Development of 3D browsing and interactive web system

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Abstract: In the current market, users need to download specific software or plug-ins to browse the 3D model, and browsing the system may be unstable, and it cannot be 3D model interaction issues. In order to solve this problem, this paper presents a solution to the interactive browsing of the model in the server-side parsing model, and when the system is applied, the user only needs to input the system URL and upload the 3D model file to operate the browsing. The server real-time parsing 3D model, the interactive response speed, these completely follows the user to walk the minimalist idea, and solves the current market block 3D content development question.

1. Introduction
Traditional web pages can only render content through text, etc., however with the WEB technology1, rendering 3D content in the web pages has become possible2 3. For the study of WEB 3D technology, the most authoritative country is the United States4 5, and the research focused on perception, user interface, background software and hardware. Compared with some developed countries, there is a great disparity in the research level of China6, but with the rapid development of computer technology, government departments and scientists have begun to pay attention to the development of WEB 3D technology. China's universities have carried out the corresponding research, such as the National Defense University of Science and Technology developed a three-dimensional Internet-based exquisite roaming environment Universe3D. As well as the Shanghai Museum of bronze Museum, the ancient scene of the simulation show and so are all in the web page to show the 3D browsing.

Open 3D model files require pass the specific PC graphics software, which is currently the biggest technical difficulty in rendering and managing 3d content in the Internet8. In the context of the Internet + and other national policies, the Internet system that can present and manage different formats of 3d data with a unified interface is a key role in the tide of industrial upgrading. This is also the main research content of this paper.

2. System framework
Nginx is a high-performance HTTP and reverse proxy server, and Node.js is a platform based on the V8 engine runtime9, which is used to easily build up the network application. Node.js uses event-driven, non-blocking I/O models to be lightweight and efficient, and is ideal for running data-intensive real-time applications on distributed devices. So the system adopts the Nginx + NodeJS server architecture, as shown in Figure 1, with HTML +CSS +JavaScript as the front-end programming language, at the same time, the system adopts a browser supporting WebGL.
The system is divided into three parts: model resolution, model rendering and model interaction. By uploading the 3d model, the model storage, the analysis of the model, and through the model format conversion, ThreeJ engine and other system completes model rendering. Finally it’s human-computer interaction. The System flowchart, is shown in Figure2.

3. Key technologies

3.1 3D Model Information
The manifold triangular mesh is one of the simplest 3d model representations, and its external file
(the type name is "SVF") describes the 3d data mainly including the geometric coordinates of the vertices and the triangular surface table information (table information of the triangles). And the SVF file in the format is composed of some text lines, according to the conventional file header and graphics data area it can be divided into two parts:

1) File header: generally fixed length, in addition to describing the type and characteristics of the file itself, mainly used to describe the geometric properties of grid elements, such as the number of vertex and surface, and their data types and other basic information.
   1) File type names: convention for .svf;
   2) Data line format format ASCII, using ASCII text line (without binary binary);
   3) The number of vertex elements is element vertex;
   4) Vertex data type property float vertex_coord, optional float or double type;
   5) The number of elements element face
   6) The data type of the Surface Table property list UINT int vertex_indices, the vertex index must be an integer; Head end marker End_header;

2) Graphic data area: is a variable length. It can be used to specifically define the 3D model of geometric data (vertex coordinates) and topological information (surface structure): x y z ... where each triples XYZ represents a three-dimensional coordinate of a vertex, separated by spaces. For example, 0.605538,0.183122,0.472278 defines a vertex. Vertex_number refers to the number of vertices of the polygon surface, because the triangle mesh is used in this paper, so the vertex number of the surface is 3. A vertex index table is followed by a representation of a triangular surface. For example: 3 1 0 1 1 defines a triangular face, which is composed of 1 vertices indexed by 0, 1, 1 3 respectively.

3.2 File Parsing
The need to analyze the structural characteristics of a 3d file is the first step in completing a transformation from a 3d file to a JSON string. So there are a wide variety of tags that may appear in 3d, and you need to turn 3d files into the standard format before converting to JSON.

After you get the 3d file in the standard format, split the labels and contents into an array in order of precedence. And then through an auxiliary stack to transform the conversion process during the auxiliary stack state changes, shown in Figure 3.

| Original label format                     | Converted label format                              |
|------------------------------------------|----------------------------------------------------|
| <element name attributes=value>          | <element name >                                   |
|                                         |         <@attributes>                              |
|                                         |         < attributes>                              |
|                                         |         value                                     |
|                                         |         </attributes>                             |
|                                         |         </@attributes>                            |
| <element name/>                          | <element name>                                    |
|                                         |         </element name>                           |
| <element name attributes=value>          | <element name>                                    |
|                                         |         <@attributes>                              |
|                                         |         < attributes>                              |
|                                         |         value                                     |
|                                         |         </attributes>                             |
|                                         |         </@attributes>                            |
Finally, the last element ejected from the stack is the converted JSON string, rendering the conversion process as shown in Figure 4 below.13

Use the browser WebGL standard to support 3D data parsing. The system uses a unified 3D file format .svf, and through AJAX interacts the front and rear data. The 3D format files are asynchronous without refreshing to parse out the SVF node, through the node to build the entire 3D model, rendering the 3D model required for the construction data stored in JSON, such as JSON rendering vector data.

```json
{
"metadata": {
"version": 4,
"type": "geometry",
"generator": "GeometryExporter"
},
"vertices": [0,50,20,14.14213],
"normals": [0.3826834323650897,0,0.9238795325112866],
"uvs": [[0,1,0,0.125,1,0.125],
"faces": [56,0,9,1,0,1,2,0,1],
}
```

3.3 Research on Spatial Transformation
Computer 3D graphics and matrix are closely related, and the graphical API interface directly uses the matrix, and Transform2d/3d encapsulates the most basic transformation operations. Each transformation can be transformed into a matrix. But for matrix multiplication, it means that multiple matrix transformations are superimposed. In the matrix operation, there is a law that the matrix does not satisfy the multiplication law, which means the transformation order is different, directly resulting in the final result of a large difference.14 Therefore, in the 3D transformation, every transformation is relative to the last transformation to do, and the reference coordinate system time is changing,
regardless of 2d, 3d, so ZXY, and YXZ results in the opposite\textsuperscript{15}.

A description of any azimuth is the azimuth angle that is derived from alpha, beta, and gamma-order rotation. This description can be viewed as three rotating orthogonal matrices, and the transformed coordinates are obtained by multiplying the order.

Rotate around the Z axis to get alpha, then rotate around X to get beta, and finally rotate around the Y axis to get gamma;

There are two characteristics of restrictive Euler angles:

Value range: Alpha:0-360, beta: $\pm 90 \degree$, gamma: $\pm 180 \degree$

When beta $= \pm 90 \degree$, both mobile phone flip, alpha, Gamma will instantly add or subtract 180

The three orientations alpha, beta, and gamma correspond to Z, X, Y, relative to our Z-axis world coordinate system.

So the final matrix transformation formula of Euler angular azimuth is:

$$R = ZXY = \begin{bmatrix}
\cos(\alpha)\cos(\gamma) - \sin(\alpha)\sin(\beta)\sin(\gamma) & -\cos(\beta)\sin(\alpha) & \cos(\gamma)\sin(\alpha)\sin(\beta) + \cos(\alpha)\sin(\gamma) \\
\cos(\gamma)\sin(\alpha)\cos(\beta) - \sin(\gamma)\sin(\beta) & \cos(\gamma)\cos(\alpha) & \sin(\gamma)\cos(\alpha)\sin(\beta) - \cos(\gamma)\sin(\beta) \\
-\cos(\beta)\sin(\gamma) & \sin(\beta) & \cos(\beta)\cos(\gamma)
\end{bmatrix}$$

Based on the above, the gyroscope returns the position of the handset relative to the world coordinate system, and the matrix transformation of the gyroscope is finally multiplied by ZXY.

Relative to the world coordinates, on the mobile phone screen, according to the above matrix transformation, it converges to the current position, but for the screen of the object, the applied matrix transformation is relative to the screen coordinate system. The matrix transformation required by the final graphics API is the ZXY opposite direction, which is its inverse matrix. That is, ZXY multiplies the sequential upside down, and YXZ can get the inverse matrix. This ensures that the relative to the world coordinate system remains unchanged.

4. Instance

To upload the bridge model in the system as an example, Figure 5 shows the upload Model page. As shown in Figure 5, System supports .3ds, .obj, .fbx, .dwg, .stf, .3dm, .dxf, .skp, .iges, .step and other 3d model format files upload. Figure 6 for the systems shows the main operations of the 3d models, including translation, rotation, model dismantling and other interactive operations, as well as changing color materials, viewing the model attributes (Long, Wide, High-level) and so on.

![Figure 5. Upload the model](image-url)
5. Summary

It is feasible to provide interface rendering and management of 3D data in different formats. By converting the contents of different storage 3D model format files into JSON data, it can be transformed into a unified management 3D model. The basic 3D model interactive operation makes WEB 3D on the Internet have been a certain degree of promotion. And the system can be applied to online games, virtual communities, e-commerce and other fields, so that network viewers, shoppers and other multimedia users such as mobile phones to achieve better viewing entertainment.

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