A 3D collaborative editor using WebGL and WebRTC

Caroline Desprat
desprat@irit.fr

Jean-Pierre Jessel
jessel@irit.fr

Hervé Luga
luga@irit.fr

VORTEX team, IRIT UMR5505, University of Toulouse, France

Online collaborative 3D design

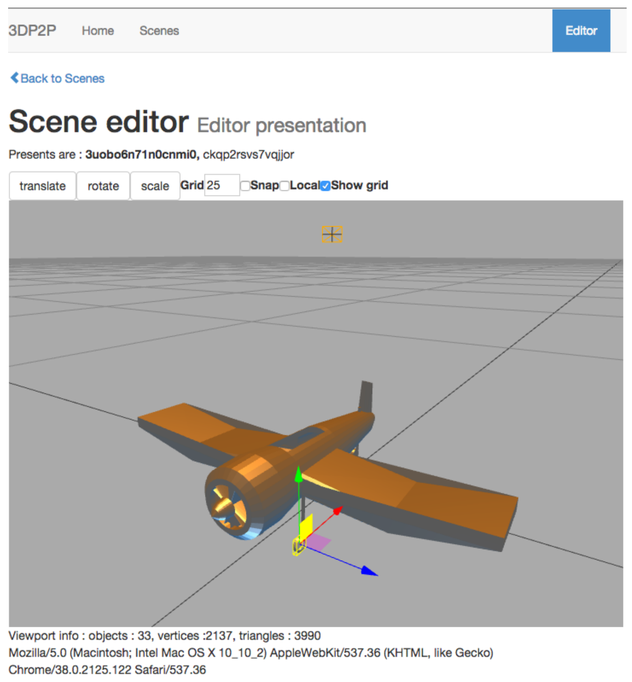
Collaborative design environments share 3D scenes across the network. 3D scenes or models are very likely to be constructed and reviewed by more than one person, particularly in the context of 3D scientific visualization [1], CAD (Computer Aided Design) [2] or BIM (Building Information Modeling) [3] solutions with various architectures [4] [5].

Objectives

- pluginless visualization of 3D scenes on the web,
- exclusive use of client resources for communication,
- message broadcasting: asynchronous and granular,
- real-time collaboration across the network with shared access to 3D models.

Question

What architecture is the best suited in online 3D collaborative design environments for small teams using exclusively browser's ressources?



Our hybrid architecture for 3D web-based collaboration

Web-based editor

Client visualization, interaction and edition.

The **3D interface** integrates a viewport and provides:

- the list of contributors,
- basic transformations tools (CRUD),
- and viewport informations.

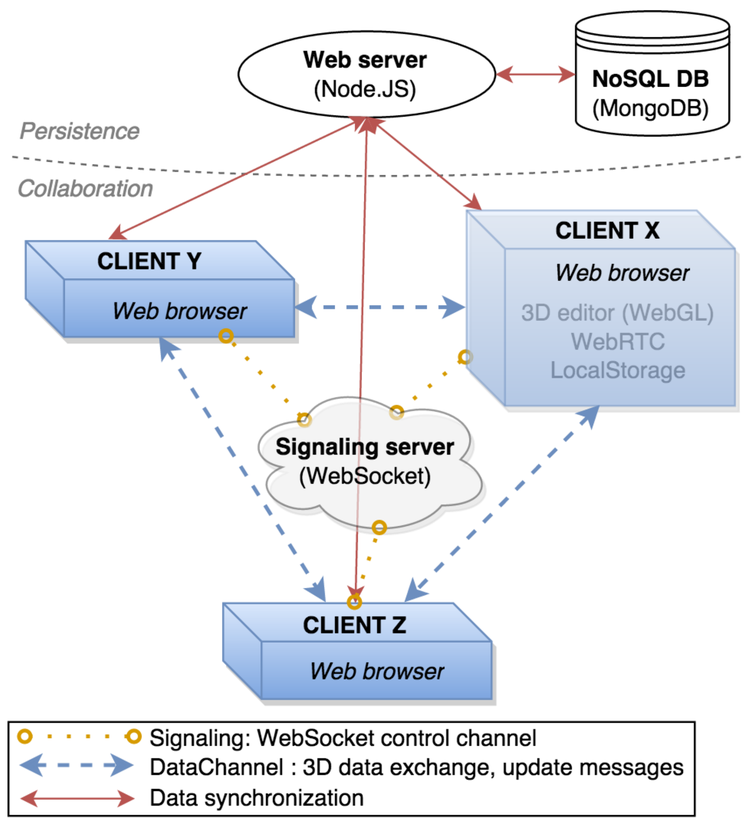
three.js WebGL JS

Server: RESTful architecture

REST architecture (client/server/NoSQL DB queries) **benefits distributed hypermedia systems**.

Mainly used **to maintain a world state persistence and provide robustness** to the system.

express node.js mongoDB



Granularity of the data transmission depends on the actions (ID, transformation matrix, materials, meshes).
Each client is responsible to broadcast its own messages (to direct neighbors in P2P and to DB).

P2P communication

WebRTC and DataChannels

WebRTC (Web Real-Time Protocol) allows DataChannel protocol for **P2P connections between web brow-sers to exchange any raw data in real-time[6].**

WebRTC uses ***signaling*** **mechanism** (via WebSocket server) to manage peers, the network configuration and the media capabilities.

Auto-management of the P2P full mesh network of users (designed for small teams).

PeerJS library bootstraps WebRTC API for compatibility reasons.

PEERJS WebRTC WEBSOCKET

Qualitative evaluation and results

We **focused on the user experience** in the experiments:

Criteria for the evaluation:
- appreciation of the interface and features,
- quality of the collaboration mechanisms (feedbacks, robustness and latency)

Goal To assemble collaboratively the parts of a scene to match a given picture with the editor and real-time information.

The system offers a **good robustness and resilience** in case of browser's crash.

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 has not altered (from 4 to 7 people) rendering and networking quality.

Global evaluation **Satisfied of the collaborative and visual results: goals are reached.**

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

Future works

- A **quantitative evaluation** of metrics for performance comparisons.
- Investigation on **WebRTC tools and web automation tools** for evaluation.
- Optimization of **3D streaming**:
  - mesh processing (LoDs),
  - distributed ressources (partial mesh topo.),
  - interface plasticity (mobile devices, user interests).
- Improvement of **interface features and visual feedbacks** for collaboration.

References

[1] C. Marion and J. Jomier, "Real-time collaborative scientific webgl visualization with websocket," in *Proceedings of the 17th international conference on 3D web technology*, pp. 47–50, ACM, 2012.

[2] B. Houston, W. Larsen, B. Larsen, J. Caron, N. Nikfetrat, C. Leung, J. Silver, H. Kamal-Al-Deen, P. Callaghan, R. Chen, *et al.*, "Clara. io: full-featured 3d content creation for the web and cloud era," in *ACM SIGGRAPH 2013 Studio Talks*, p. 8, ACM, 2013.

[3] H.-M. Chen and C.-C. Hou, "Asynchronous online collaboration in BIM generation using hybrid client-server and P2P network," *Automation in Construction*, vol. 45, pp. 72–85, 2014.

[4] H.-M. Chen and H.-C. Tien, "Synchronous design collaboration in a peer-to-peer network," 2007.

[5] T. Koskela, J. Vatjus-anttila, and T. Dahl, "Communication architecture for a p2p-enhanced virtual environment client in a web browser," pp. 1–5, 2014.

[6] I. Grigorik, *High Performance Browser Networking: What every web developer should know about networking and web performance*. " O'Reilly Media, Inc.", 2013.

VORTEX IRIT CNRS - INPT - UPS - UT1 - UT2J Université de Toulouse