

Questions and Solutions

Sol. a) When calculating the maximum angle of inclination for TWSBRs, we consider the following parameters:

1. Center of Gravity (CoG) : The position of the CoG relative to the wheels affects stability. A lower CoG improves balance.

2. Mass and Distribution : The overall mass of the robot and how this mass is distributed influences the tipping point.

3. Wheelbase : The distance between the wheels. A wider wheelbase provides better stability.

4. Motor Torque and Power : The capability of the motors to correct the robot's orientation. Higher torque allows for better correction of larger inclinations.

5. Friction Coefficient : The friction between the wheels and the ground. Higher friction provides better grip and stability.

6. Sensor Accuracy : The precision of gyroscopes and accelerometers. Accurate sensors ensure reliable detection of orientation and quick response to balance adjustments.

Sol. b) The core concept of TWSBR involves:

1. Dynamic Stabilization : The robot continuously monitors its orientation using sensors (gyroscopes and accelerometers) and dynamically adjusts the motor outputs to maintain balance.

2. Control Algorithms : The primary algorithm used is the PID (Proportional-Integral-Derivative) controller. It processes the

sensor data to determine the necessary motor adjustments to correct the robot's orientation and maintain balance.

3. Navigation : Path-planning algorithms, such as A* or Dijkstra's algorithm, are used to navigate the robot through various environments. These algorithms help the robot determine the most efficient path to its destination while avoiding obstacles.

Sol. c) Additional Component to Make TWSBR Unique

Proposed Addition: Solar Charging System

Proof of Concept:

1. Objective : Integrate solar panels into the TWSBR to extend its operational time, especially for outdoor applications. This addition reduces the need for frequent recharging and makes the robot more sustainable.

2. Implementation:

- i) *Solar Panels*: Install lightweight, flexible solar panels on the surface of the robot where they can receive maximum sunlight.
- ii) *Charging Circuit*: Design a charging circuit that can efficiently convert solar energy into electrical energy to charge the robot's battery.
- iii) *Power Management System*: Integrate a power management system that prioritizes solar energy when available and switches to battery power as needed.

3. Benefits:

- i) *Extended Operation*: The robot can operate longer without needing to return to a charging station.
- ii) *Sustainability*: Utilizes renewable energy, reducing the carbon footprint.

iii) *Cost Efficiency*: Decreases the operational costs by reducing the dependency on electrical charging.

Example Implementation : The TWSBR can be used for outdoor parcel delivery. The solar panels charge the robot during transit and while waiting at the delivery point, ensuring it has enough power to return to the base or continue deliveries without interruption. This system is particularly beneficial in sunny climates where solar energy is abundant.