**Non-Vision Sensing Approaches for Ball Tracking**

Since cameras are excluded, we need alternative methods to track the ball’s 2D position (X,Y) on the platform. Below are two viable approaches:

**1: IR Proximity Sensors**

**1. Sensors & Specifications**

* **Sensor Type:** **Multiple IR distance sensors**
* **Key Specs:**
  + Range (~10cm–80cm).
  + Fast update rate (~50Hz).
  + Narrow beam angle (~5°–10°).

**2. How It Tracks Motion**

* **Three or more IR sensors** are mounted around the platform edges at known positions.
* Each sensor measures the distance to the bal**l** (assuming a reflective or IR-absorbing surface).
* A microcontroller uses triangulation (trilateration) to compute the ball’s **(X,Y)** position.
* Motion is tracked by continuously updating distance readings.

**3. Pros & Cons**

| **Pros** | **Cons** |
| --- | --- |
| Works with non-conductive balls | Lower accuracy (~5mm error due to sensor noise) |
| Simple hardware setup (fewer sensors than a grid) | Latency (filtering needed for smooth tracking) |
| No contact required (good for fast-moving balls) | Affected by ambient IR light |

**2: Hall Effect Sensor Array (Magnetic Ball Tracking)**

**1. Sensors & Specifications**

* **Sensor Type:** **Grid of Hall effect sensors**
* **Key Specs:**
  + High sensitivity (±5mV/Gauss).
  + Fast response time (~3µs).
  + Dense arrangement (e.g., 8×8 grid).

**2. How It Tracks Motion**

* The ball contains a **small embedded magnet**.
* The Hall sensor array detects magnetic field changes as the ball moves.
* A microcontroller interpolates the strongest signals to estimate **(X,Y)** position.
* Motion is tracked via **changes in field strength** across sensors.

**3. Pros & Cons**

| **Pros** | **Cons** |
| --- | --- |
| High precision (~1mm possible) | Requires magnetic ball |
| No physical contact | Affected by external magnetic fields |
| Low latency (fast response) | Complex wiring for dense grids |
| Works in darkness/dust | Limited range (must be close to sensors) |