**Project #2: Ball Balancing Bot - Task 4 (Part A)**

**Ideal Mechanism for Ball Balancing with Unlimited Actuators**

**1. Mechanical Design**

For maximum precision and stability, I propose a **3-DOF parallel robotic platform** using **three linear actuators** arranged symmetrically at 120° apart.

* **Actuator Type:** High-precision **linear servo actuators**=
* **Platform:** A flat, lightweight carbon-fiber plate.
* **Joints:** Spherical joints at both ends of each actuator for smooth tilting.
* **Sensing:** High-resolution **optical tracking** (or LiDAR) for real-time ball position feedback, or the sensing methods I have included in Part B file.

**2. How Additional DOFs Improve Performance**

* **3-DOF Control:** Unlike the original 2-DOF (tilt X & Y), this design allows **heave (Z-axis) control**, enabling:
  + **Active damping** (lifting/lowering the platform to absorb ball momentum).
  + **Faster corrections** (linear actuators can adjust tilt and height simultaneously).
* **Parallel Kinematics:** More rigid and responsive than serial linkages.

**3. Pros and Cons**

| **Pros** | **Cons** |
| --- | --- |
| Higher stability (3D control) | More complex control |
| Faster response (parallel actuation) | Higher cost (3 precision actuators) |
| Reduced oscillations (Z-axis damping) | Increased weight/power |
| More fault-tolerant (one actuator failure still allows partial control) | Calibration complexity |