Mecanum Wheels

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1 Basic Introduction

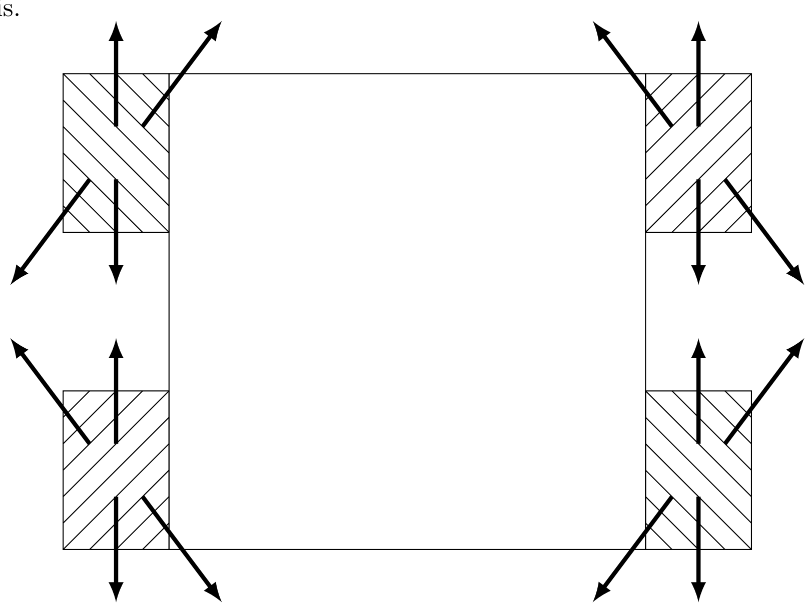
This document provides a basic introduction to Mecanum wheels, explaining their functionality, mechanics, and implementation in programming. Mecanum wheels are particularly valuable because of their ability to move a robot in any direction, offering a high degree of maneuverability.

2 How They Work

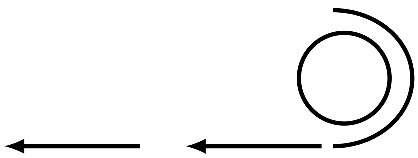
The defining feature of Mecanum wheels is the set of rollers mounted around the wheel at an angle, typically 45°. These rollers serve two key purposes:

1.They allow the wheel to slide laterally (side-to-side) while still rolling forward and backward.

2.Their angled design distributes force diagonally, so that when a wheel spins, approximately 70.7 percent of the applied force is directed along each axis.



3 How Wheels Transfer Energy

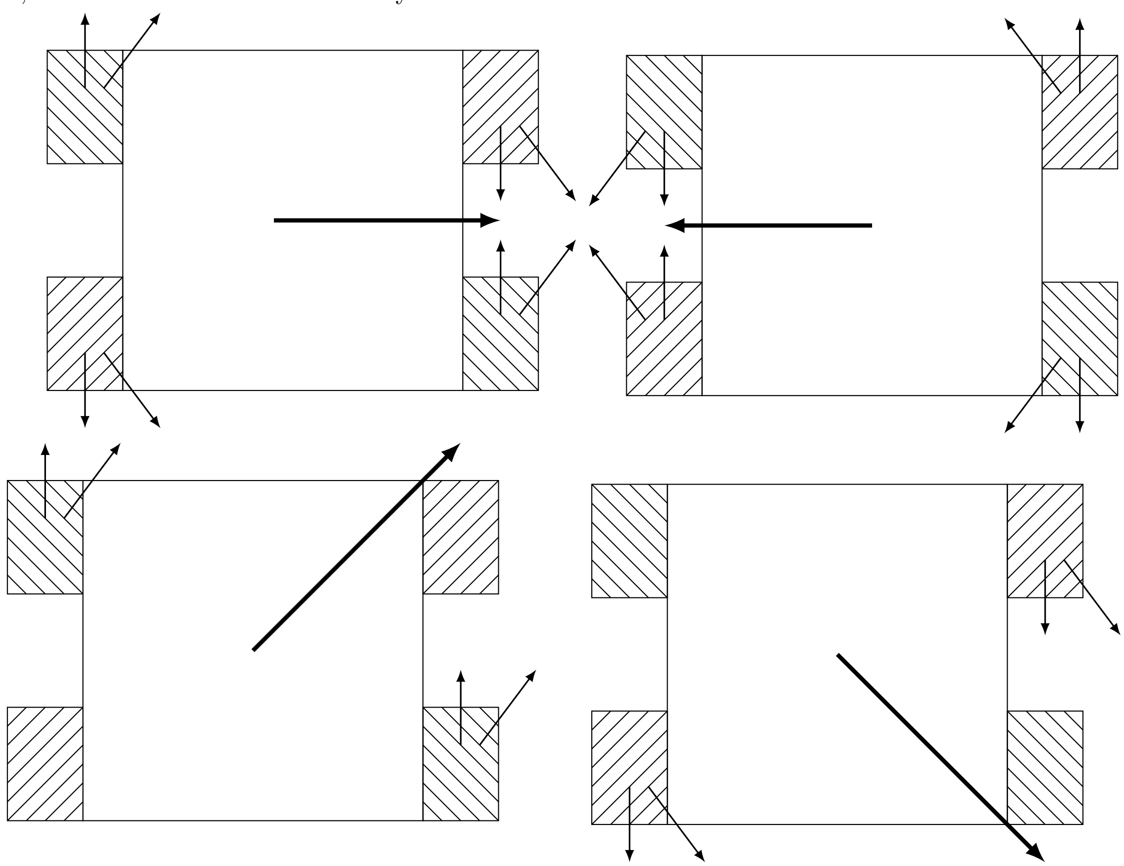


In this document, arrows drawn on the wheels represent force vectors, not rotation. For example, when a wheel rotates clockwise, the force vector is directed backward, pushing the robot forward.

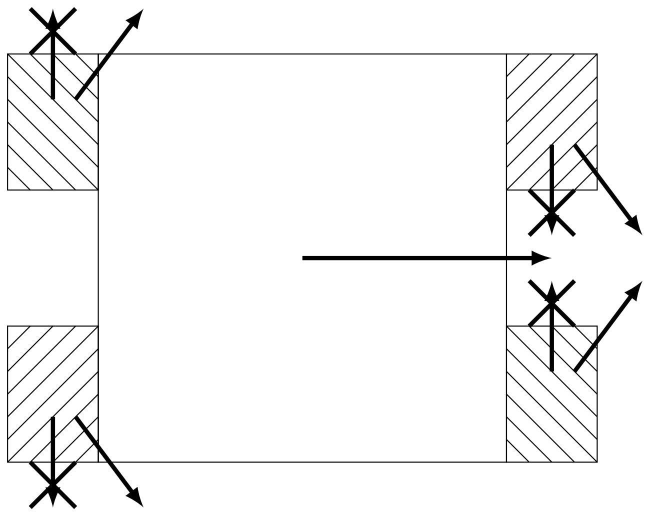
In summary, when a wheel receives a power input of 1, its force is applied directly behind it, producing forward motion.

4 How This Allows Them To Move

This distribution of force allows the robot to move in any direction. To achieve this, it is necessary to determine how the forces are applied and in which directions, as these force vectors ultimately define the robot's movement.



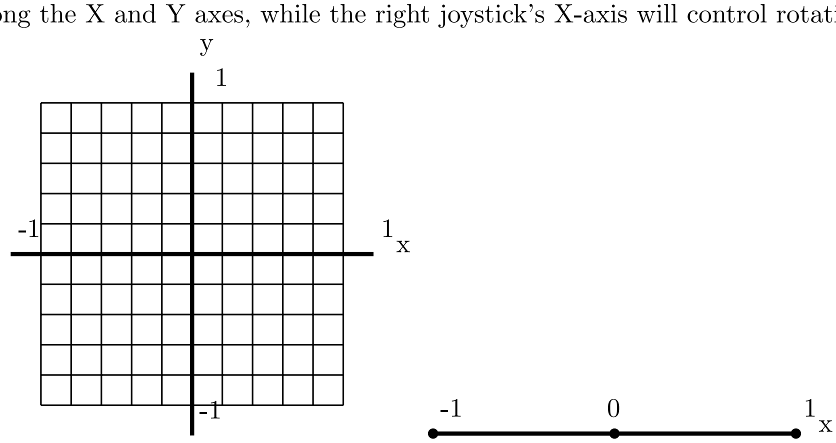
These examples represent some of the most complex movements the wheels can achieve. They also illustrate how the division of forces enables the wheels to produce such advanced motion.



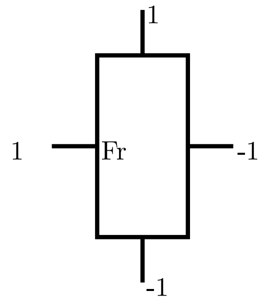
This diagram illustrates the forces acting on the robot during leftward strafing with Mecanum wheels. Opposing forces cancel each other out, leaving only the diagonal components. By applying the Pythagorean theorem, these remaining forces are combined into a single net force directed to the right.

5 How To Program

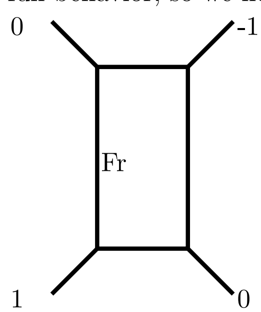
To begin programming, two steps are required: (1) defining the inputs, and (2) determining how those inputs will be implemented. During a match, the robot must be able to perform two key functions: (1) translate along the X and Y axes, and (2) rotate. To achieve this, the left joystick will control movement along the X and Y axes, while the right joystick's X-axis will control rotation.



"These graphs provide a visual representation of the joystick inputs. We will use three values: y for the left joystick's vertical axis (positive when pushed upward), x for the left joystick's horizontal axis (positive when pushed to the right), and t for the right joystick's horizontal axis (positive when pushed to the right). Implementing these inputs requires creating an equation for each wheel. Although this may sound complex, the process is straightforward: each wheel is treated in terms of the values 1 and -1, where 1 represents full forward power and -1 represents full reverse power. Using this method, we can determine how each wheel must behave to move the robot in different directions. To begin, we will focus on the front right wheel, referred to as Fr.



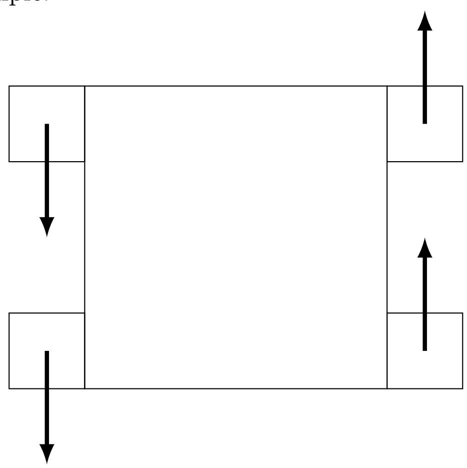
This model shows the wheel power when the robot moves forward, backward, left, and right. Forward and backward movements align directly with the controller's y-axis inputs, so no adjustments are needed there. However, left and right movements do not match the controller's x-axis inputs, so the x value must be negated in our equation. At this point, it's still impossible to determine the full behavior, so we need to examine other types of movement as well.



This shows the power the Fr wheel must produce to move diagonally. Looking at it, we see zeros — meaning zero is a possible value in our equation. Now that we have the facts, let's start constructing an equation. We know the horizontal input is negative, and when the joystick is in the top-left it must result in zero. Currently we have (x,y); plugging in the value for inputs in quadrant 2 it gives us (-1, 1), so we get -1 and 1 which if you combine them you would get 0, but it can't be that simple.

$fr = y - x$

This shows the power the front-right wheel must produce to move diagonally. We notice zeros, indicating that zero is a possible value in our equation. With this in mind, we can start constructing the equation. We know the horizontal input is negative, and when the joystick is in the top-left position, the result must be zero. Currently, we have (x, y); plugging in the inputs for quadrant 2 gives (-1, 1). Combining these values seems to give 0, but it can't be that simple.



For all wheels on the left, the turn component will be subtracted, and for all wheels on the right, it will be added. The final equation for the front-right wheel is: Fr = y - x + t

If we go through this process for all wheels we will get the equations:

Fr = y - x +t   Fl = y + x - t

Br = y + x + t   Bl = y - x - t

6 Conclusion

One last point about these equations is that they can handle all inputs scaled from -1 to 1, allowing the robot to move at any angle from 0° to 360°. These equations also support turning while moving, reducing the number of steps required for movement. You should now have a solid understanding of how mecanum wheels work and how to implement them.