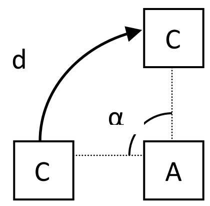
SLAM (simultaneous localization and mapping) using dead reckoning odometry methods

Turn Odometry

-robot turns keeping one wheel stationary e.g keeping wheel A stationary as shown in the figure.



-convert wheel rotation into arc length d from the rotation of the motor in degrees using: $d = \frac{\theta}{360} \times tyre\ circumference$

-now find the angle through which the robot turned using:

$$\alpha = \frac{d}{robot\ cirumference} \times 360$$

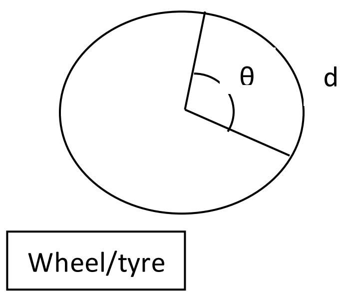
Where robot circumference = $2\pi r$ and r= distance between wheels/2

Straight Odometry

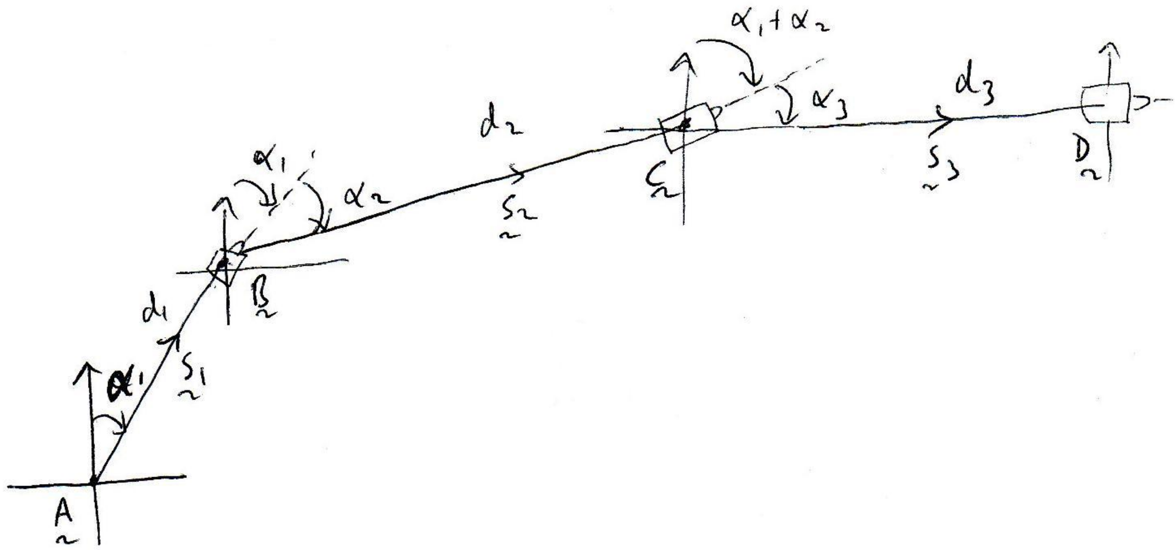
-robot moves in a straight line

-find the distance travelled by converting the rotation of the wheel into arc length d as done above:

$$d = \frac{\theta}{360} \times 2\pi r_{tyre}$$



-now consider the figure below



-before motion:

$$suma = 0$$

$$\bar{A} = 0$$

-robot turns clockwise by α1: $suma = \alpha_1 \quad / -\alpha_1 if\ robot\ turns\ anticlockwise$

$$\bar{s}_1 = d_1 \sin(suma)i + d_1 \cos(suma)j$$

$$\bar{B} = \bar{A} + \bar{s_1}$$

-robot turns clockwise by α2:

$$suma = \alpha_1 + \alpha_2 \qquad / -\alpha_2\ if\ robot\ turns\ anticlockwise$$

$$\bar{s}_2 = d_2 \sin(suma)i + d_2 \cos(suma)j$$

$$\bar{C} = \bar{B} + \bar{s_2}$$

-robot turns clockwise by α3:

$$suma = \alpha_1 + \alpha_2 + \alpha_3 \qquad / -\alpha_3\ if\ robot\ turns\ anticlockwise$$

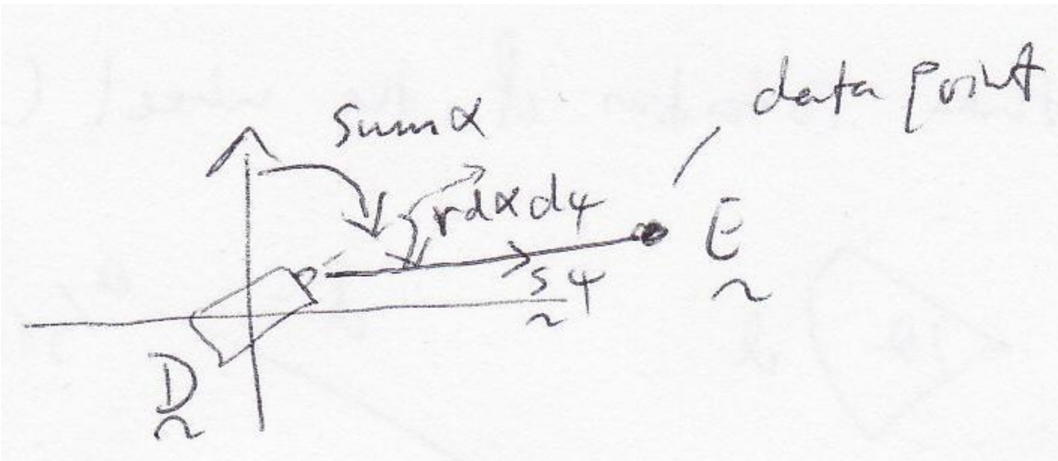
$$\bar{s}_3 = d_3 \sin(suma)i + d_3 \cos(suma)j$$

$$\bar{D} = \bar{C} + \bar{s_3}$$

In general: $\overline{location} = \overline{last\_location} + \overline{displacement}$

For printing the map

-consider the figure below



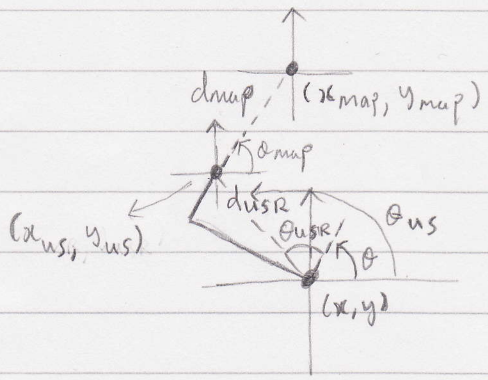
-u.s sensor right by rdα:

$$rdsuma = suma + rd\alpha \qquad / -rd\alpha\ if\ u.s\ rotates\ anticlockwise$$

$$\bar{s}_4 = d_4 \sin(rdsuma)i + d_4 \cos(rdsuma)j$$

$$\bar{E} = \bar{D} + \bar{s_4}$$

Mapping



$$\theta_{us} = \theta_{usR} + \theta$$

$$x_{us} = x + d_{usR} \cos \theta_{us}$$
$$y_{us} = y + d_{usR} \sin \theta_{us}$$

$$\theta_{map} = \theta + \theta_{usM}$$

$$x_{map} = x_{us} + d_{map} \cos \theta_{map}$$
$$y_{map} = y_{us} + d_{map} \sin \theta_{map}$$

Note: Convert θ_{us} & θ_{map} to angles between 0 & 360

Initially u.s sensor must face forward & hence $\theta_{usm} = 0$