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Ans to the ques no 1

a) Unicycle Model

- State Variables: x, y, θ
- Control Variables: v , ω (angular velocity)

Equations:

- dx/dt = v * cos(θ)
- dy/dt = v * sin(θ)
- dθ/dt = ω

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b) Differential Drive Robot

- State Variables: x, y, θ
- Control Variables: ωr (right wheel angular velocity), ωl (left wheel angular velocity)
- Constant Variables: r (wheel radius), L (distance between wheels)

Equations:

- dx/dt = (r / 2) * (ωr + ωl) * cos(θ)

- dy/dt = (r / 2) * (ωr + ωl) * sin(θ)
- dθ/dt = (r / L) * (ω*r − ωl)

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c) Simplified Car Model

- State Variables: x, y, θ
- Control Variables: v (linear velocity), φ (steering angle)
- Constant Variables: L (wheelbase)

Equations:

- dx/dt = v * cos(θ)
- dy/dt = v * sin(θ)
- dθ/dt = (v / L) * tan(φ)

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d) Planar Quadrotor

- State Variables: x, y, θ, dx, dy, ω
- Control Variables: T1, T2
- Constant Variables: m (mass), g (gravity), Izz (moment of inertia)

Equations:

- dx/dt = dx
- dy/dt = dy
- dθ/dt = ω

- $d2x/dt2 = -(T1 / m) \times \sin(\theta)$
- $d2y/dt2 = (T1 / m) \times \cos(\theta) - g$
- $d\omega/dt = T2 / Izz$

1(ii)

The Unicycle model moves forward and turns using two controls: speed and turning rate. The Differential Drive robot moves using two wheels. The Simplified Car model moves like a normal car.