Evaluation of Latency Compensation in Fruit Ninjas Multiplayer Game
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Design

1. Experimental System
- Platform: Windows 11
- Monitor: 16.5-inch, 60 Hz display
- Mouse: Logitech M510 Wireless Computer Mouse for PC with USB Unifying Receiver

2. Participant Background
- Player 1: 5 years of gaming experience (MMORPG, Strategy)
- Player 2: 8 years of gaming experience (FPS, MMORPG)

3. Latency Condition
- Latency Chosen: 15 ticks (495ms) delay
- Latency Levels: No Latency (A), Latency without compensation (B), Latency with Sword prediction (C), Latency with Sword and Fruit prediction (D)

4. Number of Runs
- Single Player Tests: 3 runs for each condition (A-D)
- Multiplayer Tests: 3 runs for each condition, with Player 1 having no latency and Player 2 experiencing latency

5. Scoring System
- +10 points per cut, -25 if the player lets the fruits out of the screen. The logs were saved using the `writeMyLog()` method in custom log files.

6. Player Experience Evaluation
 After each game, players rated their experience on a 5-point MOS (mean opinion score) scale:
 1. Very Poor
 2. Poor
 3. Fair
 4. Good
 5. Excellent

7. Data Collection
Scores were logged automatically after each game. Player experience scores were collected via survey after each round.

Results and Analysis
    1. Result
Single
Player 1:

Condition	1	2	3	Average	MOS
A	460	550	535	515	4
B	220	230	135	195	2
C	195	255	230	226.7	2
D	485	375	500	453.3	4

Player 2:

Condition	1	2	3	Average	MOS
A	490	500	595	528.3	5
B	85	15	70	56.7	1
C	30	150	105	95	2
D	445	435	345	408.3	3

Multiplayer
Player 1 with no latency:

Condition	1	2	3	Average	MOS
A	495	570	595	553.3	5

Player 2 with latency:

Condition	1	2	3	Average	MOS
B	0	85	115	66.7	1
C	10	120	145	91.7	1
D	345	475	365	395	4

    2. Statistical Analysis
- Latency Impact on Scores:
    - Player 1's scores dropped to 35% of (A) in (B). Introducing sword prediction (C) recovered 45% of the score, while Sword and Fruit prediction (D) recovered 80%.
    - Player 2's scores dropped to 10% of (A) in (B). Introducing sword prediction (C) recovered 20% of the score, while Sword and Fruit prediction (D) recovered 80%.
- Player Experience: Player 2's experience significantly improved from (B) to (D), while Player 1's experience remained consistently high across all conditions.

3. Interpretation of Results
- Effects of Latency: As expected, latency without compensation (B) caused a dramatic reduction in Player 2's performance and perceived experience.
- Benefits of Latency Compensation: The introduction of Sword prediction (C) improved performance and experience, though not fully. Full compensation (D) using both Sword and Fruit prediction brought Player 2's performance close to baseline, making the game much more playable under latency.
- Condition A gave the average best score as players had good game experiences with low or non-latency. Condition B gave the average worst score as players had the worst game experiences with high latency, and condition C gave the second worst score and game experience with high latency and only sword prediction. Condition D gave the average good score as players had acceptable experiences with high latency with compensation.
- The result shows the score has the tendency to get better after each try when they get used to the system.
- The latency could cause players to stop playing the game due to the frustration from the delay in controlling. The prediction or compensation could reduce the effect of delay on players experiences. Latency still lowers the players' experiences in the long run.

Conclusion
The experiments highlight the importance of latency compensation in maintaining both player performance and experience. Without compensation, player performance suffers significantly, but with compensation mechanisms, the impact of latency can be nearly eliminated.