C5: HoEM Run Derby

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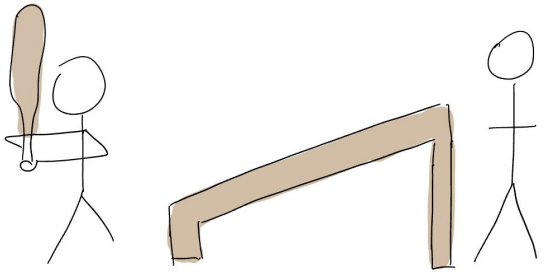
Motivation & Problem

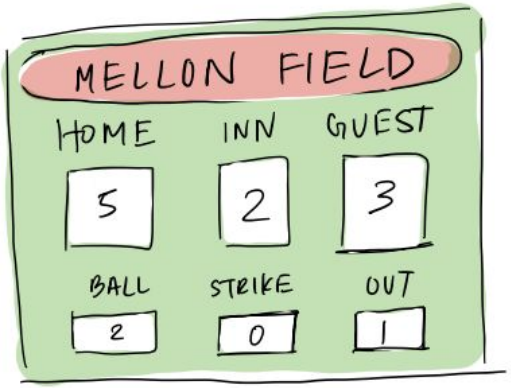
Modern entertainment is often
single-player & screen-bound

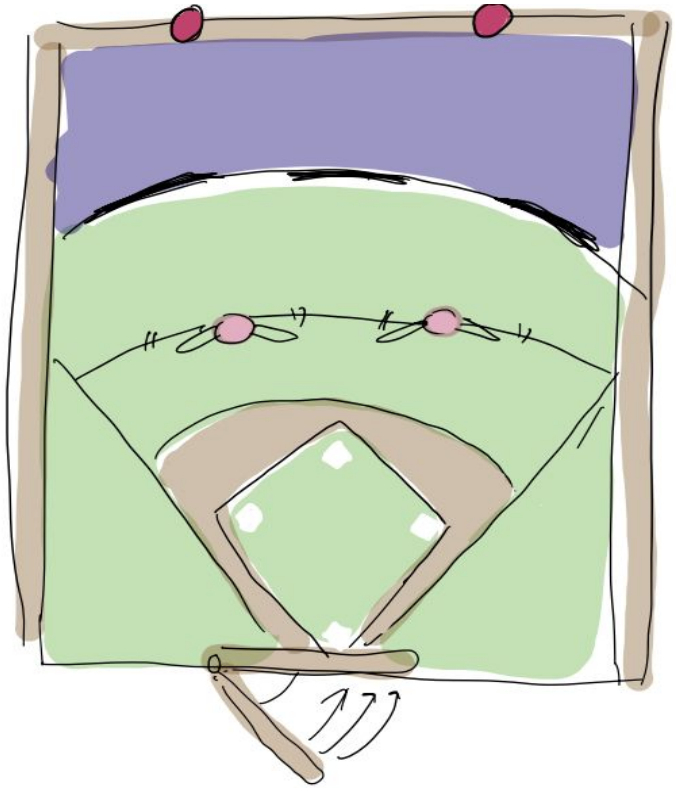
We seek to fuse ***nostalgic*** feel and modern tech to make an

immersive, bonding, social experience

Two Player Baseball Arcade Game



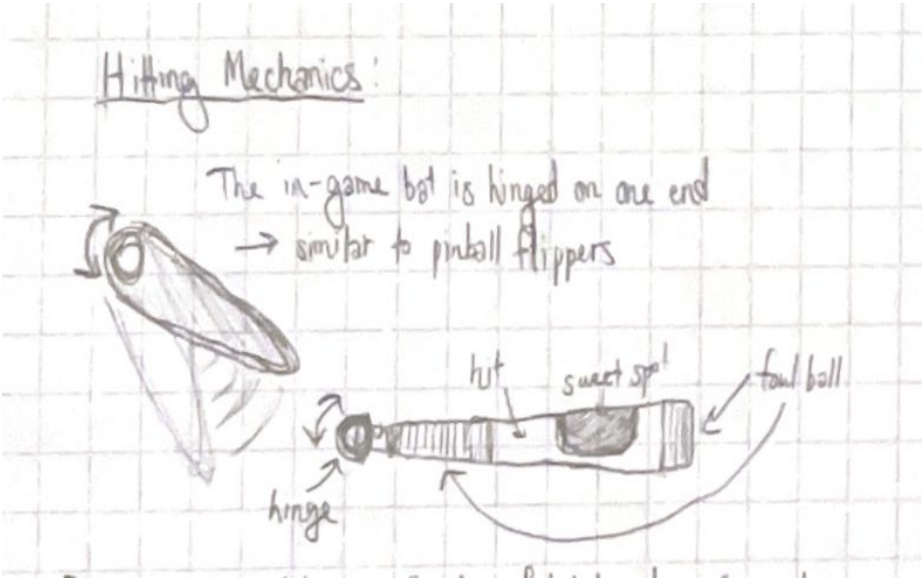




Gameplay Flow

Pitch → Swing → (Hit → Score) / (Miss) → Reset

1. Pitcher selects pitch type + throws
2. XY gantry drives pitch carriage along programmed path
3. Batter swings physical bat & IMU measures swing timing + speed
4. Ball routes into scoring lane or Miss
5. Sensors detect outcome → LEDs/audio update game state → return/reset



Use-Case Requirements

immersive, bonding, social!

1. **Two-player gameplay**.
2. **Physical Form**: ~3 ft x 2 ft gameboard. Free, physical bat. <10 min setup time
3. **Gantry motion**: XY, ~3 ft x 2 ft range, ~500 mm/s
4. **Responsiveness**: < 100 ms typical
    a. Bat swing detection-to-flipper trigger latency (IMU sensing + wireless + actuator command).
    b. Pitcher input-to-gantry response (UI to motion command).
5. **Gantry-Ball coupling**:
    a. During pitch: 95% of the time the ball remains coupled to the gantry on the pitch.
    b. Decoupling: 90% of hits feature a “clean” redirection (no visible interference from pitch carriage mech.)
6. **Pitch repeatability**: >95% two pitches of the same type will land within 5mm of each other.
7. **Player Feedback**: Haptics on bat and audio + LEDs to provide hit and pitch feedback.
8. **Electrical/Mechanical Errors**: <5% over 100 trials. (e.g. flipper not actuating on swing, ball getting stuck, etc.)

System Overview

Electrical

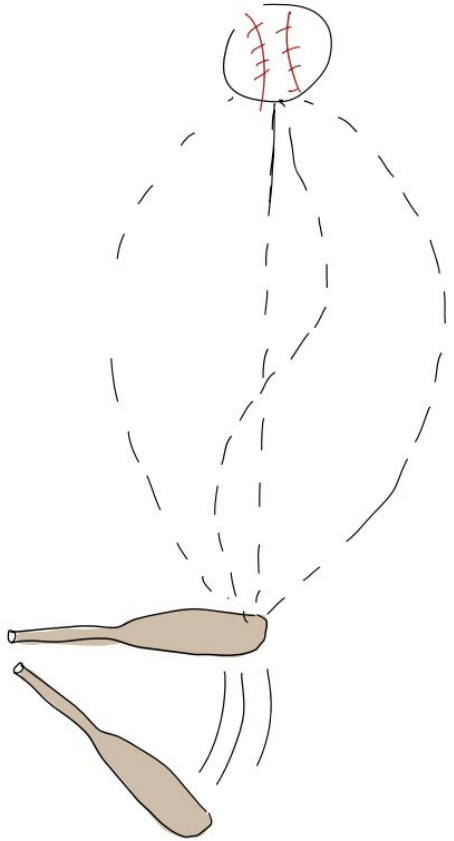
- 2 MCUs
- Drivers
- Sensors for score destection
- IMU on bat for swing metrics
- LEDs + audio

Mechanical

- Tabletop playfield (~3 ft × 2 ft)
- XY gantry, driving pitch mechanism
- Free bat, embedded with sensing unit
- Discrete scoring lanes

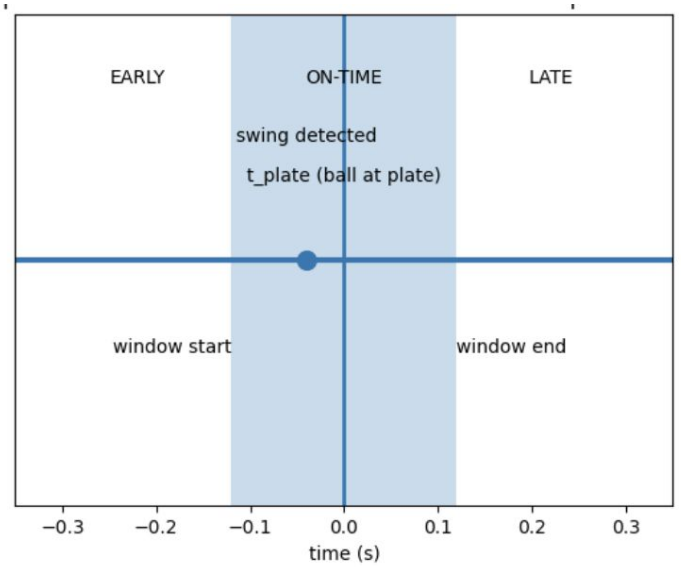
Pitch Subsystem (Gantry)

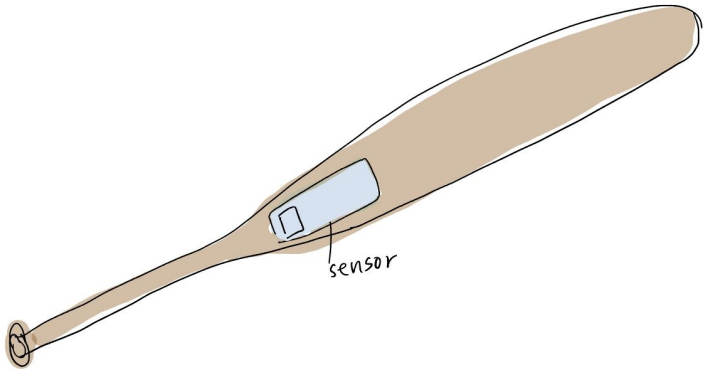
Pitch	**Parameter/Effect**
Straight	Speed V
Curve	Lateral offset
Knuckleball	Small jitter
Changeup	Lower V



Bat Subsysten (IMU)

- IMU features: peak angular velocity (**power**), swing start time (**timing**), swing duration
- Define **contact window** (when pitch is released)
- User swing and outcome is sorted into **early/on-time/late timing bins**
- IMU → on-bat MCU → gameboard MCU (**wirelessly**)





Technical Challenges

- Pitch repeatability at high speed
  - Metrics: 500 mm/s, 95% within 5 mm
- Clean hit interaction (bat actually influences outcome)
  - Metrics: “skill-based”: swing timing/speed must correlate with outcomes
- IMU swing detection is noisy / inconsistent
  - Metrics: swing classification accuracy, latency ≤ 50 ms
- Reliable scoring detection
  - Metrics: 99% scoring correctness

Testing/Verification

- **Gantry motion accuracy:** Record XY positions and compare error versus a calibrated grid (<5 mm)
- **Coupling tests:** execute 50 pitches of each type at various speeds and record any decouples or slips.
- **Plate decouple tests:** execute 30 plate arrivals of each pitch type (50% hit), recording any noticeable magnetically interfered ball redirection.
- **Scoring accuracy:** route puck into each lane/pocket 20+ times and verify the scoring logic is correct 99% of the time.
- **Gameplay latency:** Pitch/swing actuation is less than 50 ms on average.
- **Fault handling:** induce common failures, such as a stuck ball or missed pitches, and verify timeout and reset behavior.

Tasks

Aiden — Gantry + Physical Fabrication
XY gantry fab. + programming, game board design + fab.

Bing — Swing detection
IMU integration, wireless comms., filtering/features, latency measurement

Vivian — Mechanics + scoring + feedback
Playfield lanes + pockets + fielders mechanisms, pocket sensors integration, scoring logic + LED/audio feedback

Schedule

W1: System freeze + parts ordered (interfaces + pitch types + outcome lanes defined)

W2: Gantry operational (Aiden) + IMU bring-up (Bing) + lane prototype v1 (Vivian)

W3: Pitch trajectories + repeatability baseline (Aiden) + swing tiers v1 (Bing) + sensors v1 (Vivian)

W4: End-to-end gameplay loop v1 (pitch→swing→score→reset) + LED feedback integrated (Vivian)

W5: Fielding + reliability sprint (99% scoring, ≤50ms response, tuning)

W6: **SLACK + demo polish + final metrics (setup ≤10 min, final validation runs)