Final Project Report
EECE 2560: Fundamentals of Engineering Algorithms
Brickbreaker Game Project

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GitHub Link: `https://github.com/sjeevananthan/Brick-Breaker-Game`

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1 Summary of Team Progress and Final Development Updates

This document outlines the final completed implementation of the Brickbreaker game developed over the full project timeline in EECE 2560. While the structure of this report is based on our Iteration 3 template, the content has been updated to reflect the full system completion, final debugging, and final engineering validation.

Across the final development period, the team completed the following major tasks:

- Finalized complete paddle mechanics, ball physics, and variable-speed bouncing behavior.
- Implemented full brick grid generation with proper collision resolution and visibility toggling.
- Added power-up system including multi-ball, paddle expansions, and slow-motion effects.
- Integrated complete game-loop logic including reset, game-over screen, difficulty modes, and pause functionality.
- Addressed collisions using improved bounding-box checks and edge-case handling for paddle-angle deflection.
- Conducted engineering-level test cases for extreme paddle collisions, high-speed brick interactions, and multi-cycle restarts.

By the end of the project, **100% of core functionality** was implemented and verified through engineering testing. The game is fully playable, stable, and consistent across multiple runs.

2 Implemented Core Features

The following features were refined and fully completed by the end of the project:

Game Loop and Window Setup

Goal: Create a stable, real-time game environment.
Outcome: A 600x800 Pygame window with a 60 FPS clock ensures consistent timing and motion across machines. Input, collision, and rendering systems execute in a continuous update loop.

Paddle and Ball Mechanics

Goal: Finalize paddle movement and realistic physics-based ball response.
Outcome:

- Paddle movement constrained within screen bounds.
- Ball bounce angle determined by point of impact on paddle (center vs. edges).
- Ball speed maintained within stable bounds to prevent runaway velocities.

Brick Collision System

Goal: Detect and remove bricks upon collision at any speed.
Outcome:

- Axis-aligned bounding box (AABB) collision detection implemented.
- Each collision removes exactly one brick and updates state reliably.
- Improved edge detection prevents double-hits and incorrect angle flips.

Power-Up System

Goal: Implement dynamic items that modify gameplay.
Outcome:

- Multi-ball generation.
- Paddle size increase.
- Slow-motion ball effect.

Game State Management

Goal: Allow resetting, pausing, difficulty selection, and replay cycles.
Outcome:

- Fully functioning main menu and difficulty screen.
- Game-over detection and restart prompt.
- Pause function halting all motion.
- Reset cycle clears all game objects and reloads grid without leftover artifacts.

3 Engineering Challenges and Final Resolutions

Many of the original challenges from Iteration 3 persisted into later project phases, but were addressed systematically:

- **High-Speed Brick Tunneling**: Fast-moving balls could skip through bricks due to discrete time steps. **Resolution:** Improved collision checks using previous position tracking, reducing tunneling frequency. Continuous collision detection planned as future enhancement.
- **Paddle Edge Collision Accuracy**: Early builds produced vertical rebounds instead of angled trajectories. **Resolution:** Added normalized hit-position calculation to produce correct left/right deflections.
- **State Reset Issues**: Restarting the game sometimes reused objects from previous runs. **Resolution:** Fully reinitialized all lists (balls, power-ups, bricks) upon restart.
- **Team Coordination**: Development conflicts occurred due to parallel edits. **Resolution:** Adopted pull-request workflow and maintained Discord update logs.

4 Engineering Test Cases and Results

The following systematic engineering tests were run on the final implementation.

Test Case 1: Extreme Paddle-Edge Collision Behavior

Goal: Validate collision accuracy at paddle edges. **Results:** Ball correctly deflects at sharp angles when striking the outer 10% of the paddle. No tunneling occurred, and velocity remained within stable bounds.

Test Case 2: High-Velocity Brick Collision Consistency

Goal: Ensure bricks are removed reliably at high speeds. **Results:** Brick deletions were accurate with no double-counting. Minor tunneling remains possible at very high speeds, but within expected limits for discrete simulations.

Test Case 3: Game Over → Restart → Replay Cycle

Goal: Verify memory stability and state reset. **Results:** Three consecutive resets produced no leftover objects or duplicate bricks. Paddle, ball, and bricks reinitialized correctly, and the game ran without slowdown.

5 Leadership Rotation and Team Contributions

Leadership Summary

Period	Leader / Responsibilities	Key Outcomes
Iteration 2	**Ryan Yang**	Oversaw integration of core mechanics; ensured collision behavior stability.
Iteration 3	**Samyuktha Jeevananthan**	Led debugging, UI improvements, and final polish.
Final Testing Phase	**Josue Argueta**	Executed engineering tests, documented results, and coordinated final adjustments.

Individual Contributions

Team Member	Contributions (Technical / Documentation)	Hours
Ryan Yang	Finalized paddle-ball physics; implemented power-ups; improved collision accuracy.	14 hrs
Josue Argueta	Performed engineering test cases; documented final results; ensured system stability.	12 hrs
Samyuktha Jeevananthan	UI design, score display, game-over screens, menus, and difficulty implementation.	13 hrs

Statement by the Individual Submitter

I, **Josue Argueta, Samyuktha Jeevananthan, and Ryan Yang**, verify that the contributions listed above accurately reflect my individual work on the final Brickbreaker project.

6 Final Timeline

Period	Focus	Status
Iteration 3	Core mechanics (paddle, ball, bricks)	Completed
Iteration 4	UI, menus, power-ups, bug fixes	Completed
Final Phase	Full engineering testing, polish, documentation	Completed

7 Future Improvements

Although the core game is complete, the following improvements are planned for future development:

- Implement continuous collision detection for high-speed precision.

- Add sound effects, animations, and particle destruction.
- Expand difficulty modes to include randomized grid layouts.
- Add leaderboard system and persistent player scoring.

8 Appendix: Space for Additional Notes

New Bugs Found: None during final testing.
Fixes Completed: Paddle collision refinements; reset logic correction.
New Features Added: Power-ups, menus, game-over logic, multiple difficulty modes.