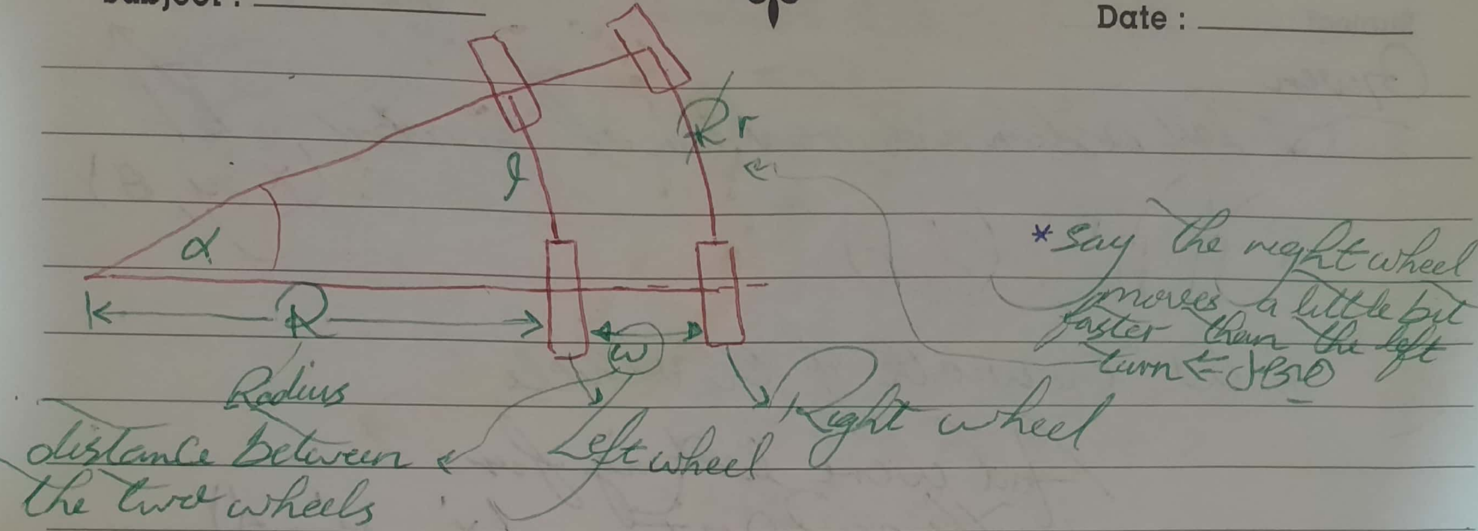
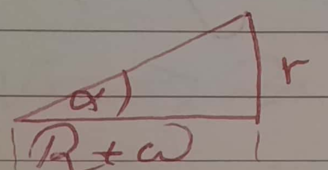
SLAM

Subject :

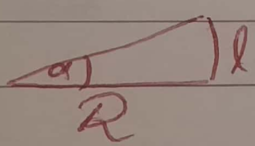
Date :





$$r = \alpha \cdot (R + \omega)$$

⊖



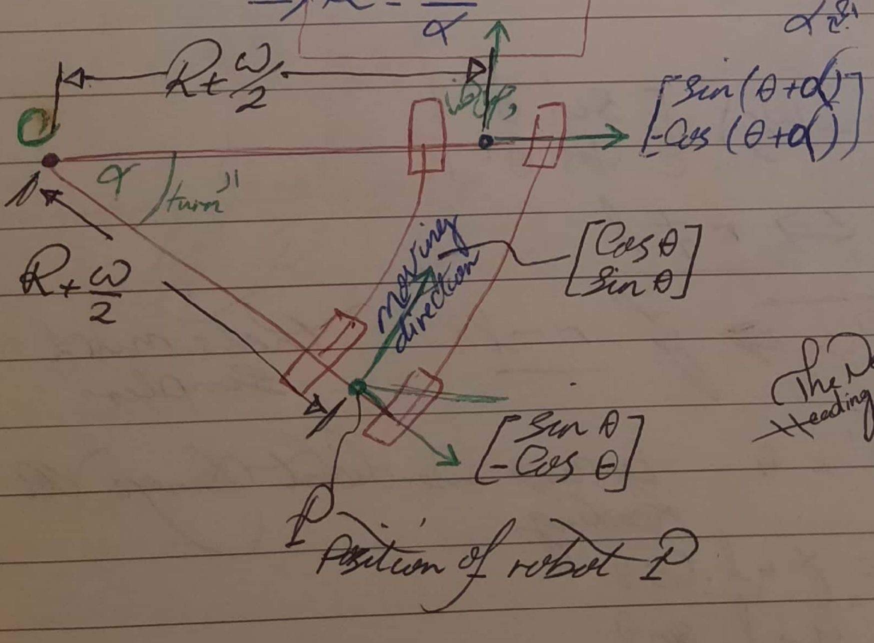
$$l = \alpha R$$

$$r - l = \alpha \cdot \omega$$

$$\Rightarrow \alpha = \frac{r - l}{\omega}$$

$\alpha \neq 0$

$$\Rightarrow R = \frac{l}{\alpha}$$



Center

$$C = P - \left(R + \frac{\omega}{2}\right) \cdot \begin{bmatrix} \sin\theta \\ -\cos\theta \end{bmatrix}$$

$$P' = C + \left(R + \frac{\omega}{2}\right) \begin{bmatrix} \sin(\theta+\alpha) \\ -\cos(\theta+\alpha) \end{bmatrix}$$

The New Heading $\theta' = (\theta + \alpha) \bmod 2\pi$

%(2*Pi) في البايثون

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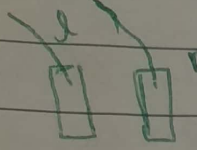
Given

* last position and orientation of the robot (x, y, θ)

* (l, r) 

* w the width of the vehicle

And we're looking for the new position (x', y', θ')

So, we first Compute

1- $\alpha = \frac{r-l}{w}$

2- $R = l/\alpha$

3- $\begin{bmatrix} c_x \\ c_y \end{bmatrix} = \begin{bmatrix} x \\ y \end{bmatrix} - (R + \frac{w}{2}) \begin{bmatrix} \sin\theta \\ -\cos\theta \end{bmatrix}$

Center — old position — vector) which uses the old heading

4- $\theta' = (\theta + \alpha) \bmod 2\pi$

the old — the New Heading

5- $\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} c_x \\ c_y \end{bmatrix} + (R + w/2) \cdot \begin{bmatrix} \sin\theta' \\ -\cos\theta' \end{bmatrix}$

the new position

if $\alpha \neq 0 \Leftrightarrow r \neq l$

The second Case → if $r = l$: that's much simpler

Robot goes straight

$\theta' = \theta$ because we didn't change the heading

$x' = x + l \cdot \cos\theta$

$y' = y + l \cdot \sin\theta$

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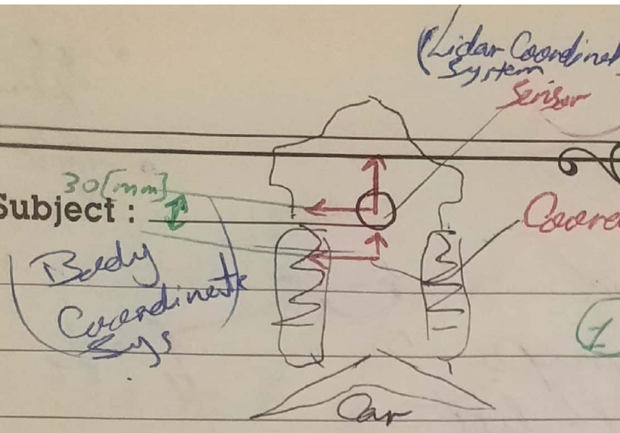
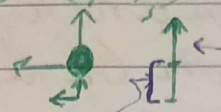


① (الإزاحة) displacement عندنا



نحتاج نsubtract الإزاحة دي

② 2nd Modification

different starting point

③ Output to file

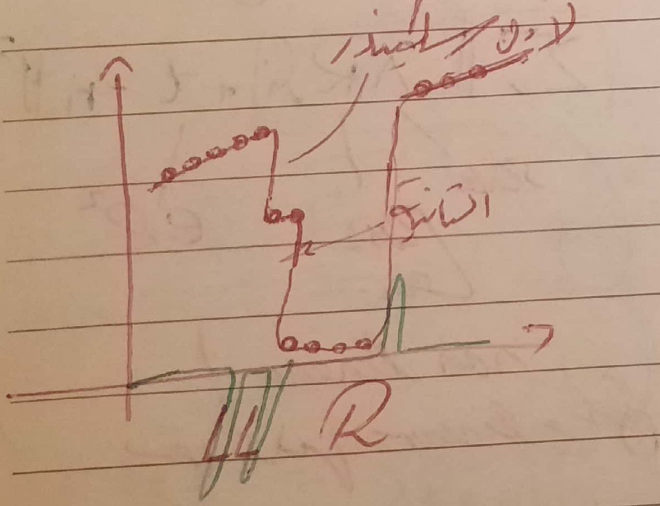
* RViz ⇒ Ros visualizer

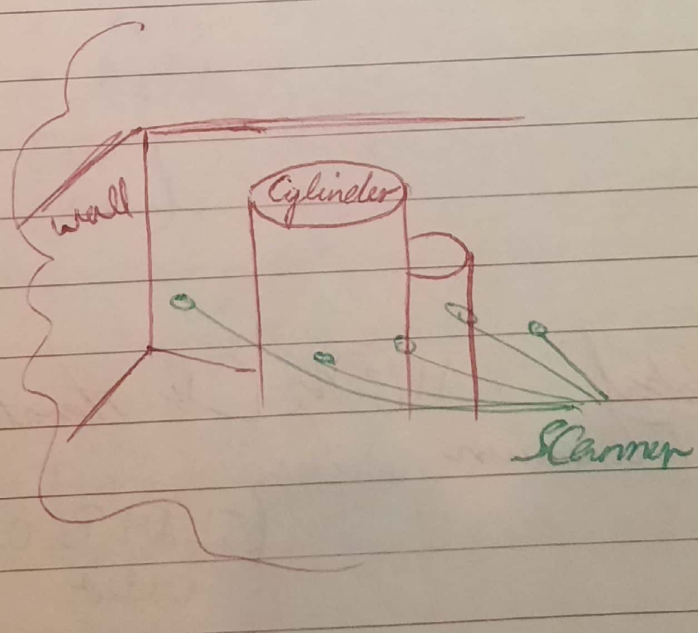
سنحتاج علشان نشوف ال Sensors اللي جاية من الروبوت وشايفاه

* Gazebo

عامل زي simulation world فيها الحقيقة

تبدأ تحط الروبوت بتاعك وتشوفه بيتحرك إزاي





• left list of points
• right list of

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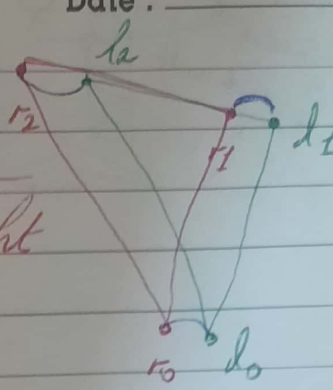
We want to know / find the transformation which maps all the points from the left list to their partners in the right

Similarity transform



$\lambda R l_i + t = r_i$

- λ: scale, ∈R — معامل الضرب
- R: rotate — مصفوفة الدوران, 4 values $\begin{bmatrix} \cos\alpha & -\sin\alpha \\ \sin\alpha & \cos\alpha \end{bmatrix}$, $\alpha \in [0, 2\pi]$
- l_i: given left point
- t: offset shift — معامل الإزاحة, $\in R^2$
- r_i: right partner — النقطة المشتركة

λR t_x, t_y

* لازم نعمل minimize الـ squared length بين النقاط والزاوية بعد التحويل

⇓

$$\sum \| \lambda R l_i + t - r_i \|^2$$

scalar, $\begin{bmatrix} \cos & - \\ \sin & ... \end{bmatrix}$, $\in R^2$

non linear!

Global Minimum — لما نعمل iteration على linear يبقى تكلفة

(SLAM B 02) video

minimize ولازم نعمل

should be maximized لازم نعمل

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$\sum r_i'^T R l_i'$ لازم

sorry

$$\lambda = \sqrt{\frac{\sum \|r_i'\|^2}{\sum \|l_i'\|^2}}$$

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Given: $l_i, r_i \quad 1 \le i \le m$

Compute: $\bar{l} = \frac{1}{m}\sum l_i \qquad \bar{r} = \frac{1}{m}\sum r_i$

$l_i' = l_i - \bar{l} \qquad r_i' = r_i - \bar{r}$

$\begin{bmatrix} l_{x,:}' \\ l_{y,:}' \end{bmatrix} \qquad \begin{bmatrix} r_{x,}' \\ r_{y}' \end{bmatrix}$

Cos Sum Sin Sum

$Cs, Ss, rr, ll = 0\,0$

for i in 1...m:

$Cs \mathrel{+}= r_x' l_x' + r_y' l_y'$

$Ss \mathrel{+}= -r_x' l_y' + r_y' l_x'$

$rr \mathrel{+}= r_x r_x + r_y r_y$

$ll \mathrel{+}= l_x l_x + l_y l_y$

$\lambda = \sqrt{\frac{rr}{ll}}$ | $\begin{matrix}\cos \\ \sin\end{matrix} \begin{bmatrix} c \\ s \end{bmatrix} = \begin{bmatrix} Cs \\ Ss \end{bmatrix} / \sqrt{Cs^2 + Ss^2}$

$\begin{bmatrix} t_x \\ t_y \end{bmatrix} = \bar{r} - \lambda R \bar{c} = \begin{bmatrix} \bar{r}_x \\ \bar{r}_y \end{bmatrix} - \lambda \begin{bmatrix} c & -s \\ s & c \end{bmatrix} \begin{bmatrix} \bar{l}_x \\ \bar{l}_y \end{bmatrix}$