

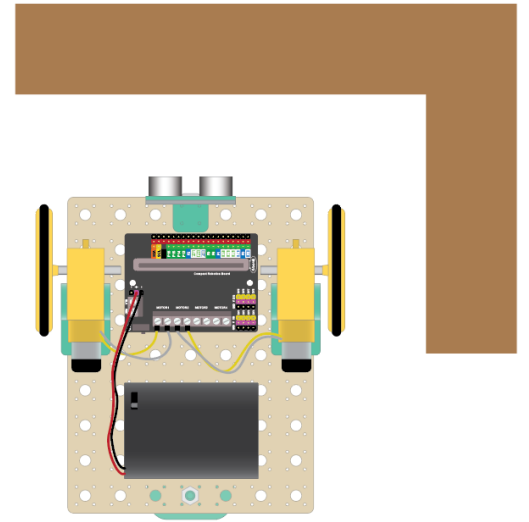
# Build an Obstacle Avoiding Robot

## Project 1.07

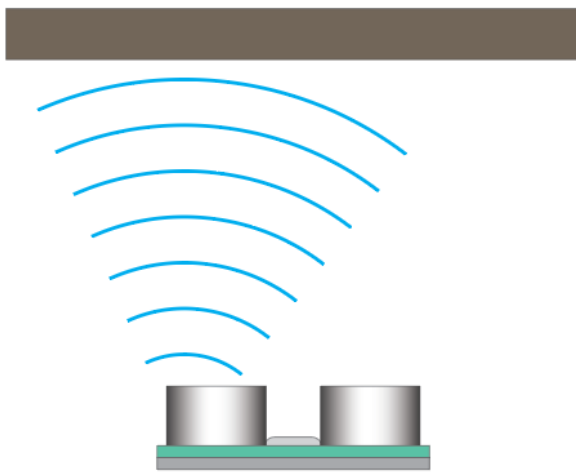
In this workshop you will make a robot that moves randomly around the room avoiding crashing into walls and other obstacles in its path.

### How it Works

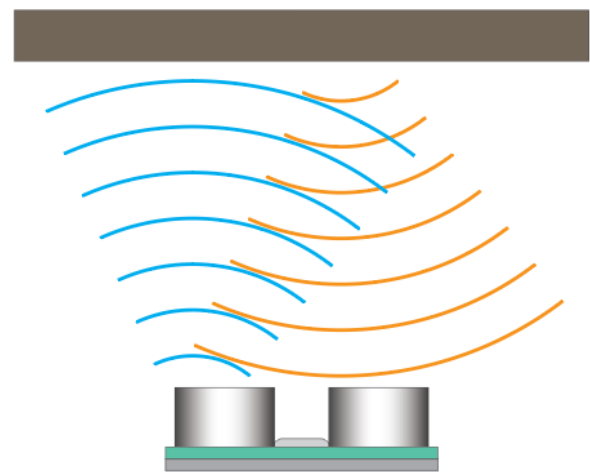
You will attach an **ultrasonic sensor** to the front of your robot. The ultrasonic sensor makes very high-pitched sounds that the human ear cannot detect. The sounds will bounce around the room and echo back to the robot. These echos are then detected by the same sensor. By timing how long it takes for the sound to come back to the sensor, we can work out how far away the nearest object is.



Can't go that way!



Ultrasonic sounds are made by the sensor



Echos are detected by the sensor

Can you think of an animal that uses a technique similar to this? Yes! A bat can “see” using a technique called echolocation. This works exactly the same way. We are going to build a robot bat!



### What to do

- If you haven't already done so, build the robot by referring to the previous worksheet (just build it, don't code it).
- Then follow this worksheet to add an ultrasonic sensor and start measuring distances to objects
- Finally, attempt the coding challenges to get your robot to move around the room avoiding obstacles

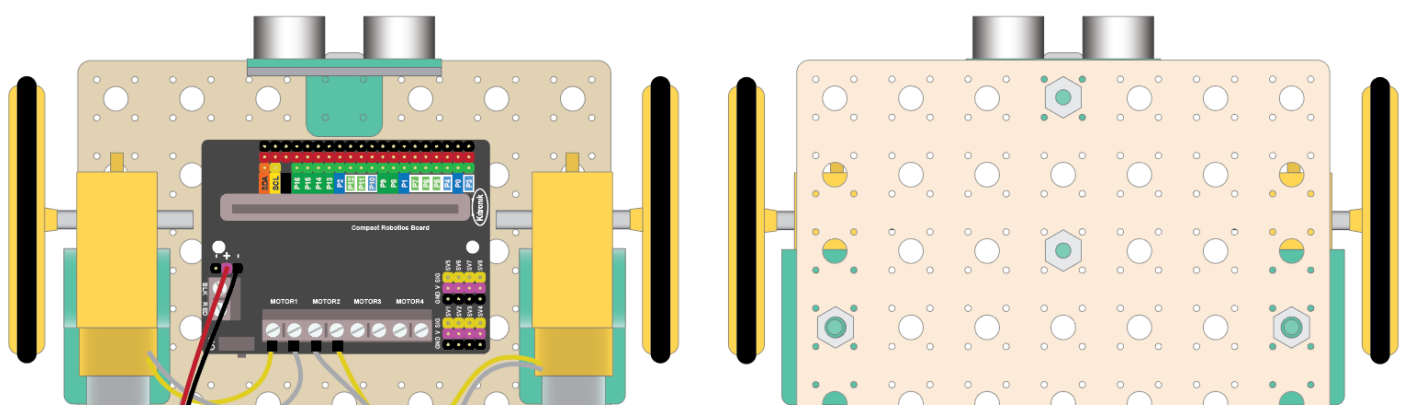
# Add the Ultrasonic Sensor

## Connect the ultrasonic sensor

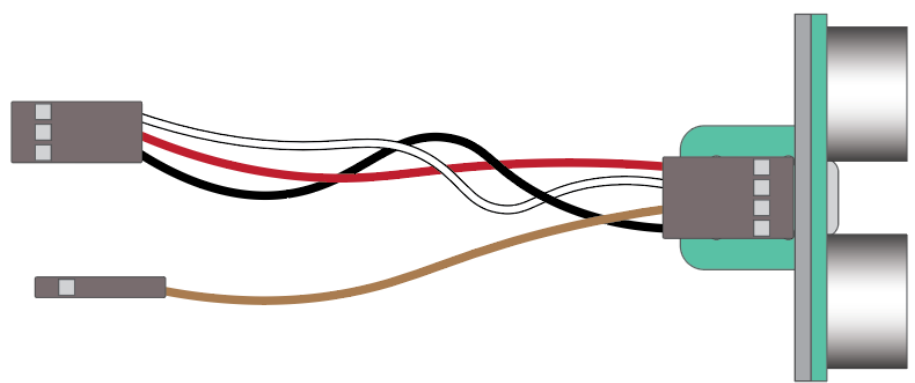
Connect the ultrasonic sensor to the top of the robot. It's best to connect it in the centre, but it will still work if it is offset a bit.

**1** On top: Connect the sensor.

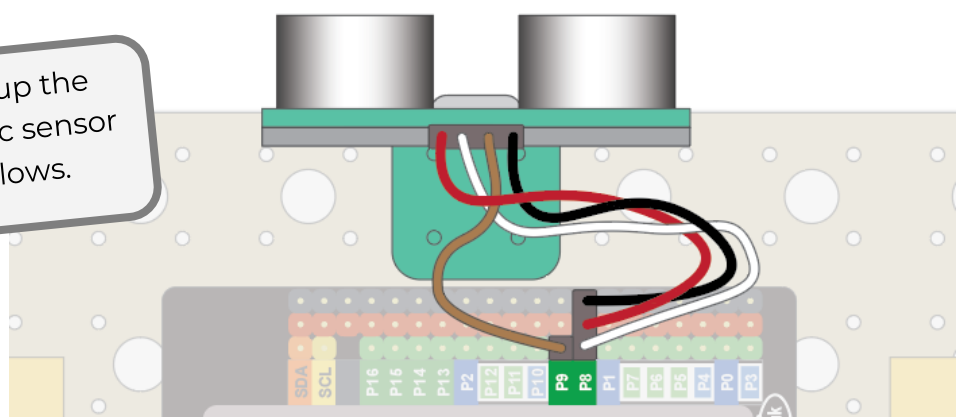
**2** Under the robot: Secure with a nut.



**3** Connect the special ultrasonic cable to the sensor.



**4** Wire up the ultrasonic sensor as follows.



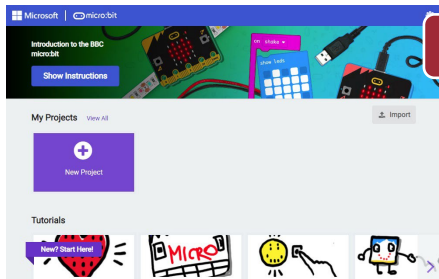
Ultrasonic	Microbit	Purpose
Black/red	Any GV pins	Power
Trig (white)	P8	Trig (make a sound)
Echo (brown)	P9	Echo (listen for sound)

# Code the Ultrasonic Sensor 1

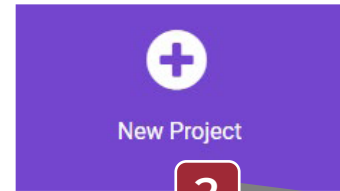
## Create a Project

Create a new Makecode project so you can start coding.

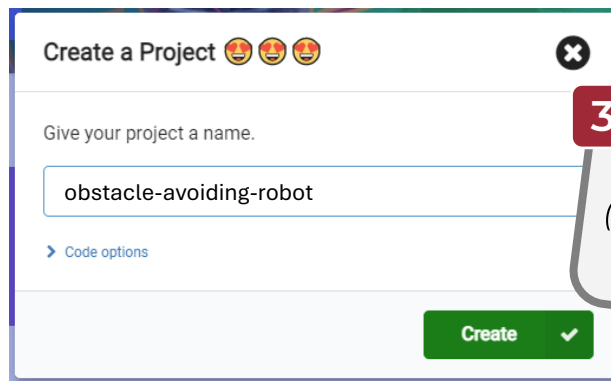
<https://makecode.microbit.org/>



1 Go to the Makecode website.




2 Click on New Project.

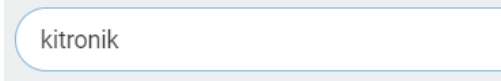


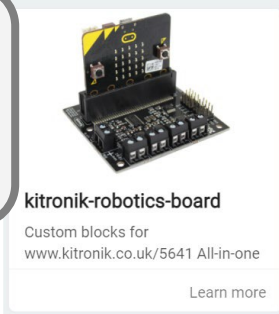
3 Give the project a name (whatever name you want!).

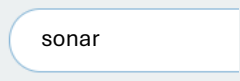
## Add the Motor Driver and Sonar Extensions

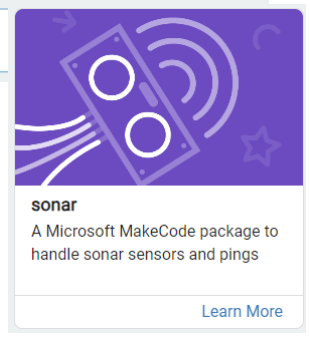
The motor driver extension gives you the ability to control motors. The sonar extension will allow you to use the ultrasonic sensor.

1 Select this block.  Extensions

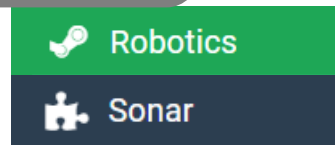
2 Search for Kitronik. 

3 Make sure you select the right Kitronik extension. There are a few of them! 

4 Search for sonar and select the extension 



5 If all goes well you will see these new menus appear.

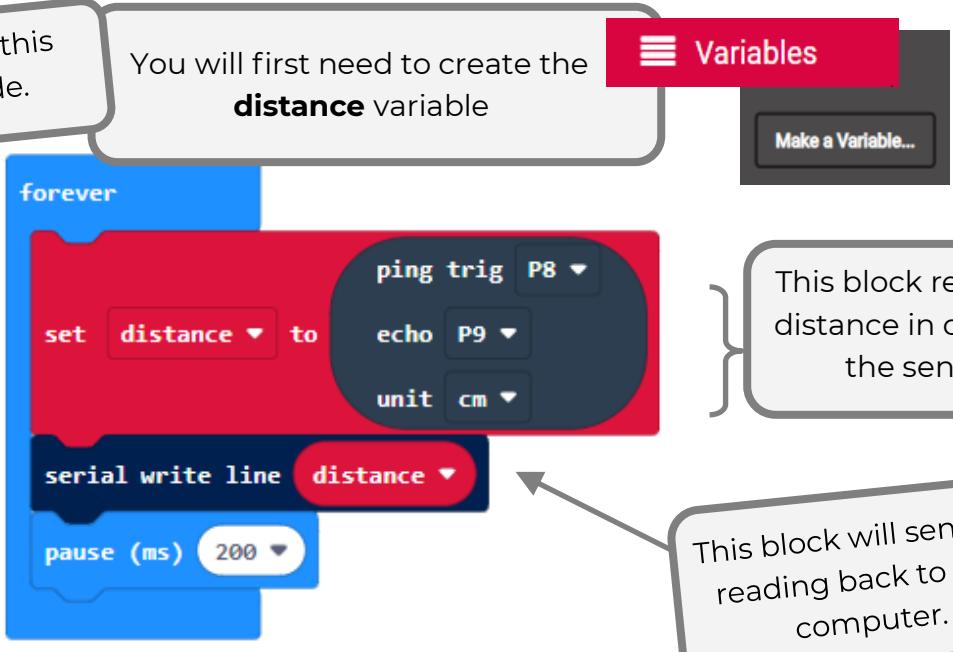


# Code the Ultrasonic Sensor 2

## Read the Sensor Values

First we will take readings from sensor to see if we can measure distances.

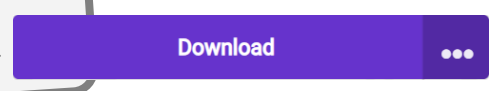
**1** Add this code. You will first need to create the **distance** variable



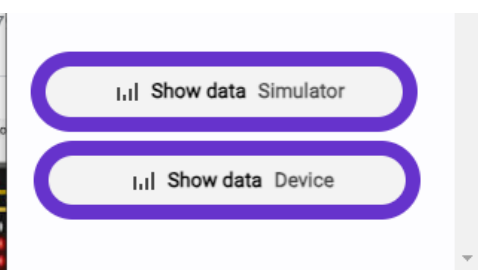
This block reads the distance in cm from the sensor

This block will send the reading back to your computer.

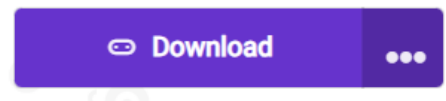
**2** Download the code to the Microbit.



**3** To see the data, click on the **Show data Device** button on the left.

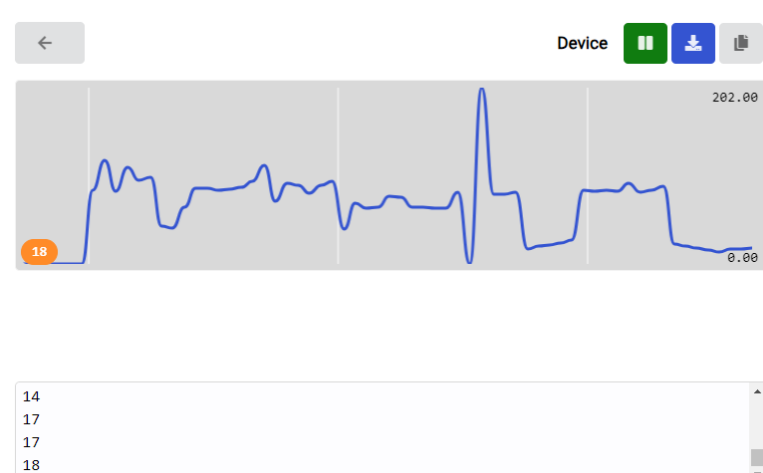


Ensure your Microbit is still connected and paired to your computer or you won't see



**4** You should see some numbers and a graph appear. These show the distance readings in cm.

Place your hand in front of the sensor and move it back and forth. The readings should show how far your hand is from the sensor.



# Code the Ultrasonic Sensor 3

## Move forwards and stop

Now let's get our robot to move forwards and then stop when it sees a wall. To do this we will create some **functions**. Functions are blocks of code that you can run whenever you want in your program, just by calling its name. This saves you repeating the same code over and over.

**1** Create a variable called **speed** and set it to 50.

**2** Create a new function.

**3** Name the function **move forward**.

**4** Add code to the function to move the robot forward.

**5** Create another function to **stop** the robot.

**6** Change the forever code to call the functions.

**7** Download the code to the Microbit. The robot should move forward but stop if it comes within 10cm of a wall.

# Code the Ultrasonic Sensor 4

## Move randomly and stop

Let's make the robot movement a bit more interesting. Instead of moving forwards, we will make it move at different speeds and directions. To do this we will create a function that moves the robot at random speeds and directions and changes the speed and direction every 3 seconds.

1 Create a variable called **count** and set it to 0.

```
on start
  set speed to 50
  set count to 0
```

2 Create a new forever block and add this code to increase count by 1 every second.

```
forever
  change count by 1
  pause (ms) 1000
```

3 Create a function called **move randomly**.

```
function move randomly
  if count >= 3 then
    Motor 1 on direction Forward speed pick random 30 to 100
    Motor 2 on direction Forward speed pick random 30 to 100
    set count to 0
```

Every 3 seconds this code changes the speed and resets the counter.

4 Change the forever code so it calls this new function, **move randomly**, instead of **move forward**.

```
forever
  ping trig P8
  set distance to echo P9 unit cm
  if distance < 10 then
    call stop
  else
    call move randomly
```

5 Download the code to the Microbit. The robot should move randomly but stop if it comes within 10cm of a wall.

Download

# Challenges

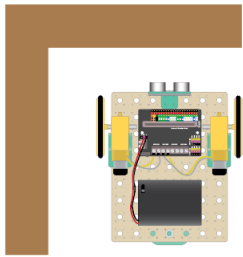
## Your challenge!

When the robot sees an obstacle it just stops. Can you get it to turn around and continue moving instead?

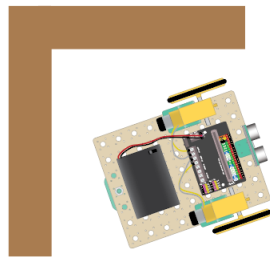
Hint: You will need a combination of movements. Create a function called **reverse** that contains all these movements and replace the **call stop** with **call reverse**.

## Super challenge!

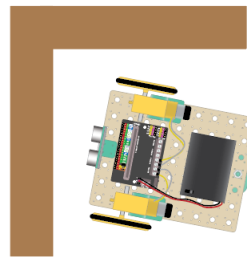
Sometimes you will find that the robot gets stuck in a corner. Change your robot's code so that it tries to find the best way out. Get it to look right then left and choose the direction that looks like it has most space to move into.



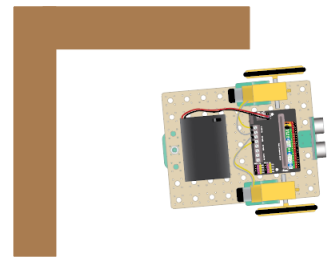
A wall!



Look right



Look left



Right was better,  
I'll head that way!





# Solutions

## Move randomly and reverse solution

This code should make the robot reverse straight, then turn to the right and move off in the new direction. Here is the complete code.

The code is organized into several functional blocks:

- on start:** A red block containing two 'set' blocks: 'set speed to 50' and 'set count to 0'.
- forever loop (top):** A blue block containing a red 'set distance to' block with a sensor block (ping trig P8, echo P9, unit cm). Below it is a teal 'if distance < 10 then' block. The 'then' branch contains a blue 'call reverse' block. The 'else' branch contains a blue 'call move randomly' block.
- forever loop (middle):** A blue block containing a red 'change count by 1' block and a blue 'pause (ms) 1000' block.
- function move forward:** A blue block containing two green 'Motor' blocks: 'Motor 1 on direction Forward speed speed' and 'Motor 2 on direction Forward speed speed'.
- function reverse:** A blue block containing a blue 'pause (ms) 500' block, two green 'Motor' blocks: 'Motor 1 on direction Reverse speed speed' and 'Motor 2 on direction Reverse speed speed', another blue 'pause (ms) 500' block, a third green 'Motor' block: 'Motor 1 on direction Forward speed speed', and a final blue 'pause (ms) 500' block. It ends with two green 'turn off Motor' blocks for Motor 1 and Motor 2.
- function stop:** A blue block containing two green 'turn off Motor' blocks for Motor 1 and Motor 2.
- function move randomly:** A blue block containing a teal 'if count ≥ 3 then' block. The 'then' branch contains two green 'Motor' blocks: 'Motor 1 on direction Forward speed pick random 30 to 100' and 'Motor 2 on direction Forward speed pick random 30 to 100'. Below these is a red 'set count to 0' block.

# Super challenge solution part 1

When the robot sees an obstacle, this code will make the robot look to the left and right and see which is the best escape route. This is the complete code.

The move forward, move randomly and stop functions remains unchanged from previous code.

```
function move forward
  Motor 1 on direction Forward speed speed
  Motor 2 on direction Forward speed speed

function stop
  turn off Motor 1
  turn off Motor 2

function move randomly
  if count >= 3 then
    Motor 1 on direction Forward speed pick random 30 to 100
    Motor 2 on direction Forward speed pick random 30 to 100
  set count to 0
```

The look left and look right functions get the robot to turn to the left and then right and take a distance reading.

```
function look left
  call spin left
  call stop
  pause (ms) 500
  ping trig P8
  set leftDistance to echo P9 unit cm
  call spin right
  call stop

function look right
  call spin right
  call stop
  pause (ms) 500
  ping trig P8
  set rightDistance to echo P9 unit cm
  call spin left
  call stop

function spin left
  Motor 1 on direction Reverse speed 50
  Motor 2 on direction Forward speed 50
  pause (ms) 500

function spin right
  Motor 1 on direction Forward speed 50
  Motor 2 on direction Reverse speed 50
  pause (ms) 500
```

## Super challenge solution part 2

Depending on whether we decided to move off to the left or right, we can call one of these functions.

```
function reverse left
  pause (ms) 500
  Motor 1 on direction Reverse speed speed
  Motor 2 on direction Reverse speed speed
  pause (ms) 500
  Motor 1 on direction Reverse speed speed
  Motor 2 on direction Forward speed speed
  pause (ms) 500
  turn off Motor 1
  turn off Motor 2
```

```
function reverse right
  pause (ms) 500
  Motor 1 on direction Reverse speed speed
  Motor 2 on direction Reverse speed speed
  pause (ms) 500
  Motor 1 on direction Forward speed speed
  Motor 2 on direction Reverse speed speed
  pause (ms) 500
  turn off Motor 1
  turn off Motor 2
```

Now the main forever block can make the robot look left and right and move off in the direction where there is most "distance" in front of the robot.

```
on start
  set speed to 50
  set count to 0

forever
  change count by 1
  pause (ms) 1000

forever
  ping trig P8
  set distance to echo P9 unit cm
  if distance < 20 then
    call look left
    call look right
    pause (ms) 2000
    if leftDistance > rightDistance then
      call reverse left
    else
      call reverse right
  else
    call move randomly
```