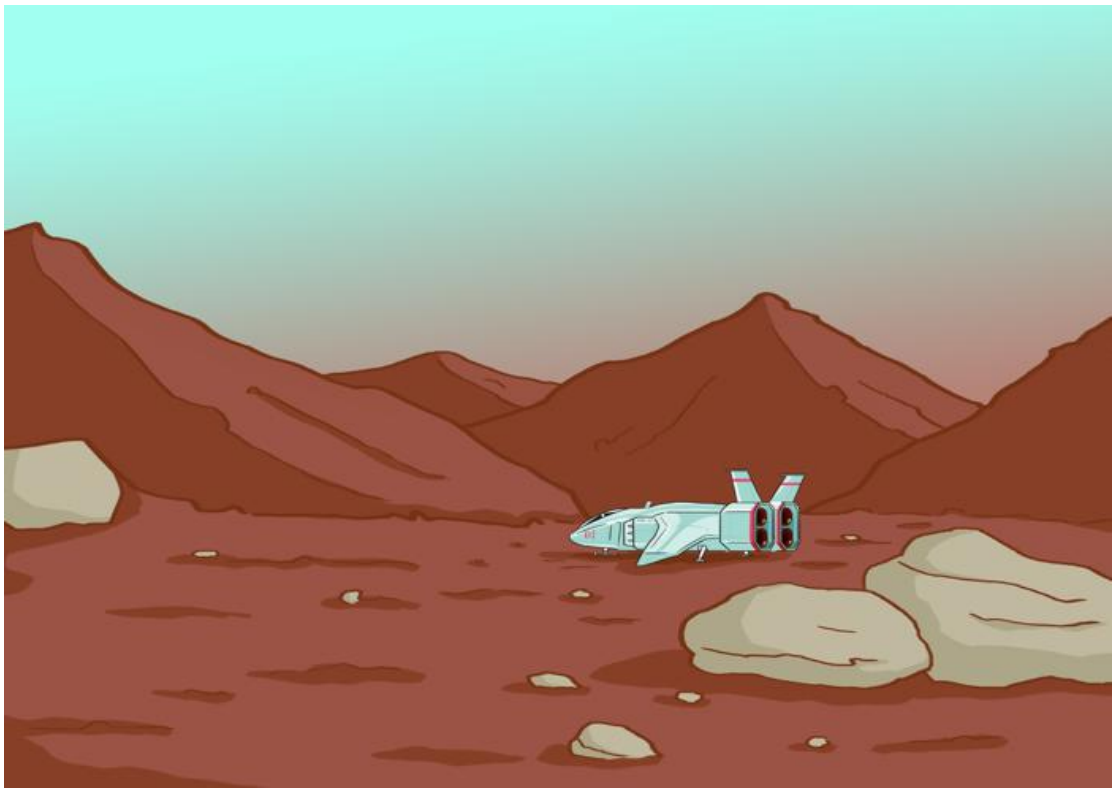
Challenge



If it weren't for being adequately prepared, it would have been difficult to visualize how to move forward in the current terrain. Apart from the small area that is relatively flat and where the spaceship lands, there are traces of weathering in the vast land of rocks, engraved with exaggerated lines.

"From the looks of these erosions, there should be regular occurrences of storms, and the intensity of the airflow is estimated to be at least twenty degrees above that of Earth's." Dr. Chiu who is operating the remote detector from the cabin, looks at the rock samples which was just collected, explaining the situation outside the cabin to everyone.

In the meantime, Mark and Peter are busy setting up the structure of the new Ranger; the huge track wheel stretches out from the side of the cabin, tightening the track after it expanded. In less than ten minutes, the strongest exploring mobile base from the surface of Mars – Land Raider, has completed what they have prepared for.

Learning Objectives

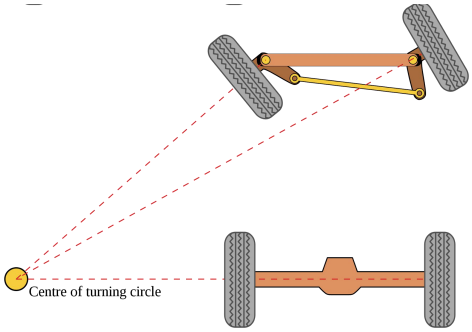
The design of mBot Ranger, because of the addition of an encoded motor control system, allows the movements of the robot to be more precise and predictable. The main content of this chapter is to familiarize you on how the use of an encoder motor, combined with instructions, can accomplish a more complex control of the robot.

Scientific knowledge

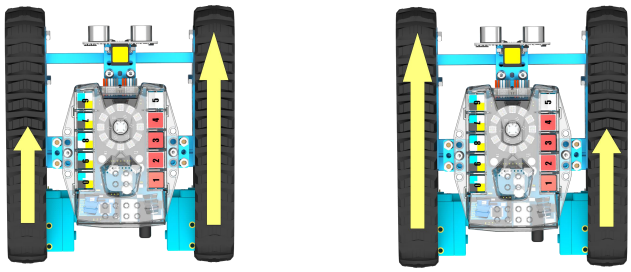
Wheeled steering control and differential speed steering control are two common ways of steering control used in cars. Wheeled steering control uses the deflection

angles of the wheels to change the direction of travel; whereas differential speed steering control uses the speed difference of both wheels to change the direction of the body.

Wheeled steering control

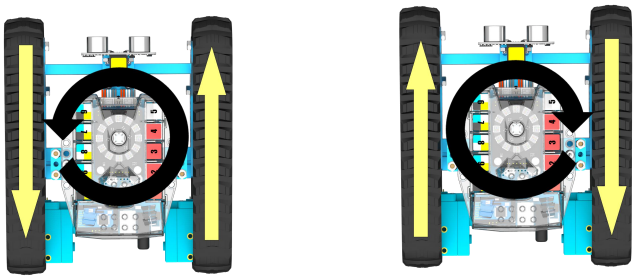


Differential speed steering control



When steering is the same

Left turn



Right turn

When steering is not the same

When the speed of the right wheel is greater than the left wheel --- turns left.
When the speed of the left wheel is greater than the right wheel --- turns right.

Assembly Preparation

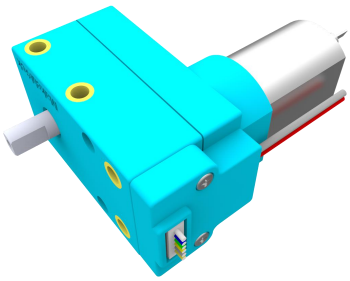
Using tracked vehicle mode

Learning Task

Learning Task 1 – Introduction to Encoder motor

Introduction to Encoder Motor

The encoder motor of the Ranger is a combination of motor, speed reducer gearbox and encoders. The speed reducer gearbox is responsible for the high-speed low-torque output, and through different sets of gear, converts into low-speed high-torque output. The total gear ratio of the Ranger Encoder Motor gearbox is 3: 140, which means that when the rotor rotates 3 times, the motor rotates 140 times and for every rotation of the motor, the encoder will output four pulses.



140 (circle) x 4(pulse) = 560 (pulse) ---- wheels turn three times

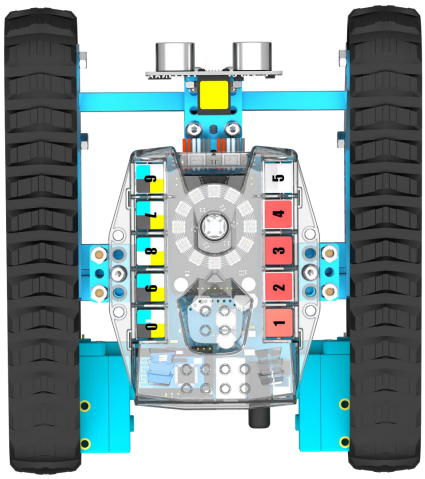
360 (degree) x 3 (circle) = 1080 (degree)

So for every unit set up, how many degrees will the wheel rotate? 1080/560 = 1.928 (degree)

What are the benefits of using an encoder motor? Through the encoder, you can control the motor to rotate to a specific location, and not be controlled by time and battery power. Thus the robot can move to a fixed distance, actualizing the accurate

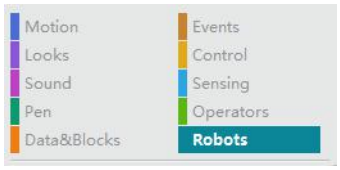
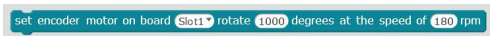
steering of the robot.

The Ranger has two encoder motors. When the Ranger Tank's ultrasonic sensor faces forward, when looking down from the top, the left encoder motor is connected to Slot2 and the right encoder motor is connected to Slot1.

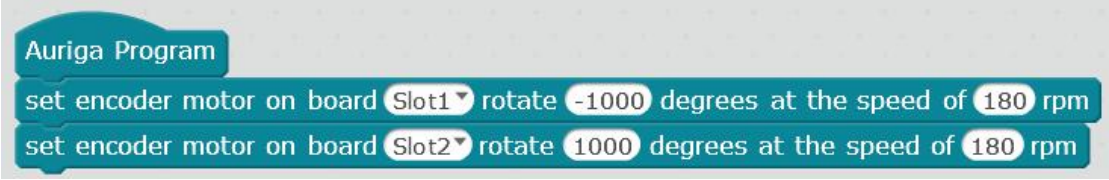


Learning Task 2 – Advance, retreat, left and right turns

Instructions for controlling the encoder motor.

<table>
<tr>
<td> 
</td>
<td> 
</td>
<td>Set the speed and angle of the encoder motor</td>
</tr>
<tr>
<td colspan="3">Function: Controls Ranger's encoder motor
[Slot1]: Selects the controller's code number of the encoder motor
[Speed]: Rotation speed of the encoder motor, ranging from 0-300, positive for forward, negative for reversal, 0 to stop the rotation.
[Degrees]: Sets the angle at which the encoder motor rotates, as indicated by [degree].</td>
</tr>
</table>

The Ranger is a two-motor vehicle with two motors running at the same speed, Slot1 sets at -1000 degrees, Slot2 sets at 1000 degrees, and the robot will then advance in a straight line.

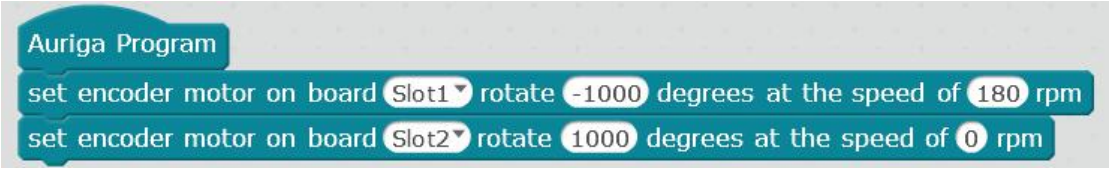


What about retreating in a straight line? Having Slot1 set at 1000 degrees and Slot2 set at -1000 degrees, the program is shown in the diagram below:

How to control Ranger to turn left?

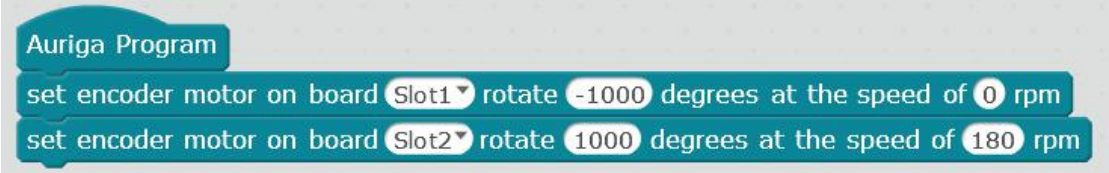
Place Ranger in front of you, the front of the vehicle (ultrasonic sensor) should be facing you, use your hand to turn the track on the right side of Ranger, can you see Ranger turning to the left?

Yes, just by turning the encoder motor on the right side (Slot1), the robot will turn and face left. The sequence to turn left is illustrated below:



Lastly, please think of how to write the program for turning right?

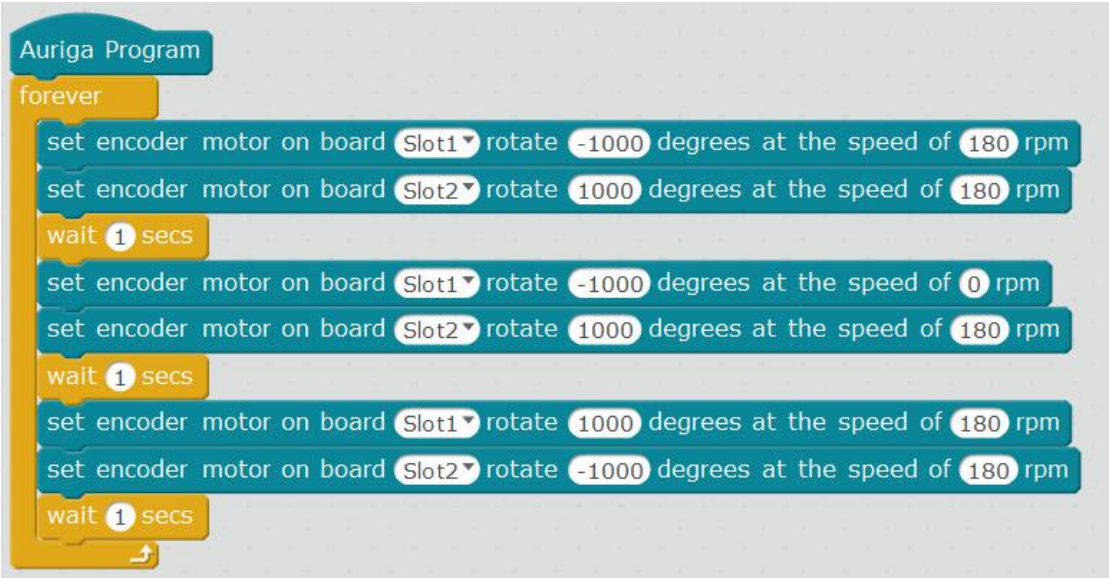
Reference answer:



Target Task

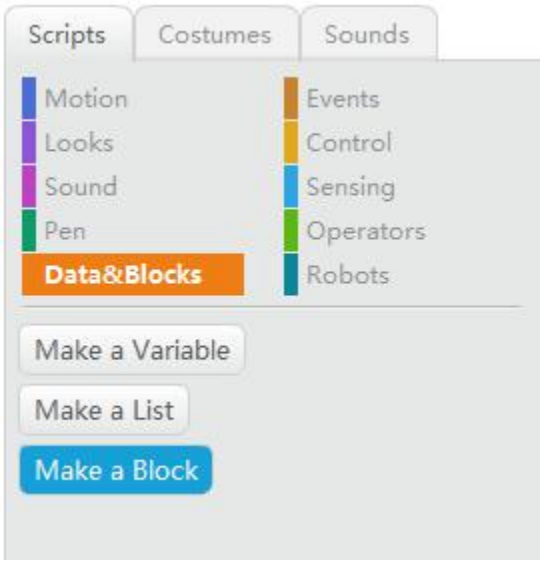
Target Task 1 – To pair a new block with encoder motor

To use the command [Set Encoder motor] to control Ranger, you would usually need to control two motors at the same time, which is to exercise two commands at the same time. Below is an example of the program for Ranger to walk. Allow Ranger to advance some distance, before turning right for some distance and lastly, retreat for some distance.



When you require more movements, the program then becomes relatively bigger and is not too easy to read. Is there a good way to make the program easier to read? Remember [Instructions to Adding Module] in Chapter 5? We can use this method to create your own blocks.

Click [Data & Blocks] --- [Make a Block]

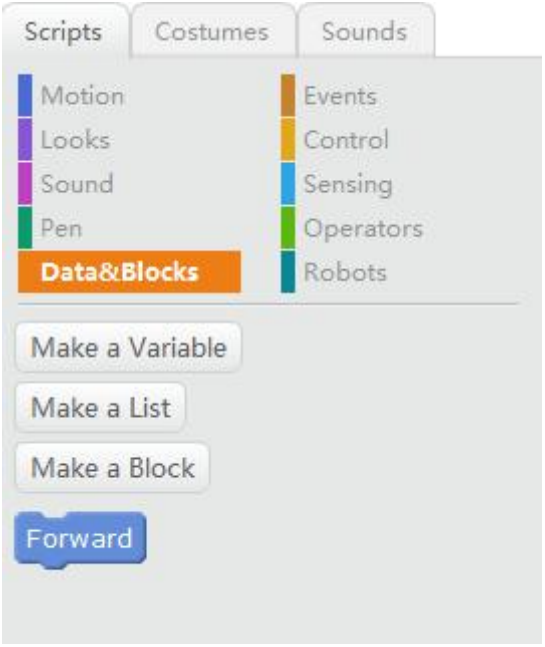


The window [New Block] appears.

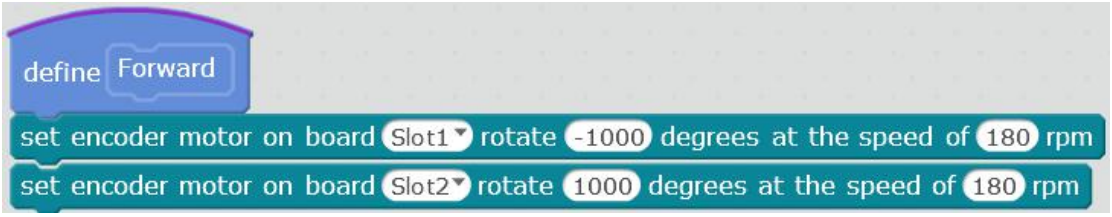
Click on the blue and purple area, and then enter the new instruction name, using English alphabets and numbers as the block name. The first letter has to be an English alphabet. It is strongly recommended to use a meaningful name so that there will be easy of viewing, and maintaining of the procedure in the future.

A case of [Forward] as an example,

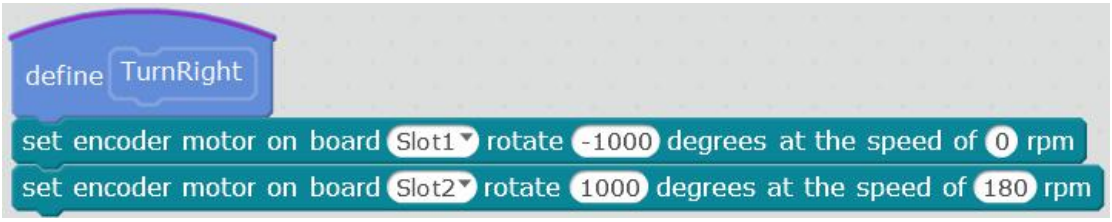
Press the confirm key, the block [Forward] will appear in the command area.

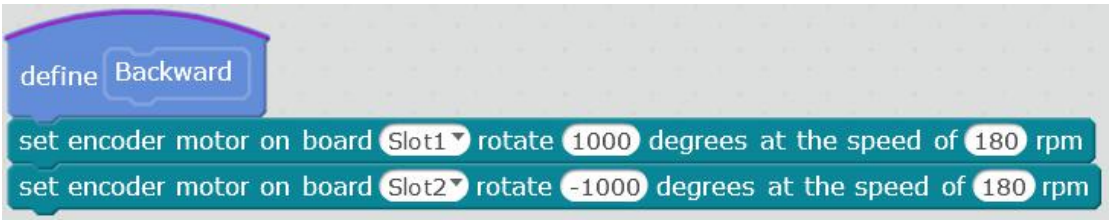


Drag the forward encoder motor related blocks under [Forward].

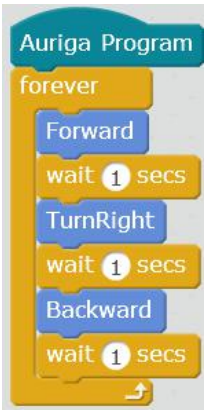


In the same way, create a [Backward] for retreating, and [TurnRight] turn left and other new blocks.

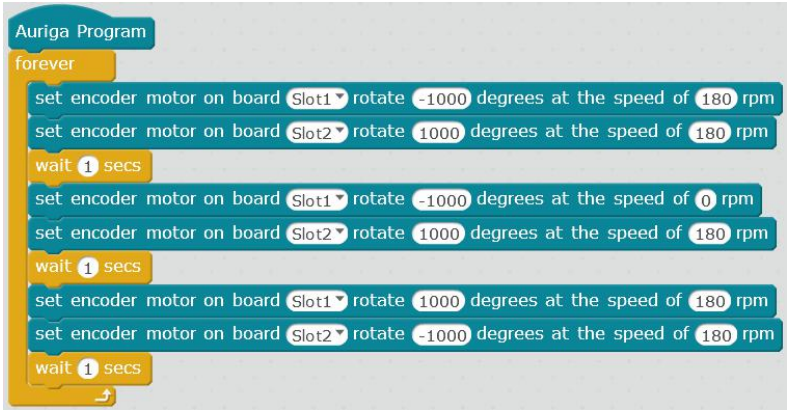




Using the function of [Make a Block], the walking program for the robot earlier can be like the diagram below, hasn't it become a lot neater:

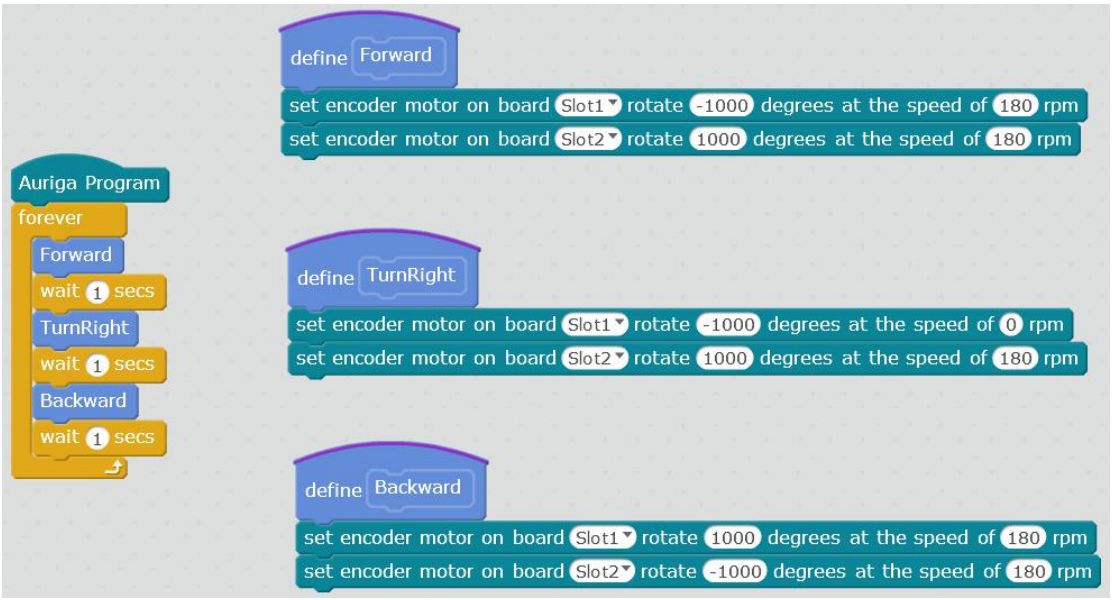


(An easy to read program)



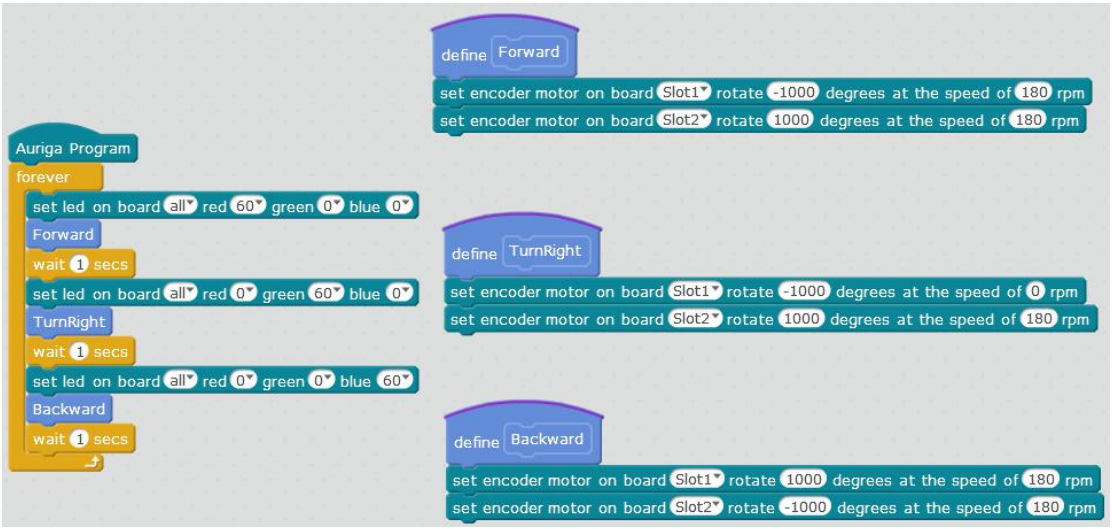
(The original program)

Another advantage of [Make a Block] is that it can be reused. When a segment of the program needs to be repeated, that segment can be made into a new instruction just by adding new blocks to it. An example of it is shown below:
If the main program requires Ranger to advance, you just need to drag the newly added [Forward] command.



When we want to make Ranger carry out more complex movements, with [Make a Block] command, the program now becomes simpler and tidy, making it very easy to read.

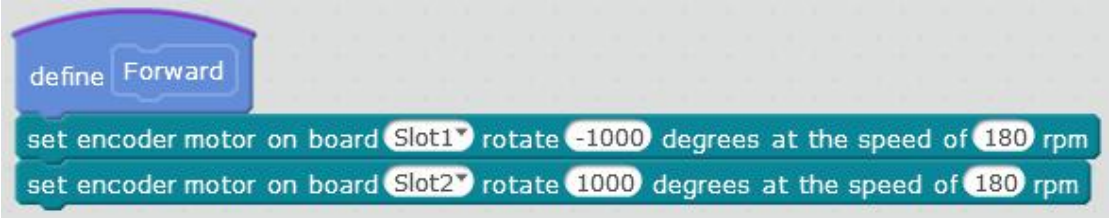
The following diagram is instructions for with LED lights. The robot emits red light as it moves forward, emits green light when turning right, and emits blue light when moving backwards.



Quickly create your own new instructions!

Target Task 2 — New blocks with parameters

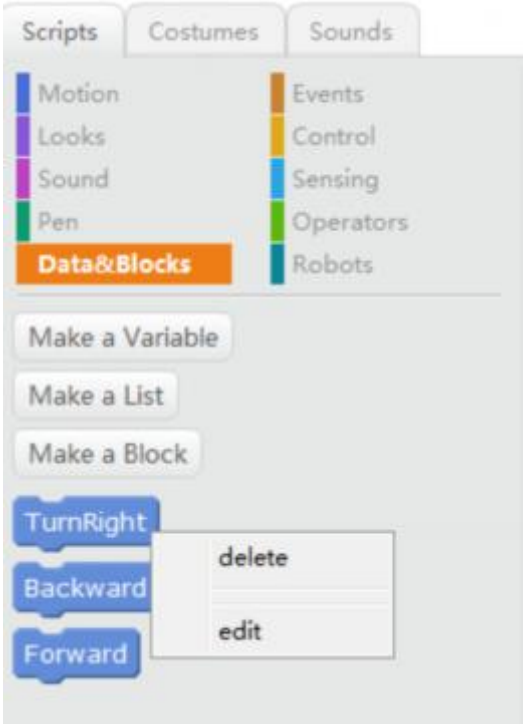
Adding a new instruction is like concentrating a fruit juice, placing the segment of the program in a block, and just by commanding the new instruction, you can execute the entire segment of the program.
But the segment of the program has been set parameters already, the following [Forward] is an example,



The speed has been set at 180, so when we use the Forward command, Ranger can only go forward at the fixed speed of 180. If you want to change the speed, you may need to use another new block.

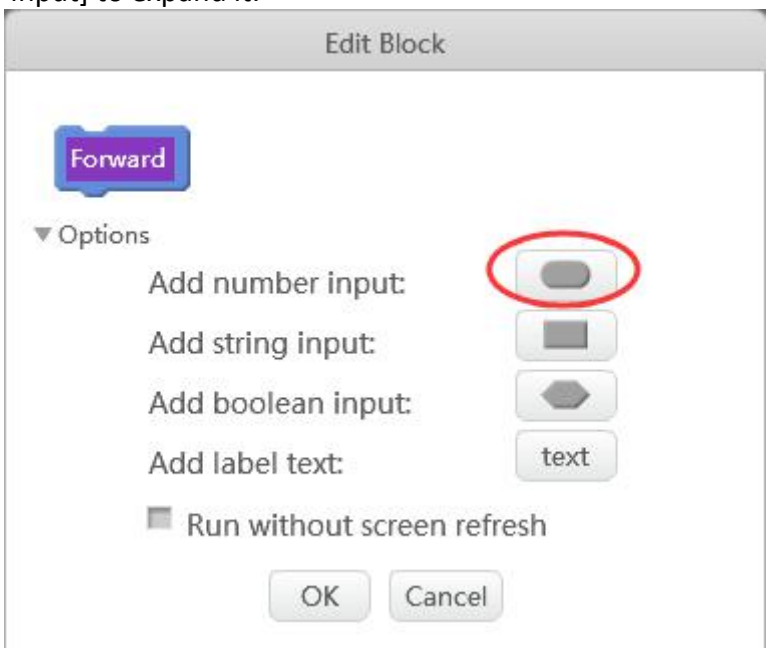
In fact there are also other ways, we can use the concept of variable to help our new instructions become more flexible and more convenient to use. We now use the method of adding new instruction parameters. Please follow the steps below:

1. Right-click the Forward module command and select [Edit].

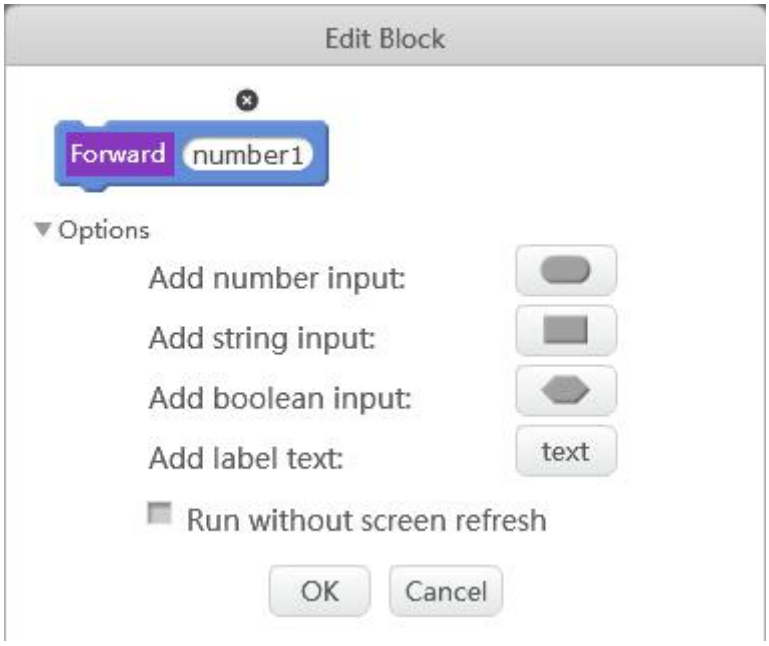


2. Click [Option]

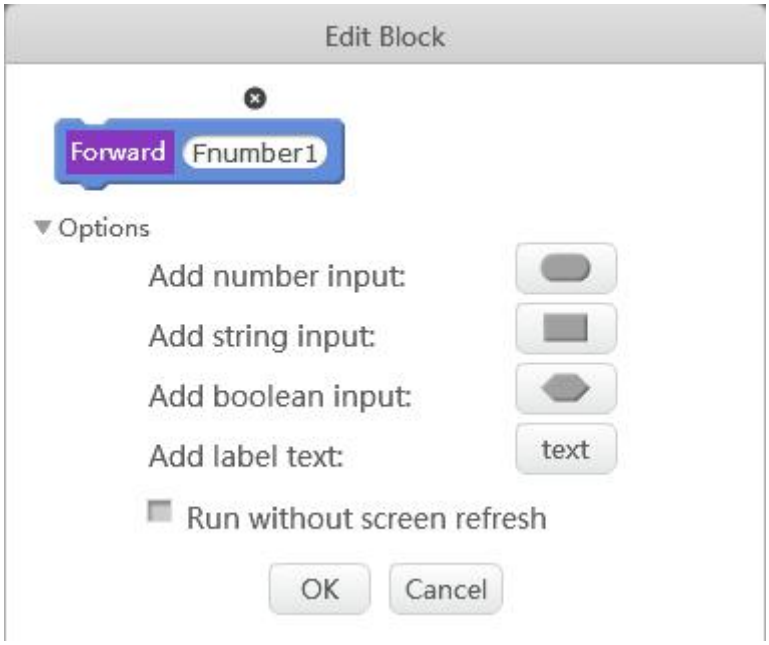
3. The window will open displaying some items, please click on the gray circle icon [Add number input] to expand it.



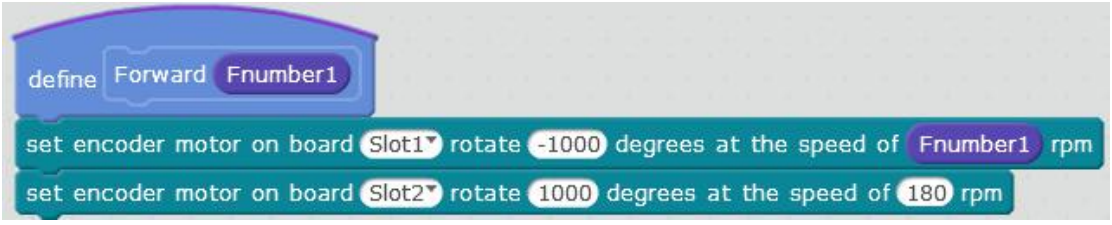
4. Notice that there will be a [number 1] grid next to Forward.



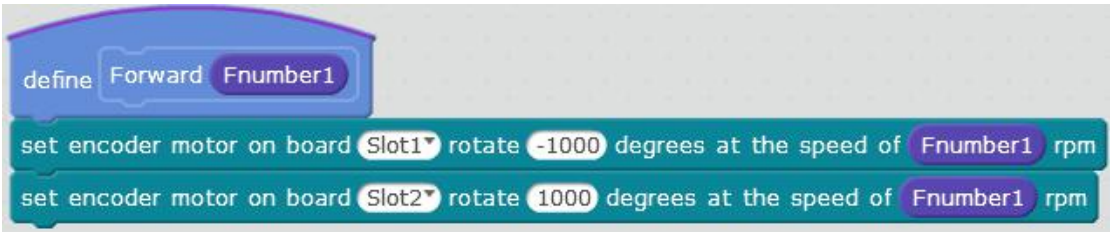
5. It is the same way in naming the variable. It is recommended to change the name of the variable in the new block from [number1] to [Fnumber1] and click [OK].



6. Go back to [Define Forward] and drag the circle icon next to [Fnumber 1] to cover the speed (previously 180).

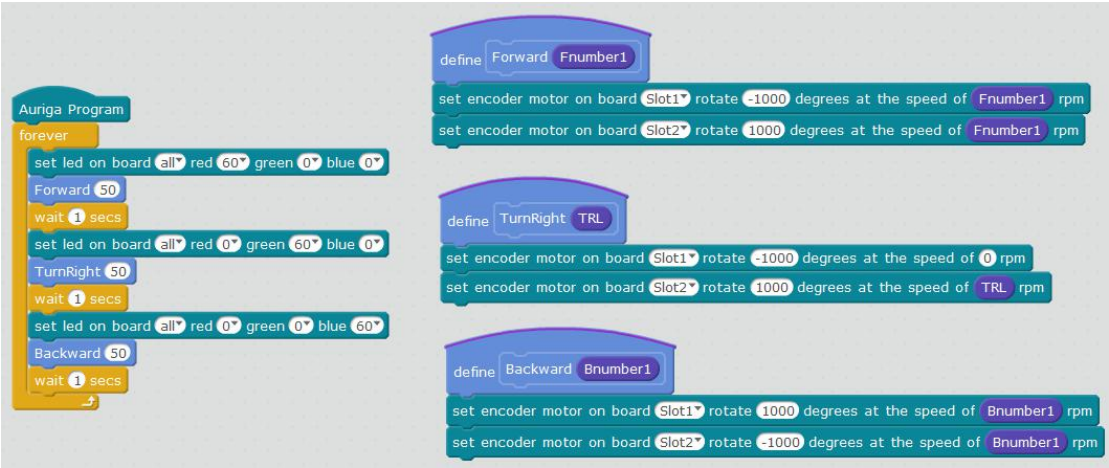


7. Drag [Fnumber1] to cover the value 180.



8. Upon completion of the change, the Forward command has the function to input parameters, such as Forward 100, meaning Fnumber1 value is 100, and while using [Fnumber1], the value of the parameters will be replaced by 100. Simply put, the Ranger's two encoder motors will rotate at a speed of 100. With parameters, the blocks will have more changes.

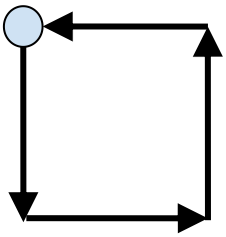
The completed program is shown in the diagram below:



Each new command can have a number of different parameters set at the same time, please test.

The challenge

Challenge Task 1 – A square, to return to the origin



Ranger has an encoder motor, after those learning tasks and achieving targets through the tasks, how would you direct Ranger to walk along a square track, and back to its origin?

According to the diagram above, we need to let Ranger do the following movements:

1. Straight forward
2. Right-angle turn
3. Straight forward
4. Right-angle turn
5. Straight forward
6. Right-angle turn
7. Straight forward
8. Right-angle turn

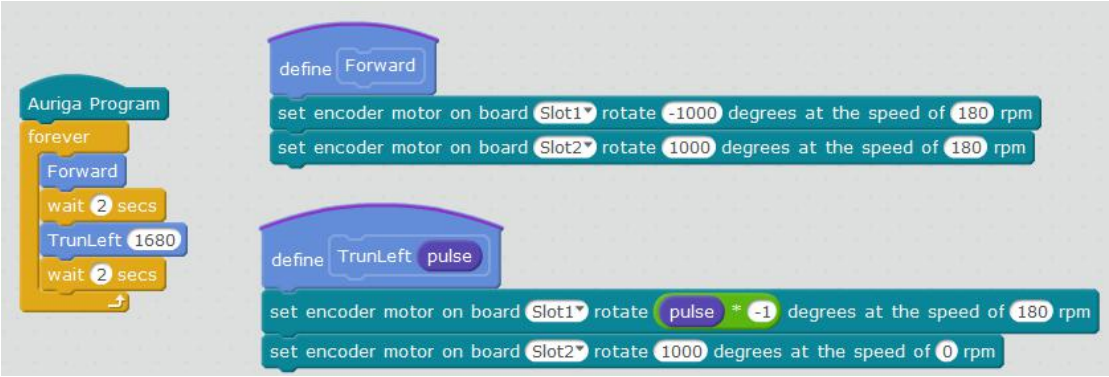
There are many ways to turn at right angles, with Ranger rotating being the quickest way to turn. When both encoders rotate in the opposite direction, the Ranger will turn in its position.

You can make a new block – TurnLeft (pulse) with parameter. The pulse specifies the

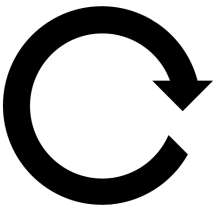
distance the encoder motor should be running (coded signal). Please test your Ranger yourself to determine how many [angles] you need to enter to allow the robot to rotate.

Should it be TurnLeft (100) or TurnLeft (150)? After confirming in the test, regardless of how much power Ranger has left, it can follow the same [distance] whether going forward or turning.

The reference procedure for going along the square and returning to the origin is as follows:



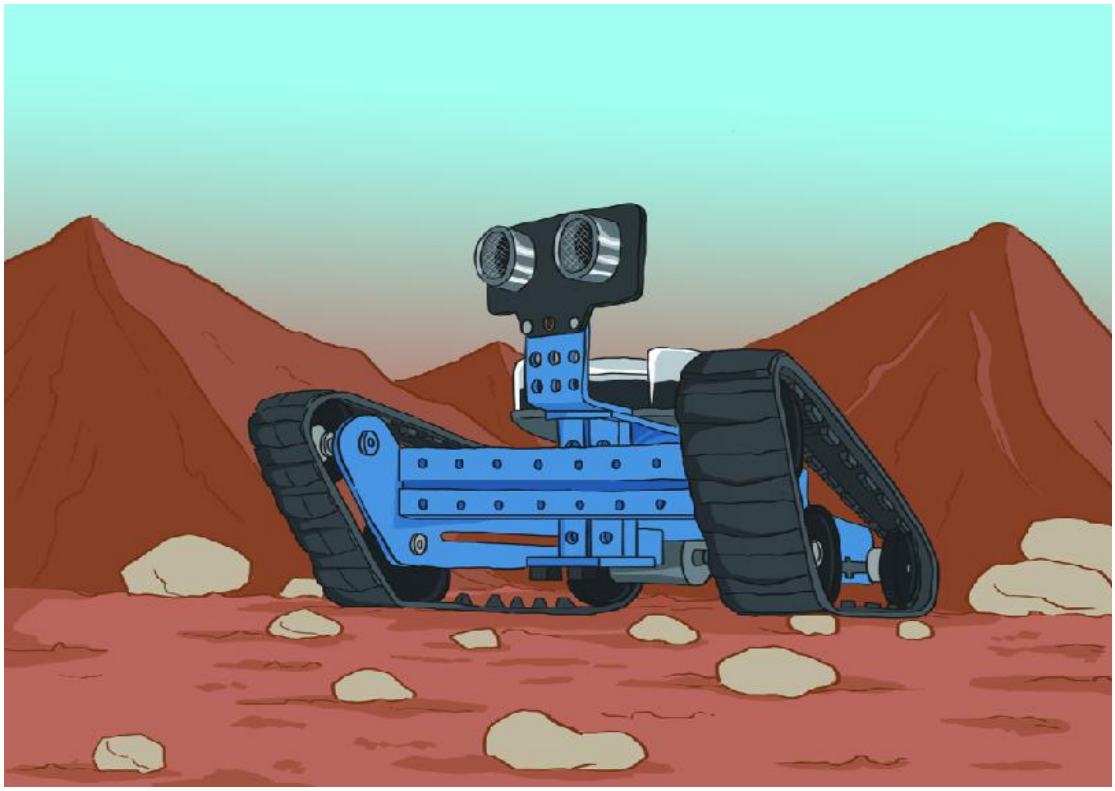
Challenge Task 2 – How to walk a circular path



Now that you know how to get Ranger to turn, please challenge to make Ranger go round the circular path!

Conclusion of this chapter

Now that you are familiar with the two methods of controlling the motor speed and distance traveled, you can easily make your robot move to any place you want. Next is the task of moving between any two points. You have to think how fastest, or the safest way, in order to reach the goal. It will be a very interesting challenge, let's start to see who will achieve it first!



Even if [Land Raiders] is designed to challenge terrible terrain, it was three to four hours of bumpy journey. If not for everyone's high levels of anticipation, they wouldn't be able to bear with it for much longer.

"Captain! Captain! The tracking signal has disappeared!" Jennifer suddenly exclaimed. Originally limp in the seat due to motion sickness, Mark instantly came back to life.
"Peter, quickly confirm if the receiver antenna is normal." After giving his command to Peter, he swiftly entered the keyboard above the system self-testing instructions.
"What happened?" Dr. Chiu walked next to Jennifer and asked.
"I'm sorry, I thought the signal was weak because of the terrain, but it suddenly disappeared a few minutes ago." Jennifer was upset by her lack of vigilance.
"Okay, it doesn't matter! How far away are we from our original destination?" Mark asked Jennifer without sounding reproachful.
"We are here!" Jennifer replied.
"Seems the signal is not the only thing disappearing, apart from rocks, there is nothing in this vicinity!" Dr. Chiu said, looking at the data the external detector brought back.