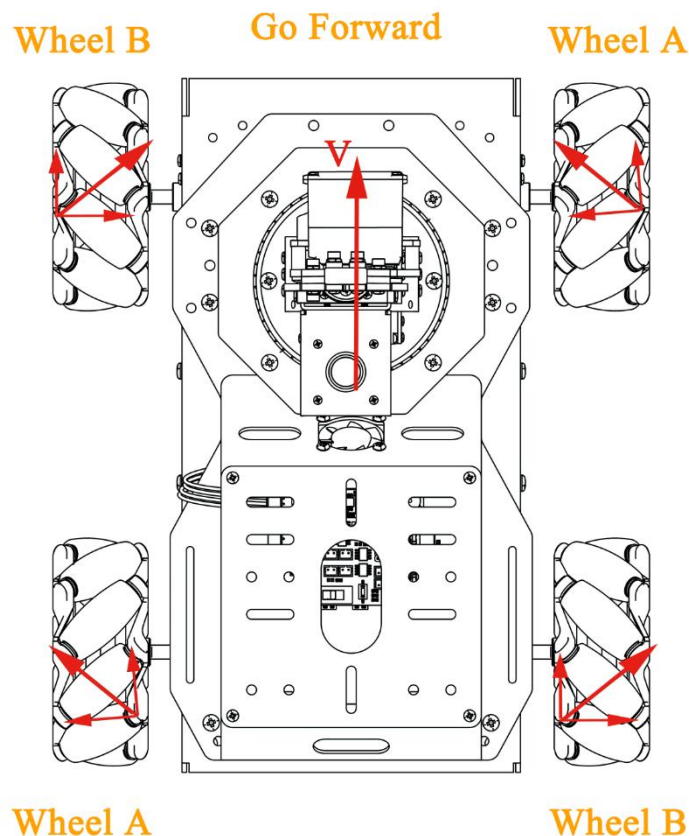


Lesson 3 Move Forward

1. Working Principle

According to the characteristic of mecanum wheel, when the car moves forward, the four wheels must rotate clockwise. The force analysis is shown in the following figure:



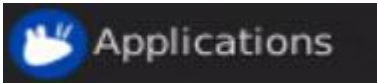
According to physical kinematics, when forces are equal and opposite to each other, they will counteract each other. Any force can be decomposed into two perpendicular vectors. Suppose the speed of wheel A and wheel B rotates at the same speed, a right force decomposed by wheel A and a left force decomposed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

 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_forward_demo.py`” and press “Enter” to start game.

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

4. Function Extension

The default movement speed is 60. In this section, change the car speed to 90.

Please refer to the following specific steps:

- 1) Click  and select  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 “vim car_forward_demo.py” command and press “Enter” to open the program file.

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

- 4) Find the code to be modified and press “i” to switch to the editing mode.

```
40      Board.setMotor(3, 0)    # No.2 servo stops  
-- INSERT --
```

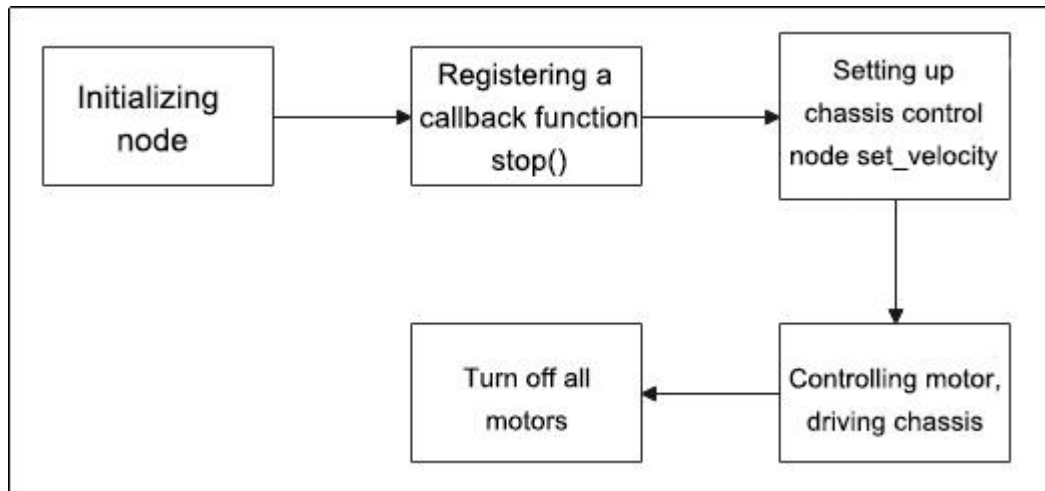
- 5) In “set_velocity.publish()” function, the first parameter represents the motor speed and we change it to 90. After changing , press “Esc” and enter “:wq”, and then press “Enter” to save and exit.

```
42      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. )
```

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

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

5. Program Analysis



The source code of program is located in:
home/ubuntu/arduino_pro/src/arduino_pro_demo/chassis_control_demo/car_forward_demo.py

```

25 start = True
26 #Process before closing
27 def stop():
28     global start
29
30     start = False
31     print('Closing...')
32     set_velocity.publish(0,0,0) # close all motors
33
34 if __name__ == '__main__':
35     # Initialize node
36     rospy.init_node('car_forward_demo', log_level=rospy.DEBUG)
37     rospy.on_shutdown(stop)
38     # Mecanum chassis control
39     set_velocity = rospy.Publisher('/chassis_control/set_velocity', SetVelocity, queue_size=1)
40
41     while start:
42         set_velocity.publish(60,90,0) # The linear velocity is 60; The directional angel is 90;
43         # The yaw rate is 0 (When the value is negative, it will rotate clockwise. )
44         rospy.sleep(1)
45
46     set_velocity.publish(0,0,0) # Close all motors
47     print('Closed')
    
```

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

1) The first parameter “50” represents the motor speed, the unit is mm/s and it ranges from -100 to 100. When the value is negative, the motor rotates

counterclockwise.

2) The second parameter “90” represents the movement direction of car, the unit is degree and it ranges from 0 to 360. The value of 90° refers 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 $5^{\circ}/s$ 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.