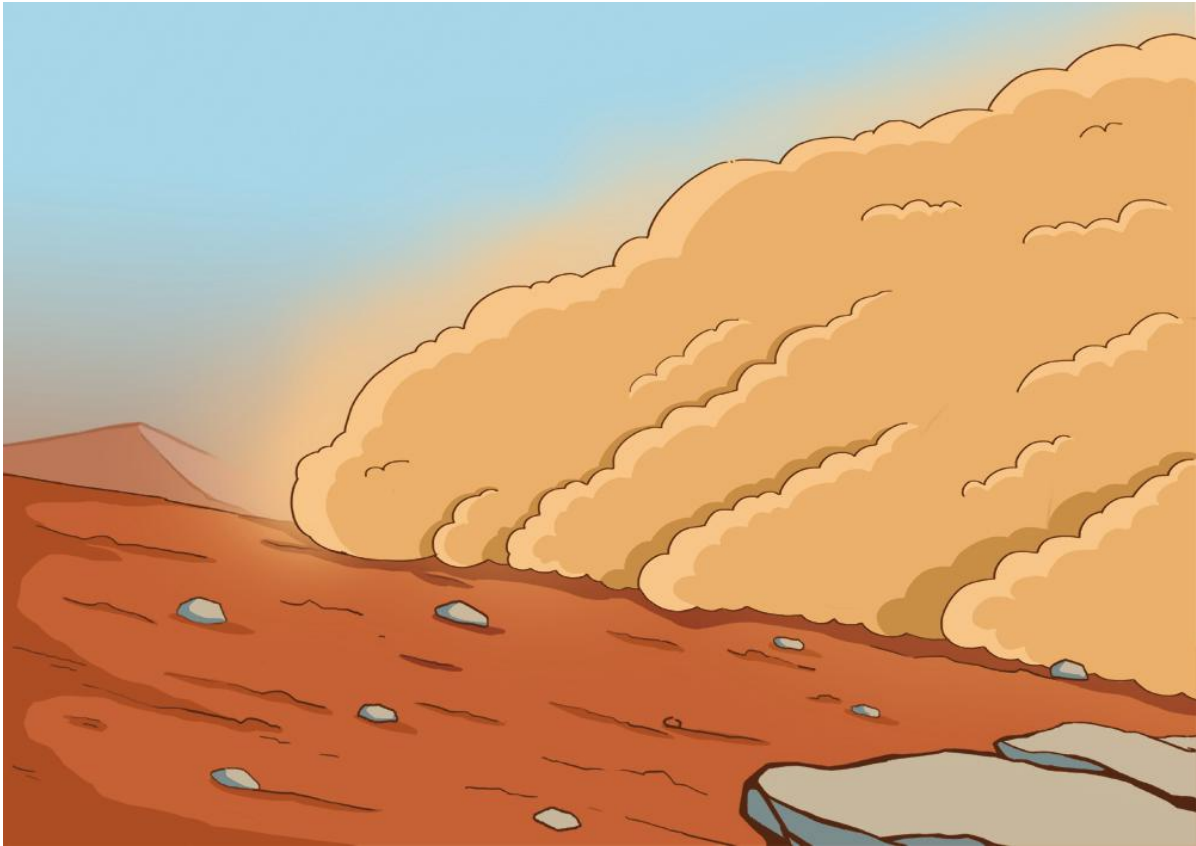


## Dust



I really don't think it is possible to breathe on the surface of the Mars where there are various air compositions and insufficient atmospheric pressure, so what kind of technology on earth can help build such isolated space? Jennifer drives Ranger Tank across the barrier area with great care, during which the tracked support sinks markedly due to the obvious influence of the gravity.

Peter returns to the capsule and takes off his space suit and cannot help sneezing. "Although it is possible to breathe the air, the lower temperature drives me round the bend and I nearly get to freeze to death," says Peter after he pours a cup of hot cocoa and then walks back to the cockpit together with Mark.

The time we just sit down, an emergency alert about the advent of severe weather comes from the orbit carrier, indicating a wide range of dust storm is approaching and instructing us to head for the valley edge to steer away from the eye of the dangerous storm.

In a short time, the dust flies all over the sky, causing Ranger Tank to get in the middle of the pitch-dark storm. To keep advancing safely in such a case, the navigation positioning system and body posture detection system will play their function to the greatest limit.

### Learning Objectives

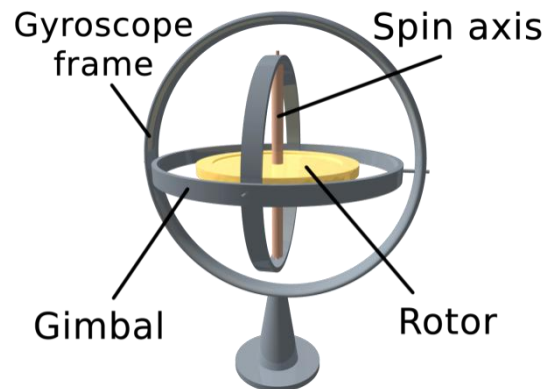
In this chapter we begin to add the concept of (proportional control) to the program, utilizing the difference between target value and measured value of the sensor to zoom in or zoom out in an appropriate proportion to control the robot's movements. Compared with the method of using a value more than or less than a fixed judgment value, this approach can keep the system more stable and reduce excessive correction.

In this chapter we use gyroscope again, but we directly use the value obtained from the sensor to change the control output, such as rotating graphs, or change the advancing direction of mBot Ranger.

## Scientific Knowledge

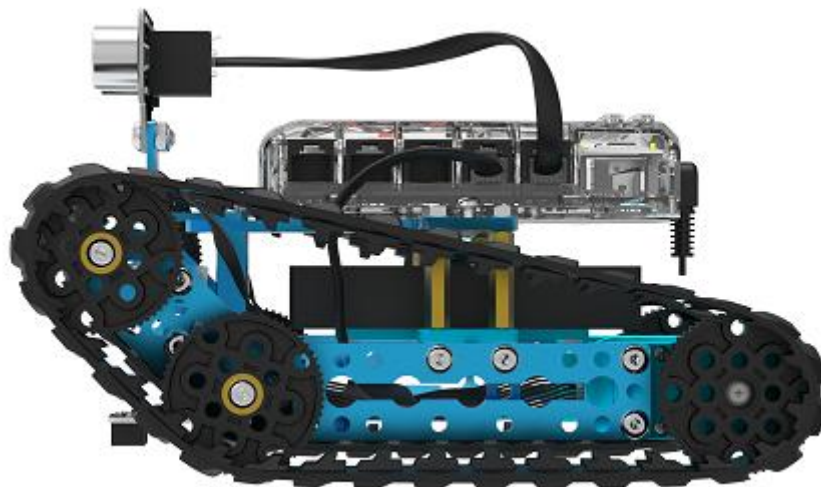
To research the Earth's rotation, the French physicist Jean-Bernard-Leon Foucault discovered the rotor turning at high speed first in 1852, whose spin axis always points to a fixed direction due to inertia effect. Then, he named this instrument "gyroscope" that combines the Greek gyro with skopein.

Gyroscope has always been the most convenient and practical reference instrumentation for motion attitude and rate in the aviation and navigational fields.

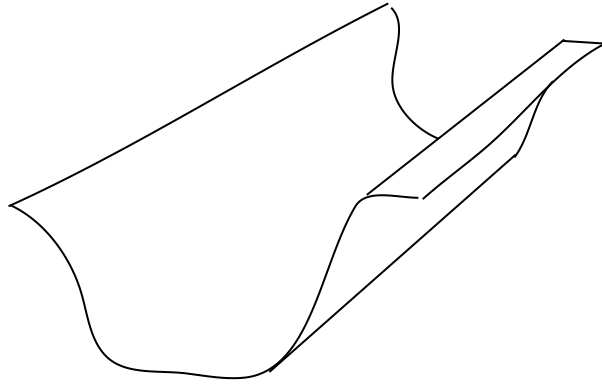


## Assembly Preparation

In this chapter we use tracked robot.



Site layout: Use a wide-open cardboard to simulate a valley form in a way that Ranger can automatically keep advancing at the bottom zone of the valley, but cannot climb up to the hill side, avoiding it from turning upside down.



## Learning Tasks

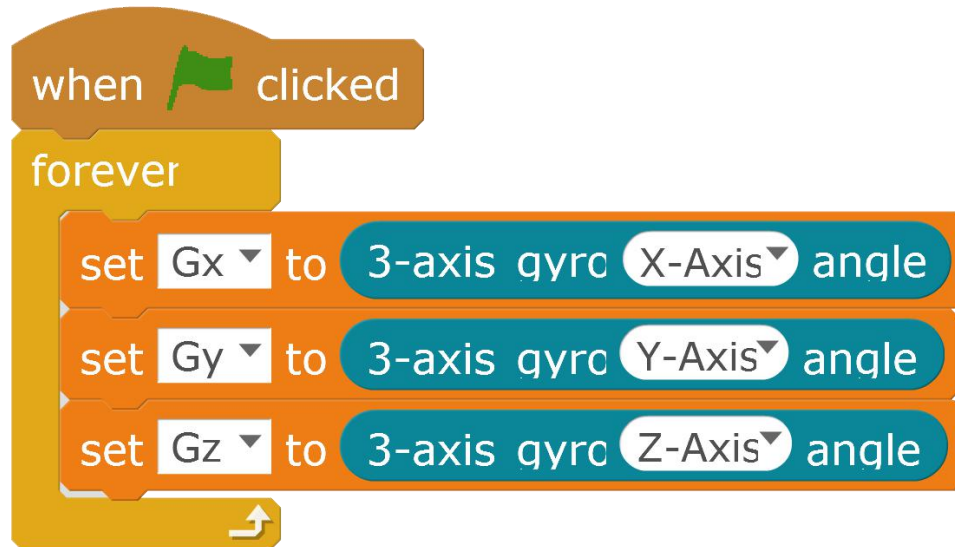
Gyroscope is a very precise sensor and can do an initial self-correcting action at the early stage of power connection, during which the controller must remain completely still to avoid the existence of any errors.

### Command for gyroscope sensor

<div> <div> Motion Looks Sound Pen Data&amp;Blocks </div> <div> Events Control Sensing Operators <b>Robots</b> </div> </div>	<div>3-axis gyro X-Axis▼ angle</div>	gyroscope sensor's angle from X-axis
Function: Read gyroscope sensor's angle data. [X-axis]: Choose X, Y and Z axial direction for gyroscope sensor.		

### Learning Task 1 – Graphical Representation of Gyroscope's Data

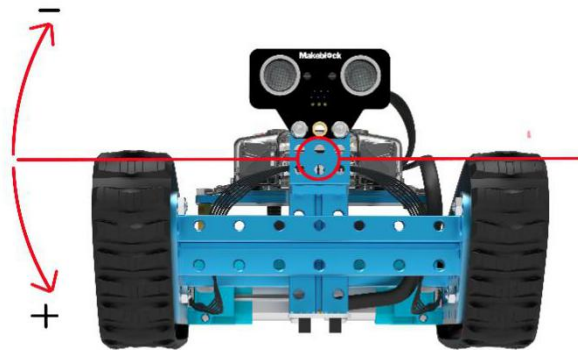
We set up three variables Gx, Gy and Gz to store gyroscope's data.



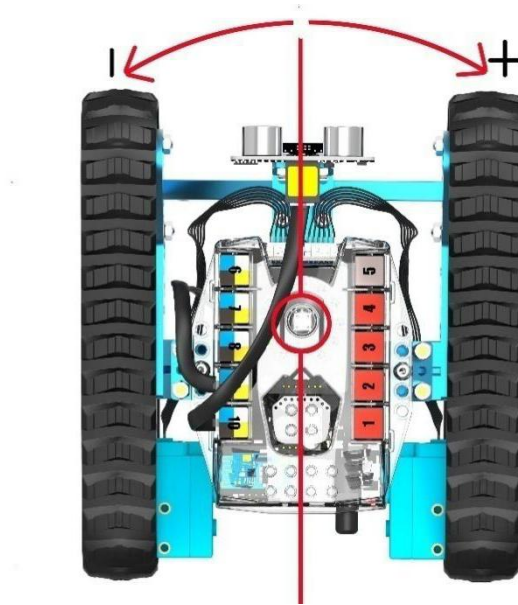
Use the cycle to constantly update the values of the three axes.  
Through observation, we know what X-axis detects is the elevation angle of the body.



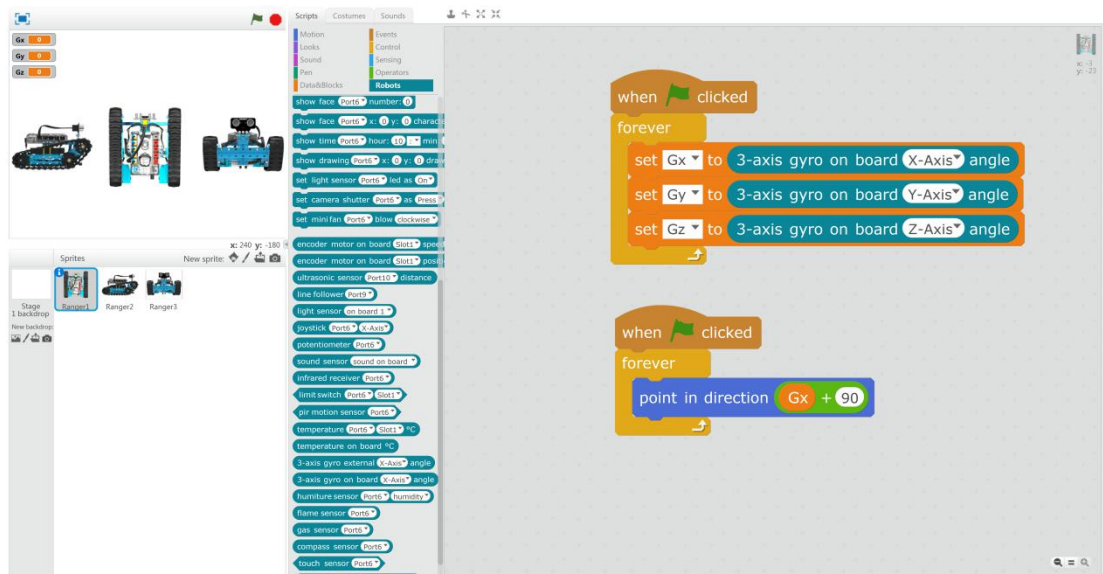
What Y-axis detects is the lateral inclination of the body



And what Z-axis detects is the direction of rotation of the body



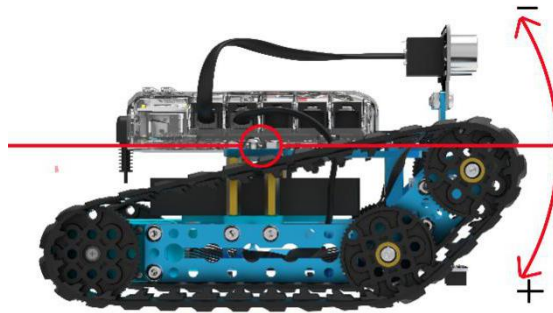
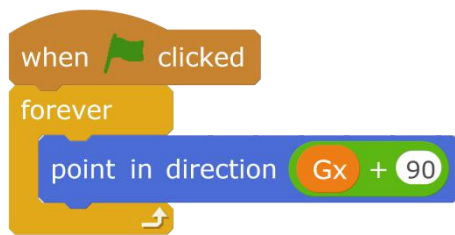
After getting such relations, we utilize [Upload sprite from file] to upload the modeling of the tank from various views onto mBlock.



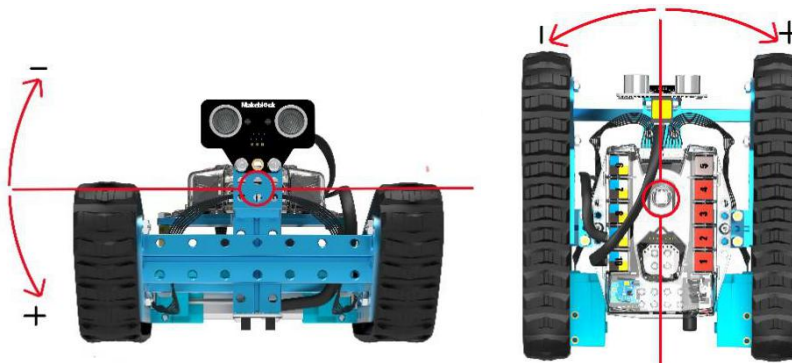
Use Gx value first to control the direction of graphics of the role at the side of the body via the command of [point in direction], and simulate the scenarios of the tank climbing and descending.

What's the additive operation in the program for? Can it not be added?



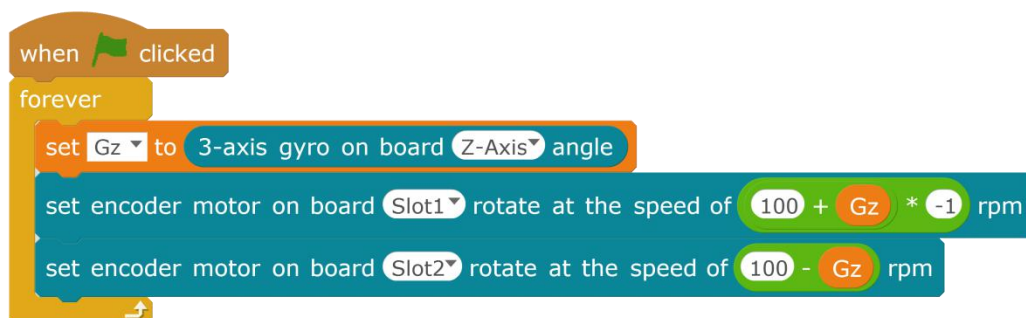


Can you use the data of Gy and Gz to make the other two graphics representing the state of the body?



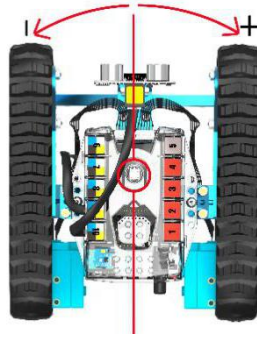
## Learning Task 2 – Control of Advancing Direction of Z-axis Value of Gyroscope

Use the measured value of Z-axis to guide the body to go straightly



The motor on the left wheel is Slot 2, and the value for forward is positive. (+100)  
 The motor on the right wheel is Slot 1, and the value for forward is negative. (-100)





Gz=-10	Gz=0	Gz=10
The body deflects to the left	Normal	The body deflects to the right
Left wheel runs faster than right wheel	Left wheel runs as fast as right wheel	Left wheel runs slower than right wheel
Left wheel: $100 - (-10) = 110$		Left wheel: $100 - (10) = 90$
Right wheel: $(100 + (-10)) * (-1) = -90$		Right wheel: $(100 + (10)) * (-1) = -110$

## Target Task

### Target Task 1 – Control Tilt Ratio

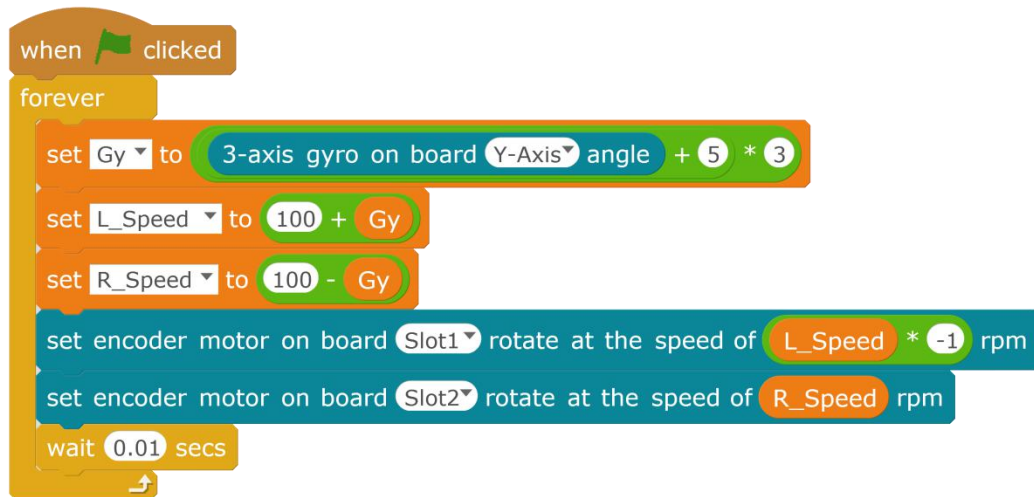
Let's set variables:

The y-axis value of gyroscope is multiplied by scale-up value

L\_Speed: speed of left motor

R\_Speed: speed of right motor

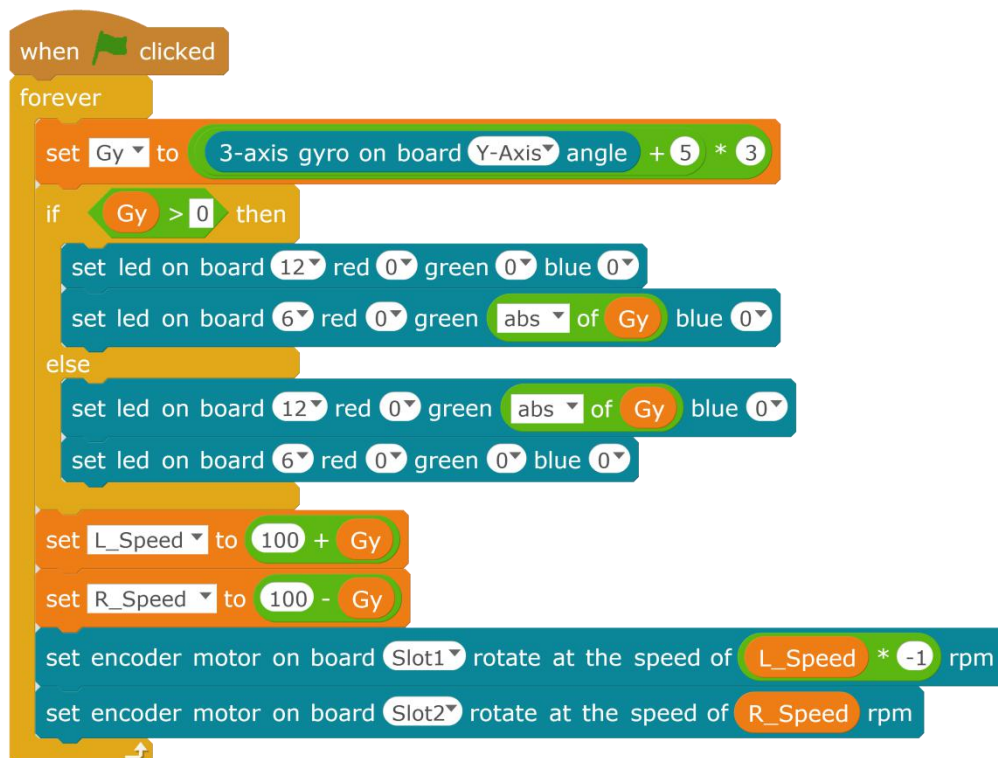
Y-axis	Gy=-10	Gy=0	Gy=10
Condition	The body with the right higher than the left	Normal	The body with the left higher than the right
Countermeasure	Left wheel runs slower than right wheel The body needs to be deflected to the left	Left wheel runs as fast as right wheel	Left wheel runs faster than right wheel The body needs to be deflected to the rights
	Left wheel: $100 + (-10) = 90$		Left wheel: $100 + (10) = 110$
	Right wheel: $(100 - (-10)) * (-1) = -110$		Right wheel: $(100 - (10)) * (-1) = -90$



## Target Task 2 – Number Indicator Lights

When the right side of Ranger is higher, the rightmost LED light (No. 6 LED) flashes, with its brightness increased/decreased according to inclination.

Conversely, when the right side of Ranger is higher, the leftmost LED light (No. 12 LED) flashes, with its brightness increased/decreased according to inclination as well.





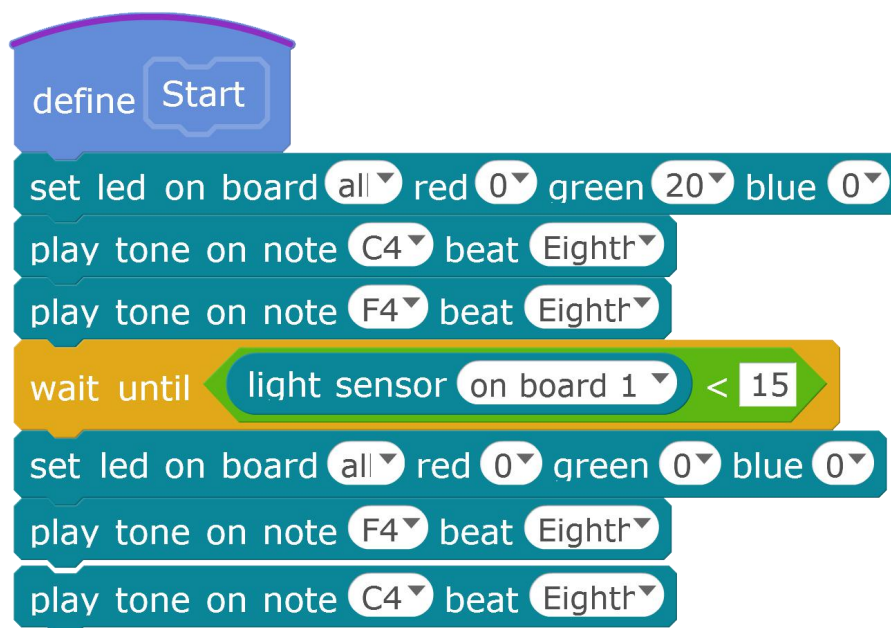
## The Challenge

### Challenge Task – Climb and Descend

For the application of X-axis value of gyroscope, as the robot climbs, the motor speed is improved to increase climbing force; as the robot descends, the motor speed is reduced to prevent dangers as a result of over-speed.

In case of offline control, it is required to use USB cable to transmit program, because at the end of the transmission, the robot will automatically execute the program and the motor starts running to cause the robot to pull the USB cable. The addition of the command of waiting light sensor is needed at the earliest stage of program execution, which is used as the switch.

We make a “Start” block command and start running the program. After the robot makes a sound and the LED green light flashes for indication, the user will put his/her fingers above the light sensor to reduce its detection value. Then the robot will make an alert sound and close the signal of LED light.



The main program is as below: Please adjust the parameters according to proportion control.

```

Auriqa Program
run forward at speed 0
Start
forever
  set Gx to 3-axis gyrc on board X-Axis angle + 5 * 3
  set L_Speed to 100 - Gx
  set R_Speed to 100 - Gx
  set encoder motor on board Slot1 rotate at the speed of R_Speed * -1 rpm
  set encoder motor on board Slot2 rotate at the speed of L_Speed rpm

```

## Conclusion of This Chapter

Ranger can turn the complex gyroscope and acceleration sensors into very easy-to-operate attitude sensors with the help of engineers. And we can directly use the angle value as the data source of robot control, allowing us to have more advanced applications in terms of the motion control ability of robot, for example, two-wheeled self-balancing vehicle is one of the typical examples.



The dust storm comes and goes very swiftly. At last the violent storm calms down, but the sun has gone down. At this moment, there is only silence in the darkness of the Mars.

“Carrier, this is Ranger, please respond after hearing me. Over!” Mark keeps trying to contact the carrier, but no messages are received. “How should I put my team out of the woods? I wish someone could give me somewhere...” Mark is a little depressed, staring into the distance.