Cloud Based Interactive Kinematic Simulation of Tiles Display Stand (TDS)

T.E.Rao, B.Srinivasa, T.Srinivas Rao, T.Krishna Kaushika

Abstract— Web based simulations , which requires no explicit installation and has better graphics programming interface are getting more attentions. This paper illustrates the process of designing, implementation and utilization of webGL simulation engine for creating interactive cloud based kinematic simulation of Tiles Display Stand (TDS). Using three.js editor 3D geometric models of the body and frames of TDS were built up and webGL technology is utilised to build kinematic simulation .In this way it is possible to demonstrate not only various static views of the presented product but also its functionality. The developed application can be used as digital marketing tool which facilitate the customers to access the product details via various online devices like mobile, tab and laptop anytime from anywhere .Using the created cloud based graphical user interface (GUI) a user can visualise the kinematic behaviour and features of the TDS. The results of the simulation trials are presented. The article ends with lessons learnt and future possible research areas.

Keywords:— Web Graphics Library (WebGL), three.js, kinematic simulation.

1. INTRODUCTION

Information technologies are influencing practically all aspects of our day to day life. Exponential expansion of Internet just demonstrates their importance. However, in spite of the fact that the number of online applications is constantly growing, one can always finds a gap that could be filled. In the area of digital marketing there is a scope to build 3d interactive applications show casing the product and thereby helping the vendors to reach more potential customers. The current trend of digital marketing, especially in the area of 3D content display through simulations had emerged broadly. Vendors can boost their audience reach by implementing 3D marketing that is not restricted to one medium. Presentations and virtual tours created can be accessed from any desktop or mobile browser that supports WebGL on Windows, Mac or Android. Implementing 3D content into marketing strategy enables the vendor to stay ahead of the others in marketing.

Digital marketing demands simulation of the behaviour of selected real systems on web interface to Ensure wider access via multiple devices. The developed simulation also helps in planning the control algorithm to operate the TDS using Internet of things concepts.

In this paper the procedure to create interactive, web based kinematic simulation of TDS is given. Tiles display stand is used in show rooms for physical display of tiles to the customers.

We can do simulation not only in WebGL, but also in commercial software like Matlab and Simulink. The simulation developed through any commercial software requires its installation on the user's system for any animation or analysis. By using WebGL, we can eliminate the use of software installation on the user system. This paper describes an efficient and straight forward approach of creating a kinematic simulation of TDS in a web interface using WebGL technology. In the present work, components were modelled in three.js editor and were imported directly into the WebGL-based platform utilizing a library of three.js to do simulation and display on web for promoting the sales of the product.

The web based interactive 3D simulations are being used in many applications like model simulation, online game, remote robot control, 3D view of a car and virtual laboratory. Kinematic Analysis through simulation requires creating a virtual model of its representation. In general a 3D model is built using some model designing software and its simulation is observed through matlab or Simulink. But for simulation to run, user must install the software in the system. This procedure is a slow working process and less 3D graphics visualisation. Hence web based interfaces are developed to render 3D images with interactive application enabled, which is free from any supporting software or plugins. For better graphics display of 3D content WebGL based platforms are emerging. WebGL is a java script application program interface for rendering 3D computer graphics within any HTML5 supported browser. This type of interface is completely free from any plugins, which makes it an open source. It is based on openGL embedded system exposed through the HTML5 canvas element as a document object model interface. By using WebGL, we can run simulation from anywhere via a particular chain of commands by storing the simulation files in a server under cloud environment. It is a server independent program and does not have lag between execution and visualisation. In three.js editor window, we can create 3D geometries with some specific commands from which a virtual model is made, and its simulation is performed. Complicated components can be modelled using any solid modelling software like solid works and can be imported into webGL environment for simulation purpose. A 3D model is first designed in solid works or any other designing software and then extracted triangular vertex coordinate data from the file is imported into the program. But direct application of

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webGL technology is very tiresome, especially when a model with multiple components is to be rendered. For viewing a 3D object one needs to describe the entire vertex coordinates extracted from the solid works file through some application. Therefore using the library may reduce the steps and makes the process much faster. Three.js is a java script library which provides high level features for 3D visualisation. It is capable of combining with other libraries and provide interactive applications. It has also different features of camera control, position control, light control and animations. WebGL technology is not only used in robotics, but also in many other fields like medicine, nuclear stations, radiation emerged areas etc. This paper describes the kinematic simulation of a TDS for better visualisation of TDS through WebGL. Here WebGL technology is explored via three.js library for importing each part into WebGL interface and creating simulation. Major browsers like Apple (Safari), Google (Chrome), Microsoft Edge, and Mozilla (Firefox) are members of the WebGL Working Group[1]. WebGL is one of the 3D rendering application program interfaces designed for web. Itself it cannot create 3D objects and display in the web supported browser, it runs based on the code written in the form of java script language used in three.js one of the java script libraries to create 3D objects. Java script is one of the platform-independent application interfaces and its solution is attained by employing web browser as a final 3D renderer like WebGL, which is mostly used for human machine interface[2].There are several ways for rendering 3D objects in web supported browser. Some years ago, the only way to render 3D objects was, by using third party plug-ins such as java applets, Adobe Flash plug-ins or different Active X components. But, at present WebGL technology is available which does not require any plug-ins to render 3D objects. Programming WebGL directly from java script to display 3D scenes is very difficult and complex process [3]. Three.js is one of the Java script library for making this process very easy. Some of the features that Three.js makes easier is listed below.

1. Creating 2D and 3D complex geometries.
2. Applying materials and textures to our objects.
3. Loading objects from 3D modelling software.

There are some java script editors for editing java script coding. In this project we used notepad++ java script editor to edit java script coding. Notepad++ can support a wide range of programming languages and it can easily format java script.

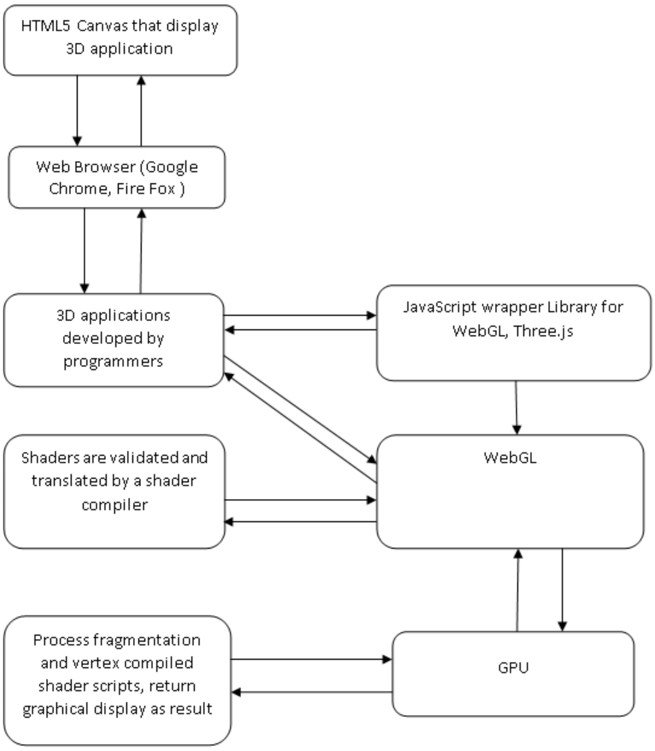

HTML5 Canvas that display 3D application
Web Browser (Google Chrome, Fire Fox)
3D applications developed by programmers
JavaScript wrapper Library for WebGL, Three.js
Shaders are validated and translated by a shader compiler
WebGL
Process fragmentation and vertex compiled shader scripts, return graphical display as result
GPU

Fig 1.WebGL Stack[4]

2. OBJECTIVES OF THE PRESENT WORK

1. The main aim of developing the application was to create kinematic simulation with actual dimensions so as to predict constructional and control difficulties which otherwise expensive on actual model.
2. To develop a digital marketing tool for selling the TDS. The interactive kinematic simulation can be stored in a cloud server and link is shared to the customers to visualise the product features.
3. To develop a frame work which is useful for developing virtual laboratories which are useful in engineering teaching.

3. METHODOLOGY OF CREATING TILES DISPLAY STAND & RESULTS

Three.js is an open source JavaScript 3D library which uses WebGL Technology. It is used to create the 3D scene to display it through WebGL renderer. For viewing any particular object, one need to setup a canvas within which a scene is created and position of camera is specified. Then that scene is rendered through THREE.WebGLRenderer( ) function[5]. Three.js has some already predefined functions to create basic 3D geometries, which are appropriately assembled to model any system. After preparing the primary interface of the program, it allows an user to visualize and manipulate STL geometry within HTML canvas. In order to view any 3D model of a product, the path of saved STL file location and STL loader library must be specified clearly within the program. Apart from STL format three.js also support other extensions of the 3D object, which can be loaded through that particular loader library. We can add different material and texture to get clear visibility of a product.

The Methodology adapted to create simulation of TDS is given below.

Step 1: Creation of 3d models for body and frame defining the geometry and material in the three.js editor (Fig.2).

Step 2: Saving individual models in stereo lithography (STL) binary format using export STL (binary) option.

Step 3: Importing model files into the webGL environment using three.js (Fig 3).

Step 4: Preparing the assembly (Fig.4).

Step 5: texture loading in webGL (Fig 5).

3.1

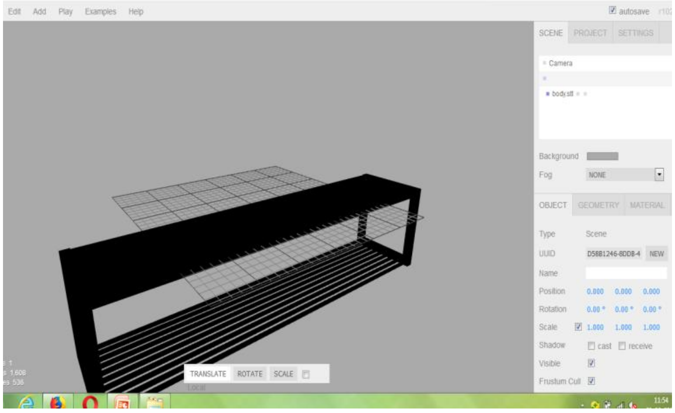


Fig. 2 creation of body of in three.js editor

3.3 Importing model files into the WebGL environment using three.js

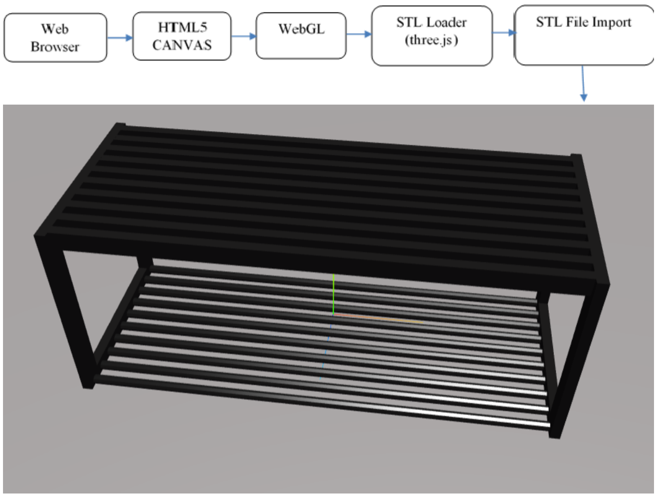


Fig 3 Body of TDS displayed in WebGL.

3.4 Assembly

Assembly for TDS with body and frame is done in three.js JavaScript library by clearly defining the space coordinates, geometry and material for both body and frame. It clearly shown in the below figure.

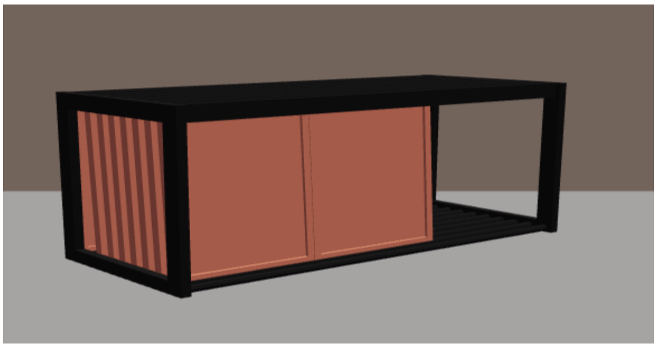


Fig 4 Assembly of TDS in WebGL.

3.5 Texture loading in WebGL

To draw any image in WebGL, textures usage is necessary WebGL is expecting texture coordinates when reading a texture.Texture coordinates always ranges from 0.0 to 1.0 no matter the dimensions of the texture [6]. Create a texture and Set the parameters of texture, so we can render any size image. After we Upload the image into the texture.

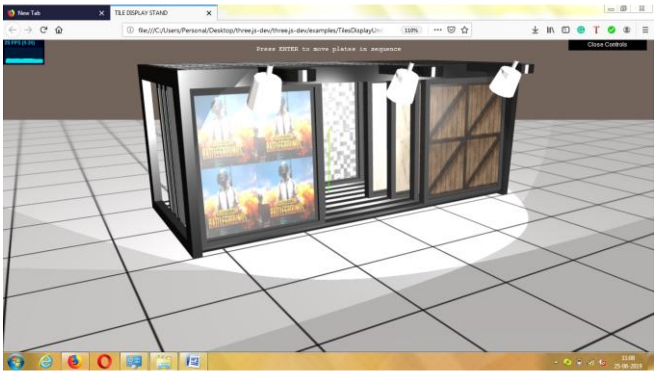
WebGL can only supports 2D textures. There are three steps to apply a texture are listed below.

step 1: specify the texture.

step 2: Assign texture coordinates to the vertices.

step 3: Specify the texture parameters.

Here we use texture.Loader() to load the texture and display with the objects. Texture parameters include wrapping and filtering and shown in WebGL environment as shown in fig5.



Press ENTER to move plates in sequence

Fig 5 Texture loaded to frame in WebGL.

4. KINEMATIC SIMULATION OF TDS

Kinematic simulation is used to show the position of each frame in its working space and to get linear movement of each frame is obtained through javascript coding and finally do simulation and clearly show the objects movement in WebGL interface with the help of WebGL supported browser like firefox, chrome etc. So, by doing kinematic simulation it is easy to show how the tiles are shown to the customers by moving each frame.

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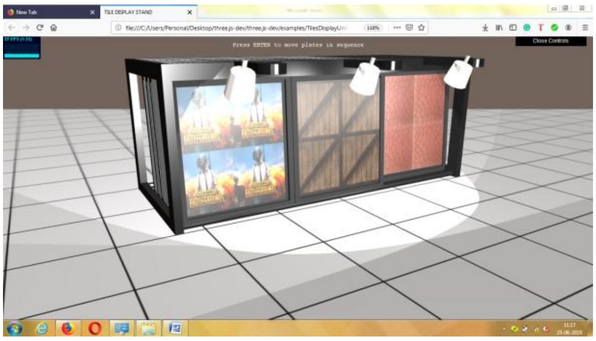

Fig. 6 kinematic simulation in WebGL.

5. ALGORITHM FOR TDS FRAME POSITION CONTROL

To view a particular tile, TDS frames position has to be controlled using IOT concepts i.e. by using a remote device either a wireless remote or an android phone. Every tile that is available to display is assigned a particular QR code. Desired tile is bought to display by specifying the QR code of the tile. Initial configuration of the TDS is given in fig.7.To display a particular tile specified by QR code which is placed in odd numbered frame has to be moved right and even numbered frame has to be moved towards left.

Rack 1	Frame 1	Frame 2
Rack 2	Frame3	Frame 4
Rack 3	Frame 5	Frame 6
Rack 4	Frame7	Frame 8
Rack 5	Frame9	Frame 10
Rack 6	Frame11	Frame 12
Rack 7	Frame 13	Frame 14
Rack 8	Frame15	Frame 16
Rack 9	Frame 17	Frame 18
Rack 10	Frame 19	Frame 20

Fig 7 Initial configuration of the TDS

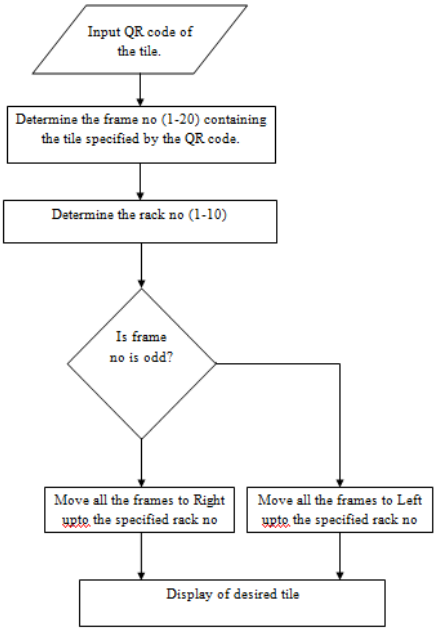
Input QR code of the tile.
Determine the frame no (1-20) containing the tile specified by the QR code.
Determine the rack no (1-10)
Is frame no is odd?
Move all the frames to Right upto the specified rack no
Move all the frames to Left upto the specified rack no
Display of desired tile

Fig. 8 algorithm to display the desired tile using IOT concepts.

After simulating the TDS frame simulation an algorithm to display a desired tile was evolved and it is described in fig.8.

6. CONCLUSIONS

This project illustrates the utilization of three.js for developing 3D kinematic simulation of TDS, which is useful as digital marketing tool and in development of control algorithm. We used WebGL technology, which provides us a very efficient web-based platform for 3D visualisation. Use of WebGL for development web presentations was proved suitable. This technology is beneficial for creating virtual laboratories, which enhances not only the clear visibility of 3D models, but also enhances the process of E-learning. One major prospect of this kind of open source program is freely available to others and it can be modified many times to improve the design. We carried out kinematic simulation of a TDS which helped to promote the sales of tiles. It is almost similar to real practical environment.

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