/*	
. Bobotics with the BOE Shield - Rightly	ervoTers.
. Right serve turns clockwise three seco	onds, stops 1 second, then
* counterclockwise three seconds.	
•/	
Almolude (Serve-No	// Include servo library
Servo servoRight;	// Declare right servo
void setup()	// Built in initialization block
1	
serviAight.sttAch(12)/	// Attach right signal to P12
servoRight.writeNicroseconds(1300);	// Right wheel clockwise
delay(3030);	//for 3 percents
serviAight.writeHisroseoonde(1500);	// Stay still
delay(1000);	//for 3 seconds
servellight.writeHicroseconds(1703)/	// Right wheel ocusterolockwise
delay(\$000)/	//for 3 seconds
servilight.writeHirroseconds(1500);	// Right wheel counterclockwise
1	
velid loop()	// Main loop with-repeats
	// Empty, nothing meeds repeatin

Objectives of Coding Labs

- To insure the Arduino IDE is installed correctly.
- To explore the Arduino IDE's programming environment.
- To explore turning the Arduino into a servo motor controller.

Note: We'll be using examples from <u>Robotics with</u> <u>Board of Education Shield for Arduino Book</u> by Andy Lindsay, version 1.0

Book Source:

https://www.parallax.com/sites/default/files/downloads/122-32335-Robotics-BOE-Shield-Bot-Arduino-v1.0.pdf







* Bebetles with the BOE Shield - Bishals	areaTers.
. Right serve turns clockwise three seco	onds, stops 1 second, then
* counterclockwise three seconds.	
•/	
Almolude (Serve-No	// Include servo library
Servo servoRight;	// Declare might servo
void setup()	// Built in initialization block
1	
serviAight.sttAch(12)/	// Attach right signal to P12
servoRight.writeNicroseconds(1300);	// Right wheel clockwise
delay(3030);	//for 3 seconds
serviAight.writeHisroseoonde(1500);	// Stay still
delay(1000);	//fog 3 seconds
servellight.writeHicroseconds(1703)/	// Bight wheel ocusterolockwise
delay(\$030);	//for 8 seconds
servsRight.writeHirroseconds(1503);	// Right wheel counterclockvise
1	
velid loop()	// Main loop with-repeats
	// Depty, nothing meeds repeating

Activity 3: LED Servo Signal Monitors

The high and low signals that control servo motors must last for very precise periods of time. That's because a servo motor measures how long the signal stays high, and uses that as an instruction for how fast, and in which direction, to turn its motor.

This timing diagram shows a servo signal that would make your Shield-Bot's wheel turn full speed counterclockwise. There's one big difference though: all the signals in this timing diagram last 100 times longer than they would if they were controlling a servo. This slows it down enough so that we can see what's going on.

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. Bobotics with the BOE Shield - Righth	ervoTers.
* Right serve turns clockwise three sec-	unds, stops 1 second, then
. counterclockwise three seconds.	
•/	
ALDOLUGE (Serve.h)	// Include servo library
Servo servožight;	// Declare right servo
void setup()	// Built in initialization block
1	
servoRight.attach(12))	// Attach right signal to P12
servcRight.writeNicroseconds(1300);	// Right wheel clockwise
delay(3030):	//for 3 pecoads
servoRight.writeHisroseconde(1500);	// Stay still
delay(1000);	//for 3 seconds
servellight.weiteMicroseconds(1703);	// Right wheel counterclockwise
delay(3030);	//for 8 seconds
servsRight.writeMirroseconds(1503);	// Right wheel counterclockwise
1	
veld loop()	// Main loop with-repeats
1 Control (Control)	// Empty, nothing meeds repeating

Timing Diagram for Servo Motor full speed counterclockwise rotation





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. Bobotics with the BOE Shield - Righth	ervoTers.
. Right serve turns electivize three see	onds, stops 1 second, then
· counterclockwise three seconds.	
•/	
ALDOLUGE (Serve.h)	// Include servo library
Servo servožight;	// Declare right servo
void setup()	// Built in initialization block
1	
serviAight.attAch(12))	// Attach right signal to P12
servoRight.writeNicroseconds(1303);	// Right wheel clockwise
delay(3030);	//fee 3 seconds
servicitight.weiteHissomeoonde(1500);	// Stay still
delay(1000);	//for 3 seconds
servellight.weiteMicroseconds(1703);	// Right wheel ocusterclockwise
delay(\$000);	//for 8 seconds
serveRight.writeNicroseconds(1300);	// Right wheel counterclockwise
1	
veid loop()	// Main loop with-repeats
100000000	// Empty, nothing meeds repeating

Example Sketch: ServoSlowMoCcw

- ✓ Create and save ServoSlowMoCcw, then run it on the Arduino.
- ✓ Verify that the pin 13 LED circuit pulses briefly every two seconds.

```
/*
    Robotics with the BOE Shield - ServoSlowMoCcw
    Send 1/100th speed servo signals for viewing with an LED.
*/
void setup()
                                         // Built in initialization block
                                         // Set digital pin 13 -> output
  pinMode(13, OUTPUT);
void loop()
                                         // Main loop auto-repeats
  digitalWrite(13, HIGH);
                                         // Pin 13 = 5 V, LED emits light
  delay(170);
                                         // ..for 0.17 seconds
  digitalWrite(13, LOW);
                                         // Pin 13 = 0 V, LED no light
  delay(1830);
                                         // ..for 1.83 seconds
```

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/*	
. Bobotics with the BOE Shield - Rightly	IFV0Ters.
. Right serve turns clockwise three sets	nds, stops 1 second, then
* counterclockwise three seconds.	
•/	
Anelude Cherve.ho	// Include servo library
Servo servokight:	// Declare right servo
void setup()	// Built in initialization block
1	
servoRight.attech(12)/	// Attach right signal to P12
servoRight.writeblcroseconds(1300);	// Right wheel clockwise
delay(3030);	//for 3 percents
servoRight.writeHisroseconds(1500);	// Stay still
delay(1000);	//for 3 seconds
servellight.writeHicroseconds(1703)/	// Right wheel counterclockwise
delay(\$030);	//for 8 seconds
serveRight.writeNicroseconds(1500);	// Right wheel counterclockwise
1	
velid loop()	// Main loop with-repeats
	// Empty, nothing meeds repeating

Using the Servo library to send servo control signals takes four steps:

 Tell the Arduino editor that you want access to the Servo library functions with the #include declaration at the start of your sketch, before the setup function.

#include <Servo.h> // Include servo library

 Declare and name an instance of the Servo library for each signal you want to send, between #include and the setup function.

Servo servoLeft; // Declare left servo

 In the setup function, use the name you gave the servo signal followed by a dot, and then the attach function call to attach the signal pin. This example is telling the system that the servo signal named servoLeft should be transmitted by digital pin 13.

servoLeft.attach(13); // Attach left signal to pin 13



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. Bobotics with the BOE Shield - Rightly	IFV0Ters.
. Right serve turns clockwise three sets	nds, stops 1 second, then
* counterclockwise three seconds.	
•/	
Anelude Cherve.ho	// Include servo library
Servo servokight:	// Declare right servo
void setup()	// Built in initialization block
1	
serviAight.sttAch(12)/	// Attach right signal to P12
servoRight.writeNicroseconds(1300);	// Right wheel clockwise
delay(3030):	//for 3 percends
servoRight.writeHisroseconds(1500);	// Stay still
delay(1000);	//for 3 seconds
servellight.writeHicroseconds(1703)/	// Right wheel counterclockwise
delay(\$030);	//for 8 seconds
servilight.writeHirroseconds(1500);	// Right wheel counterclockwise
1	
veid loop()	// Hain loop wito-repeats
10000000000	// Empty, nothing meeds repeatin

 Use the writeMicroseconds function to set the pulse time. You can do this inside either the setup or loop function:

servoLeft.writeMicroseconds(1500); // 1.5 ms stay-still signal

Seconds, Milliseconds, Microseconds

- A millisecond is a one-thousandth of a second, abbreviated ms.
- A microsecond is a one-millionth of a second, abbreviated μs.
- There are 1000 microseconds (μs) in 1 millisecond (ms).
- There are 1,000,000 microseconds in 1 second (s).





 Subolics with the BOE Shield - SightServitest Right pervs turns obcowkies three seconds, stops 1 second, then constructedocknies three seconds. 	
finclude (Serve.h)	// Include servo library
Servo servokight;	// Declare right servo
void setup()	// Built in initialization block
f servoRight.attach(12)/	// Attach right signal to P12
servoRight.writeHicroseconds(1300); delay(3000);	<pre>// Right wheel clockwise //for 3 records</pre>
servcRight.writeHioroseconds(1500); delay(1000);	// Stay still //for 3 seconds
serveBight.writeHicroseconds(1700); delay(\$000);	<pre>// Bight wheel ocusterclockwise //for 3 seconds</pre>
servcRight.writeNicroseconds(1500);	// Right wheel counterclockwise
1	
vešil Leop() (<pre>// Hain loop suit-repeats // Empty, nothing meeds repeating</pre>

LeftServoStayStill Code

```
/*
Robotics with the BOE Shield - LeftServoStayStill
Generate signal to make the servo stay still for centering.
*/
#include <Servo.h> // Include servo library
Servo servoLeft; // Declare left servo
void setup() // Built in initialization block
{
   servoLeft.attach(13); // Attach left signal to pin 13
   servoLeft.writeMicroseconds(1500); // 1.5 ms stay still signal
}
void loop() // Main loop auto-repeats
{
    // Empty, nothing needs repeating
}
```



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/*	
 Bubonics with the BOE Shield - Bighnb Right serve turns electwise three see counterclockwise three seconds. 	erveTess. Inds, stops 1 second, then
•/	
Alsolude (Serve.h)	// Include servo library
Servo servolight;	// Declare right servo
Void setup()	// Built in initialization block
t	
servoR1051-attach(12))	// Attach right signal to Pip
servoRight.writeNicroseconds(1300);	// Right wheel clockwise
delay(1030):	//for 3 seconds
servoRight.writeHiproseconds(1500))	// Stay still
delay(1000);	//for 3 seconds
servellight.weiteMicroseconds(1703);	// Right wheel counterclockwise
delay(3030);	//for 8 seconds
serveRight.writeNicroseconds(1300);	// Right wheel counterclockwise
1	
veid loop()	// Hain loop auto-repeata
1	// Empty, nothing meeds repeating
1	

Design Challenge:

Modify the code in the previous slide to make the right servo motor stay still for centering.



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