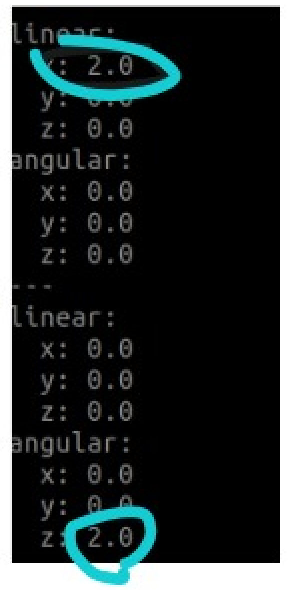
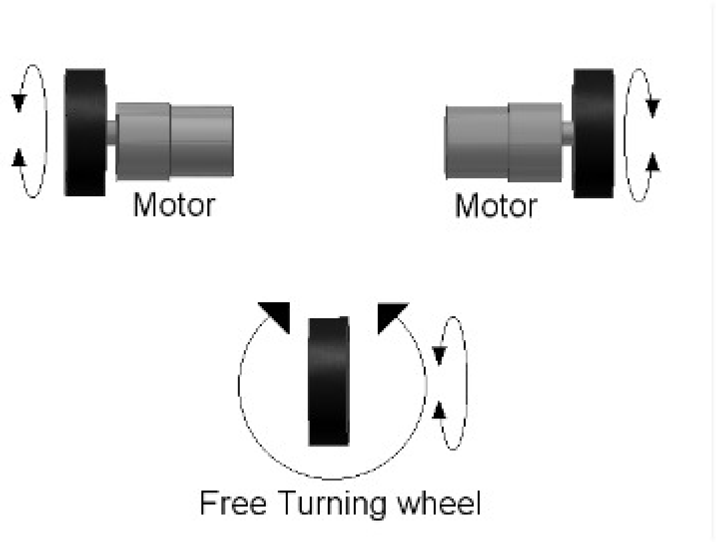
why We need kinematics in mobile robot?

As ROS is sending command velocity data in
(v ,w) [unicycle model]



But in Real Robot we need speed command for left wheel and Right wheel (Vl , Vr)

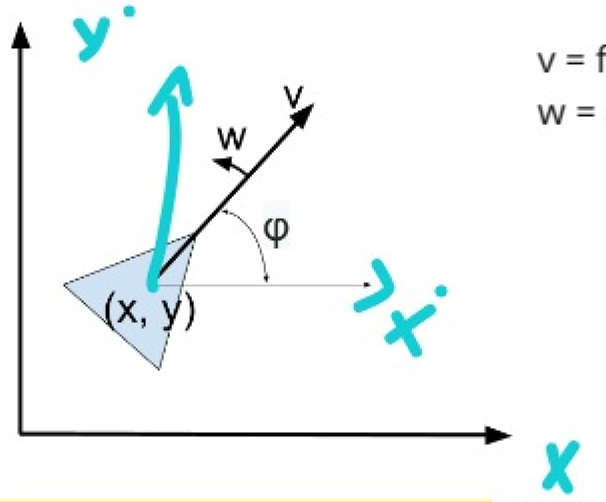


so we need some equations to convert (v ,w) To (Vl , Vr)

and that's what Forward kinematics do...

Forward kinematics of a differential robot

Unicycle Model → convert (V,W) To (Vl,Vr) → Differential Drive Model

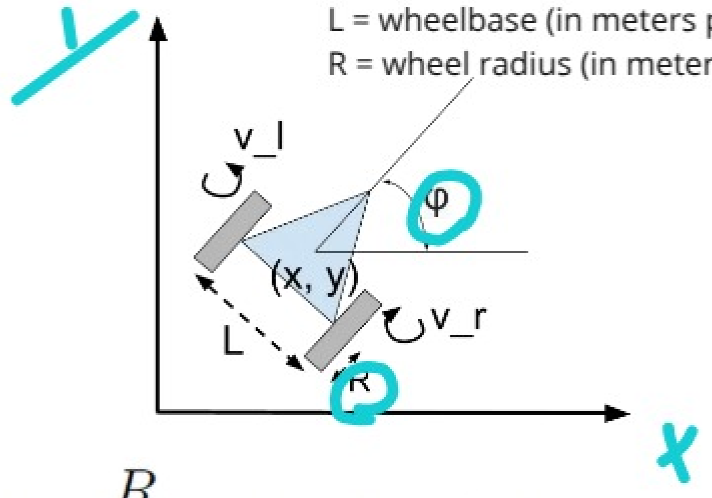


v = forward velocity (ie meters per second)
w = angular velocity (ie radians per second)

$$\dot{x} = v\cos(\phi)$$

$$\dot{y} = v\sin(\phi)$$

$$\dot{\phi} = w$$



L = wheelbase (in meters per radian)
R = wheel radius (in meters per radian)

$$\dot{x} = \frac{R}{2}(v_r + v_l)\cos(\phi)$$

$$\dot{y} = \frac{R}{2}(v_r + v_l)\sin(\phi)$$

Robot is Non-Holonomic
so we will neglect movement in Y

$$\phi' = \frac{R}{L}(v_r - v_l)$$

Final forward kinematics Equations

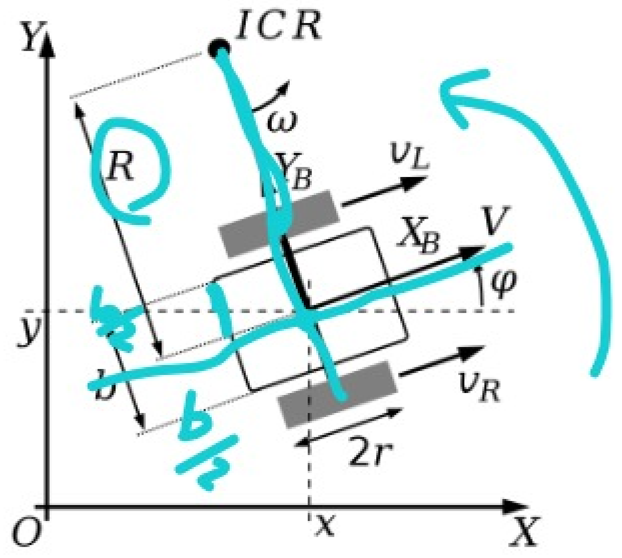
$$v_l = \frac{2v - wL}{2R}$$

$$v_r = \frac{2v + wL}{2R}$$

Inverse kinematics of a differential robot

Odometry: is x,y and theta position of the robot according to starting location

vehicle always rotates around a point
(referred to as ICR - instantaneous center of rotation).

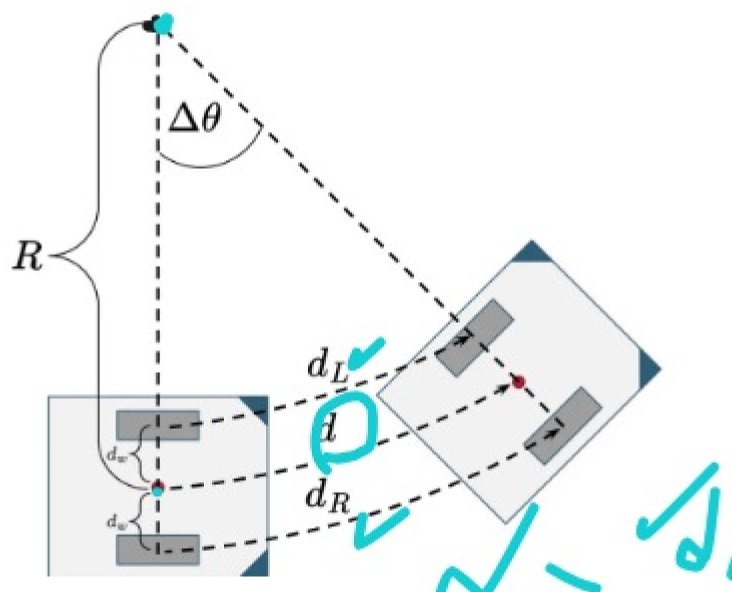


$$V = \omega \cdot R$$

$$\omega \cdot (R + b/2) = v_R$$
$$\omega \cdot (R - b/2) = v_L$$

Solving these two equations for W and R, while the latter is defined as the distance from ICR to the center of the robot

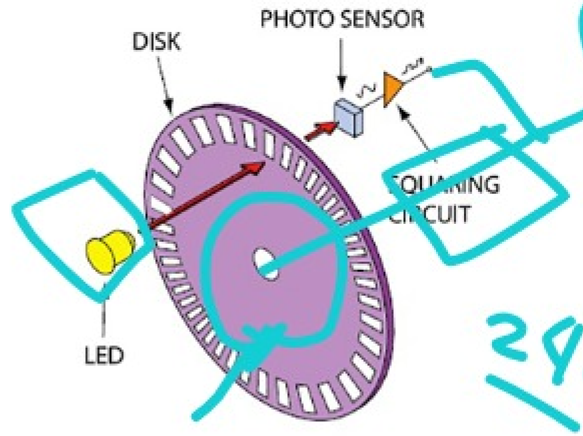
$$\omega = (v_R - v_L)/b$$



$$V = \frac{v_R + v_L}{2}$$

$$v_R = r \cdot \omega_R$$
$$v_L = r \cdot \omega_L$$

Calculate (Wr ,Wl) from wheel encoder



24 count

revolutions = Δ*count* / *counts per revolution*

$$w_{wheel} = \frac{revolutions}{\partial t}\ rad/s$$

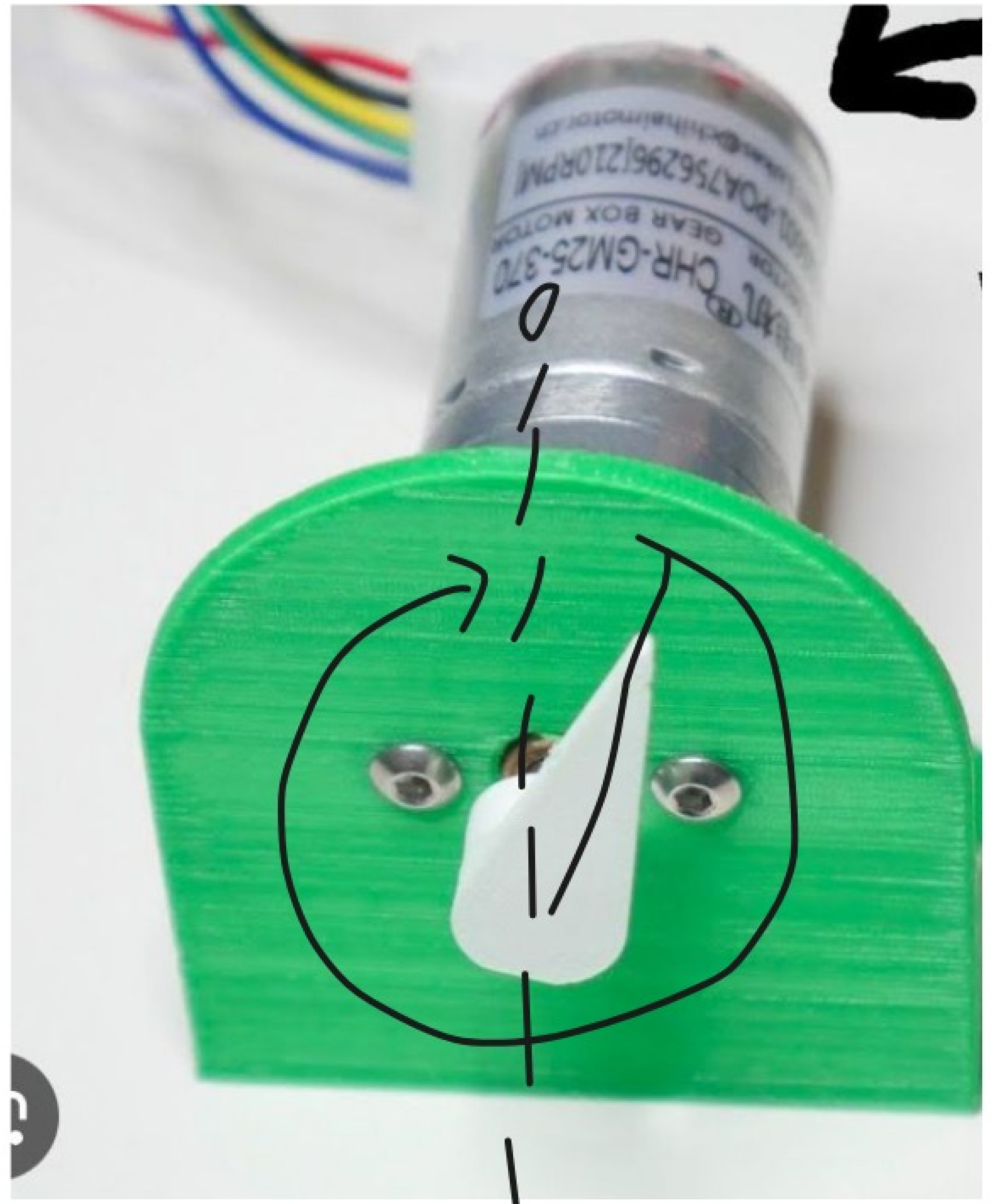
To Calculate odometry from (V ,W) of the Robot

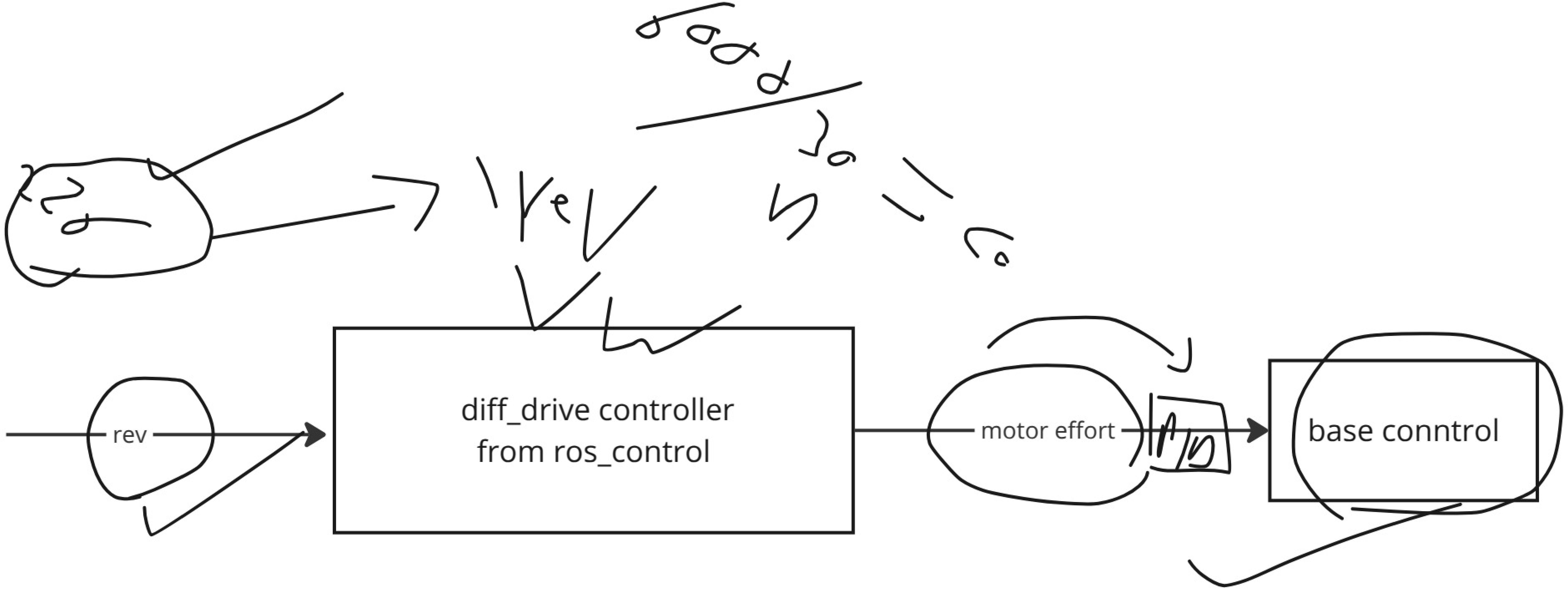
$$\Delta x = v \cdot \cos(\phi) * \partial t$$
$$\Delta y = v \cdot \sin(\phi) * \partial t$$
$$\Delta \phi = w * \partial t$$

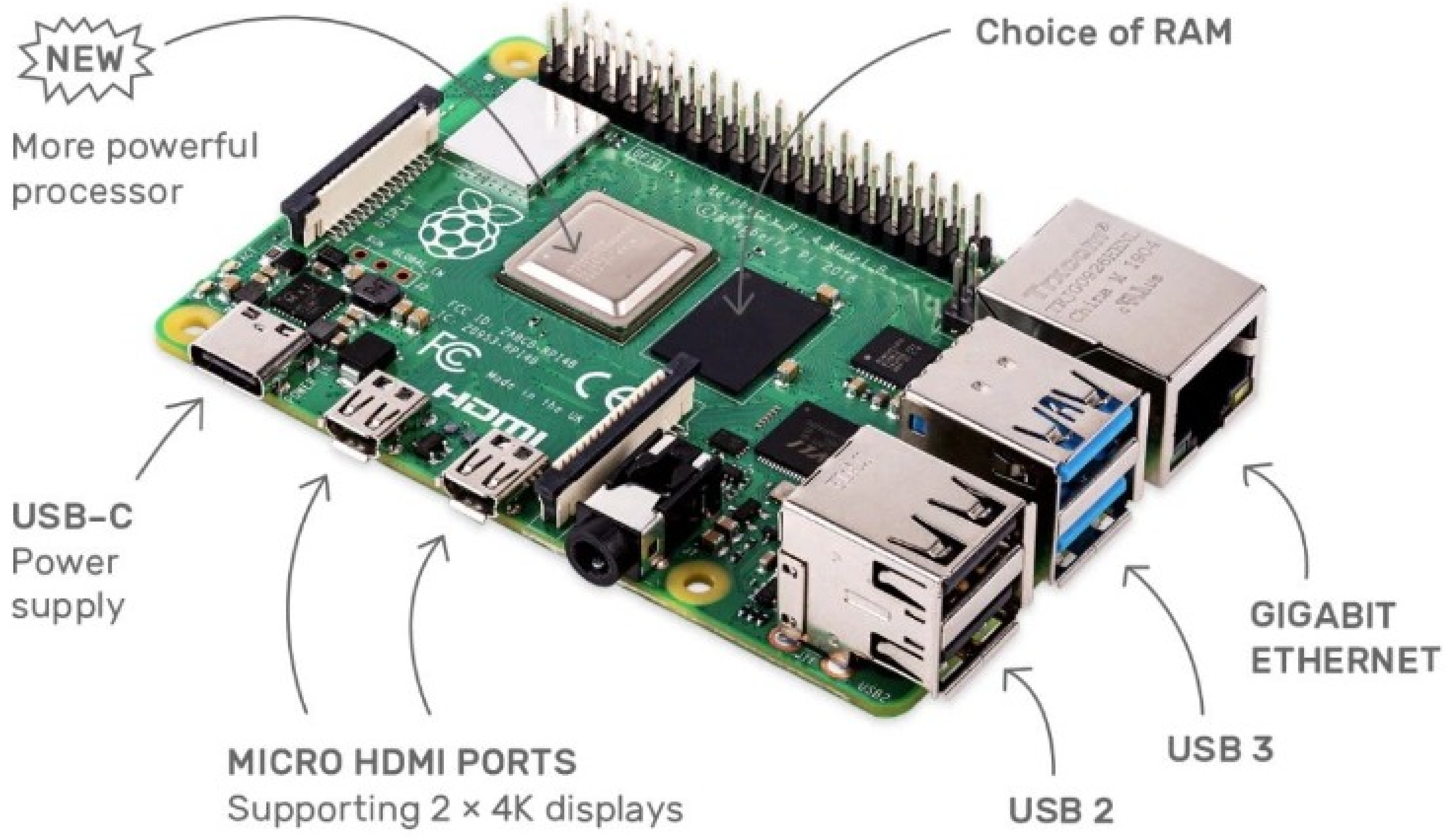
$$x = x + \Delta x$$
$$y = y + \Delta y$$
$$\phi = \phi + \Delta\phi$$

1 RPS

Get encoder resolution (count/rev)



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