

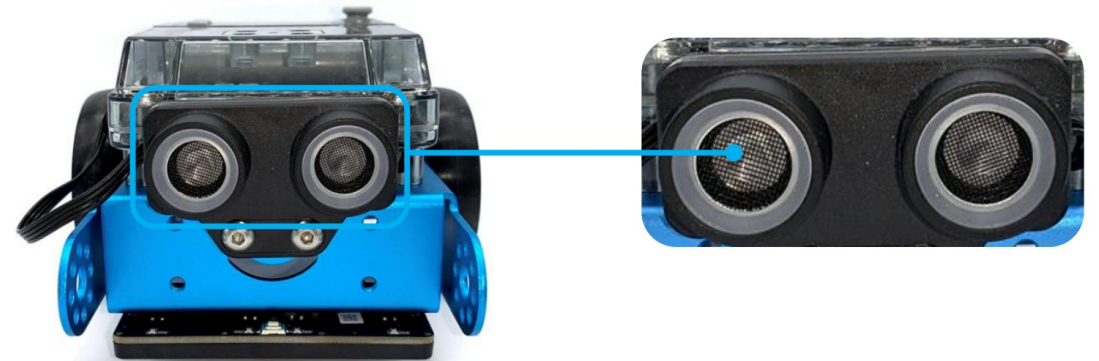
Lesson 4

Seeing With Sound!

STEAM • 45 minutes • Beginner

Today your robot gets superpowers that bats and dolphins already have.

You will use sound humans cannot hear to measure distance. By the end, your mBot2 will drive a whole square course without bumping into anything!



What You Will Be Able To Do Today

1

Explain what ultrasound is and how an ultrasonic sensor works

2

Spot where these sensors are used in everyday life and in robots

3

Use the ultrasonic sensor to measure range and detect obstacles

4

Make mBot2 react to obstacles and avoid them while driving

Robots Need To Know What's In Front

- A robot driving on its own must avoid crashing into obstacles or people
- mBot2 has one special sensor at the front just for this job
- It is called the ultrasonic sensor
- It finds objects in its path using sounds humans cannot hear
- That is exactly why it is called ultra-sound

Big word

Autonomous means the robot decides for itself — like a self-driving car or a vacuum robot.

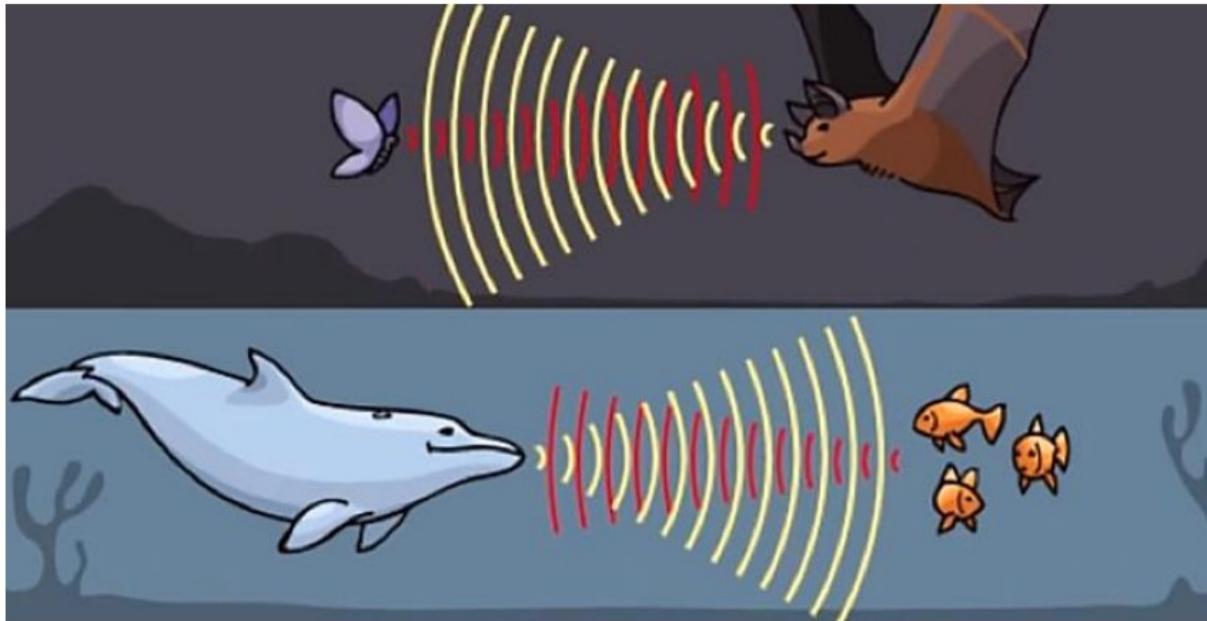
Ultrasound Is Too High For Human Ears

- Ultrasound is sound with a very high frequency — so high people cannot hear it
- Special microphones can record it and show it on a computer as a wave
- Because the frequency is so high, the peaks and valleys sit very close together
- It is genuinely useful: the vibrations can clean objects or detect objects
- It is real sound, just outside our hearing range

Just like...

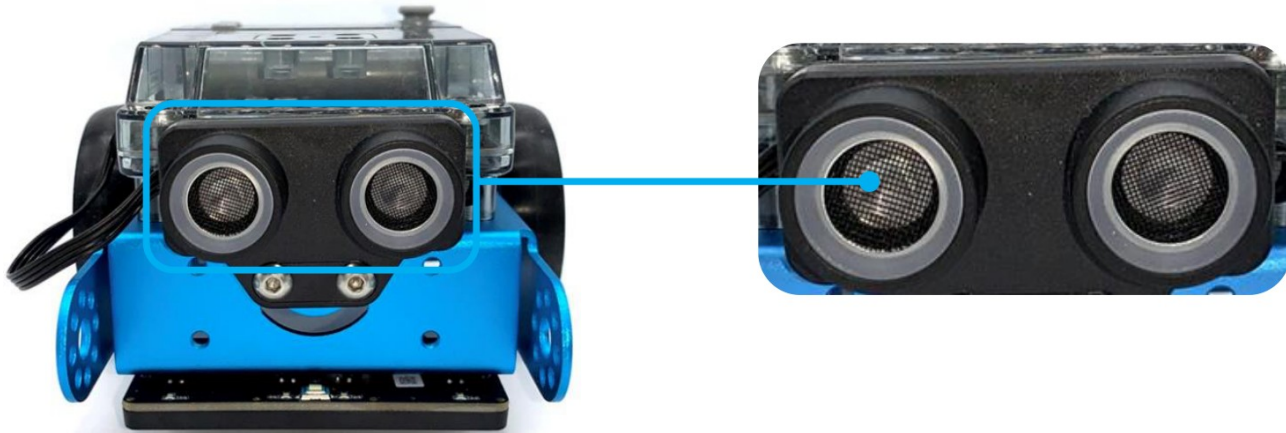
A dog whistle! The sound is really there — our ears just cannot pick it up.

Bats and Dolphins Invented This First



- A bat or dolphin sends out an ultrasonic sound, like a short scream
- The sound bounces off something and comes back as an echo
- Their ears catch the returning vibrations
- From the echo they know where obstacles are
- Radar works the same way, but with radio waves instead of sound

The Two Little Cylinders Are Its Eyes



- mBot2 has an ultrasonic transmitter and a receiver on its front
- They sit in the two little cylinders that look just like eyes
- The transmitter sends out short bursts of ultrasonic sound
- The receiver listens for any echo coming back
- One "eye" is the mouth, the other is the ear — not really eyes at all!

Distance = How Long The Echo Takes

- mBot2 gets close to an obstacle, so the ultrasonic sound reflects back to it
- The robot measures the time the sound took to travel out and come back
- From that time it calculates the distance all by itself, inside the chip
- Short time back = the object is close; long time = it is far away
- You then use that distance number to decide what the robot should do

Try it

Clap in a hallway and listen for the echo. A nearer wall = a faster echo!

You Decide How The Robot Reacts

The distance data is just a number until you give it meaning. You tell the robot what to do with that number — and that is programming!

Reaction 1

Stop driving before you hit something.

Reaction 2

Make a turn and go a different way.

Same sensor, completely different behaviour — because of your code!

First, Add The Ultrasonic Sensor 2 Extension



Ultrasonic Sensor 2

- In mBlock, ultrasonic blocks are not there by default
- Add the extension 'Ultrasonic Sensor 2' from the extension library
- Then find the blocks in the 'Ultrasonic Sensor' category
- These code blocks are green — easy to spot
- Do it now: everyone add the extension before we go on

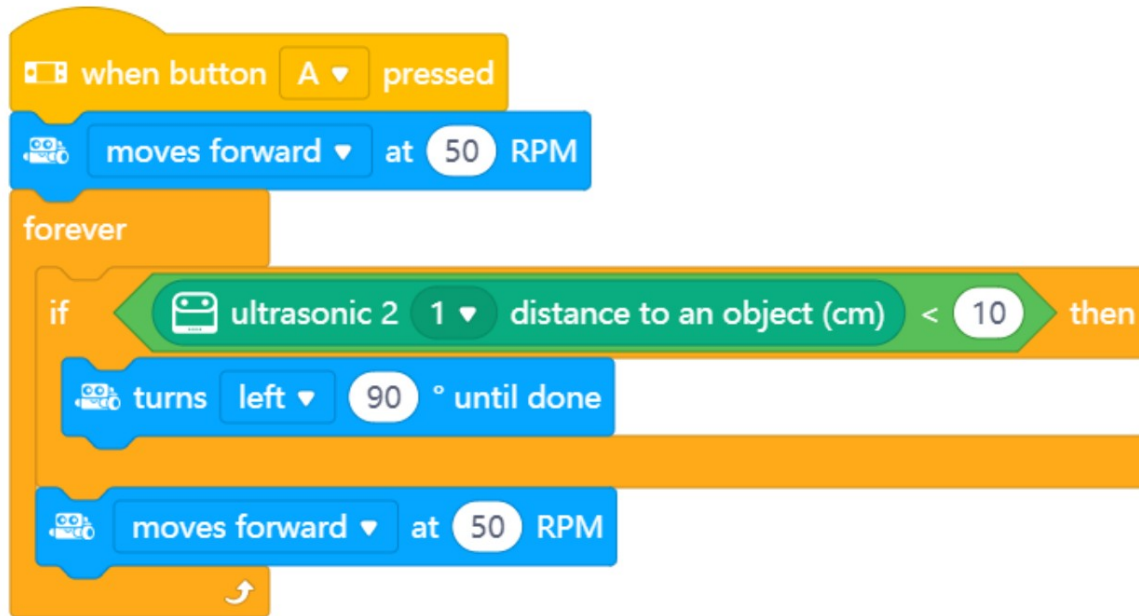
One Green Block Reports The Distance



- This block measures the distance between the sensor and an obstacle
- Its sensing range is 3 cm to 300 cm
- Closer than 3 cm or further than 300 cm and it cannot measure properly
- Use the distance value to make the robot perform an action

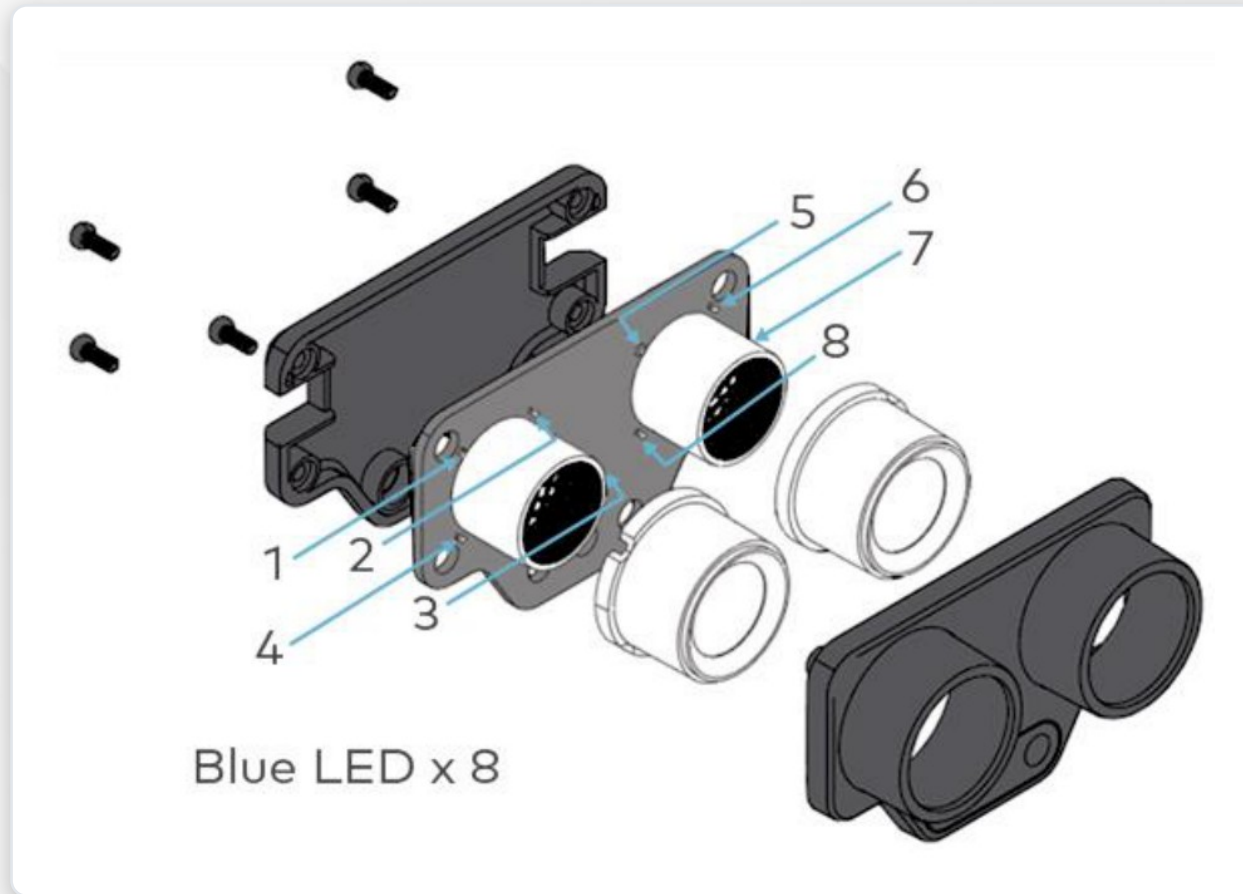
Best use: stop mBot2 from colliding with obstacles!

Drive Forward, Turn When Something's Close



- Press button A and mBot2 starts driving forward at 50 RPM
- The forever loop keeps checking the distance over and over
- If the distance is less than 10 cm, turn left 90° until done
- Then drive forward again and keep checking
- Build this one now and test it against a book or a box!

The Sensor Has Eight Blue LEDs



- The ultrasonic sensor has eight blue LED lights built in
- Use them to make mBot2 show an emotion, without saying a word
- Shine very brightly when it is happy, dimly when it is gloomy
- There is even a special block for ready-made emotions
- The diagram shows exactly where LEDs 1 to 8 sit

Control Brightness From 0% to 100%

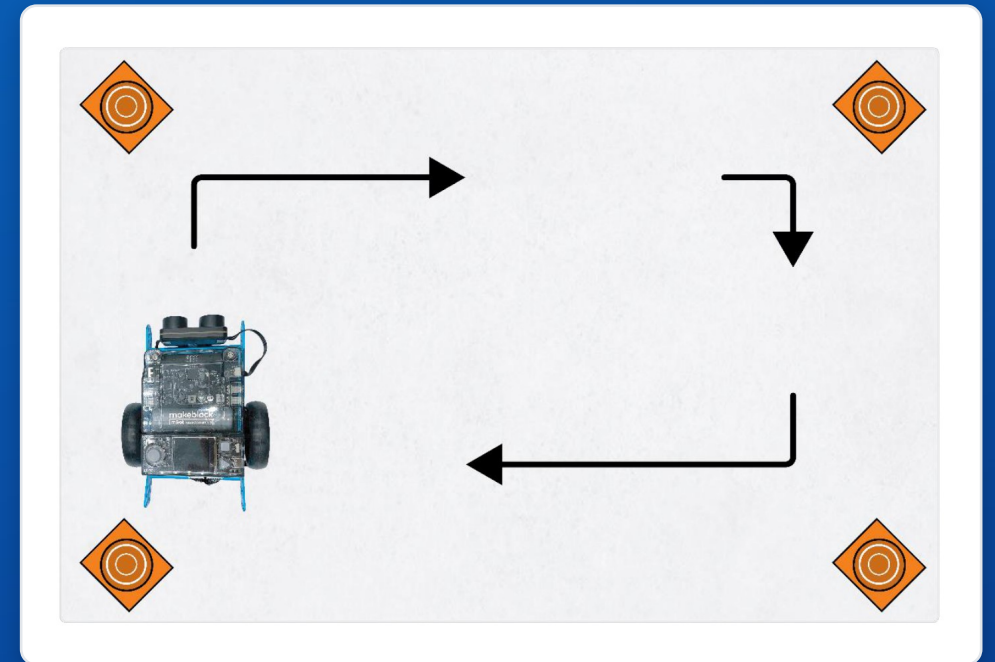


- You can increase or decrease brightness by a percentage
- Or set the brightness straight to an exact percentage
- The range is 0% to 100%
- Works on one single LED or all of them at the same time
- In this example, pressing the up arrow increases brightness by 50%

Your Mission

Drive An Endless Square Lap

- Place one object at each corner of a square
- Program mBot2 to turn at each object and come back to the start
- Then keep going round and round in endless laps
- Obstacles at least 10×10×10 cm and about 1 square metre of floor
- Use everything from Step 2 — and feel free to experiment



25 minutes

Plan Before You Code — 4 Steps

- 1 What do you want to do?** In what way should the mBot2 move?
- 2 What do you need?** What else do you need besides the mBot2?
- 3 Which code blocks?** How will it turn at each corner? Sketch it in plain words or a flowchart
- 4 Test and improve** Write down the problems, then fix them until it runs the course error-free

Stuck? Ask a classmate, ask me, or use the built-in help on every block.

Finished? Film it and ask about posting with #mBot2

Showtime and Wrap-Up

- Did you manage to get mBot2 to drive a full lap?
- Film a short, fun movie of your robot in action
- Reflect: What turned out well? What could be better?
- Which parts were easy, and which were tricky?
- What do you want more explanation about, and who could help you?

Today you learned

- What ultrasound is
- How to stop mBot2 hitting obstacles
- How to use the LED lights to show emotion