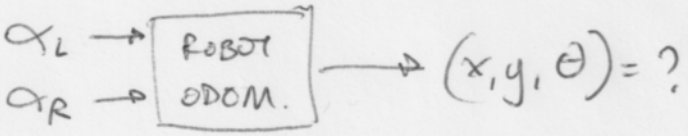
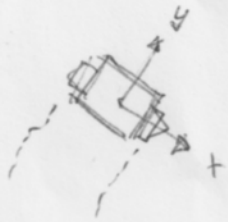
ODOMETRY II (LOCALIZATION)

I. FORWARD MOTION



- all a matter of keeping track of incremental robot motions and accumulating values to determine an overall position
  - ↳ similar to "counting steps"

ASSUMPTIONS



1. 2-wheeled non-holonomic robot (i.e. WALL-E)
2. all forward motions move the robot forward by an amount:

   δ_l = the incremental amount moved in displacement by a single forward motion command.

3. all backward motions move the robot backward by an amount:

   $-\delta_l$ = the incremental amount moved in displacement (backwards) by a single backward motion command.

4. all turns move the robot clockwise / counter-clockwise by an amount:

   δ_θ = left turn

   $-\delta_\theta$ = right turn

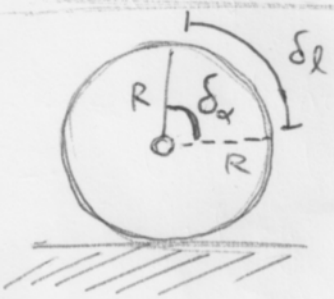
5. all turns will be considered IN-PLACE_TURNS.

NOTE: $\boxed{\delta_\ell}$ and $\boxed{\delta_\theta}$ are representative of the smallest incremental change that can be made in forward/backward motion and rotational motion, respectively.
It can either be derived from the smallest angle change of the motor, or specified by user preference.

(ex.) Suppose we set:

$$\delta_\ell = 0.005 \text{ m}$$

and the wheel radius $R = 0.027$ m



$$\delta_\ell = R \cdot \delta_\alpha$$

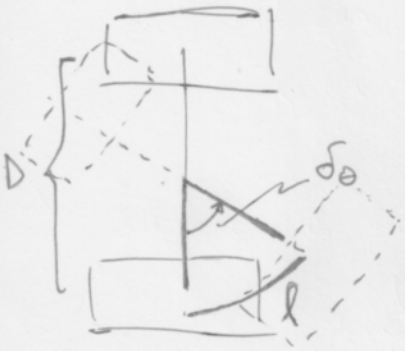
$$0.005 = 0.027 \times \delta_\alpha$$

$$\boxed{\begin{aligned} \delta_\alpha &= 0.185 \text{ (rad)} \\ &= 10.6^\circ \text{ (deg)} \end{aligned}}$$

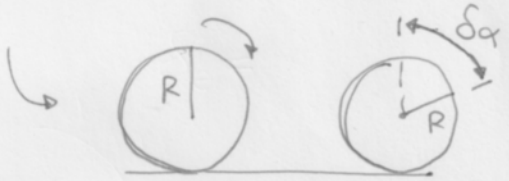
this is how much to command α_L, α_R for every forward command motion; i.e. if the user wants every forward command motion to result in 0.005 m of incremental travel, then the user must program a forward command to move the left & right wheels to rotate 10.6°.

ex) Suppose we set:

$\delta_\theta = 1.0°$ and the wheel radius $R = 0.027\,m$ and the wheel base $D = 0.12\,m$



$$l = \frac{D}{2} \cdot \delta_\theta \qquad \alpha_L = -\alpha_R$$



$$l = R \cdot \delta_\alpha = \frac{D}{2} \cdot \delta_\theta$$

$$\delta_\alpha = \frac{D}{2} \cdot \frac{\delta_\theta}{R}$$

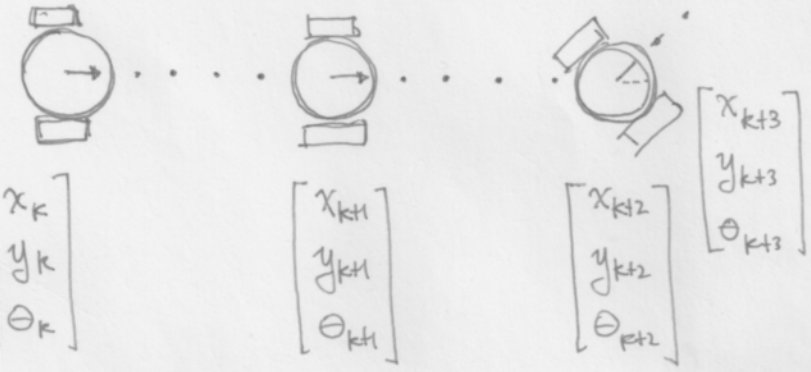
$$= \frac{0.12}{2} \cdot \frac{1°}{0.027}$$

$$\boxed{\delta_\alpha = 2.22°}$$

this is how much to command α_L (and $-\alpha_R$) for every incremental in-place turn motion command.

i.e. if the user wants every turn motion command to result in 1.0° of heading change, then the user must program a turn motion command to move the left wheel by 2.22° and the right wheel by −2.22°. (right turn; for left turn, switch signs)

PUTTING IT ALL TOGETHER



$$x_{k+1} = x_k + \delta_\ell \cdot \cos\theta_k$$
$$y_{k+1} = y_k + \delta_\ell \cdot \sin\theta_k$$
$$\theta_{k+1} = \theta_k + \delta_\theta$$

$\Rightarrow$ RECALL: δ_ℓ & δ_θ user defined !!

Thus at any moment in time, (x_k, y_k, θ_k) represent the "POSE" of the robot.

(*) when forward/backward command motions are called,
$\delta_\ell \neq 0, \ \delta_\theta = 0$

(*) when turn motion commands are called,
$\delta_\ell = 0, \ \delta_\theta \neq 0$