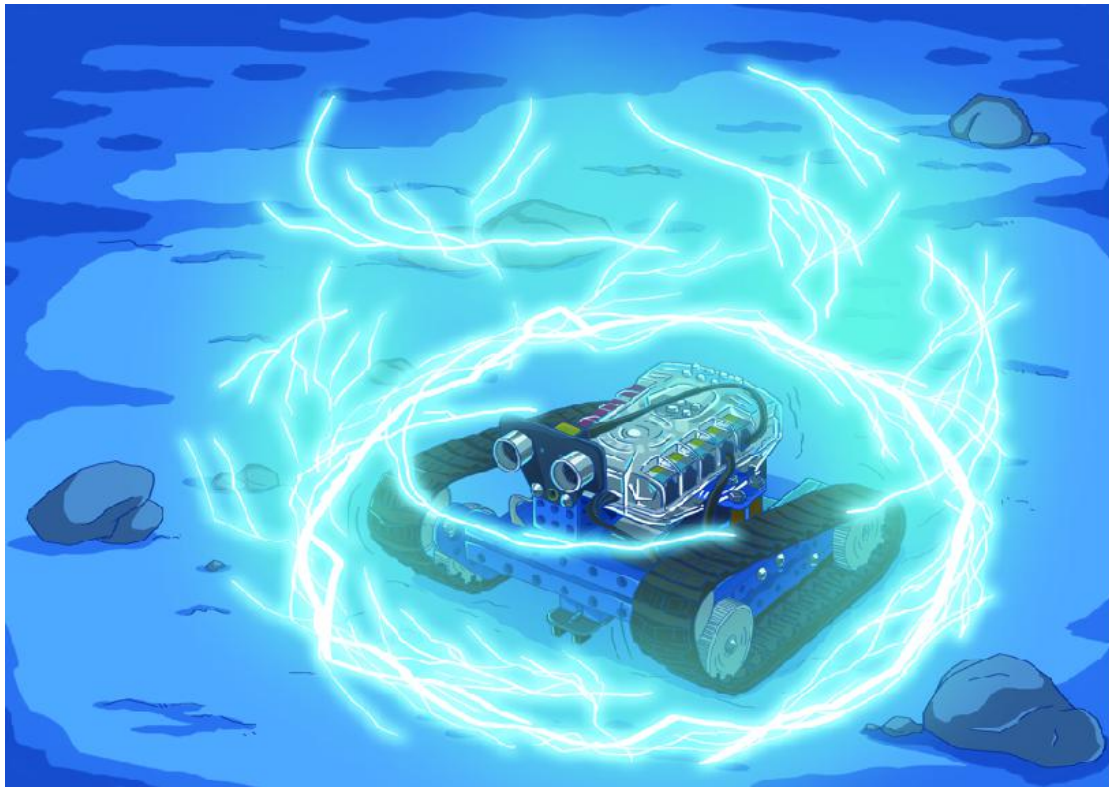


Barrier

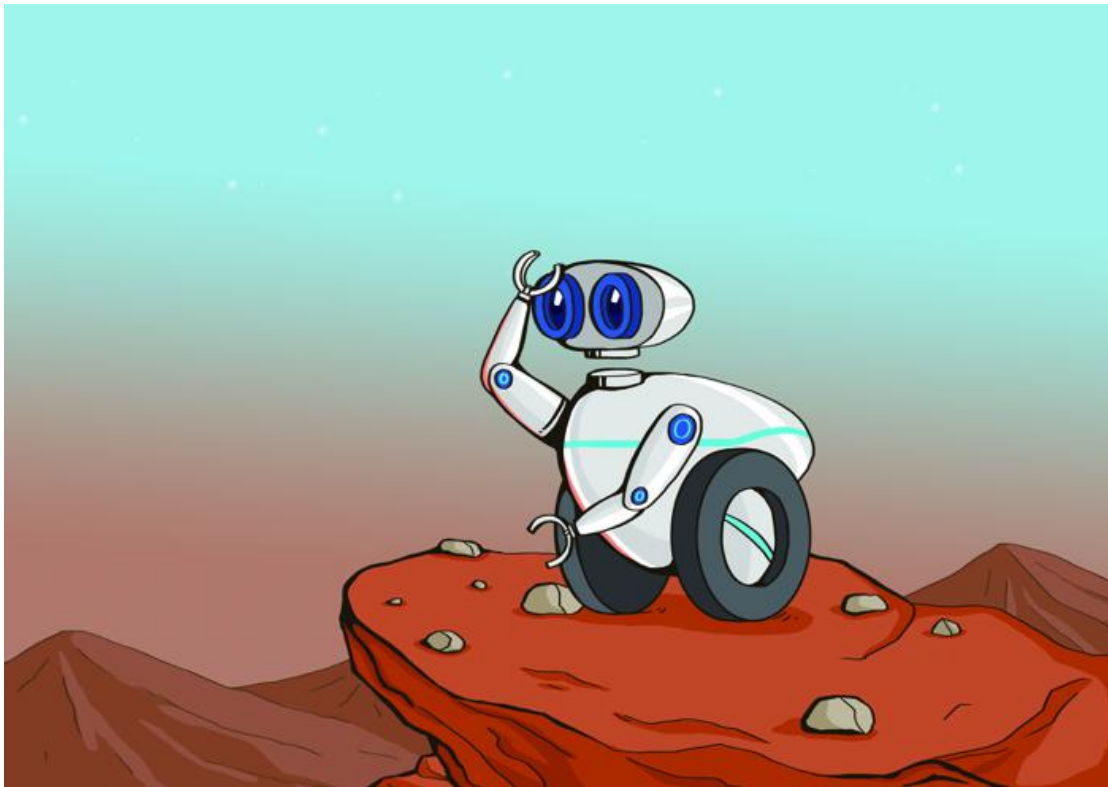


Ranger Tank slows down without any early warning, and the value of distance displayed on the obstacle detector is continuously reducing, 190...180...170....However, except a land of desert, there is nothing ahead that can activate the obstacle detector.

“Peter, check whether our obstacle detector is broken.” Jennifer says as she holds the joystick tightly, trying to keep Ranger Tank moving.

23...22...21...20, Ranger Tank cannot move anymore, since 20 is already the minimum alert distance.

Learning Objectives



In robot field, the ability to detect space and distance usually decides whether a machine can move safely within an area. In this chapter, we will learn how to use ultrasonic sensor to detect distance, and to assist mBot Ranger to avoid obstacles, so that it can walk a safe path.

Scientific Knowledge

From chapter five, we know that sound is transmitted as waves through medium. The speed of sound in the air is 340m/s. But the speed is also influenced by temperature and humidity. That is to say, the higher the temperature or humidity, the faster the speed of sound is.

If we emit a sound signal and detect measures how long the sound takes back and forth, we will be able to calculate the distance between the object and us.

For example: Mark shouts “help” [Note] at one side of the valley and after 3 seconds he hears his sound. Now we know the distance between Mark and the opposite side of the valley is

$340 \text{ (speed of sound)} \times 3 \text{ (time)} = 1020 \text{ (distance that the sound travels back and forth)}$

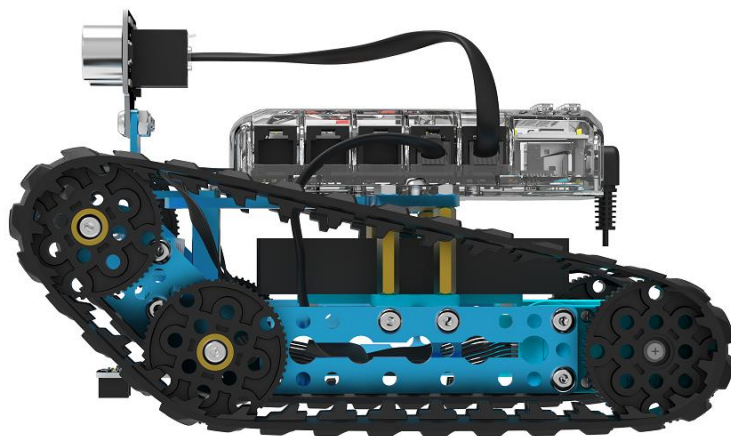
$1020 \div 2 = 510$ (one-way distance)



Note: In your own experiment, please shout “hello” or “hi”. DO NOT shout “help” in the valley unless you are in danger.

Assembly Preparation

In this chapter we use tracked robot.

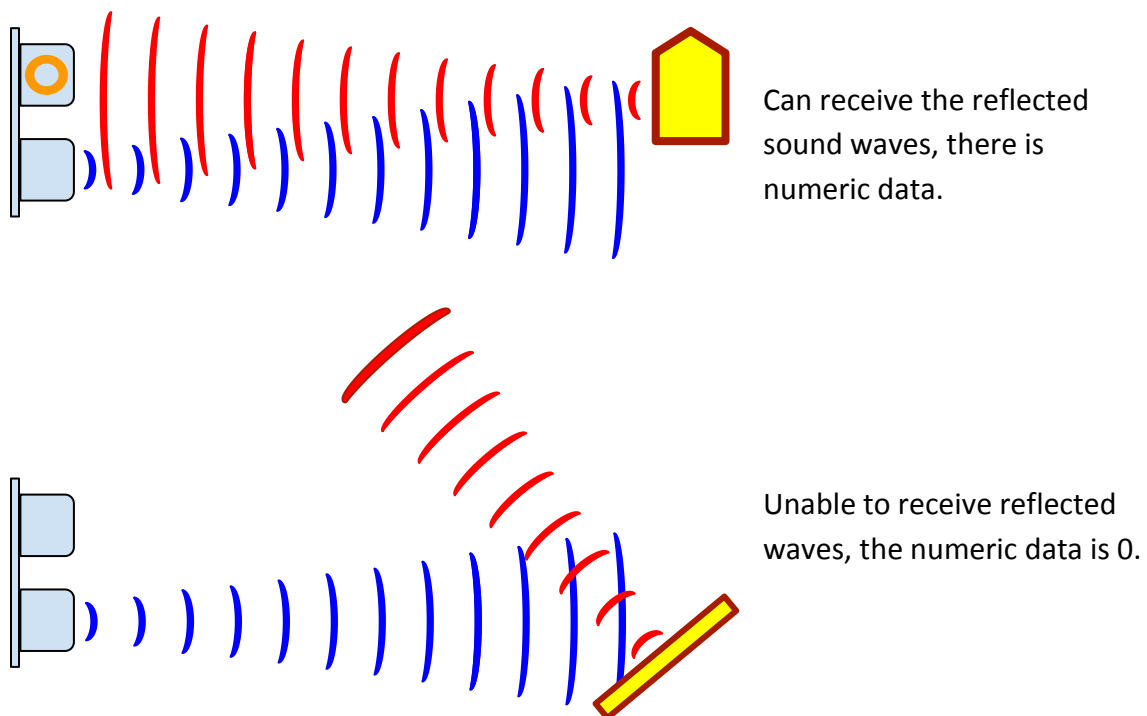


Learning Tasks

Tasks 1 — Introduction to Ultrasonic Module

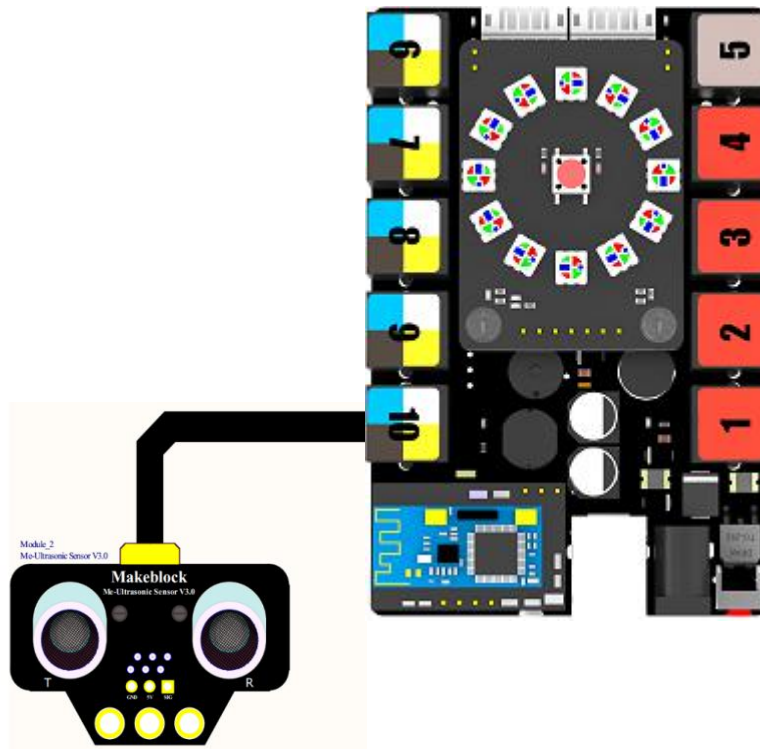
The ultrasonic module that mBot Ranger uses is consists of “ultrasonic transmitter”, “ultrasonic receiver” and control circuit. When ultrasonic transmitter receives command, it will emit high frequency sound waves ahead. When the reflected sound waves are received by ultrasonic receiver, Auriga will calculate how long the sound waves take and transfer the data into distance for command blocks.

Such procedure seems very complicated. However, in mBlock it has become a simple command for collecting distance data. Next we will teach you to use these commands to help robot avoid obstacles or measure various distance.



Learning Task 2 - Read distance data

The port for ultrasonic sensor is yellow. You can connect it to Auriga's yellow port with RJ25 cable.



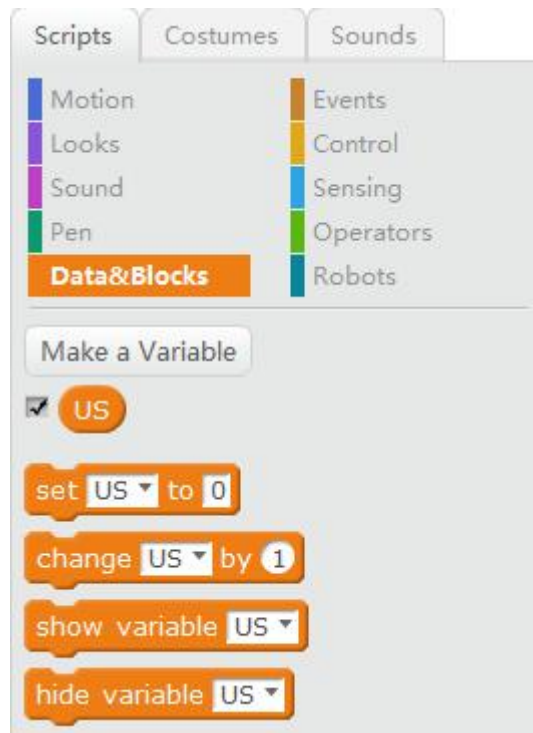
Command for ultrasonic sensor

<div> <div> Motion Looks Sound Pen Data&Blocks </div> <div> Events Control Sensing Operators Robots </div> </div>	<div>ultrasonic sensor Port10 distance</div>	ultrasonic sensor's distance value(cm)
<p>Function: Read ultrasonic sensor's distance value</p> <p>[Port10]: Choose one port for ultrasonic sensor (default number is 10)</p>		

Effective measuring range of the ultrasonic sensor is: 6 cm to 400 cm

To read the value change of the ultrasonic sensor, connect computer and Ranger with a USB cable, and through [online mode], ultrasonic distance values can be displayed on mBlock's stage.

Please add a variable “US”,



Set the value of US as the ultrasonic sensor's distance value,



Please connect Ranger to the computer with USB cable to upgrade Ranger's firmware, and then click the green flag to start the program. The variable value is displayed on mBlock's stage. Put your hand in front of the ultrasonic sensor and observe the value changing while your hand getting close or far away from the sensor. The value indicates the distance between your hand and ultrasonic sensor.



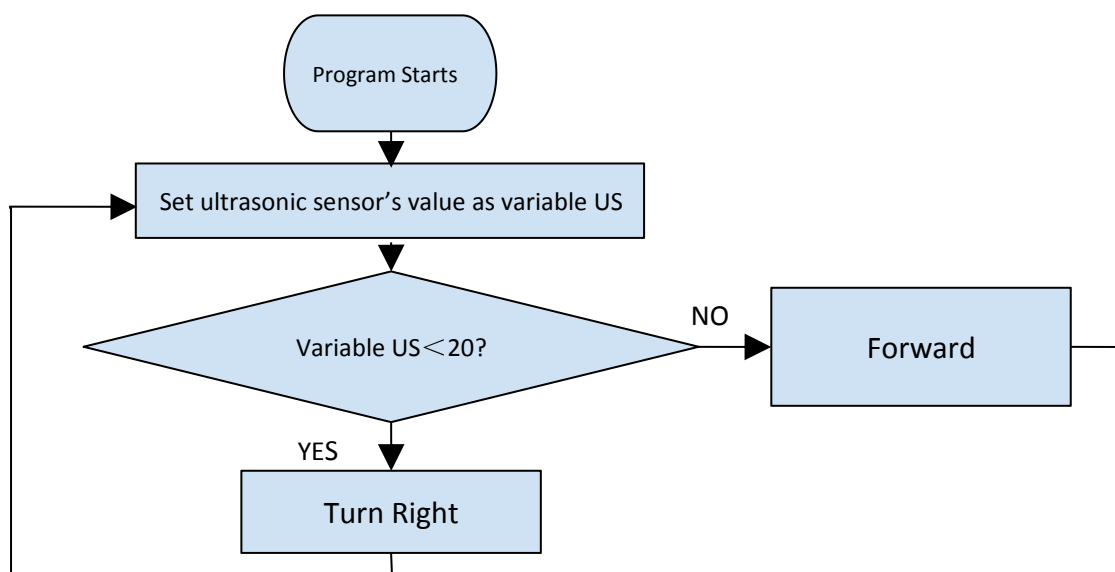
Target Task

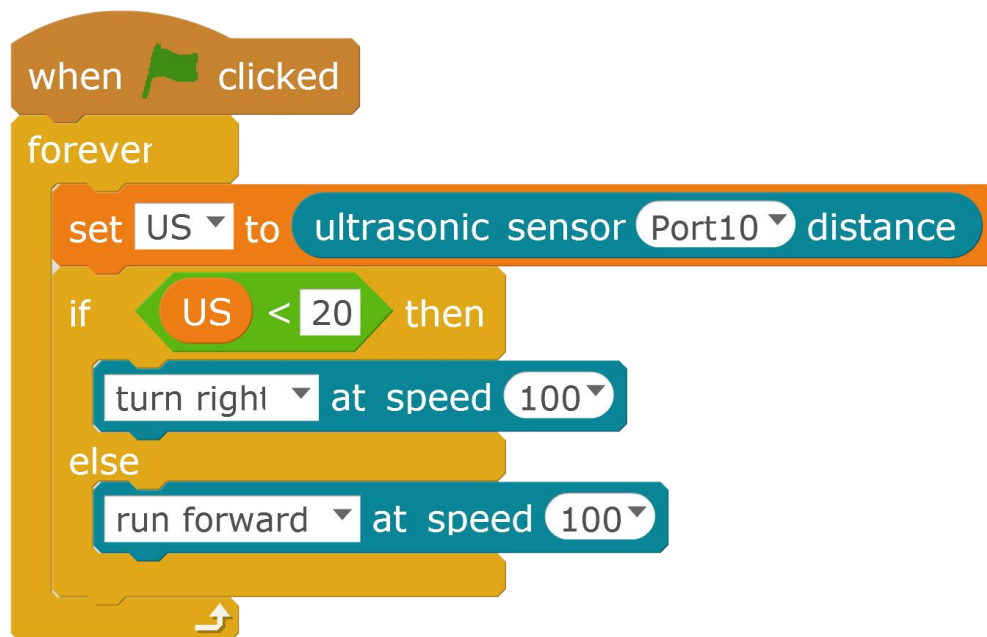
Target Task 1 — Automatically Avoid Obstacles

Through the learning tasks, we already know what ultrasonic sensor's value means. Ranger detects obstacles ahead by the changes of ultrasonic sensor value.

Let's use the comparison modules in [Operators]:

1. If ultrasonic value is below 20cm, which means there is an obstacle ahead, robot need turn right.
2. If ultrasonic value is equal to or over 20cm, which means there is no obstacle ahead, robot will keep advancing.





Ranger will keep advancing. When it encounters an obstacle within 20cm, it will turn right.

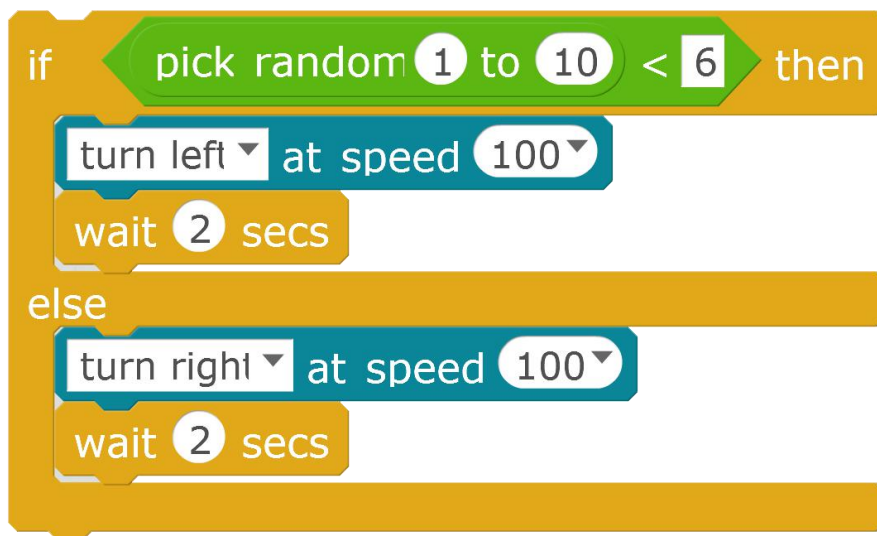
Target 2 — Turn left or turn right

In Target 1, Ranger can only turn right when it encounters obstacles, but actually, it can also turn left. So, what shall we do to make it decide whether to turn left or turn right by itself?

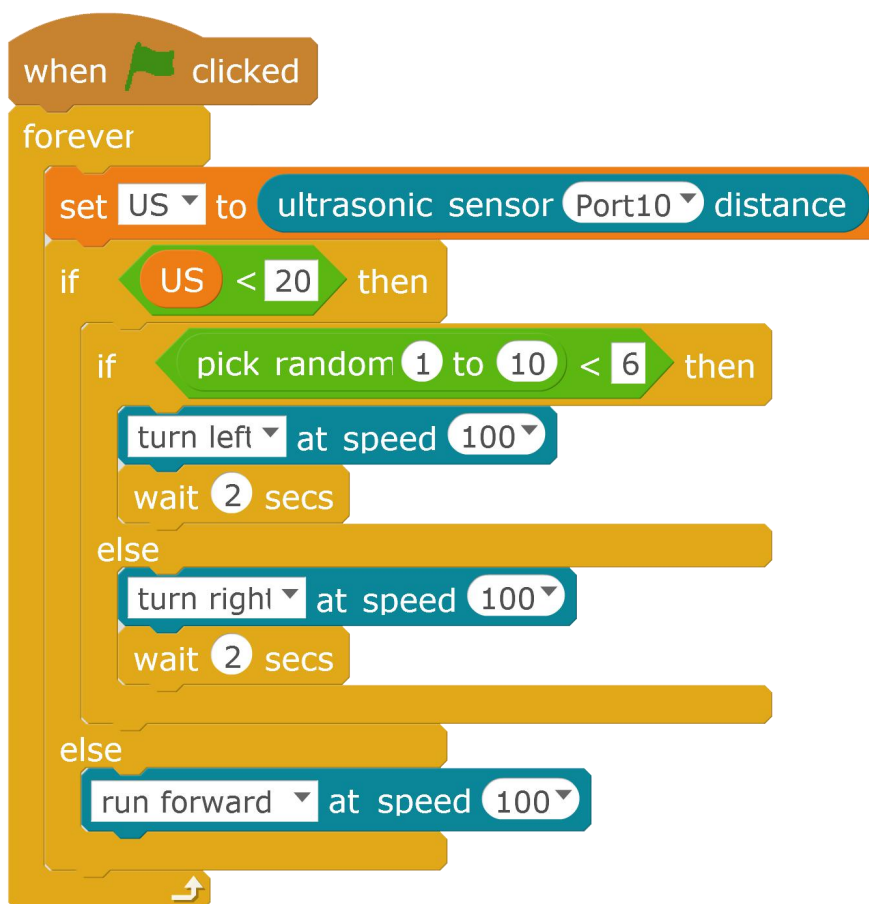
Let's do this with [pick random 1 to 10] command.

<div> <div>Motion</div> <div>Looks</div> <div>Sound</div> <div>Pen</div> <div>Data&Blocks</div> <div>Events</div> <div>Control</div> <div>Sensing</div> <div>Operators</div> <div>Robots</div> </div>		select a number randomly
Function: select a number randomly within an interval. (the default values of interval are from 1 to 10)		

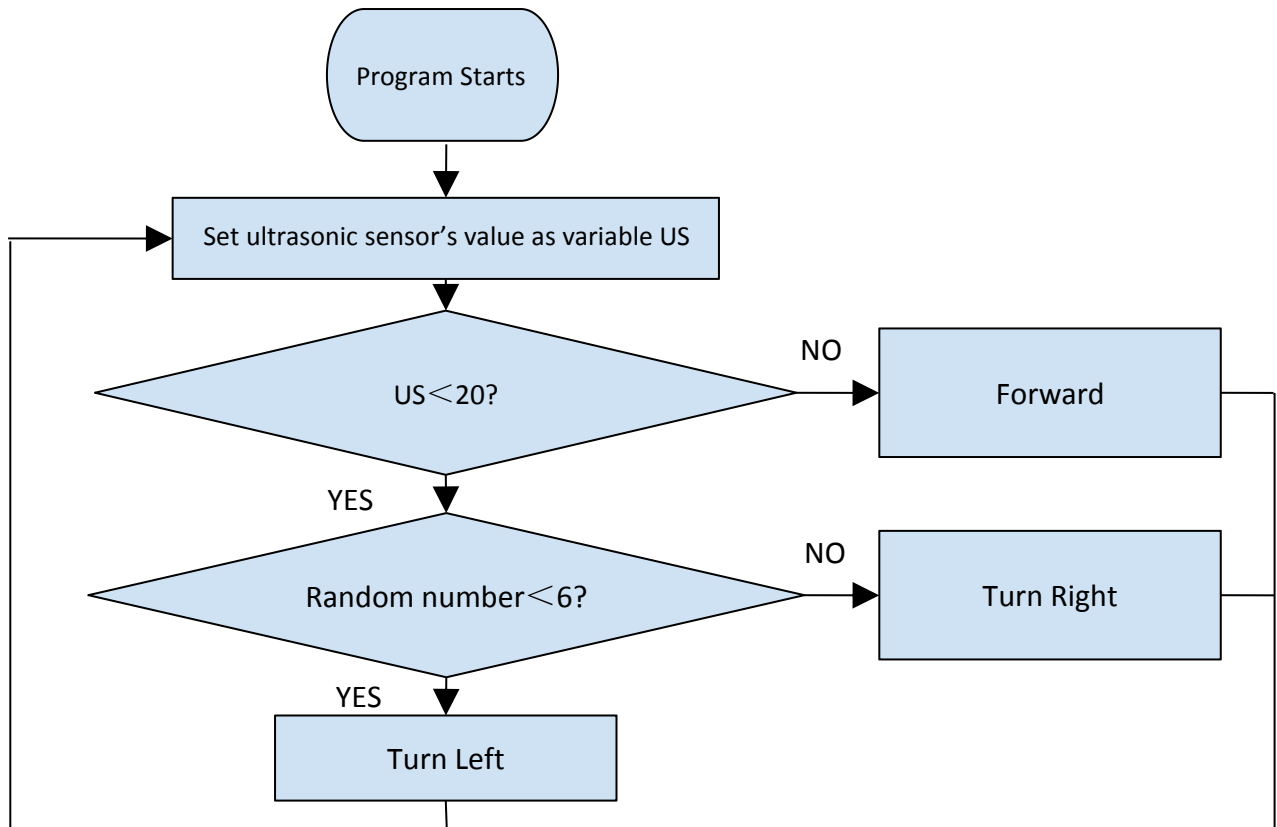
Cooperating with [If...then...else] command, the [pick random 1 to 10] command will divide the selected numbers into two groups: numbers that are less than 6 (1, 2, 3, 4, 5) and that are greater than or equal to 6 (6, 7, 8, 9, 10).



Replace the original [turn right] command with [If...then...else] command, as shown below:



The flow chart is shown below:



Have a try! Can your Ranger turn right or turn left when it encounters an obstacle? The random number will provide your robot with more chances!

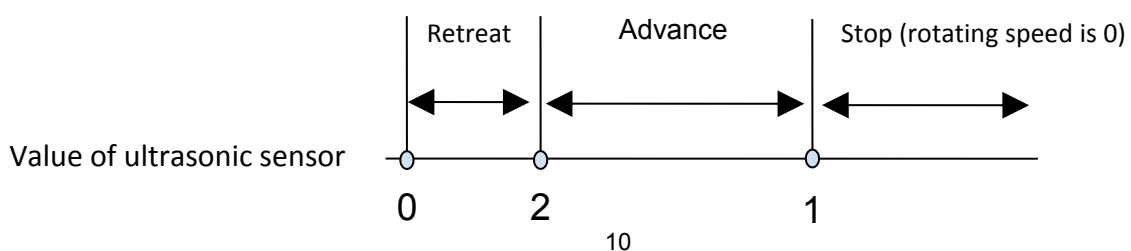
The Challenge

Challenge Task 1 – Location-aware

Besides avoiding obstacles, ultrasonic sensor can also assist the robot to fulfill other tasks. Let Ranger move forward or backward with your hand, without touching your hand or going too far away from your hand.

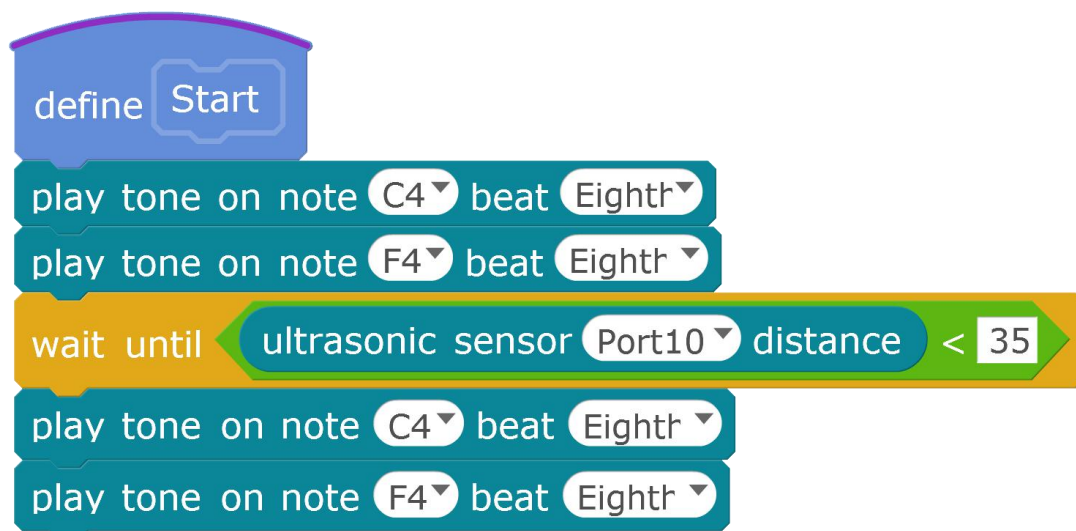
With [If...then...else] command, the value of ultrasonic sensor is divided into three parts:

1. Less than 20cm: retreat
2. Over 20cm, less than 100cm: advance
3. Over 100cm: stop



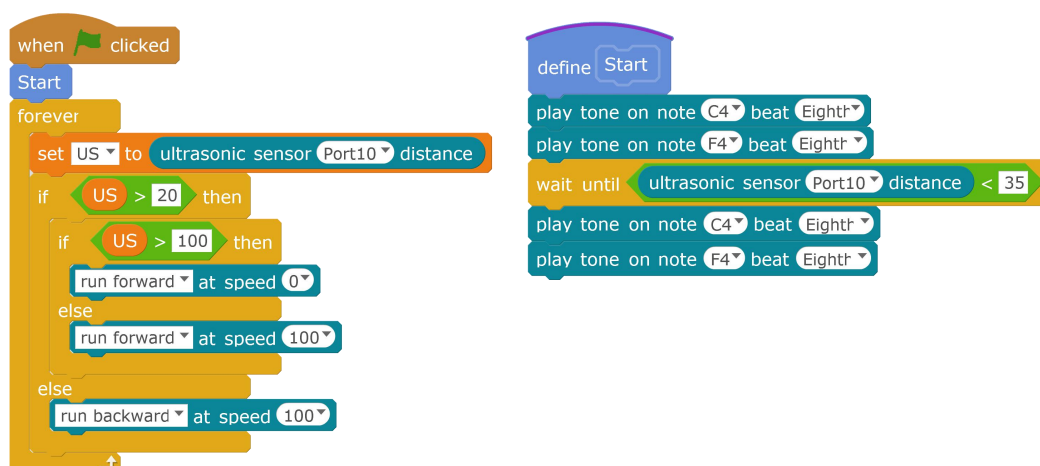
Now, Ranger can move automatically with your hand. When your hand gets too close to Ranger, it will retreat; when your hand gets too far away from Ranger, it will advance; when you don't put your hand, Ranger will stop.

With the [upload to Arduino] offline mode, Ranger can also work in offline mode. Here we add a new block named Start, it will make a sound when the program is running and then we should use the [wait until ultrasonic sensor Port10 distance<35] command. After the robot making a sound, the user should cover the light sensor with his hand, which is the starting signal of robot. Then the robot will make a different sound to inform people that Ranger is going to run.



(Please change the number [35] according to specific situation.)

The whole program is as below:

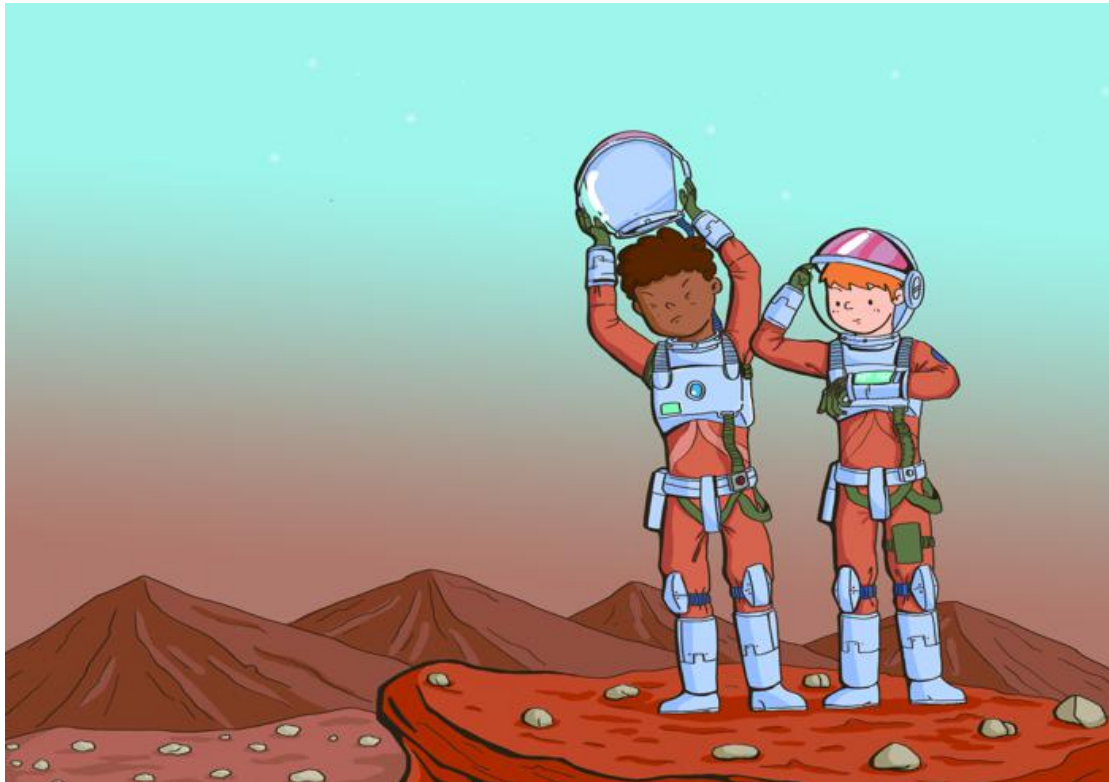


Remember to connect Ranger to the serial port of computer with a USB cable before uploading the program to Arduino.

Can your Ranger move with your hand? What a convenience to have a robot following you!

Conclusion of This Chapter

In this chapter, we only introduced how to measure the distance between two objects with ultrasonic sensor. In fact, you can also use other mediums, such as laser and infrared ray, or other measuring methods, such as time difference, phase difference and energy loss difference, etc. Every sensor has its own way to measure the distance. You can search the internet for more information about this!



Mark and Peter put on their space suits, holding an ultrasonic rangefinder and getting close to the invisible wall...

The value of distance keeps reducing as they are getting closer to the wall. Mark raises the rangefinder and tries to touch the wall, but it just penetrates the wall – nothing stops it.

“We have walked across the refraction zone without any obstacle, and the space suit is getting heavier. The environment detector shows that the atmospheric pressure and atmospheric composition here are similar to that of the Earth. The inside environment is totally different from the outside. We are safe here.” Mark says through radio. Then we see that Peter is taking off his helmet...