Ball Capture Game Documentation

Project Overview

Ball Capture is an interactive game built with p5.js that uses Arduino hardware for physical control input. Players use a joystick to move a cup horizontally across the screen to catch falling balls. The game features increasing difficulty, scoring mechanics, and audio feedback to create an engaging player experience.

How It Works

Gameplay

- Use the joystick to move a cup at the bottom of the screen
- Catch falling colored balls to score points
- Balls fall with increasing speed as the game progresses
- Players have 30 seconds to catch as many balls as possible
- Win by catching at least 35 balls before time runs out

Technical Components

Software Architecture

1. **Game Loop System**
    - Frame-rate controlled game loop ensures consistent gameplay regardless of device performance
    - Time-based movement calculations prevent speed inconsistencies
    - Serial communication handling for joystick input
2. **Game Objects**
    - **Cup Class**: Player-controlled object that handles movement, rendering, and collision detection
    - **Ball Class**: Generates randomly colored balls with varying sizes and speeds
3. **Game State Management**
    - Tracks game time, score, remaining balls, and game status
    - Handles transitions between waiting, playing, and game over states

4. **Audio System**
    - Background music that begins when gameplay starts
    - Sound effects for ball catches
    - Uses Tone.js library for audio synthesis

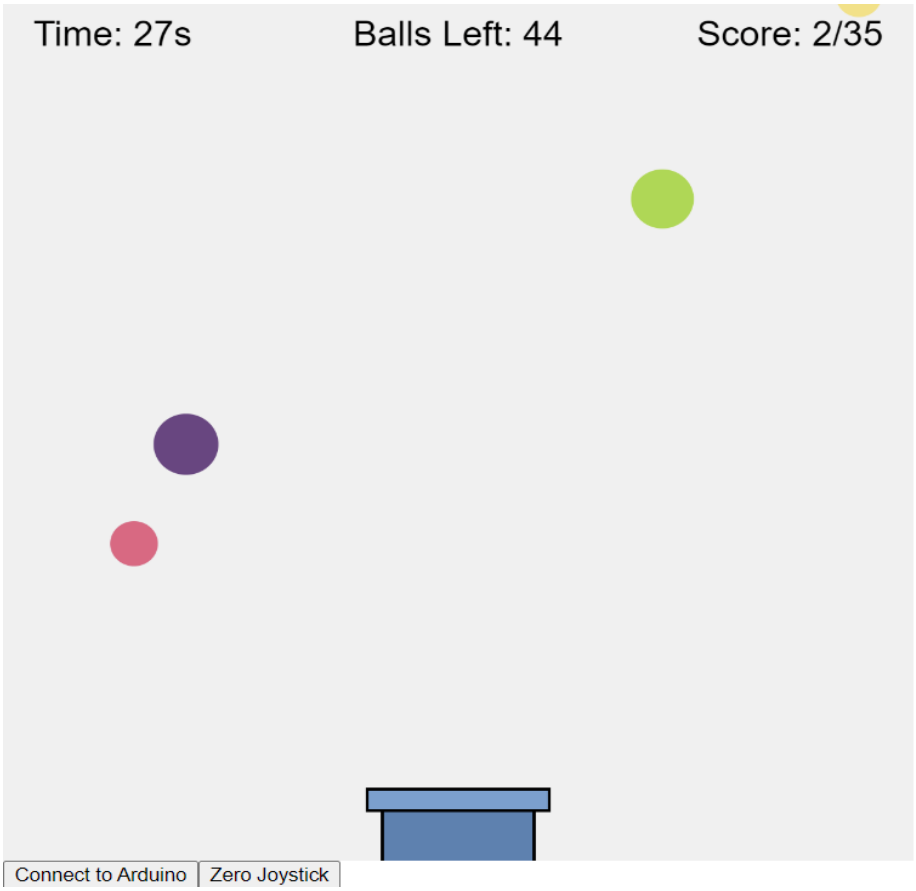
Hardware Integration

The game interfaces with an Arduino through serial communication:

- Reads joystick input for cup movement
- Sends game state information back to Arduino
- Provides haptic or visual feedback through Arduino outputs based on game events

Project Demonstration

Here's how the game looks in action:



System Requirements

Software Dependencies

- p5.js library (for graphics and animation)
- p5.webserial.js library (for Arduino communication)
- Tone.js library (for audio synthesis)

Hardware Requirements

- Computer with web browser that supports p5.js
- Arduino board (any model with analog input support)
- Joystick module connected to Arduino
- USB cable for Arduino-computer connection

Installation and Setup

1. **Arduino Setup**
    - Connect the joystick to your Arduino board
    - Connect 1 Green, 1 Blue, and 1 Red Led to the board
    - Upload the companion Arduino sketch (not shown in this documentation)
    - Connect Arduino to computer via USB
2. **Web Application Setup**
    - Host the p5.js sketch on a web server or run locally
    - Connect to Arduino using the "Connect to Arduino" button
    - Calibrate joystick if needed using the "Zero Joystick" button

Development Challenges and Solutions

Challenge: Inconsistent Frame Rates

Solution: Implemented a time-based movement system that calculates object positions based on elapsed time between frames rather than assuming a constant frame rate.

Challenge: Premature Collision Detection

Solution: Refined the collision detection algorithm to only register collisions when balls are within a specific vertical range relative to the cup, preventing balls from being caught as soon as they spawn.

Challenge: Serial Communication Timing

Future Development Ideas

1. **Enhanced Gameplay Features**
    - Multiple game modes (time attack, endless mode, etc.)
    - Power-ups that affect ball behavior or cup size
    - Obstacles that make catching balls more challenging
2. **Hardware Enhancements**
    - LED display to show score and game status on the physical device
    - Haptic feedback when catching balls
    - Additional control inputs (buttons for special abilities, etc.)
3. **Visual and Audio Improvements**
    - Enhanced graphics with particle effects when catching balls
    - Animated Cup and Balls
    - More varied audio feedback based on game events
    - Customizable themes for visuals and sounds

Conclusion

Ball Capture demonstrates the integration of physical controls with a digital game environment, creating an engaging and interactive experience. The project showcases how relatively simple hardware components can enhance gameplay and provide a more immersive experience than keyboard or mouse controls alone.

The modular architecture allows for easy expansion and modification, making it an excellent starting point for more complex game development projects that incorporate physical computing elements.