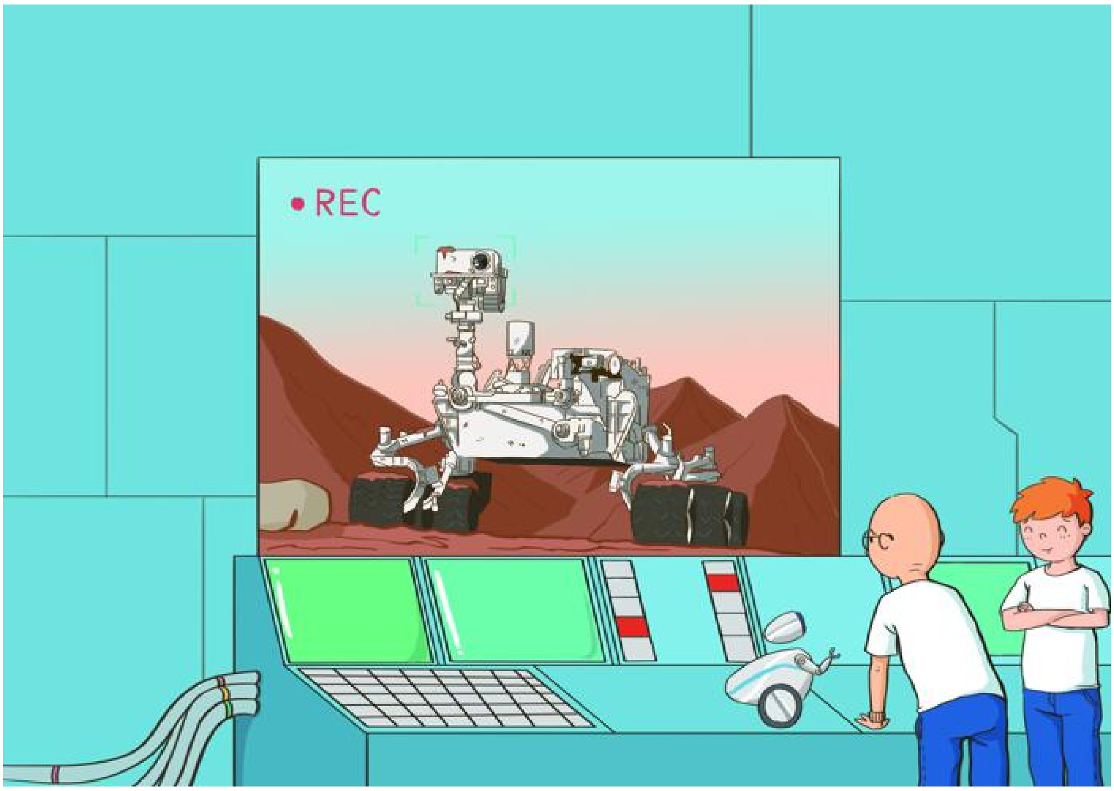
Tracking

A day earlier, the carrier arriving on Mars and entering into a synchronous orbit, immediately scanned the source of the signal as well as planned for its landing. However the image it sent back then did not make anyone feel excited…

“The probe, Curiosity, landed on Mars in 2012, the system malfunctioned in 2029, and all contact was lost.” Rex reported back on the results of the analysis.

“What! We spent so much time coming all the way here just to look at a faulty old machine?” Jennifer who was standing on the observatory, pointed emotionally to Curiosity on the screen and questioned loudly.



While everyone was debating, Mark sat aside thinking.

“Compare Curiosity’s original system design and its preloaded task content, and whether it includes the transmitted data received during this time.” Mark instructed Rex to search.

“Done. Curiosity’s current implementation of the signal launch task does not meet both the original system design and the mission planned." Rex reports back with the results of the analysis.

“This is exactly right!” Mark jumped up excitedly and said. “A machine whose signal has broken down for 69 years, has suddenly restarted and doing what it should not be doing, this should be the reason why we have come.”

Compared to the surrounding terrain, the landing area is relatively flat. However, the promise of large field of vision did not bring about anything they had hoped to appear. Even the source of the signal (Curiosity) is gone.

While everyone was staring nervously at the information transmitted back from the detector outside the cabin, the sharp Dr. Chiu immediately found an unnaturally formed platform made from stone. At the same time, the IR detector loaded on the Ranger Tank is scanning the remaining energy response on the side.

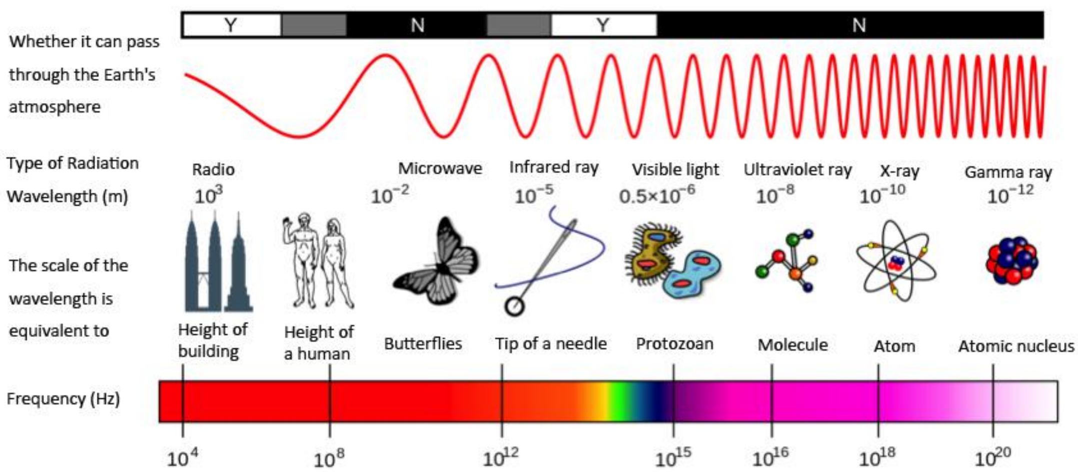
“This should be the trajectory of the infrared ray energy left by some sort of vehicle when it was traveling,” says Peter.

Learning Objectives

The most common method of maintaining a safe course of travelling on a given route is to establish a track, such as our commonly seen train or high-speed railway. In addition, there is also the technology of using special sensors to allow cars to move on tracks that have corresponding materials laid on it. E.g., magnetic induction unmanned vehicles using magnetic field lines, as well as IR line-follower vehicles, which can travel on either a white or black line track. These are automated equipment used in factories to solve manpower shortages.

Now, we will learn how to use the IR line-follower module to allow Ranger to keep advancing by maintaining it on the black track.

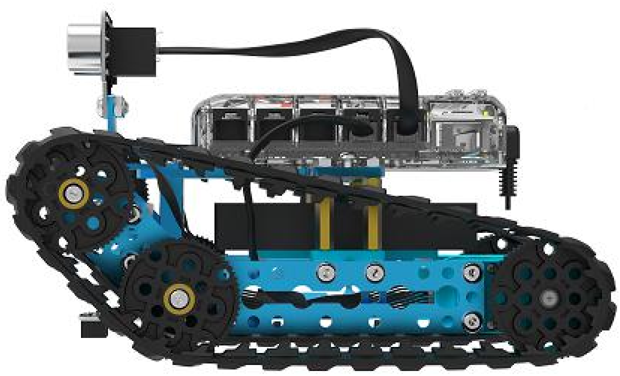
Scientific Knowledge



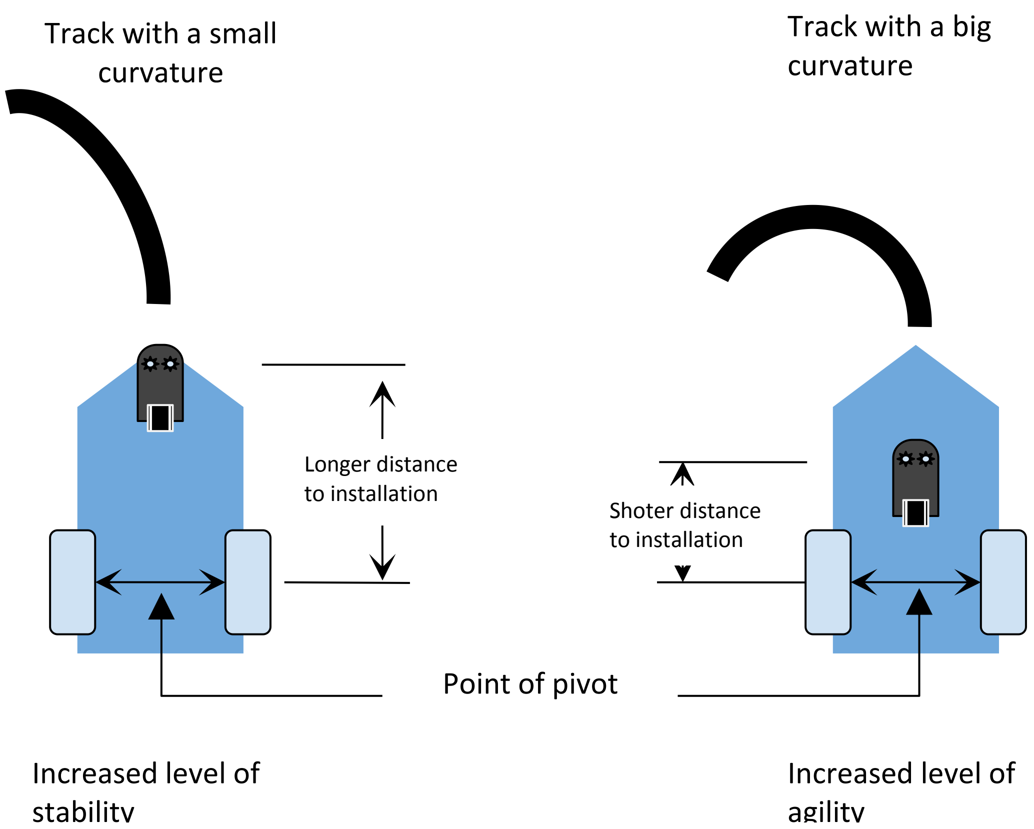
Light is an electromagnetic wave; the light that the human eye can see is known as visible light. The visible light emitted by the sun is red, orange, yellow, green, blue, indigo, purple when refracted by a prism. The wavelength of red light is the longest in the visible light. The human eye is not able to see infrared ray, which has an even longer wavelength than that of red light. But through the use of some electronic components, we can still detect the presence of infrared ray!

Assembly Preparation

We use the tracked vehicle for the line-follower task.



The position of the line-follower sensor being assembled will affect the ability of the robot to follow the track. Different track shapes will then require different installation positions in order for it to be most efficient.

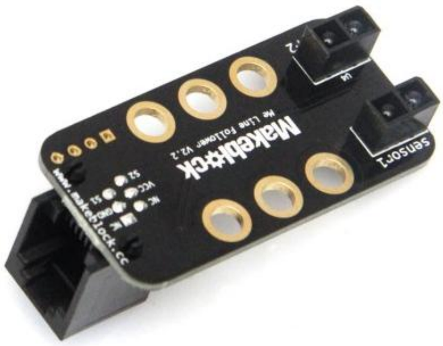


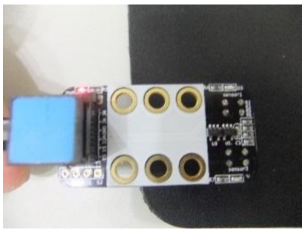
Learning Task

Learning Task 1-Introduction to Line-Follower Sensor

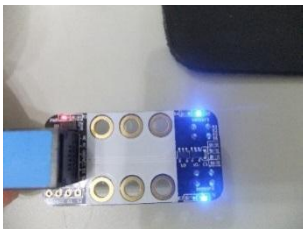
The line-follower sensor is composed mainly of two sets of IR transmitter and receiver (TCRT5000). At both sides, on the back of the module, there are corresponding blue LED lights. When the corresponding blue LED lights are illuminated, it indicates that there is an object reflecting infrared ray under the sensor (Eg: white or light-colored paper). When the blue LED lights are turned off, it indicates that the distance is too far or that there is an object absorbing the infrared ray under the sensor (Eg: black paper or black electrical tape).

The line-follower sensor has a better reaction on either a white or black surface. Please use a white paper and black electrical tape, as the effect is more obvious.

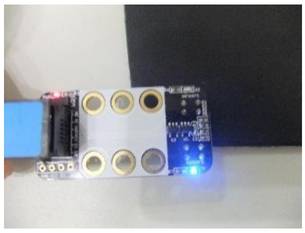




A． Both sides encountering black absorb infrared ray



B． Both sides encountering white reflect infrared ray



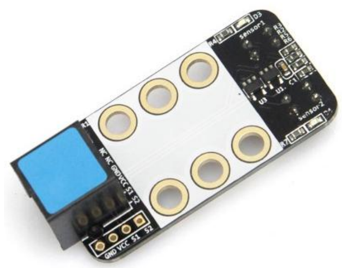
C． One side encountering black absorb infrared ray

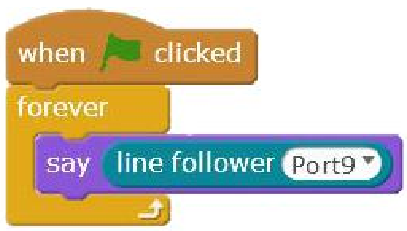
Learning Task 2 - Read the data of Line-follower sensor.

The connection port for the line-follower sensor is blue color coded, and can be connected to the Auriga main controller which has a blue targeted slot (6 ～10) using an RJ25 cable.

1. Write a program to have the panda continuously say out the status tracked by the line-follower sensor.

2. Do not forget to check the port number of the line-follower sensor.





Is your panda able to correctly state the value of the status?

The following table shows the value of the status returned by the line-follower sensor：

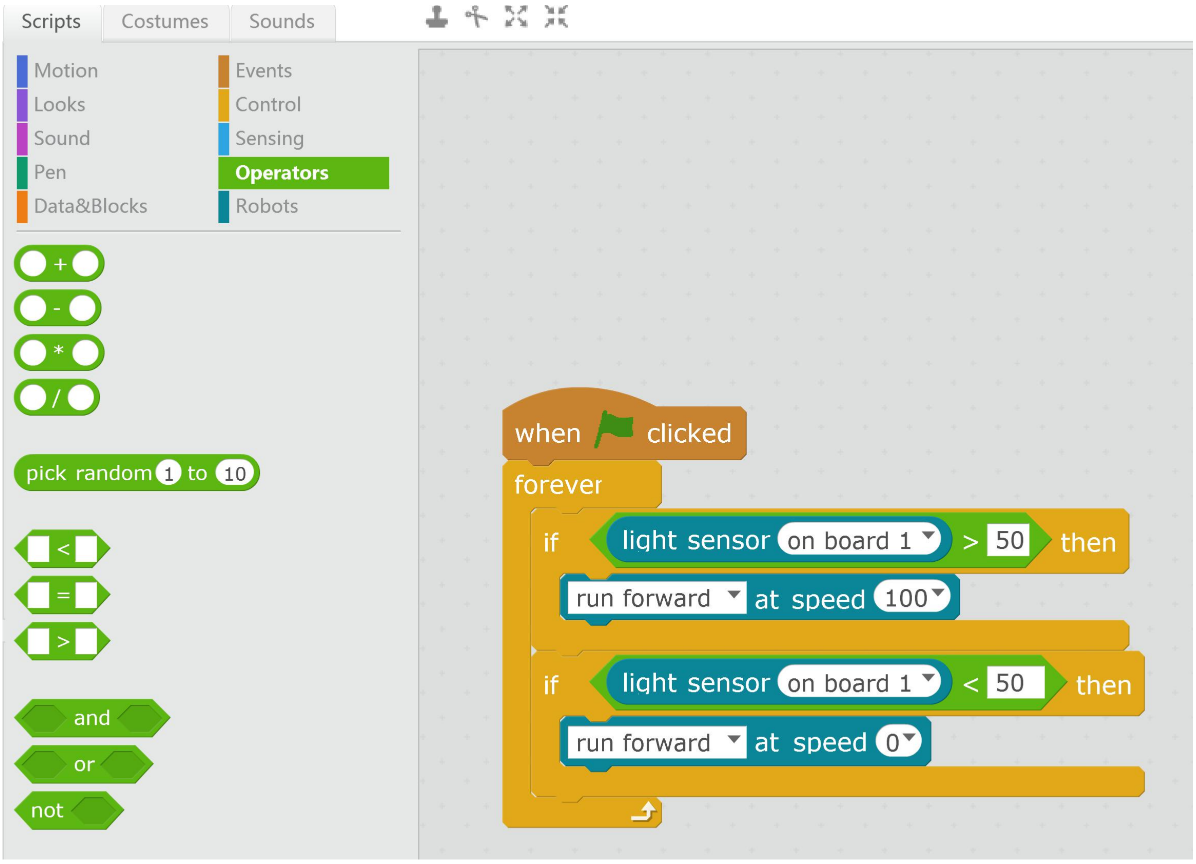
Left side sensor 1	**Right side sensor 2**	**Line-follower sensor value**
Black (non-reflective)	Black (non-reflective)	0
Black (non-reflective)	White (reflective)	1
White (reflective)	Black (non-reflective)	2
White (reflective)	White (reflective)	3

Learning Task 3 - Application of line-follower value

The return value of the line-follower sensor is expressed as 0, 1, 2, 3. We are able to know the detection status of the Ranger line-follower sensor by judging these four numbers.

Using the "if…" command is a good way to detect, if the condition requires using the "=" command of the "Operators".

Write a program whereby Ranger will automatically stop when it encounters a black line.



This procedure must be used during offline mode. Upload the program to the Auriga controller by connecting the USB so that the mbot Ranger has adequate reaction speed to the black line. Why is the reaction speed during (online mode) slower? Let's take a closer look ...

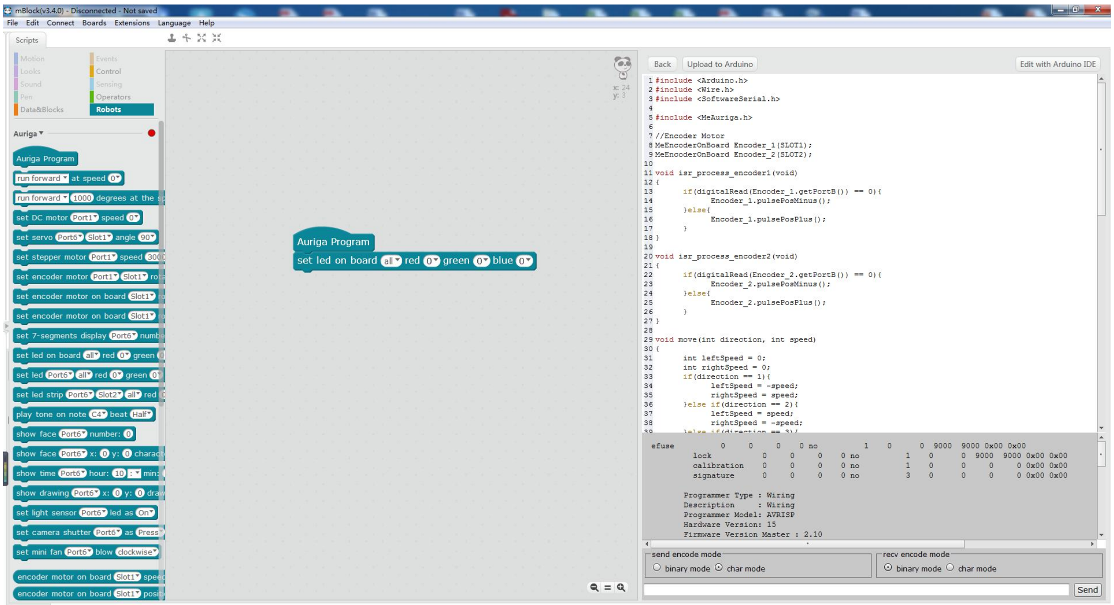
During online mode, Ranger collects data from the sensor. The data is combined into packets (note) after it goes through the controller's internal online software. After which they are transmitted to the computer through the USB cable, Bluetooth or 2.4G wireless module and other ways.

When the computer receives and opens the packets, it will use the data to make judgments. Finally, according to the determined results, the command code that controls the motor is made into a packet and sent back to Ranger through the original path. The controller then opens the packet of instructions, and commands the motor to make the corresponding corrective work.

From when the sensor detects derailment, until the motor receives the command to commence correcting the direction; through this way of control, the car will derail unless its speed is very slow. Therefore, we must use what we have learnt in Chapter 2 on (off-line mode); upload the program to the controller of the robot so that the function to swiftly detect and make corrective measures to the direction, can be fully utilized.

Review Challenge Three' s offline mode in Chapter 2!

(Note) Having more than one data combined together according to the established format, is referred to as data packets. In mBlock, we can observe the packet type in (upload to Arduino) mode.



In order to prevent the car from starting immediately after uploading and to activate the switch, we make use of the waiting command, whose value will become smaller, when the light sensor is being covered.

After the upload is complete, you can remove the USB cable connector from Ranger. Place Ranger properly and turn on its power switch. Start it by covering the light sensor with your hand, does your Ranger stop when it encounters a black line?

Great if you succeeded!

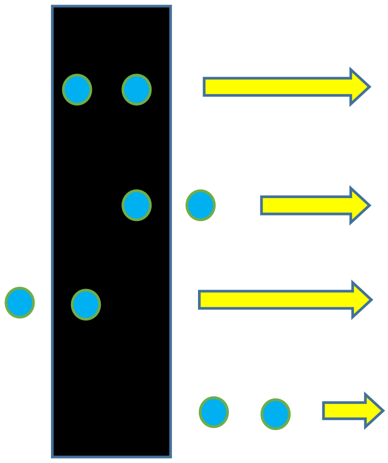
Next, you can change the program to have him stop after counting three lines?

Target Task

Target Task 1 – Follow the Trajectory

Let Ranger walk along the black trajectory. The ideal scenario is for the robot to advance when the line-follower sensor is on the black line; if the Ranger veers to the right, it needs to be corrected to move to the left(turns left); if the Ranger veers to the left, it needs to be corrected to move to the right (turns right).

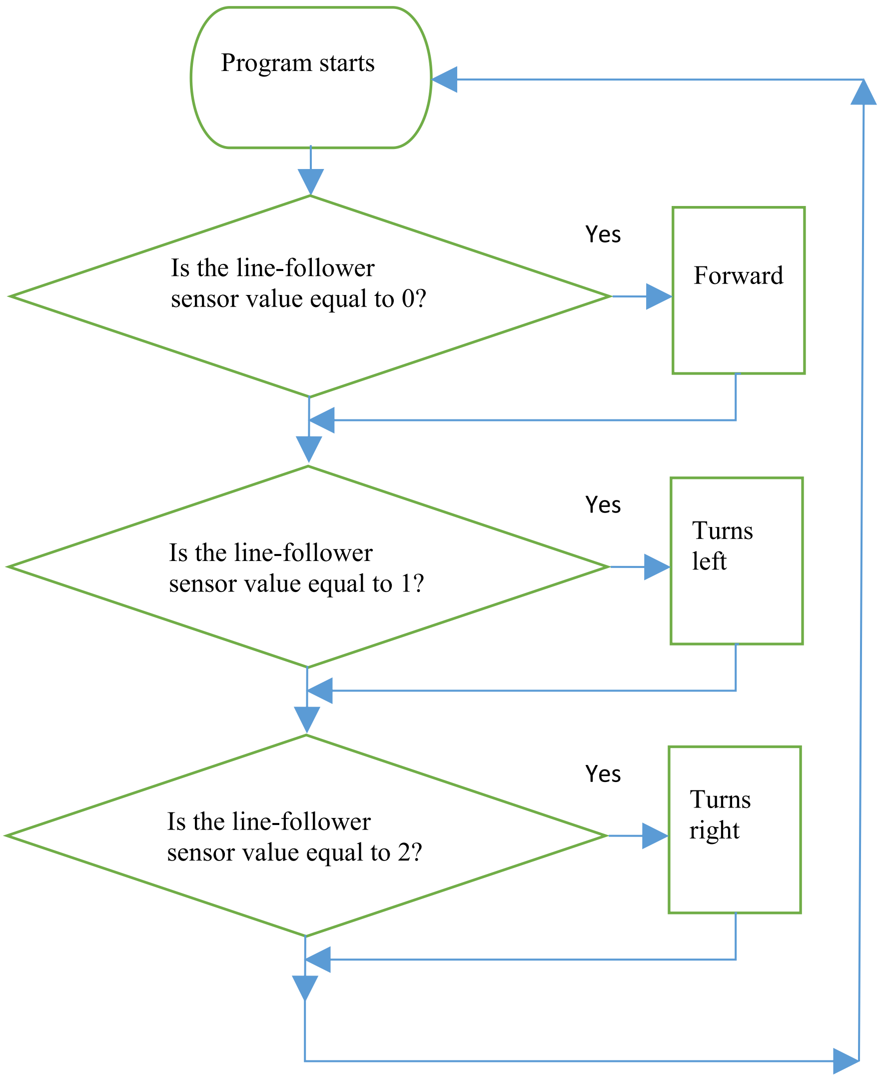
Black line

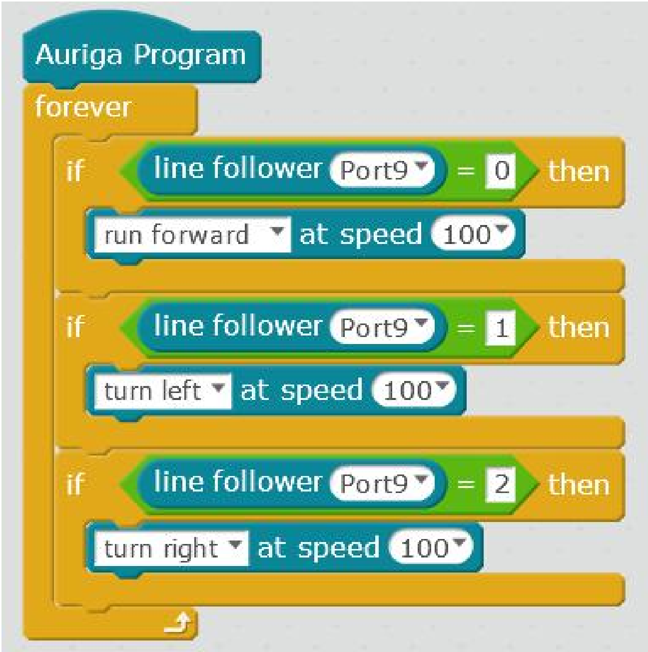


Left side sensor 1	Right side sensor 2	Line-follower sensor value
Black	Black	0
Black	White	1
White	Black	2
White	White	3

We can draw the program's flow chart as below:

Has your Ranger started following the trajectory?

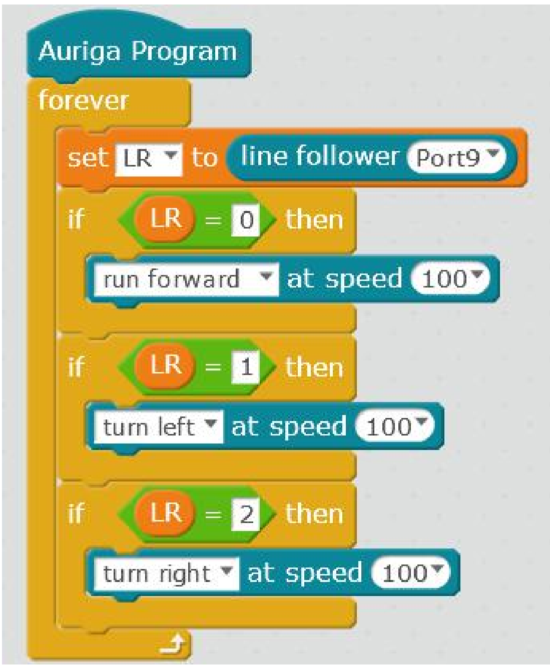




Using variables to speed up your program

In the microcomputer world, the calculation speed of the internal instruction when compared to the speed at which the data is read by the external sensor, is at least hundreds of times faster or even thousands of times and above.

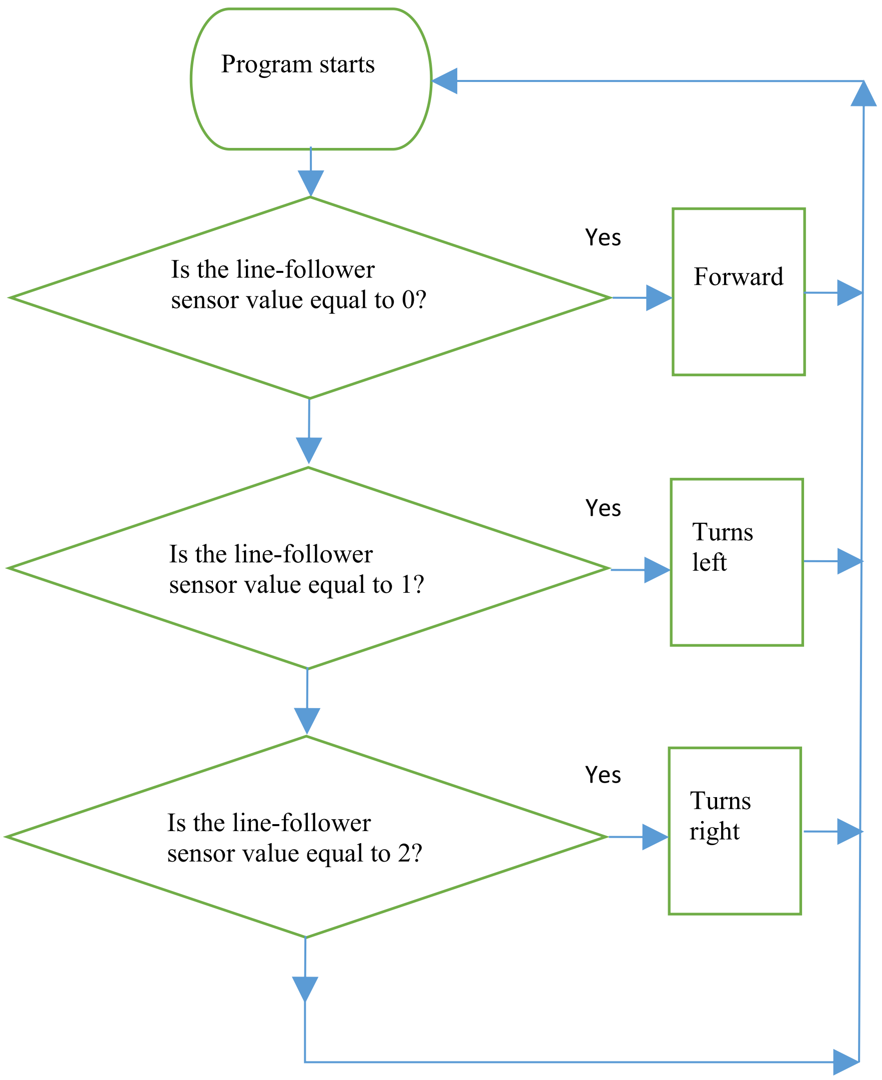
In the previous program, to determine the three different states of derailment, we read data that was collected by the line-follower sensor three times. Too much time is wasted that way. Thus we will use the variables to store the sensor's data before using the advantage of a fast execution of the internal instruction. This is faster in comparison to the state of derailment. A steering command is then issued. Through this way, it saves the time that would have been used to read the external sensor constantly.

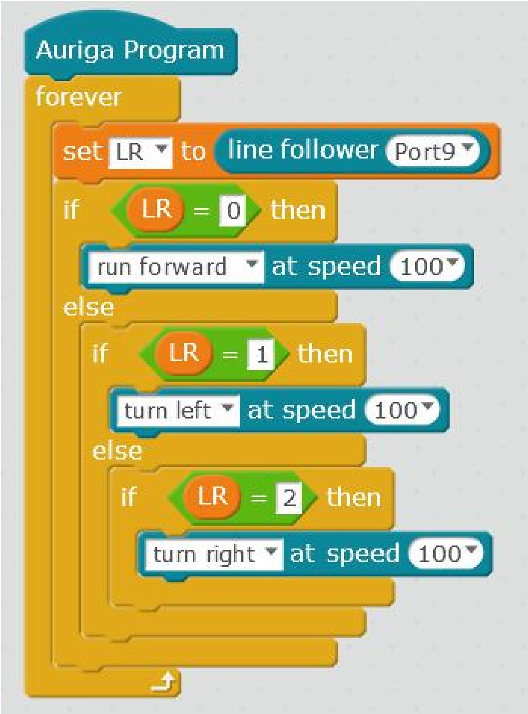


Can it be faster?

Of course it can because only one state will appear when you read the value of the sensor once. That is to say, it is redundant to execute two additional judgment commands.

For example: When LR = 0, Ranger gets a “Forward” command. Then when LR = 1 and LR = 2 is carried out in order to check, that is redundant. Therefore, in order to increase the efficiency of the program, we can use “if... then... otherwise...” to reduce the unnecessary judgment. As shown below:





Target Task 2 – Smooth sailing, no derailment

The Ranger robot moves along the trajectory and does not derail.

The mode of Ranger's instruction block to turn left and right, is one wheel rotating forward while the other reverses in position. Thus for the line-follower tasks in this chapter, the correction of direction is too fast, resulting in too much swing amplitude and making derailment easily. Thus we change the method of control; instructions for two different rotating speeds are released to both the left and right motor respectively. This reduces the (speed difference) between both wheels and as well as the swing amplitude. Ranger is then able to turn on the track smoothly.

(Speed difference) = Left wheel rotating speed - Right wheel rotating speed

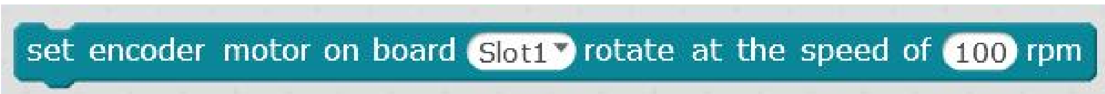
Advance speed difference = 100 – 100 = 0

Single wheel rotating speed difference = 100 - 0 = 100

In position rotating speed difference = 100 - (-100) = 200

Operation:

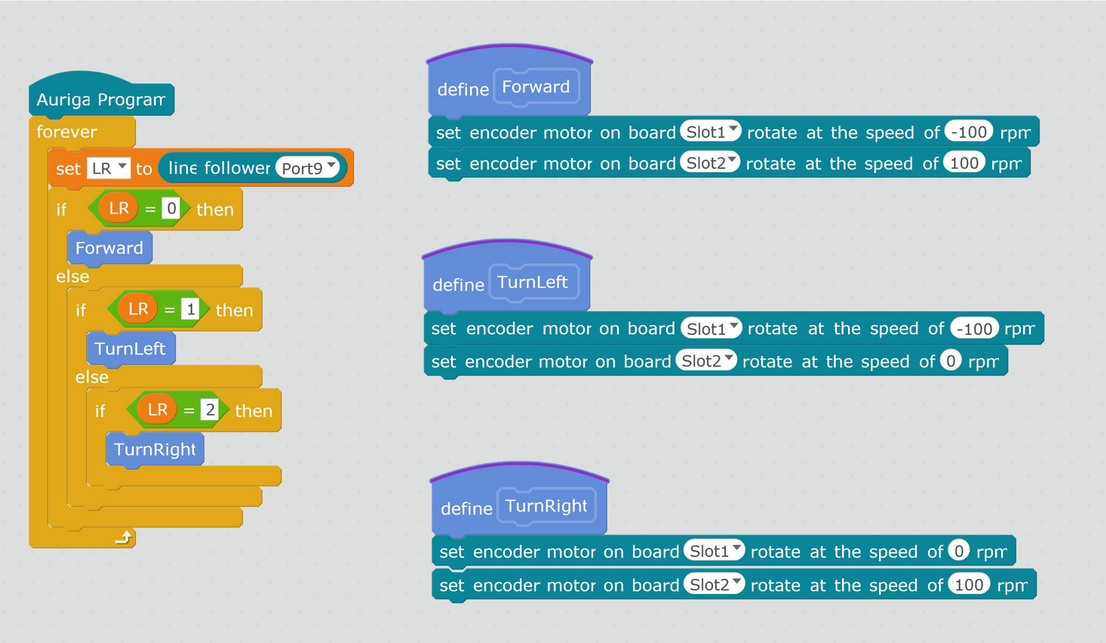
Modify the “turn left / right” command to “set encoder motor on board (slot 1/2) to speed (xx)” command instead. Respectively, control the rotation speed of the left and right motor to achieve the effect of different turns.



Ranger left encoder motor wiring is at M2(Slot2), the forward rotation speed is set to 100;

Ranger right encoder motor wiring is at M1(Slot1), the forward rotation speed is set to -100;

The program is shown below:



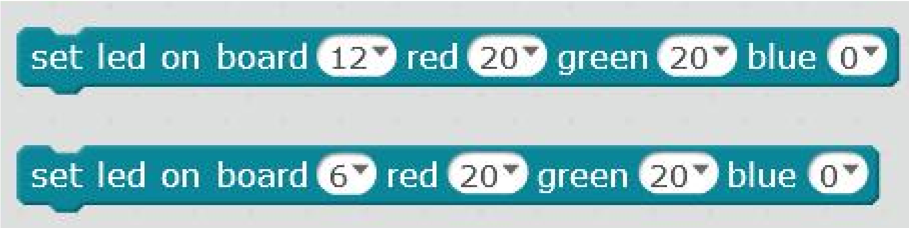
Please modify the rotation speed of each motor to adjust your Ranger turning. Do not derail!

The Challenge

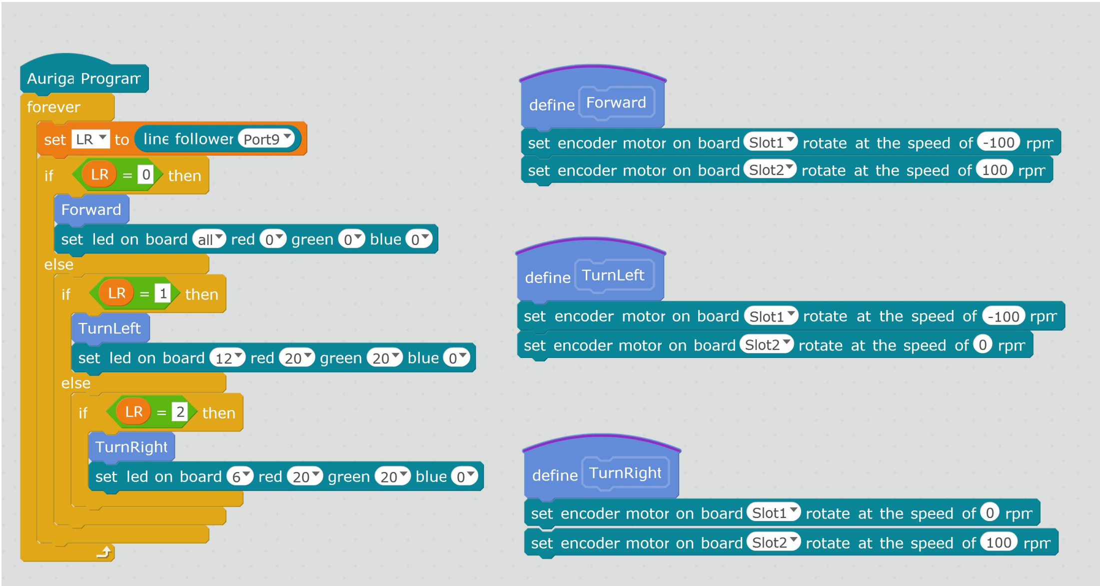
Challenge Task 1 – Direction lights

1. Please help add Ranger with direction lights, where the corresponding positions will light up when it turns.

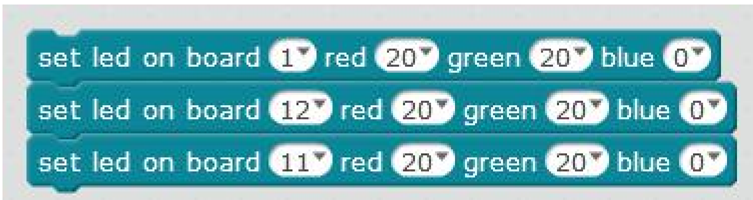
Facing the direction that Ranger advances, LED lights number 12 is on its left hand side, LED lights number 6 is on its right hand side.



Program reference:



As Ranger has a lot of LED lights, a few more can be lighted up. Such as number 1, 12, and 11 LED on the left side,



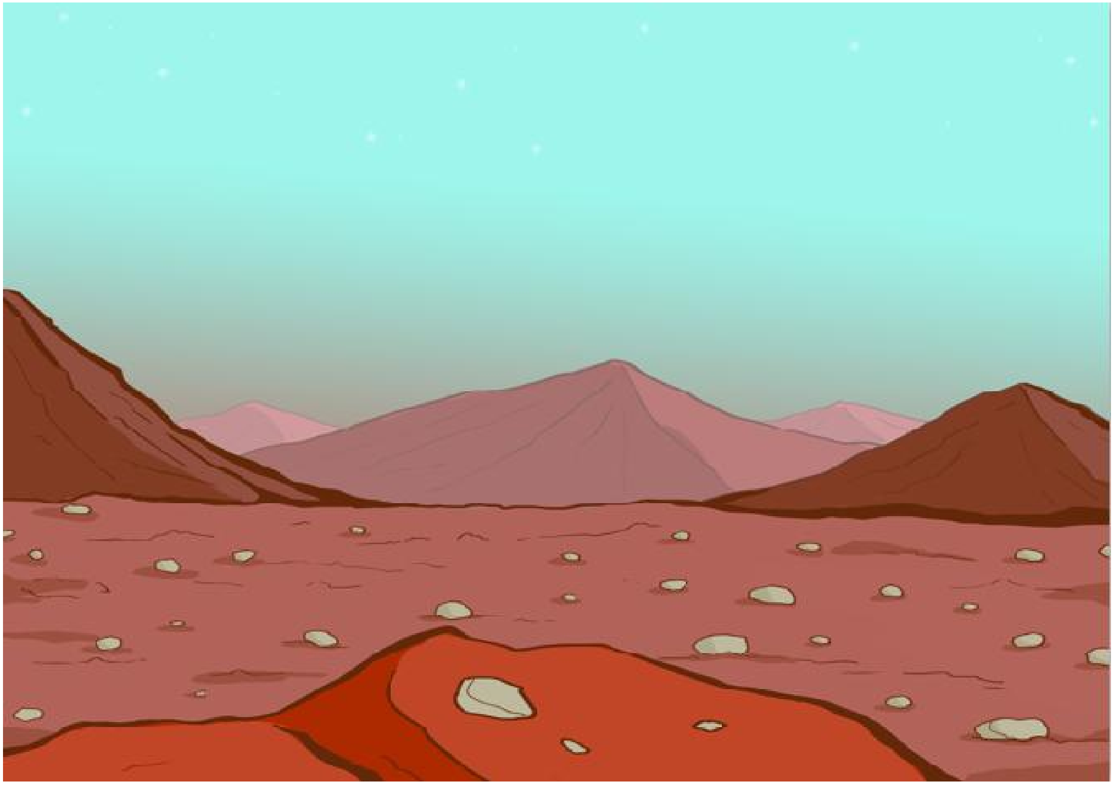
and number 5, 6 and 7 LED on the right side.

Choose a suitable light and help your Ranger have direction lights added on.

Conclusion of This Chapter

By constantly adjusting the way it turns, and changing both online and offline mode of operation, and after finding the most suitable data for the robot to operate, we found that the combination of sensors, coupled with the appropriate logical judgments of the program, the robot does not require too much man-made control towards the given task.

It also relatively enhances its ability to control itself.



What was (Curiosity) actually taken away by? And to where does the mysterious trail actually lead to? The entire team boarded Ranger Tank, and under the guidance of the infrared ray detector, has embarked on a journey of nearly a few hundred kilometers.

The monotonous scene of the desert along the way makes it hard to imagine that any higher organisms could be living in this region…