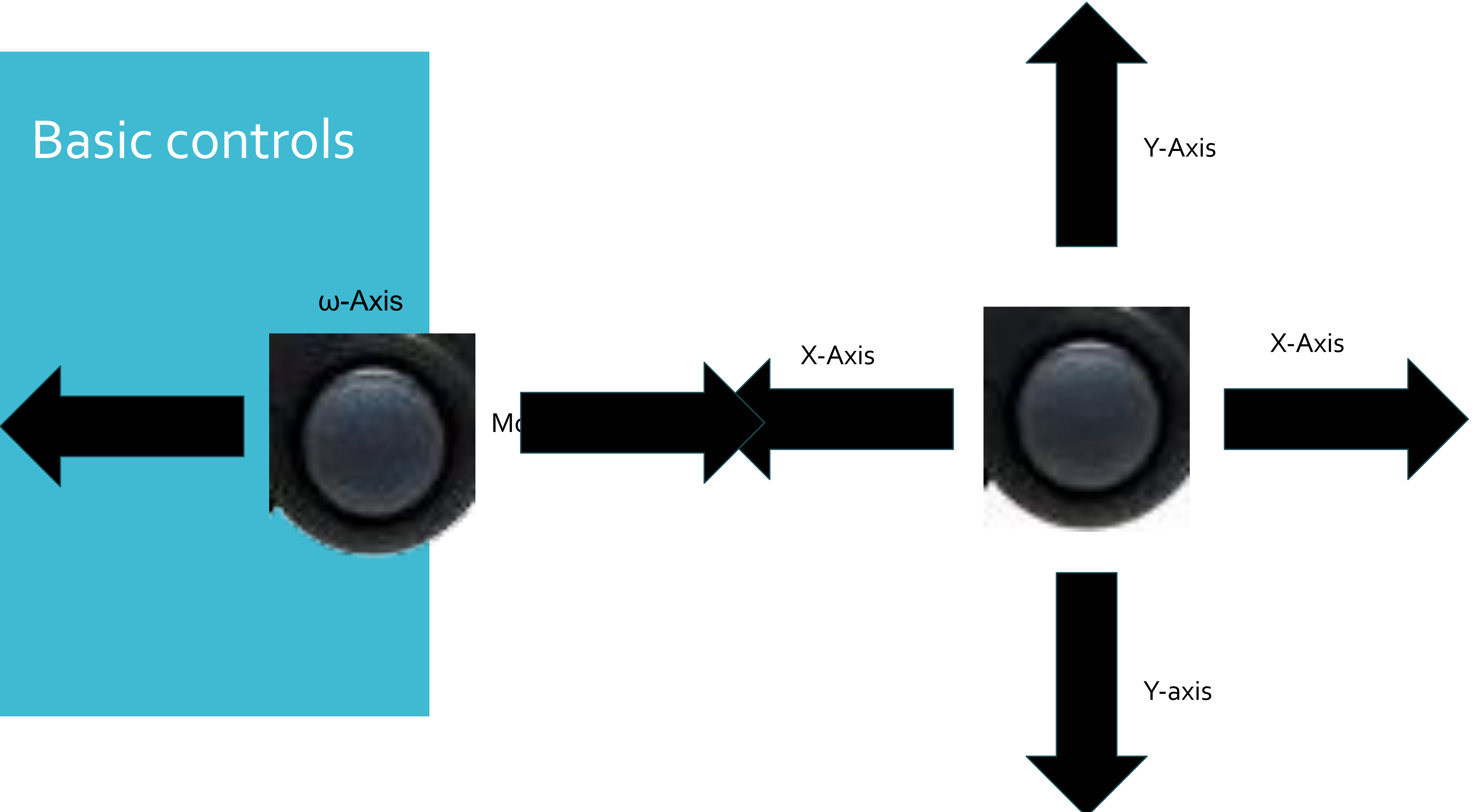
Swerve drive math

Basic controls



Unit circles!

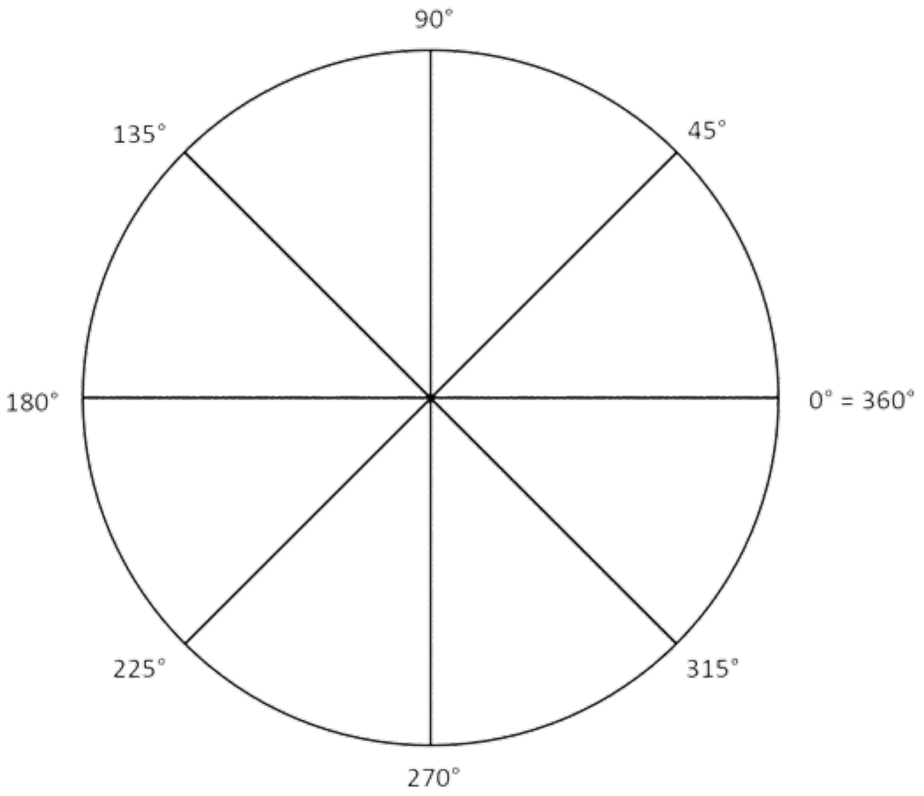
Unit circles are what we use to get the angles for the movements we need

Unit circle give us an exact angle between 0 and 0 left 90 top 180 right 270 down and 360 left again

Notice the similarities between a joystick and a unit circle

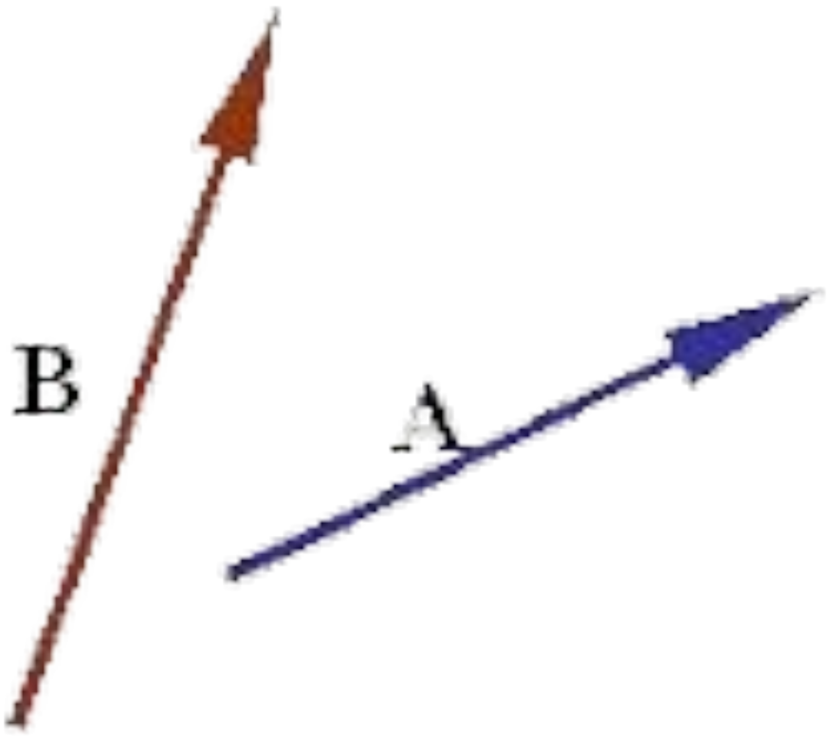
This is because we use a joystick to get an angle on a unit circle for movement

For rotation the angle of the wheel will always be 45 but the joy stick just tells us which direction for the wheel to spin



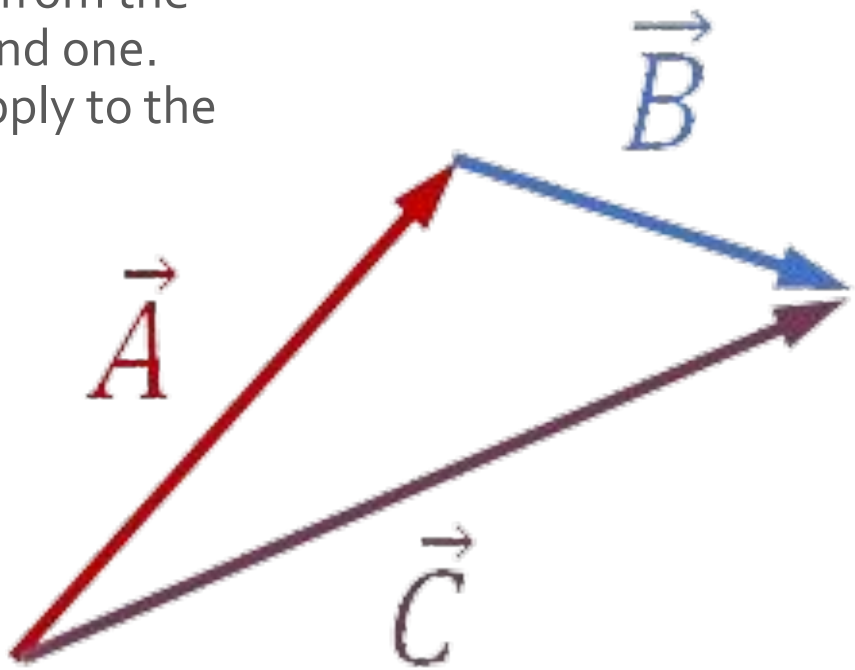
Vectors

A vector is a magnitude(a value) and a direction. For us the magnitude will be between 0 and 1 and we will will get by how far the joystick is pushed. If its pushed to the edge it will be 1 half way to the edge 0.5 and etc. And we get the direction from the unit circle in the previous slide



Tip to Tail(adding vectors)

Now we now know how to get the angles and forces for movement and rotation so now lets see how to make it so we can move and rotate at the exact same time. How we do this is we do tip to tail where we take the vectors we got from the previous slide combine them. We do this by taking the tail of the second one putting it on the tip of the first and then drawing a new vector from the tail of the first one to the tip of second one. This new vector is the one we will apply to the wheel.



Equations

The equations to get the vector we need are

$V1=V+\omega r$

V1 is the vector we want for the first wheel V is the movement vector and ω is the rotation vector and r is the radius

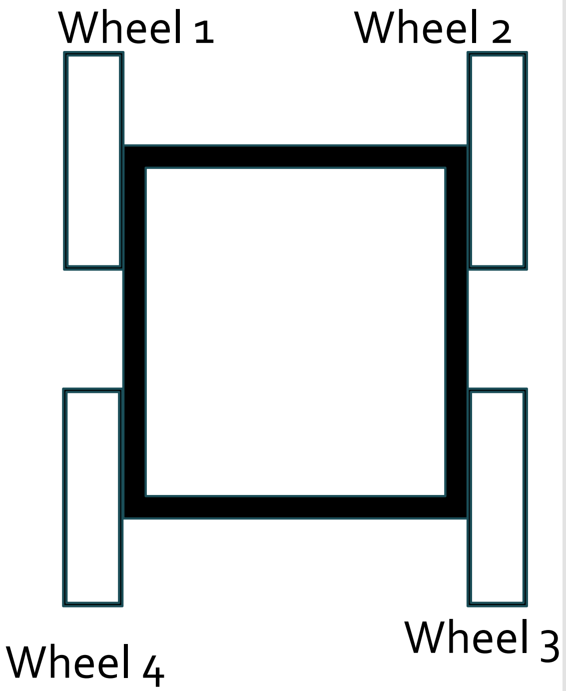
To get more precise values we can use the 2 equations

$V1x = Vx + (\omega r)x$ And $V1y = Vy + (\omega r)y$

Which can be simplified to

$V1x = Vx + \omega L/r$ And $V1y = Vy - \omega W/r$

The other wheel equations are
Wheel 2: $V2x=vx+\omega L/r$ $V2y=Vy+\omega W/r$
Wheel 3: $V3x=Vx-\omega L/r$ $V3y=Vy+\omega W/r$
Wheel 3: $v4x=Vx-\omega L/r$ $V4y=Vy-\omega W/r$



- W = track width
- L= wheelbase
- R(radius) = sqrt(L^2+W^2)

Equations part 2

We can simplify the equations even further by creating 4 variables A, B, C, and D

$A=Vx-\omega L/r$ $B=Vx+\omega L/r$

$C=Vy-\omega W/r$ $D=Vy+\omega W/r$

These variables simplify the equations to

Wheel 1= $V_{1x}=B$ $V_{1y}=C$
Wheel2= $V_{2x}=B$ $V_{2y}=D$
Wheel3= $V_{3x}=A$ $V_{3y}=D$
Wheel4= $V_{4x}=A$ $V_{4y}=C$

We can lose get equations to solve for the speed and angle of the wheels

Wheel1: speed=sqrt(B^2+c^2) angle=atan2(B,C)*180/pi
Wheel2: speed=sqrt(B^2+D^2) angle=atan2(B,D)*180/pi
Wheel3: speed=sqrt(A^2+D^2) angle=atan2(A,D)*180/pi
Wheel4: speed=sqrt(A^2+C^2) angle=atan2(A,C)*180/pi