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EEE187 - 01
HOMEWORK 01

Robotics: Homework Assignment # 1

Problem 1

A differential drive robot is characterized by the following kinematics equations:

$$\dot{x} = v \cos(\theta) \quad (1)$$

$$\dot{y} = v \sin(\theta) \quad (2)$$

$$\dot{\theta} = \omega \quad (3)$$

We know that

- Speed of the right wheel is $35rpm$
- Speed of left wheel is $30rpm$
- Radius of the wheels $5cm$
- Distance between the wheels is $25cm$

Answer the following questions

- 1) What is the angular speed of the wheels in rad/s?
- 2) What is the linear velocity of the robot?
- 3) What is the angular velocity of the robot?
- 4) Determine the location of the ICC.
- 5) Assuming the initial configuration is $(x_0, y_0, \theta_0) = (10m, 10m, 0)$. What is the position and orientation of the robot after 9s?

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GIVEN: $n_r = 35 \text{ rpm}$

$n_1 = 30 \text{ rpm}$

$r = 5 \text{ cm}$

$L = 25 \text{ cm}$

1. What is the angular speed of the wheels in rad/s?

$$\omega_r = \frac{35 \text{ rpm}}{60} \cdot 2\pi = \frac{7\pi}{6} \text{ rad/s}$$

$$\omega_1 = \frac{30 \text{ rpm}}{60} \cdot 2\pi = \pi \text{ rad/s}$$

2. What is the linear velocity of the robot?

$$v = \frac{r}{2} (\omega_r + \omega_1) = \frac{0.05}{2} \left(\frac{7\pi}{6} + \pi \right) = \frac{13\pi}{240} \text{ m/s} \approx 0.170 \text{ m/s}$$

3. What is the angular velocity of the robot?

$$\omega = \frac{r}{L} (\omega_r - \omega_1)$$

$$= \frac{5 \text{ cm}}{25 \text{ cm}} \left(\frac{7\pi}{6} - \pi \right) = \frac{\pi}{30} \text{ rad/s} \approx 0.105 \text{ rad/s}$$

4. Determine the location of the ICC.

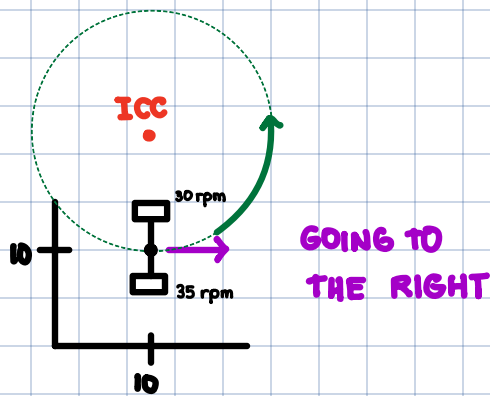
$$R = \frac{L}{2} \cdot \frac{v_r + v_1}{v_r - v_1} \quad v = r\omega \text{ or } r\omega$$

$$= \frac{0.25}{2} \cdot \frac{\omega_r + \omega_1}{\omega_r - \omega_1}$$

$$= \frac{0.25}{2} \cdot \frac{\frac{7\pi}{6} + \pi}{\frac{7\pi}{6} - \pi} = \frac{13}{8} \text{ m} \approx 1.625 \text{ m}$$

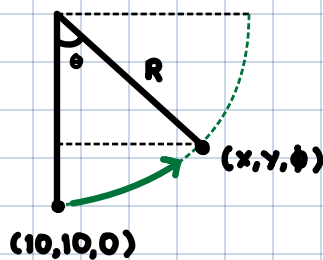
ICC is located at 1.625 m distance from the reference point of the robot.

5. Assuming the initial configuration is $(x_0, y_0, \theta_0) = (10\text{ m}, 10\text{ m}, 0)$.
what is the position and orientation of the robot after 9s?



$$\text{ICC: } x = 10\text{ m}$$

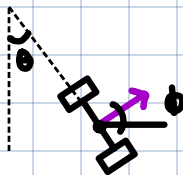
$$y = 10 + R = 10 + 1.625 = 11.625\text{ m}$$



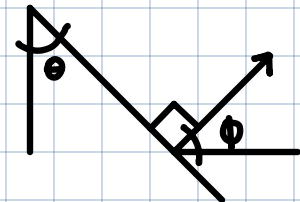
$$\theta = \omega t = (\pi/30)(9) = 3\pi/10$$

$$\begin{aligned} x &= 10 + R \sin \theta \\ &= 10 + 1.625 \sin(3\pi/10) \\ &= 11.315\text{ m} \end{aligned}$$

$$\begin{aligned} y &= 10 + R - R \cos \theta \\ &= 10 + 1.625 - 1.625 \cos(3\pi/10) \\ &= 10.670\text{ m} \end{aligned}$$



$$\phi = \theta = 3\pi/10$$



The position and orientation of the robot after 9s
is $(11.315\text{ m}, 10.670\text{ m}, 3\pi/10)$

5 Significant Robotic Events:

1. 2002: Roomba robotic vacuum is released
2. 2005: Self-Driving Car named Stanley, a Volkswagen Touareg, won the challenge with AI trained on the driving habits and five "Lidar" laser sensors that identify objects within a 25-meter range.
3. Robonaut 2, a human-like robotic assistant launched into space on space shuttle Discovery to become permanent resident of the International Space Station.
4. 2012: First driveless car is licensed in Nevada.
5. 2015: Sofia as the global celebrity humanoid robot receiving citizenship to a country.

