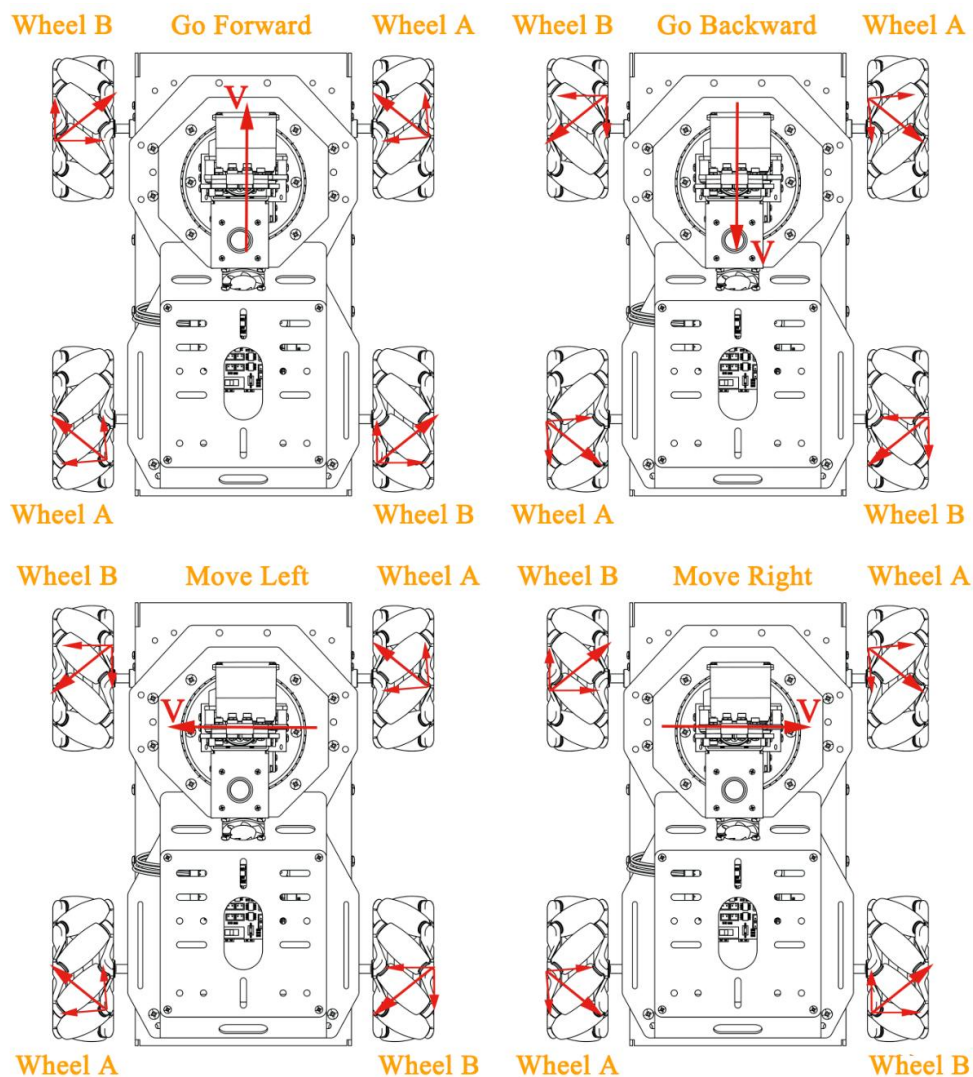


Lesson 5 Movement

1. Working Principle

According to the characteristics of meacanum wheel, when all wheels rotate clockwise, the car will move forward; when all wheels rotate counterclockwise, the car will move backwards. When two A wheels rotate counterclockwise and two B wheels rotate clockwise, the car will move sideways to the left; when two wheels B rotates counterclockwise and wheels A rotates clockwise, the car will move sideways to the right. The force analysis for moving forwards, backwards and sideways is shown in the following figure:



According to physical kinematics, when forces are equal and opposite to each other, they will counteract each other. Any force can be decomposed into two perpendicular vectors. Suppose the speed of wheel A and wheel B rotates at the same speed, a right force decomposed by wheel A and a left force decomposed by wheel B will counteract each other, which the direction of resultant velocity is forward.


Based on Newton's second law ($F=ma$), if the direction of acceleration is forward, the final resultant force is also forward.

2. Operation Steps

i It should be case sensitive when entering command, and the "Tab" key can be used to complete the keywords.

- 1) Please refer to the content in "7. ArmPi Pro Basic Lesson/1.Mecanum Wheel Chassis Lesson/ Lesson 2 Set Environment Development" to connect system desktop via No Machine.

- 2) Click  Applications in the lower left corner and select

 Terminal Emulator to enter the terminal.

- 3) Enter command "`cd armpi_pro/src/armpi_pro_demo/chassis_control_demo/`" and press "Enter" to enter the directory of game programmings.

```
ubuntu@ubuntu:~$ cd armpi_pro/src/armpi_pro_demo/chassis_control_demo/
```

- 4) Enter command "`python3 car_move_demo.py`" and press "Enter" to start game.

```
ubuntu@ubuntu:~/armpi_pro/src/armpi_pro_demo/chassis_control_demo$  
python3 car_move_demo.py
```


- 5) If want to exit the game, press “Ctrl+C” in terminal. If fail to exit, please keep trying until the program is closed.

3. Project Outcome

After starting the game, ArmPi Pro will move forward, shift to right, backwards, shift to the left in sequence.

4. Function Extension

The default speed is 60. This section will change the moving speed to 90 and the specific operation steps are as follow:

- 1) Click  and select “Terminal Emulator” to enter the terminal.

- 2) Enter command “cd armpi_pro/src/armpi_pro_demo/chassis_control_demo/” and press “Enter” to come to the directory of game programmings.

```
ubuntu@ubuntu:~$ cd armpi_pro/src/armpi_pro_demo/chassis_control_demo/
```

- 3) Enter command “vim car_move_demo.py” and press “Enter” to open the program file.

```
ubuntu@ubuntu:~/armpi_pro/src/armpi_pro_demo/chassis_control_demo$  
vim car_move_demo.py
```

- 4) Find the code to be modified and press “i”. When the prompt “INSERT” appears in the lower left corner, it means the terminal has been switched to the editing mode.

```
41      set_velocity.publish(60,90,0) # The linear velocity is 60;
      The directional angel is 90; The yaw rate is 0 (When the value is
      negative, it will rotate clockwise. )
42      rospy.sleep(2)
43      set_velocity.publish(60,0,0)
44      rospy.sleep(2)
45      set_velocity.publish(60,270,0)
46      rospy.sleep(2)
47      set_velocity.publish(60,180,0)
48      rospy.sleep(2)
-- INSERT --                                     43,1      89%
```

- 5) Then change the first parameter in all the “set_velocity.publish()” function from “60” to “90”, that is , the moving speed is changed to 90, as the figure shown below:

```
41      set_velocity.publish(90,90,0) # The linear velocity is 60;
      The directional angel is 90; The yaw rate is 0 (When the value is
      negative, it will rotate clockwise. )
42      rospy.sleep(2)
43      set_velocity.publish(90,0,0)
44      rospy.sleep(2)
45      set_velocity.publish(90,270,0)
46      rospy.sleep(2)
47      set_velocity.publish(90,180,0)
48      rospy.sleep(2)
```

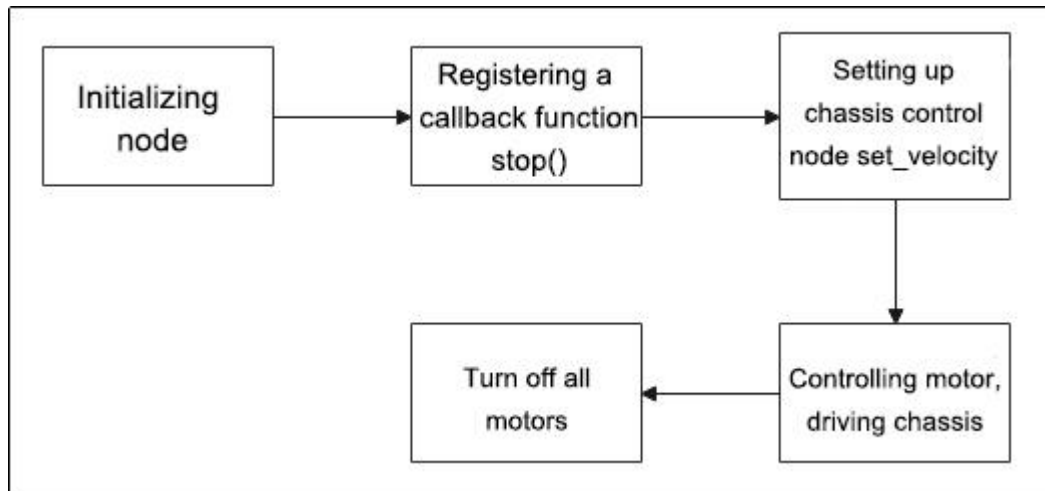
- 6) After modifying, press “Esc” and enter “:wq”, and then press “Enter” to save and exit.

```
48      rospy.sleep(2)
:wq
```

Note: The adjustable range of speed is from -100 to 100. When the value is positive, the motor will rotate clockwise. When the value is negative, the car will rotate counterclockwise. When the value is changed to the negative value, it may change the movement direction of car. Therefore, it is recommended to adjust the value between 0 and 100.

- 7) After modifying, you can refer to the content of “2.Operation Steps” to check the effect.

5. Program Analysis



The source code of program is located in:
 home/ubuntu/armpi_pro/src/armpi_pro_demo/chassis_control_demo/car_move_demo.py

```

27 global start
28
29 start = False
30 print('关闭中...')
31 set_velocity.publish(0,0,0) # 关闭所有电机
32
33 if __name__ == '__main__':
34     # 初始化节点
35     rospy.init_node('car_move_demo', log_level=rospy.DEBUG)
36     rospy.on_shutdown(stop)
37     # 麦轮底盘控制
38     set_velocity = rospy.Publisher('/chassis_control/set_velocity', SetVelocity, queue_size=1)
39
40     while start:
41         set_velocity.publish(60,90,0) # 线速度60, 方向角90, 偏航角速度0(小于0, 为顺时针方向)
42         rospy.sleep(2)
43         set_velocity.publish(60,0,0)
44         rospy.sleep(2)
45         set_velocity.publish(60,270,0)
46         rospy.sleep(2)
47         set_velocity.publish(60,180,0)
48         rospy.sleep(2)
49     set_velocity.publish(0,0,0) # 关闭所有电机
50     print('已关闭')
51
  
```

Control motor through `set_velocity.publish()` function. There are three parameters in function. Take the code “`set_velocity.publish(60,90,0)`” as an example:

1) The first parameter “60” represents the motor speed, its unit is mm/s and it ranges from -100 to 100. When the value is positive, the motor rotates counterclockwise.

2) The second parameter “90” represents the movement direction of car, its unit is degree and it ranges from 0 to 360. The value of 90° refer to move forward. 270° refers to move backward. 0° refers to move to the right. 180° refers to move the left. Other movement directions are obtained according to the same reference method.

3) The third parameter “0” represents the rotation speed of the car, its unit is 5 degree/s and it ranges from -2 to 2. When the parameter value is positive, the car will rotate clockwise. When the parameter value is negative, the car will rotate counterclockwise.