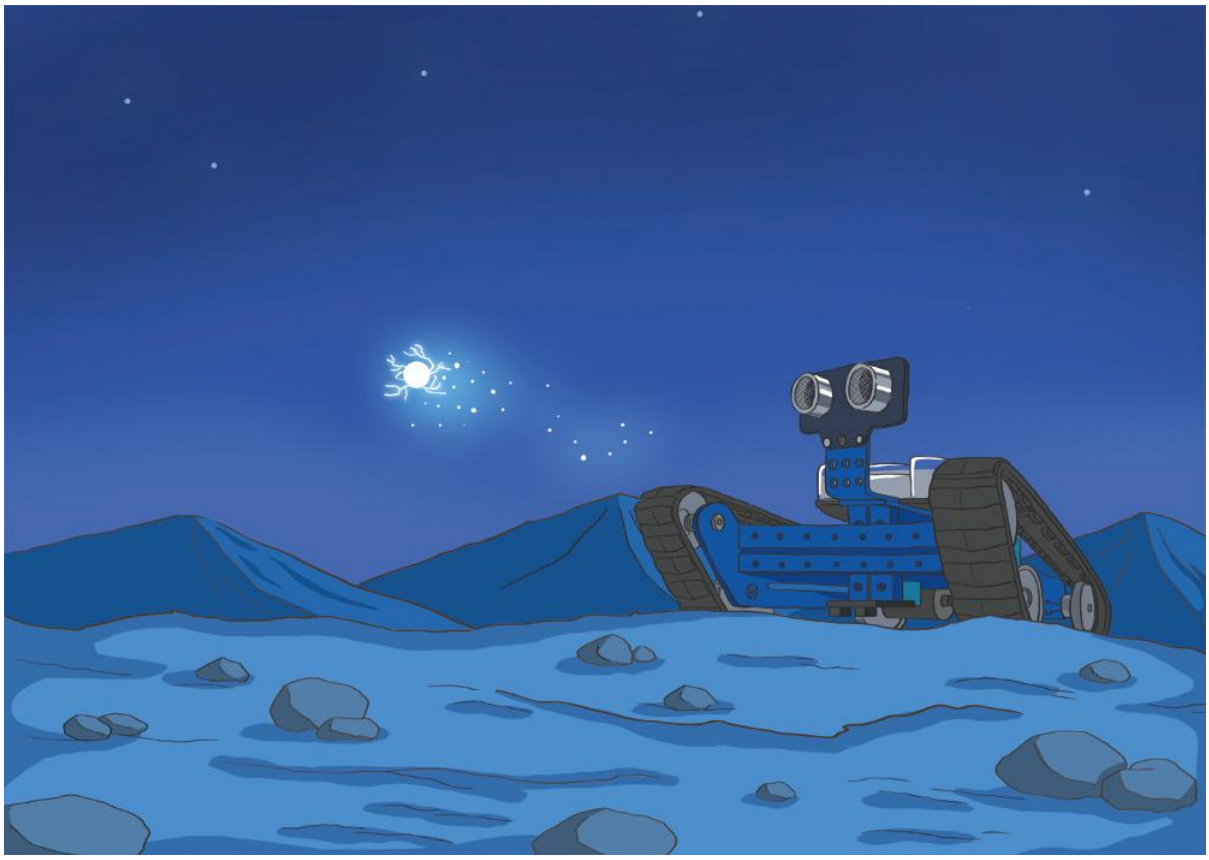
Guidance



"There has been no reply from the carrier, it’s supposed to be disturbed by radio wave," Mark says to himself.

"Captain, seemingly there is a fast-moving light spot outside," Peter stares at the screen, shouting.

Mark also sees the light spot in the darkness, but after taking a closer look, he finds it is a very unusual aerocraft with extremely strong light at its tail just like fireflies. The light goes from left to right, near and far, but does not stay too far. There seems to be something it waits for.

Mark is conscious that the aerocraft intends to follow them and turns to Peter. "Peter, open the light source detector and make its way forward."

"Yes, Sir!" Peter quickly adds the data of the light tracer to the navigation system and helps Ranger Tank to follow the guidance of the light and bravely move ahead in the darkness.

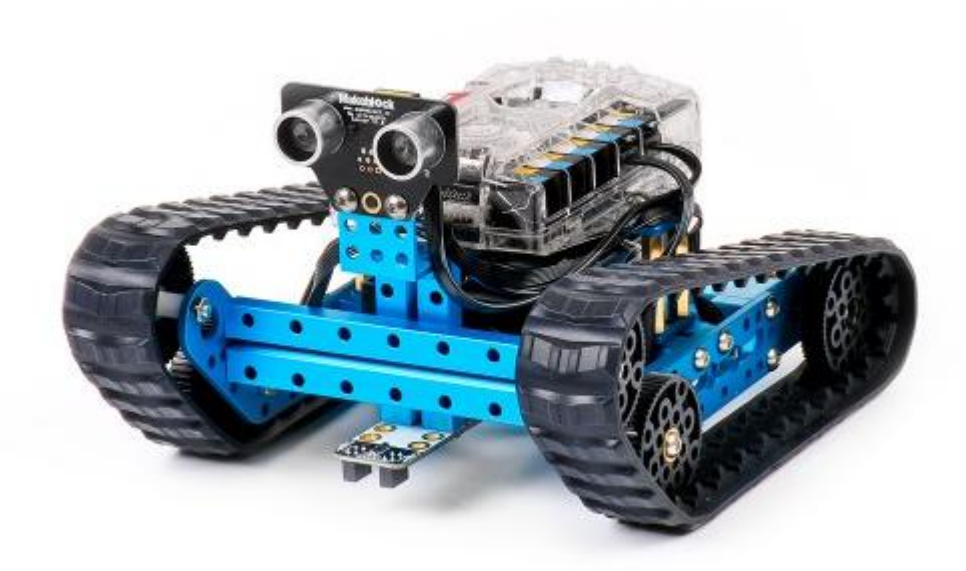
Learning Objectives

In this chapter we introduce the application of dual-light sensor—light following robot.
There are two onboard light sensors in Ranger. By utilizing the detection difference of light sensor, Ranger can identify where the light source is and then trace the light source to move on. We can take a flashlight in hand to guide Ranger to advance and make a turn, making it a light following robot.

Scientific Knowledge

Light Travels in a Straight Path

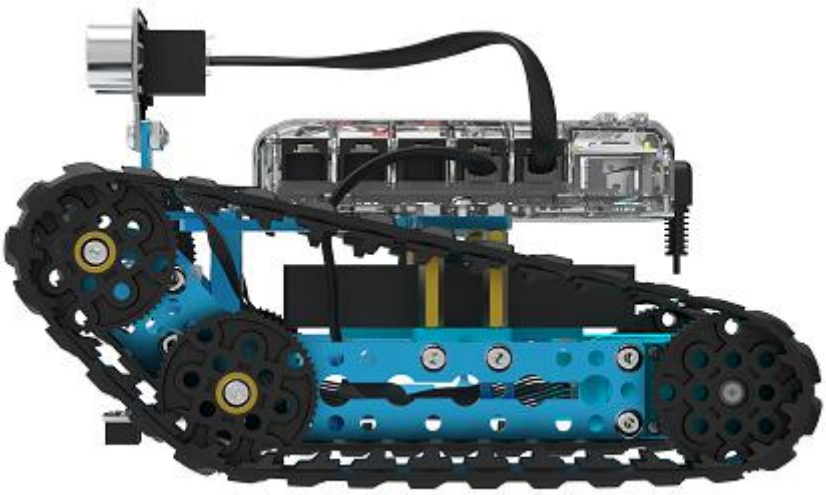
Light can travel through vacuum or homogeneous medium. As light encounters an opaque object that stops it, a shadow will be formed at the other side of the object. The shape of shadow is similar to the obstacle.



(A shadow of Ranger is formed under the light)

Assembly Preparation

In this chapter we use tracked robot



Learning Tasks

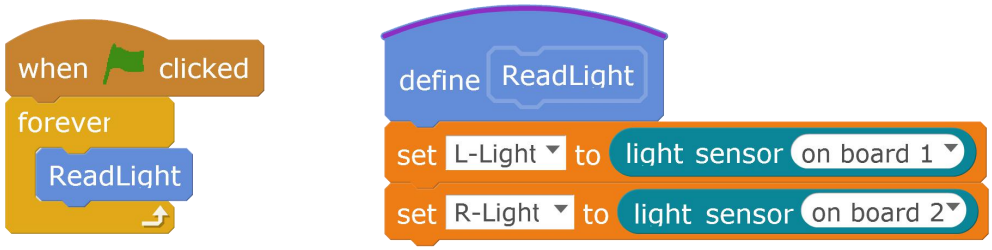
Task 1 – Read Values of Light Sensor

Ranger comes with two onboard light sensors with Light Sensor 1 located on the left and Light Sensor 2 on the right.

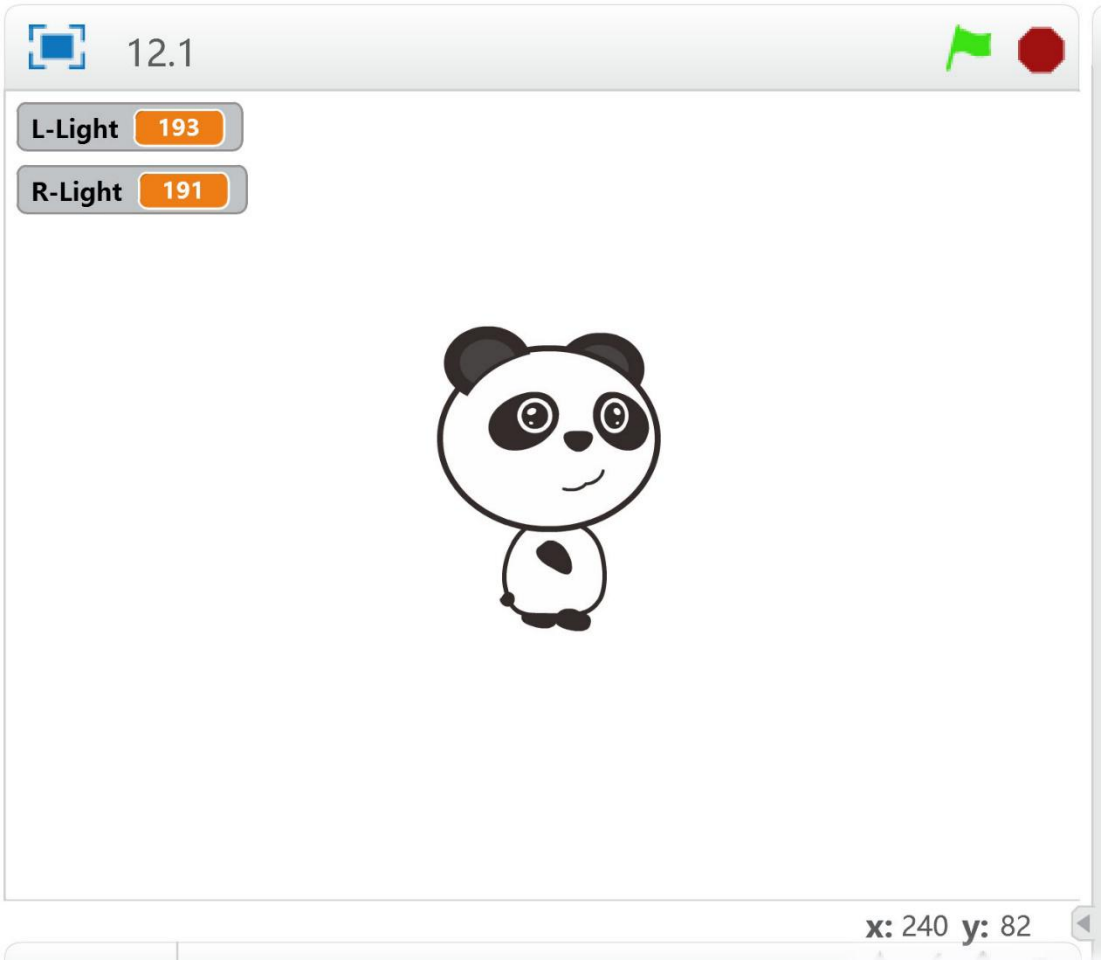
Similarly, we can clearly observe the numerical changes of light sensors from mBlock's stage on which the variables are displayed.

Please add two variables: L_Light and R_Light.
Then add a new block: ReadLight. The main task of the newly-added block is to set the variable value to the corresponding value of light sensor.

The program is as below:

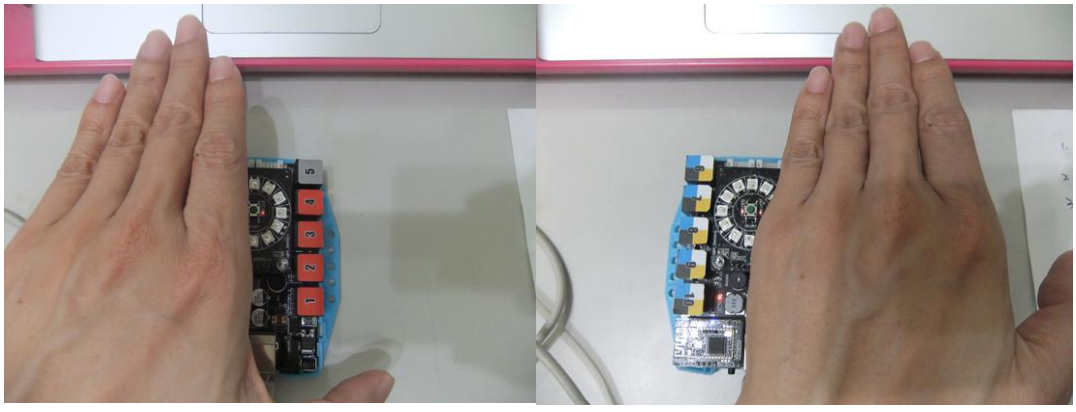


Please connect Ranger to the computer with USB cable to upgrade Ranger's firmware, and then click the green flag to start the program. The value of light sensor will keep bouncing. The increase or decrease in value of light sensor varies with the changing of ambient light. The brighter the environment is, the higher the value is, whereas the darker the environment is, the lower the value is.



Learning Task 2 – Turn Left or Turn Right?

When we cover the left light sensor (Light Sensor 1) with hand, the value of L_Light will decrease; on the contrary, when we cover the right half of Auriga, the right light sensor (Light Sensor 2) receives less light and then the value of the variable R-Light will decrease.



The data record is as shown in the following table:

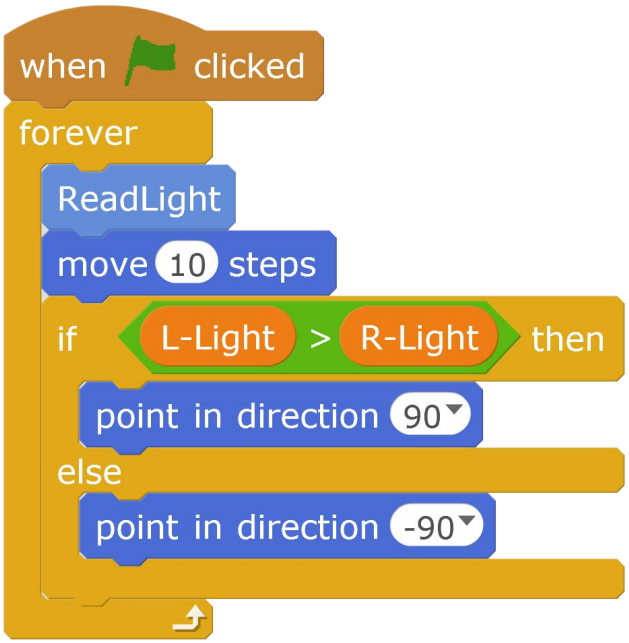
	L_Light (Sensor 1)	R_Light (Sensor 2)
Left half covered by hand	8	100
Right half covered by hand	103	6

We can utilize the numerical difference between the two light sensors to carry out some interesting activities, such as to control the panda to face the left or right.

Modification Procedures:

1. Add [Set the rotation mode to left-right] command, which restricts the panda icon to face the left (90 degree) or right (-90 degree) of the stage only.
2. Add [Move 10 steps] and then the panda advances towards the direction it faces.
3. Add [If...then...else] command:

If L_Light is larger than R_Light, it faces 90 degree (the right of the stage);
Or it faces -90 degree (the left of the stage).



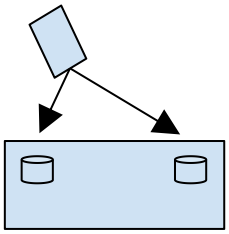
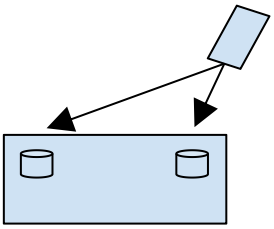
Have a try! When we cover the right half of Me Auriga with hand, the panda advances facing the right; and when we cover the left half of Me Auriga, the panda advances facing the left.

Target Tasks

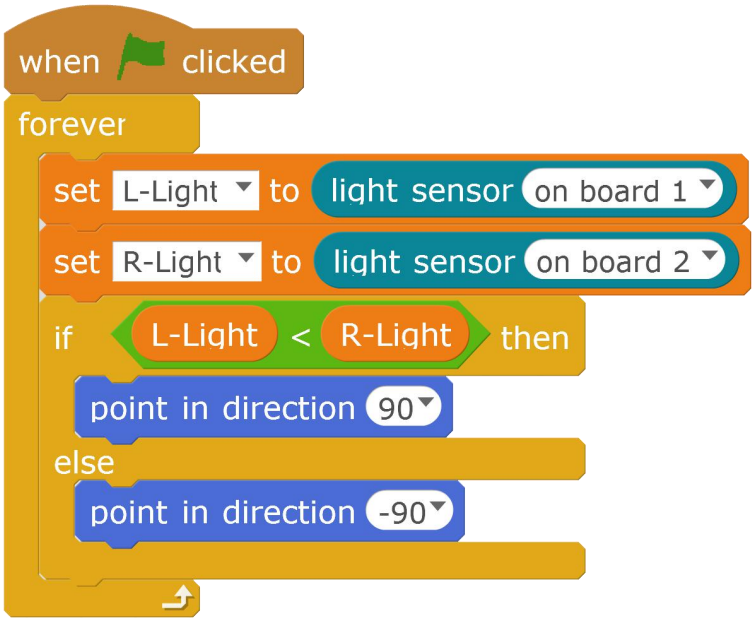
Target Task 1—Follow Light

Since that two light sensors can detect if our hand is put on the left or right, can Ranger robot automatically follow the light to make a turn? The answer is yes.

Let's make a simple test first. Put the flashlight on the left of Ranger and record the values of the two light sensors. Then put the flashlight on the right of Ranger and record the values of the two light sensors again.

	Light Sensor 1 Light Value (L-Light)	Light Sensor 2 Light Value (R-Light)	Diagram of Shining the Flashlight
Flashlight is on the left	150	82	
Flashlight is on the right	80	148	

Have you found that when we shine the flashlight to one side, the two light sensors have different values, of which the smaller one means the sensor is away from the flashlight and the larger one represent the sensor is close to the flashlight. Based on the inference, comparison of the values of light sensors determines if Ranger turns left or turns right as shown below:



Please connect the computer with Bluetooth to control the robot. Notice that the robot Ranger is put on a safe and open place in advance to prevent it from falling from the table.
Have you made it? Will your Ranger rotate with your flashlight?

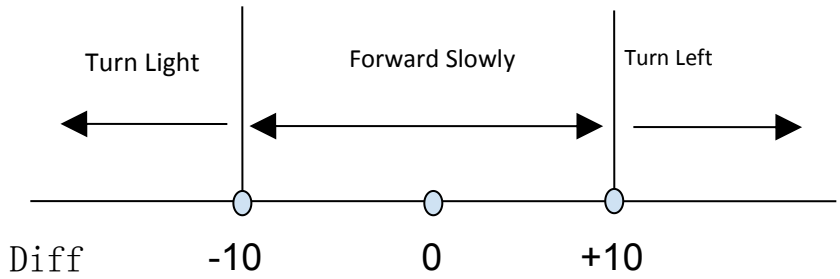
Target Task 2—Improve Light Following Robot

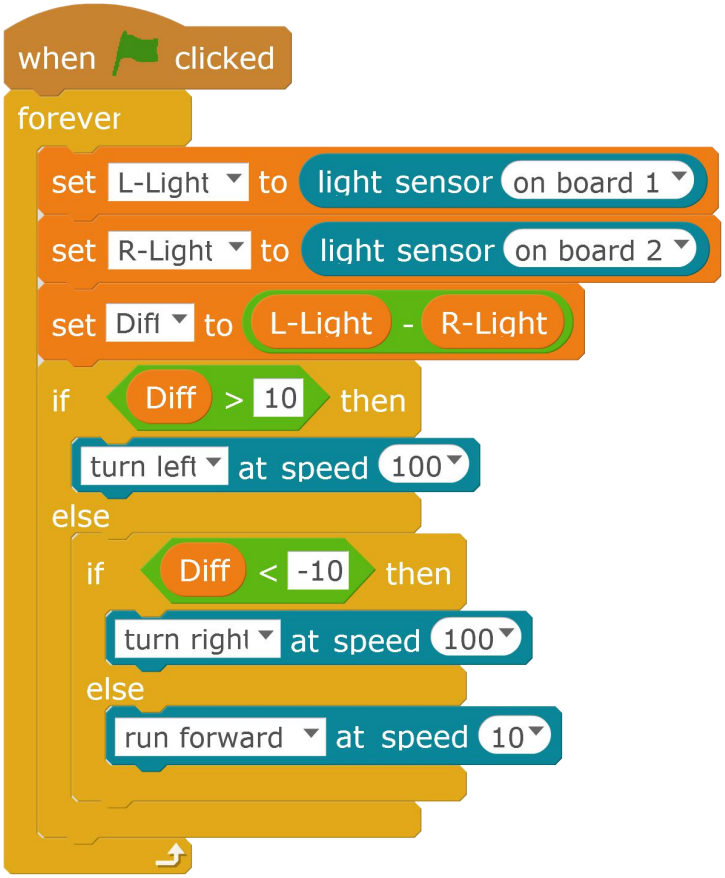
In Target 1, although the task of automatically following the light has been completed, Ranger can only spin on the spot. Also, due to a simpler operation for judgment and comparison, it seems that Ranger is too responsive and then jitters at any time.
Since there are some differences among the values read by light sensors, we switch to the numerical difference of the two light sensors that is used as judgment condition as shown in the following table:

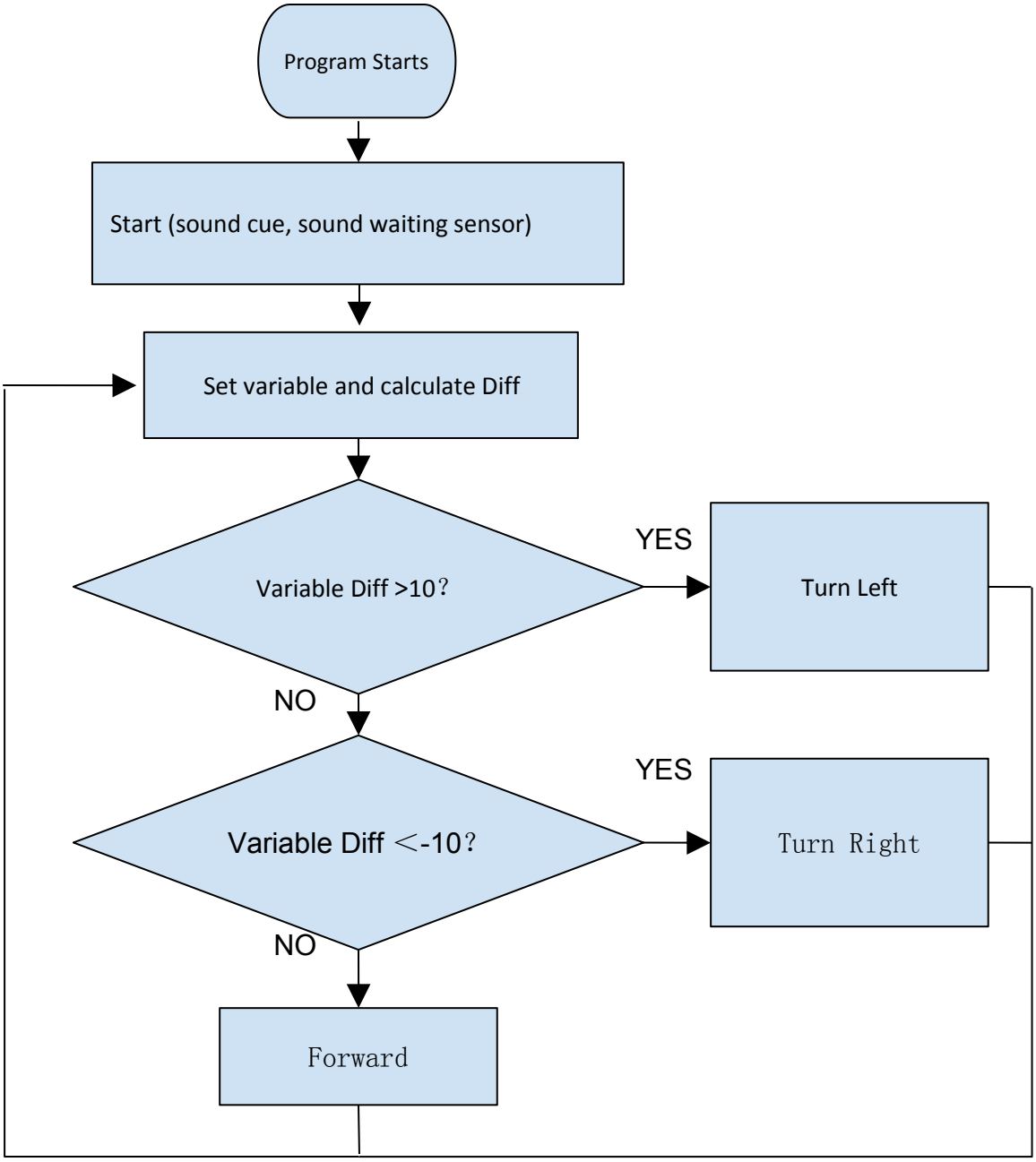
Situation	Light Sensor 1 Light Value	Light Sensor 2 Light Value	Difference in Values(L 1-L 2) Diff
Flashlight is on the left	150	80	70
Flashlight is in the middle	100	99	1
Flashlight is on the right	88	148	-60

According to the above table, we can obtain the conditions as below:

1. When the flashlight is put in the middle of the two light sensors, the difference in values read by the two light sensors is within a certain range (±10), which can be viewed as a small difference of light change. The robot keeps advancing slowly.
2. When the flashlight is put on the left of the two light sensors, the difference in values read by the two light sensors gets larger (>+10), which controls the robot to turn left.
3. When the flashlight is put on the right of the two light sensors, the difference in values read by the two light sensors gets larger (<-10), which controls the robot to turn right.







Connect the computer with Bluetooth to start the program and then the robot will turn with the light of flashlight. Put the flashlight right ahead of Ranger and the robot will advance slowly.

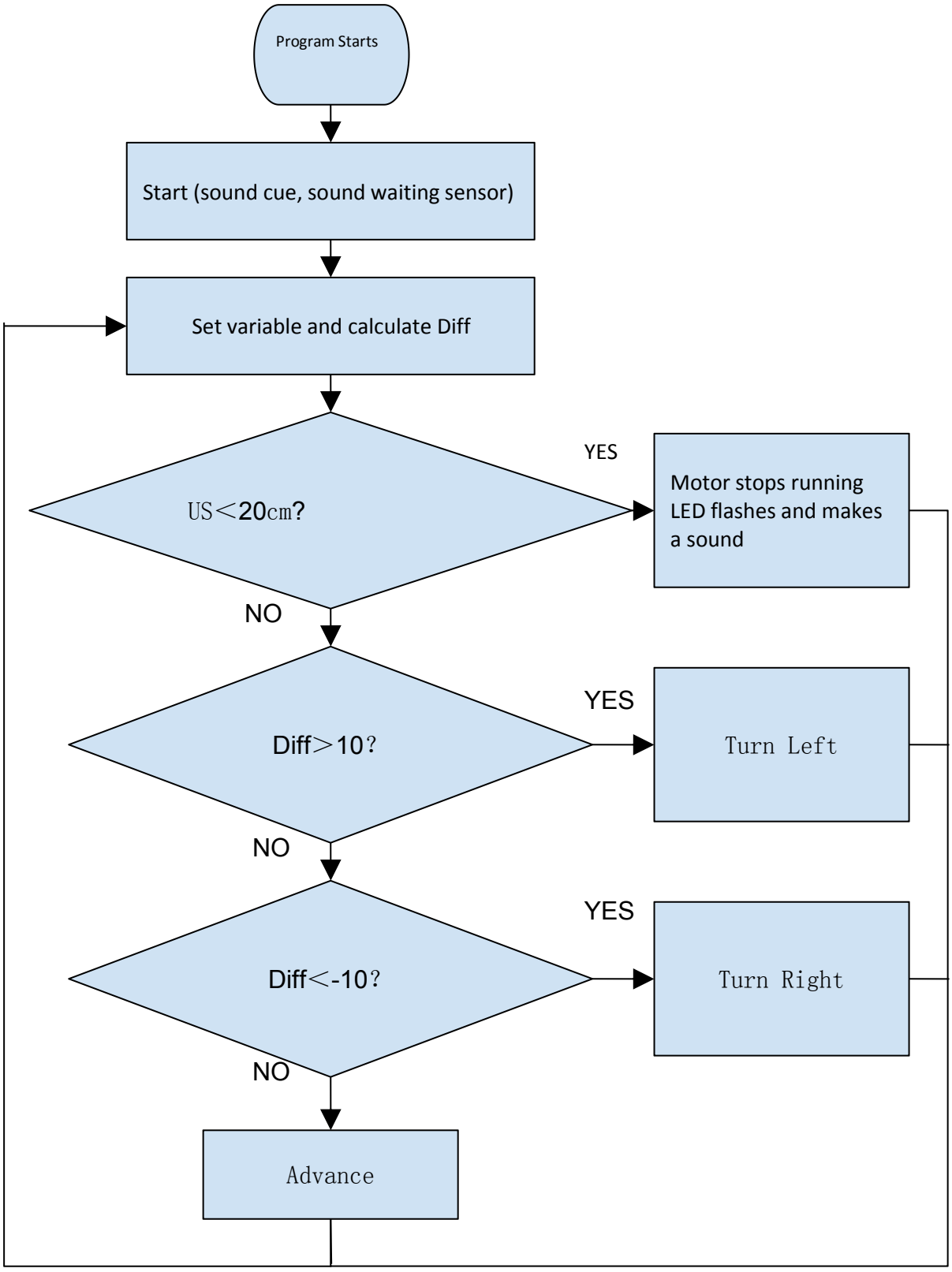
Please test the values of the two light sensors by yourself, and modify and adjust the range of +10 and -10 (increase or decrease), for the convenience of combining with the shining conditions of your flashlight to control your ranger to advance or make a turn by light.

The Challenge

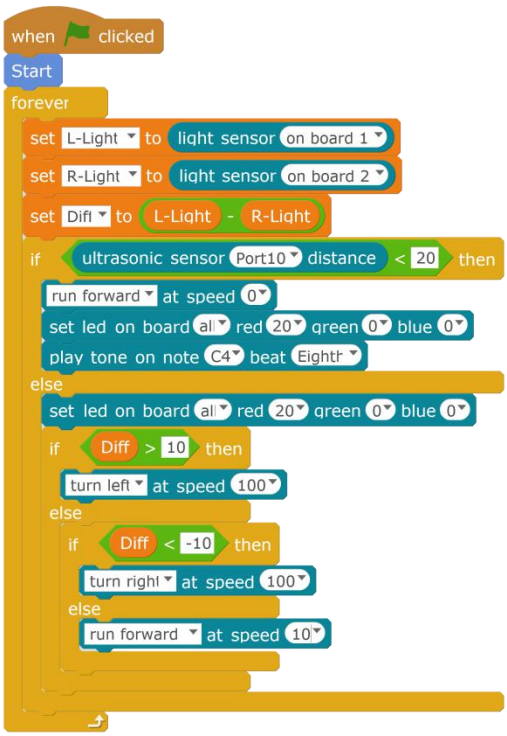
Challenge Task 1—Add Function of Avoiding Obstacles

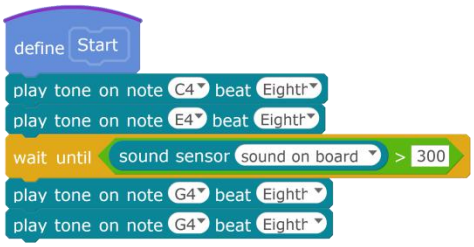
Although Ranger can automatically follow the light, it is still possible to encounter obstacles ahead. Find a way to utilize ultrasonic sensor to avoid obstacles. We can add a

[If ultrasonic sensor distance ＜ 20cm, then…else] to deal with the condition that Ranger encounters obstacles.
The program is as below:



Answers for Reference:

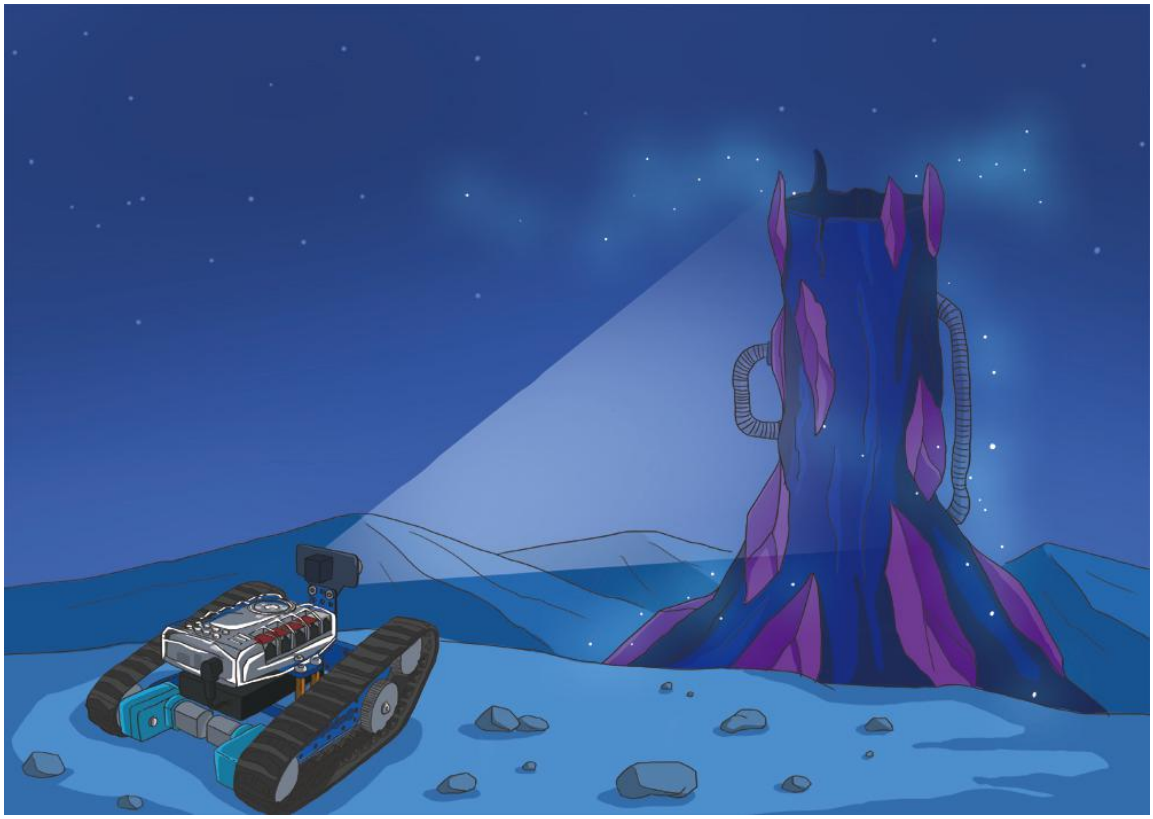




Have a try! Connect Ranger to the computer with USB cable and upload the program to Arduino to make Ranger start the program offline. Can it stop and make an alarm when it encounters obstacles?

Conclusion of This Chapter

In this chapter, we reviewed the value reading of light sensor and calculated the detection difference between two onboard light sensors in Ranger by means of a simple arithmetical operation to allow Ranger to identify where the light source is and follow the light source.



In the darkness, Ranger Tank runs quickly for more than ten minutes under the guidance of mysterious illuminant. Suddenly, the illuminant stops moving at a place not far ahead. As Ranger Tank approaches, the light disappears.

Peter opens the searchlight, and the scene ahead astonishes all the people.

"The protruding platform definitely was not formed naturally, but why such large artificial building relics appear here. So, are they made by the Martians?" says Dr. Qiu excitedly.