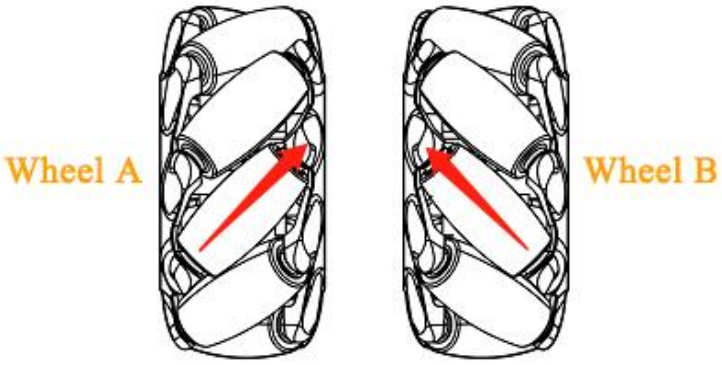
Lesson 2 The Motion of Mecanum Wheels Car

1. Preface

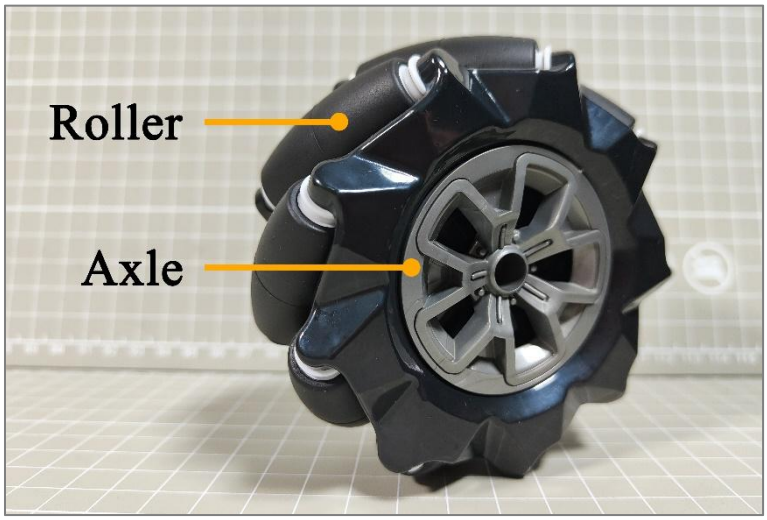
ArmPi Pro uses omnidirectional movement mecanum wheels. According to the the included angle 45° between the roller and axle of the mecanum wheels, the wheels can be divided into wheel A and wheel B which are in mirror-image relationship with each other, as the figure shown below:



Featuring 360° movement, flexibility and stability, the mecanum wheel is a successful omnidirectional wheel. The combination of four mecanum wheels can be more flexible to realize the omnidirectional movement.

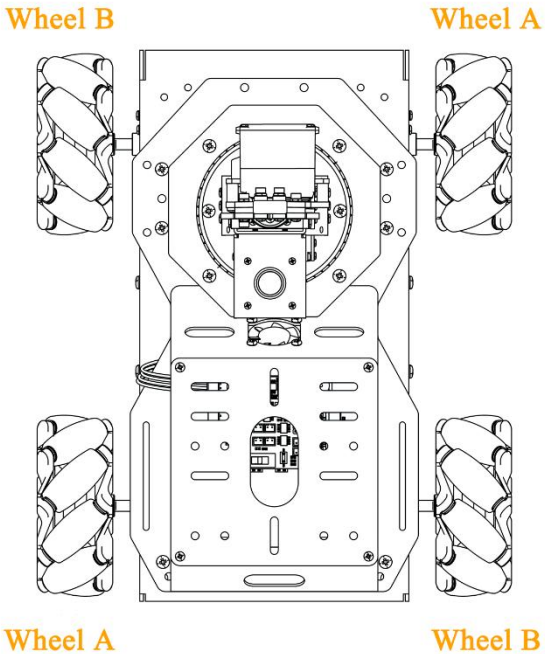
2. Working Principle

2.1 Hardware Structure and Physical Characteristics



The mecanum wheel is composed of rollers and axle. The axle is as the main bracket of the whole wheel and a series of rubberized external rollers obliquely attached to the whole circumference of its rim. The rollers at its rim oriented at an angle of 45° to the wheel circumference.

There are several configuration methods of four mecanum wheels, such as AAAA, BBBB, AABB, ABAB, BABA. Not all combination methods of the wheels enable robot car move forward, backward, and sideways, etc. The combination of ArmPi Pro's wheels are ABAB, which can realize omnidirectional movement.



2.1 Physical Characteristics

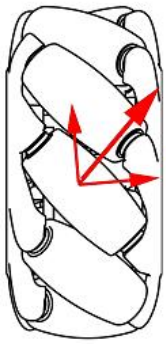
The omni-directional motion of the vehicle is achieved as the vector summation of propelling forces on the ground-engaging rollers can be in any direction by adjusting the wheel rotation direction and torque magnitude of the four wheels.

Due to the rollers at its rim oriented at an certain angle to the wheel circumference, the mecanum wheels can slip in sideways direction. The generatrix of small rollers are special. When the mecanum wheel revolves around its fixed axle, the envelope of each small roller is a cylindrical surface so that the wheel can roll forward continuously.

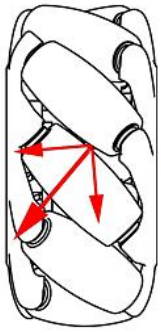
3. Motion Mode Analysis

Take wheel A as an example to analyze. When wheel A moves forward, the roller has a tendency to move to the right front relative to the ground. When wheel A is in reverse rotation, the roller has a tendency to move to the left rear relative to the ground. The specific analysis is as follow:

Choose one of rollers for force analysis. When wheel A rotates clockwise, the friction force acting on the roller opposes its movement direction. The roller moves right ahead relative to the ground while the direction of the friction force acting on roller is left rear. By decomposing the roller motion at this time, the right and forward velocity components will be obtained, so it is said that the mecanum wheel moves to the right and forward at this time.



When the mecanum wheel rotates counterclockwise, the friction force acting on roller opposes the direction of movement. The roller have a tendency to move to the left rear while the direction of friction force is right front direction of the contact point. By decomposing the roller motion, the left and backward velocity components can be obtained, so the movement direction of mecanum wheel is the left rear.



At the same rotation speed, the forces in opposite directions from A wheel and B wheel will be counteracted, and the remaining force in the same direction will drive the car forward, which is the working principle.