Progressive Cache Replacement for Massive Peer-to-Peer WebVR Worlds

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Background

- Large scale WebVR becomes more popular
  - E.g., Google Earth, Virtual Earth, Second Life
  - WebVR scenes has been more gigantic than before

- Huge 3D content and limited cache
  - Clients can not store the whole VE once
  - Cache capacity of PDAs, Mobile phones is less than PCs

- Current Scenes replacement policies are designed for C/S-DVE, the characteristics of P2P-DVE are not considered
Related Work:

- **LRU、MRU used in database applications**
  - Principle of locality
  - Not suitable for DVE well

- **Cache policy in P2P media steaming**
  - Content are viewed as one-dimensional (i.e., time)
  - 3D scenes are accessed in terms of viewer’s non-linear way

- **Cache policy in C/S-DVE (e.g. MRM)**

- **Scenes replacement in P2P-DVE should consider the relation between viewers and their neighbors**
Our Work--- Progressive Scene Replacement Mechanism (PSRM)

- Concept of **Preservation Degree**
- Composed of:
  - Visual Attention Degree
  - Potential Relavence Degree on AOI neighbors
Visual Attention Degree

- the farther from the viewer and the larger angle an object is from the viewer’s line of sight, the smaller the visual attention degree
Potential Relevance Degree (PRD)

- Removal of an object will bring adverse influence to AOI neighbors’s downloading behaviors.
- If an object has been downloaded more times, it can be removed with higher priority.
Potential Relevance Degree

- **PRD on one AOI neighbor**
  - Current formula:

\[
R(O_i, V_j) = \frac{1}{\sqrt{1 + DIV_j(O_i) + DBV_j(O_i)}}
\]

- Average PRD on AOI neighbors

\[
R^{AOI_k}(O_i) = \frac{1}{n} \sum_{i=1}^{n} \frac{R(O_j, V_i)}{n}
\]
Removal Policy

- Preservation Degree = visual attention degree + potential relevance degree
- How to remove 3D content in PSRM?
  - Remove PM increments until the optimal resolution
  - Remove remaining PM increment
  - Remove base mesh
Experimental platform based on ASCEND project

- We compare three scene replacement mechanisms:
  - P2P-MRM
  - Distance-based replacement in FLoD
  - PSRM

Experiment
Experimental Results

Fig. 5: Effect of cache ratio on fill ratio (the left is RW and the right is CW)
Experimental Results

- Requests to Server

**TABLE II: Requests to server per step in RW**

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<th>cache ratio</th>
<th>FLoD-500</th>
<th>P2P-MRM500</th>
<th>PSRM-500</th>
<th>FLoD-1000</th>
<th>P2P-MRM1000</th>
<th>PSRM-1000</th>
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**TABLE III: Requests to server per step in CW**

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<th>cache ratio</th>
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<th>P2P-MRM500</th>
<th>PSRM-500</th>
<th>FLoD-1000</th>
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</table>
Future Work

- Optimal weights of each factor of the preservation degree
- How clients should interact with content servers collaboratively
- More realistic user traces and bandwidth distributions …
Thanks

Q&A
Reference[1]


