Towards Understanding User Tolerance to Network Latency in Zoomable Video Streaming

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**Goal**

We conducted a user study with 35 participants to understand:
- User tolerance to network latency when interacting with zoomable video streams
- How the choice of concealment schemes affects user tolerance to delay

**Zoomable Video Streaming**

Zoomable video allows users to zoom and pan around a video to watch a region-of-interest (RoI) at a higher resolution.

- View RoI at the display size, with higher resolution
- Send request for new RoI
- Delay due to network latency
- New RoI received
- New RoI to request

We are interested in supporting zooming and panning in the streaming context, where video sources are available at the server side.

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**Experiment Parameters**

- Video Clips: 5 video clips captured by a HD camera
- Pilot Study: a pilot study with 8 users to find out the proper range of delay values
- Delay values (second): 1, 2, 3, 4, 5
- Five delay values were randomly assigned with different videos to form five configurations:
  - avoiding the same video content to be watched multiple times in a session
  - avoiding fixed coupling between a delay and a video
- Five configurations were tested in each concealment schemes. So, we had 10 test cases.

**User Study**

- 35 participants (22 male, 13 female) were in the experiment.
- A demo & practice session was provided. No network latency was introduced in this session.
- Participants were not told about the presence of delay and delay values.
- Test cases were presented in a random order to avoid:
  - preference to any delay value or concealment scheme
  - users’ adaptation to gradual change of delay (by not using method of limits)
- For each test case, a participant was asked to watch, interact (zoom/pan) with a video, and evaluate the responsiveness of zooming and panning.
  - Do you find the responsiveness when zooming and panning acceptable?

**Results and Finding**

We measure user acceptance, the percentage of participants who rated a delay value as acceptable.

![Graph showing user acceptance (%) vs delay (seconds)]

**Finding**

- More users were tolerant to delays in Low-Res scheme than Black scheme.
- Tolerable delay value in viewing zoomable video streams is higher than thresholds found in some high interactive multimedia applications.
- User tolerance starts degrading beyond 1 second: prefetching or caching is necessary.
- More time to request or forward data through multi-prefetching or caching is necessary.

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**Conclusions**

Our user study presented findings on:
- how much network latency users can tolerate in interaction with zoomable videos
- how their tolerance degrades in the presence of network latency
- how the choice of concealment scheme helps improve delay tolerance levels of users

Our findings can be incorporated into designing a system for streaming of zoomable videos that provide both good Quality of Experience and Quality of Service.