HYBRID CLIENT-SERVER AND P2P NETWORK FOR WEB-BASED COLLABORATIVE 3D DESIGN

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INTRODUCTION
3D CVEs for design review (CAD, PLM, BIM)

Small teams (7/8 people) constraints:

- Mobility
- Real-time interactions in 3D
- Optimal resources (rendering, storage, networking)

Need a light and efficient support for 3D distributed content accessible (almost) everywhere...
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The web browser (and the Internet)!
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What is the best suited architecture?
STATE OF THE ART
Client-Server

Client-server [HLL+13] [MJ12] [GSWG13]

Client: rising of HTML5 -> WebGL.

Centralized data access and collaboration: Websocket.

Question

As a mimic of small team organization (people-to-people collaboration): why pass through an intermediary (server)?
Architectures

Peer-to-peer [CT07]

Direct data transmission. Distributed resources.

Question

What if there is no seeder?
Hybrid: Client(s)-Server and P2P [KVaD14], [CH14]

Persistence + direct data transmission between clients.

Flexibility and robustness.
OUR HYBRID MODEL
**Overview**

**Hybrid**: Persistence + collaboration

Users are working together on a scene where they can interact with 3D data.

**Figure**: System overview
3D WEB EDITOR

Features

- View, navigation and transformations tools
- Upload 3D models, textures
- Switch point of view
- Referential modification
- Grid snap

Content access policy to avoid modification conflicts during the collaboration: lock/unlock
**Persistence Layer**

**NoSQL DB**  dynamic schema well supporting 3D data format (JSON), updatable on-the-fly.

**Peer flow management**  auto (re)connect peers in a scene.

Mainly used for **persistence** of the world state and **resilience**.
Collaboration layer

Figure: Message broadcasting inside a full mesh topology network.

Message broadcasting to direct peers and server DB.

Update rendering at message reception.

Granularity of the data transmission depends on the actions.
WebRTC: Web Real-Time Communication (W3C draft)

- allows DataChannel protocol for P2P connections between web browsers to exchange any raw data in real-time.
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- allows **DataChannel protocol** for P2P connections between web browsers to exchange any raw data in real-time.
- uses signaling mechanism (via WebSocket server) to manage peers, the network configuration and the media capabilities.
IMPLEMENTATION
WORKFLOW

Get the workspace scene

Enter the P2P network

Interact with the scene (CRUD)

Leave the scene

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EVALUATION
**Objective**
Demonstrate the feasibility of our model focusing on the user experience.

**Experiment description**
Assemble collaboratively multiple parts of a scene to match a given picture. Users are on the same network.

**Qualitative criteria**
- 3D modeling (interface)
- Collaboration (robustness, fluidity)

**Table:** Model descriptions for the experiments

<table>
<thead>
<tr>
<th>Experiment</th>
<th>objects</th>
<th>size</th>
<th>users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind turbine</td>
<td>6</td>
<td>1.0 MB</td>
<td>2</td>
</tr>
<tr>
<td>Pick up</td>
<td>8</td>
<td>1.3 MB</td>
<td>4</td>
</tr>
<tr>
<td>Castle from <em>server</em></td>
<td>35</td>
<td>1.3 MB</td>
<td>4</td>
</tr>
<tr>
<td>Castle from <em>peer</em></td>
<td>35</td>
<td>1.3 MB</td>
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</tr>
</tbody>
</table>
Global evaluation  Satisfied of the collaborative and visual results: goals are reached.

User interface  Reports about a lack of visual feedbacks on collaborative object prehension.

Object manipulation  Good evaluation except at the reception of a new model (not optimized).

User charge  The variation (from 4 to 7 people) has not altered rendering and networking quality.
The system offers a good **robustness and resilience** in case of browser’s or server’s crash.

The quality of the collaboration has been considered as **real-time** more than interactive.

**Figure:** 3D editor’s captures during experiments
CONCLUSION
Our hybrid model for 3D web-based collaborative modeling mixing Client-server (WebGL and NodeJS) and P2P (WebRTC) architecture is:

- exclusively based on web-browser resources (cross-platform);
- supported by a functional prototype providing
  - 3D rendering with basic interactions,
  - real-time updates with persistence and granularity,
  - and transparent P2P collaboration;
Future work

- **Quantitative evaluation** (throughput, FPS...) for performance comparisons (WebRTC tools and web automation tools).
- Mesh processing for **3D streaming with distributed resources**
- Richer interface (feedbacks, versionning, **plasticity**)
THANK YOU FOR YOUR ATTENTION

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