Exploring the Effects of Latency Compensation Techniques on Player Performance and Experience in FPS Games

Ivan Klevanski, Alex Mitchell, Yihong Xu, Sitsanok Young

Acknowledgements
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NVIDIA: Ben Boudaoud, Josef Spjut, Joohwan Kim
WPI Contributors: Samin Shahriar Tokey, Alexander Hayden, Ben Peters, Mattheus Faria, Miles Gregg, Jonathan Hsu, Pari Nguyen
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Introduction
Motivation

• Latency affects user experience in networked games
• Delay between player's action and server feedback can cause unresponsiveness
• Mitigation techniques have been developed to compensate
• Limited public research and testing in this field
• Study focused on two compensation techniques: time warp and latency exposure
Introduction

First-Person Science (FPSci)

• Open-source, experiment-centric Single Player FPS game

• Developed by NVIDIA for research purposes

• Designed to study a broad set of user interactions at low local latency
Introduction

Previous MQP

- Converted FPSci to a multiplayer game
- Broadcasting Server
- Client authoritative movement and shooting
- Networking and packet infrastructure
Goal

- Add latency compensation techniques
- Conduct user studies and evaluate effectiveness
- Extend FPSci to support authoritative server
Implementation
## Authoritative Server

### Structure

<table>
<thead>
<tr>
<th>Functionality</th>
<th>Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td></td>
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<tr>
<td>Movement</td>
<td>Client</td>
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<tr>
<td>Location</td>
<td>Server</td>
</tr>
<tr>
<td>Shooting</td>
<td>Server</td>
</tr>
</tbody>
</table>

In the diagram, the client (C) communicates with the authoritative server (S) for authoritative information, such as position, movement, location, and shooting.
Authoritative Server
Location and Movement

1. Predict location
2. Request Movement
3. Speed Check
4. Location Broadcasting

≈ 1 Round Trip Time (total)

Client
- Movement Calculation
- World Collision

Server
- Movement Validation
- Player Collision

Authoritative Player Locations
Authoritative Shooting and Time Warp
Authoritative Shooting and Time Warp

Frame 70
Authoritative Shooting and Time Warp

Runner move into view

Frame 70
Authoritative Shooting and Time Warp

Server receives movement, notifies shooter

Frame 75
Authoritative Shooting and Time Warp

Frame 80

Shooter receives movement, shoots Runner
Authoritative Shooting and Time Warp

Server receives shot

Frame 85
Authoritative Shooting and Time Warp

Server receives shot
Server rollback, confirms hit, broadcasts shot

Frame 85
Authoritative Shooting and Time Warp

Both clients receive shot confirmation

Frame 90
Latency Exposure

- Also known as: ping display
- Multi-threaded: not bounded to the game's tick rate
- Multiple different latency statistics besides latest ping
- Lots of configuration options:
  - Toggle-ability of feature as a whole
  - Other numeric parameters
- Statistics are logged to database file (both client-side and server-side)
User Study

- 3 weeks; 42 participants
- Player-versus-player 1v1
- 20 rounds (2 groups of 10 rounds)
  - Groups' Time Warp settings vary (on/off)
  - First round in each group is discarded
How ping display affects quality of experience

Latency Group

0
250
500

Quality of Latency Experience

4.0
3.5
3.0
2.5
2.0
1.5
1.0

Ping Hidden

Displayed Ping

Ping Hidden

Ping Hidden
Accuracy with time warp on/off close-combat

Latency Group

Hit Percentage

Time warp On/Off
Achievements

• Latency Compensation
  • Time Warp
  • Latency Exposure (Ping Display)
  • Latency Concealment
  • Extrapolation

• Authoritative Server Structure
  • Movement
  • Shooting
  • Authoritative Validations
  • Data Logging
  • User Testing
  • Data Analysis
Questions?

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