Applications of Web3D Technology in Architecture, Engineering and Construction

Jozef Doboš
3D Repo Ltd
London, UK
ceo@3drepo.org

Carmen Fan
3D Repo Ltd
London, UK

Pavol Knapo
3D Repo Ltd
London, UK

Charence Wong
3D Repo Ltd
London, UK

ABSTRACT

Architecture, engineering and construction (AEC) has witnessed a boom in the use of web3D technologies over the past few years thanks to the proliferation of WebGL support in modern web browsers, and the ever increasing need for multidisciplinary collaboration across large-scale construction projects. In this summary, we present a number of AEC-specific requirements and a set of applications for interactive visualization via the Internet based on the 3D Repo open source platform. These span collaborative design, 3D change and clash detection, data mining, maps integration and health and safety training. The presented use cases were developed in collaboration with large AEC companies, namely Atkins, Balfour Beatty, Canary Wharf Contractors, Costain and Skanska in the UK.

CCS CONCEPTS

• Computing methodologies → Rasterization; Image processing;

KEYWORDS

3D Repo, Unity 3D, Web3D, architecture, engineering, construction

ACM Reference Format:


1 INTRODUCTION

Web3D technology has come a long way since the early days of VRML [1997]. Thanks to the proliferation of WebGL [2011], it is now possible to support a myriad of different AEC applications directly in web browsers. In contrast to other industries such as automotive, aerospace, games, etc., AEC has a very distinctive set of requirements that make the task of transmitting and rendering 3D data over the Internet considerably different. Thus, a suitable web3D solution needs to support complex 3D models in industrial file formats that were not designed for real-time rendering. It has to render geometry across large geographical areas with potentially frequent updates and work across many different devices with often limited processing capabilities. Finally, it must to be collaborative without the need to install any plug-ins. Fortunately, many requirements from the aforementioned industries such as multiplayer interaction; fast phased animation and shooting; complex interactivity; etc., are not needed in AEC.

3D Repo. The presented use cases are based on the open source 3D Repo web platform [2012] which evolved from an initial rendering in XML3D [2013], through to X3DOM [2015; 2016], and finally to Unity 3D [2017]. Server-side, the system runs on MongoDB which stores decomposed Building Information Modelling (BIM) data and highly pre-processed geometry for web-based rendering.

2 3D CHANGE AND CLASH DETECTION

On large construction projects, various disciplines create partial 3D models in their respective silos. During a regular design coordination meeting, such models are federated into a single visualization so that design problems can be resolved in situ. Fig. 1 demonstrates the latest 3D Diff [2018] change detection tool running on an iPad. There, different revisions of AEC models are compared to reveal
Figure 3: A section of a highway surrounded by terrain models and base map tiles. Model courtesy of Highways England.

Figure 4: Visual coding in IBM Node RED (top) defines data workflows in a web browser. Results are in charts (bottom left) or in 3D (bottom right). Model courtesy of Skanska.

additions in green and deletions in red. This is especially useful during review process when design changes need to be identified quickly. The inverse calculation can also reveal clashes, i.e. areas where two 3D models intersect. Since different parts of the same building are being modelled concurrently, it often happens that sections overlap, yet they cannot be built. For instance, as shown in Fig. 2, pipes cannot intersect a steel beam in real life.

3 GIS INTEGRATION AND DATA MINING

Construction of buildings is only one part of AEC. Another major part consists of infrastructure projects such as highways, railways, utilities, etc. These often span large geographical areas which means that detailed engineering models need to be mapped onto Geographical Information Systems (GIS) datasets. Web-based applications such as 3D Repo, CesiumJS and BIMSync provide varying capabilities. Fig. 3 demonstrates a section of a highway being geolocated within the Ordnance Survey base map tiles in 3D Repo. All such data can then be queried via APIs over the Internet. A visual coding tool by IBM originally developed for Internet of Things supports creation of custom workflows directly in web browsers. Output of such flows can be either an online dashboard with various charts or color-coded rendering within a BIM model as shown in Fig. 4. This is very powerful due to its flexibility but also direct visual link.

4 HEALTH AND SAFETY

AEC industry also puts a strong emphasis on health and safety. Unfortunately, physical training on site is time consuming, costly and enables interaction with only one piece of machinery at a time. An obvious solution to this problem is Virtual Reality (VR) since workers can be exposed to various hazardous situations from the safety of a site office. However, instead of providing one-off VR simulations with baked-in assets, 3D Repo developed a dynamic library [2017] on top of Unity 3D game engine as shown in Fig. 5.

5 CONCLUSIONS

Web3D technology plays an integral part in industrial deployments and solutions such as 3D Repo clearly demonstrate advantages in AEC via applications of the same technology in different scenarios

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REFERENCES


