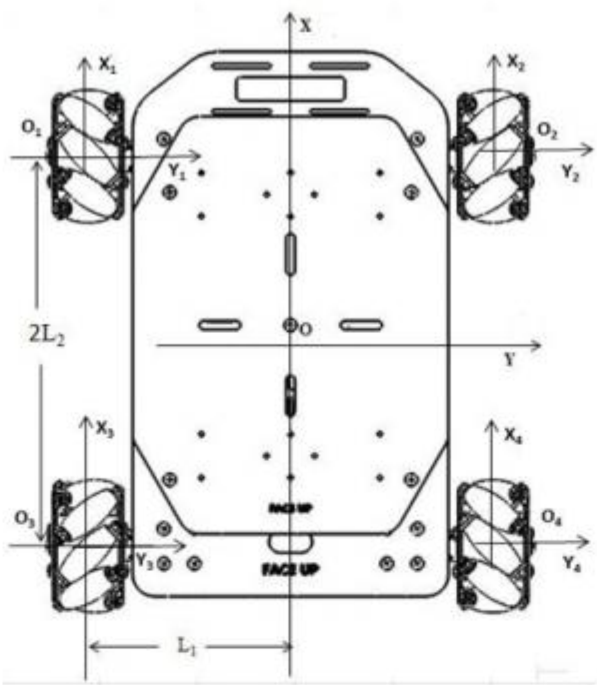
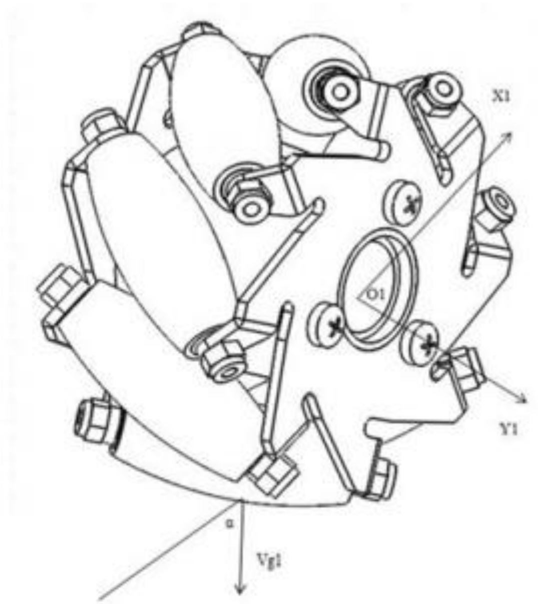
The angled peripheral rollers translate a portion of the force in the rotational direction of the wheel to a force normal to the wheel direction. Depending on each individual wheel direction and speed, the resulting combination of all these forces produce a total force vector in any desired direction. Let the radius of the wheel to be R, the angular velocity of four wheels to be ω1, ω2, ω3, ω4, the speeds of rollers on each wheel to be *v*g1, *v*g2, *v*g3 and *v*g4, and the speed of platform in x-direction, y direction and angular velocity to be *v*x, *v*y, and ω0. The global coordinate origins at O, the center of the platform, and local coordinate systems at each wheel have origin of O1, O2, O3 and O4. The distance from the mid of platform to the mid of wheel is L1, and L2 is for the distance between mid of the platform to the wheel' s axis of rolling. α is the angle of the rollers: 45° in this case.



Global Coordinate System



Local Coordinate System

In the global coordinate, the speed at the center of wheel 1, O1, is

$$v_{o1x} = v_x - \omega_0 * L_1 \tag{1}$$

$$v_{o1y} = v_y - \omega_0 * L_2 \tag{2}$$

While in the local coordinate at wheel 1, the speed of O1 is

$$v_{o1x} = -v_{g1} * \cos\alpha + \omega_1 * R \tag{3}$$

$$v_{o1y} = v_{g1} * \sin\alpha \tag{4}$$

Combine equation (1) ~ (4), we have

$$v_x - \omega_0 * L_1 = -v_{g1} * \cos\alpha + \omega_1 * R \tag{5}$$

$$v_y - \omega_0 * L_2 = v_{g1} * \sin\alpha \tag{6}$$

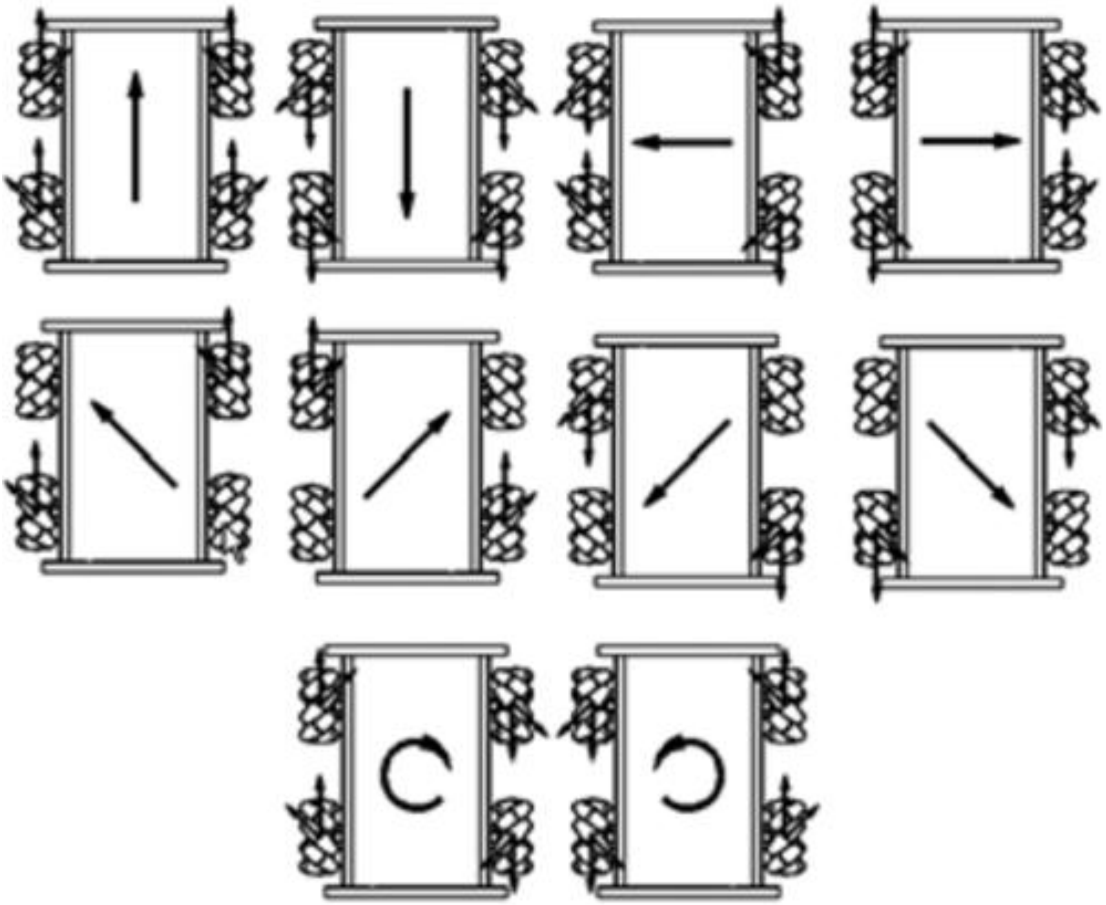
Solving (5) and (6), then the angular velocity of wheel 1 is

$$\omega_1 = \frac{1}{R}\begin{bmatrix} 1 & \frac{1}{\tan\alpha} & -(L_1 + \frac{L_2}{\tan\alpha}) \end{bmatrix}\begin{bmatrix} v_x \\ v_y \\ \omega_0 \end{bmatrix} \tag{7}$$

Similarly, the velocity of other 3 wheels can be calculated as

$$\begin{bmatrix} \omega_1 \\ \omega_2 \\ \omega_3 \\ \omega_4 \end{bmatrix} = \frac{1}{R}\begin{bmatrix} 1 & 1 & -(L_1 + L_2) \\ 1 & -1 & (L_1 + L_2) \\ 1 & -1 & -(L_1 + L_2) \\ 1 & 1 & (L_1 + L_2) \end{bmatrix}\begin{bmatrix} v_x \\ v_y \\ \omega_0 \end{bmatrix} \tag{8}$$

The equation (8) shows the relationship between the rotation speeds of the wheels and the movement of the platform. Theoretically, the platform can move in any direction by a proper combination of the four wheels'angular velocity. In fact, For this platform, The most common used movements are quite limited. Here we give out a simplified working principle of the platform. If you are disgusted with the numbers or equations, just ignore the dynamic analysis section, and read the figure below.



Mecanum Wheel Working Principle (Simplified)