Structural Design and Techniques of Client-Server for 3D Visualization on Mobile Devices

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***Abstract*— Scene data is of large amount thus it is not possible to store such data in mobile memory for 3D visualization due to less memory storage of mobile devices. Hence client server plays an important role while the visualization of large amount of complex data on mobile devices, In client server concept clients are nothing but a mobile devices while servers are at remote side which store the actual data and then send it to mobile devices for the visualization with the help of various techniques discuss in this papers. In this paper focus is also on client and server architecture for 3D visualization on mobile devices and various visualization techniques used at client and server.**

***Keywords*— client-server, architecture, 3D visualization, mobile devices**

I. INTRODUCTION

Due to the limitations of mobile devices like low bandwidth, less computation power, minimum storage capacity etc it is not possible to store whole data for 3D visualization on mobile devices. Therefore to minimize the load of mobile devices there is use of server in case of remote 3D visualization on mobile devices (clients). For 3D visualization on mobile devices various techniques are used at server side as well as at mobile side for different purpose. Some techniques directly provides 3D visualization and some techniques are indirectly responsible for 3D visualization on mobile devices.

II. CLIENT SERVER ARCHITECTURE FOR 3D VISUALIZATION ON MOBILE DEVICE

A. Client-Server Approach

Visualization can be client based only, that can be recognized as local visualization. In case of client based visualization data is store at client and such data then visualized with the help of various techniques. But for local visualization client must have vast storage capacity. However the mobile clients are adversary to this. Therefore remote visualization plays an important role in complex data visualization. Remote visualization can be client-server based or proxy based visualization. Proxy is an intermediary between client and server [1, 2].

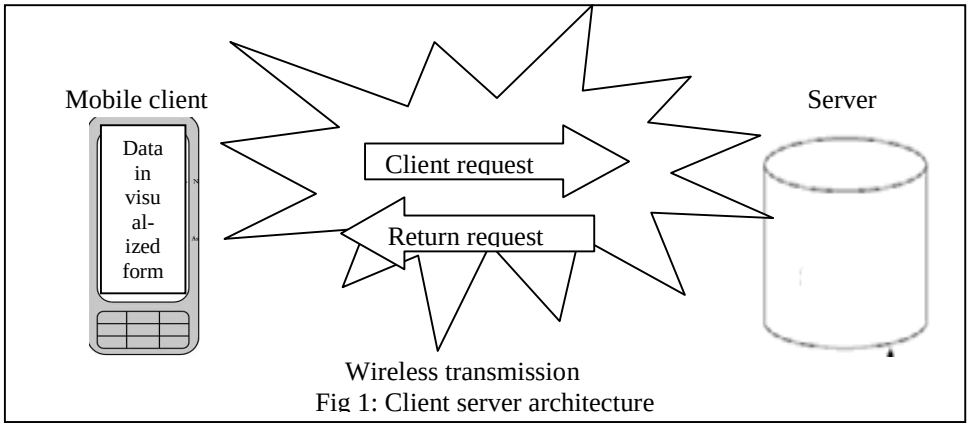

Fig 1: Client server architecture

In previous client server system proposed in [3, 4] does not mention any function like image quality, frame rates etc. Therefore Ross Mitchell et al. [5] proposed a client server for current generation smart phone i.e. iPhone, iPad, Itouch device etc. to get a sufficient functionality, image quality and frame rates in remote visualization. In client server system images are not directly transfer to client mobile but the server load and render the image and then transmit render frame to remote mobile device. Communication between client and server is done through standard protocol. Due to limitation of mobile advance visualization methods are not occurs on remote mobile device hence it is done by server. In the client server system it is necessary to know the clients and server architecture shown in Fig 1.

1) *Server architecture:* In case of remote visualization server must have higher configuration because it stores the large complex data and also perform interactive 2D or 3D visualization, rendering of images. Such type of work is probably carried out on system having Linux operating system with 80 GB RAM. Interaction is done via hyper text transfer protocol. Remote users connect to server through URL (Universal Resource Locator) and web browser and different actions will executed by server based on specified URL.

Such type of system is also stated in [6] but recent system provides efficient use of existing bandwidth and permit complicated user interface.

2) *2) Client architecture:* Remote mobile client used in [5] are of 8GB flash memory for remote visualization on iOS platform. iOS allows 2D, 3D visualization, interaction, rotation, translation and zoom. Secure wireless network Wi-Fi 802.11g is generally essential for the communication between client and server.

III. CLIENT SIDE TECHNIQUES FOR 3D VISUALIZATION ON MOBILE DEVICE

A. Asynchronous adaptation, progressive refreshment, roaming, rendering

To release the burden of data catch there is the adaptation of asynchronous and progressive refreshment strategy. To render data in 3D form on mobile 3D rendering is used. Implementation is done on the platform of PDA with the help of OPENGL ES 3D programming package and VC language [7].

B. Interaction/ Interfacing, event generator and frame decoder

At client side mobile devices uses mobile 3D viewer application for the visualization. At client side to handle user interaction with mobile view there is use of interfacing and users occurrences are also handle at this side with the help of event generator. Frame decoder is also used to extract synchronies data, decode it and put it into visualization buffer. Frame buffer is also used to mange packet losses. This application also supports Gtk+ 1.2 and X11 graphics libraries under Linux [8].

With the help of 3D based user interface the room metaphor has been developed. Therefore the user can selects and identify devices based on position, orientation and form without having a technical knowledge. 3D user interface has so many advantages which allow the visualization of environment and its devices and create a direct correspondence between the physical objects and their 3D representations within the user interface. On a mobile device the Interaction Appliance (IA) runs this makes available the AMCO client and the user interface [10].

C. Web Browser, 3D viewer

At the client side of this application uses compact 3D viewer in JAVA and web browser to browse and rate 3D model. Viewer performs zooming function [9].

D. Data Decompression

Along with compression method decompression is also used at client side to decompress the compressed data which comes from server side. Data has been compress at server side to reduce the transmission rate of complex data. After decompression mobile users gets the view of whole data [11, 13, 14].

E. *Zooming*

Tile images visualized at client side with the help of view operations like zoom, rotations etc. Client also supports multi threaded pull model for multiple tiles [12].

IV. SERVER SIDE TECHNIQUES FOR 3D VISUALIZATION ON MOBILE DEVICE

A. Roaming step length control, motion blur, and triangle strips division, data scheduling

There are different techniques to improve the efficiency of 3D rendering with smooth roaming function in 3D environment, on the intelligent mobile devices. This rendering occurs through wireless data transmission. Different techniques to improve the 3D rendering are roaming step length control, motion blur, and triangle strips division. Roaming step length means minimized change of view. To achieve this view, in roaming step length control the rendering process would not be executed until the actions of operations have exceeded the limit. It has been found that roaming step length of operations directly reflects the correctness of user's operations.

It is clear that when the roaming step length is short, the globe would rotate accurately, and if the step length is long, the globe would rotate in a rough manner. Dynamic adjustment rules are set for the smoothness of real-time operation and to reduce the actual frequency of rendering.

Motion blur is used to improve the system rendering speed i.e. when the small patch of geographic picture is render in the procedure of dynamic roaming operation it extract the reduced pictures. To reduce the 3D representation time there is division of landscape meshes of each patch into triangle strips [7].

To manage data on wireless network data scheduling is also required.

B. *Cluster based rendering*

The focus is on remote visualization in [8] and for that three tired architecture is proposed. In this architecture clients or mobile devices has been connected to the remote visualization server (RVS) which manages the communication between the 3D graphics application in a distributed environment. Also the visualization interface is organized on mobile devices. OPENGL applications are also used at server side whose callback functions adjust the rendering and mapping parameters. Also the cluster based rendering subsystem has been organized using Chromium which follows client-server paradigm by which OPENGL directives are intercepted. One s/w module is implemented i.e. SPU (steam processing unit) as a dynamically loadable library. It supports graphics context subdivision in tiles, distributing computing workloads to cluster nodes, performing actual rendering, returning the result to Chromium clients, and reassembling image tiles.

C. *Interactive generic algorithm and controller*

In [9], interactive generic algorithm has been produced to improve the performance which allows high quality graphics contents on site by linking set of 3D model. This system also allows user to design 3D graphics content on mobile devices for real time visualization. As the mobile device has less computing power for real time visualization so it provides client server architecture to manage computing load.

In interactive generic algorithm the numbers of steps are creation of initial generation, find out optimum solution, check the model and specify rates, execution of GA operation to produce new pair of models and last step is the visualization of new models as shown in fig. 2. Server side also includes controller to manage interaction with user.

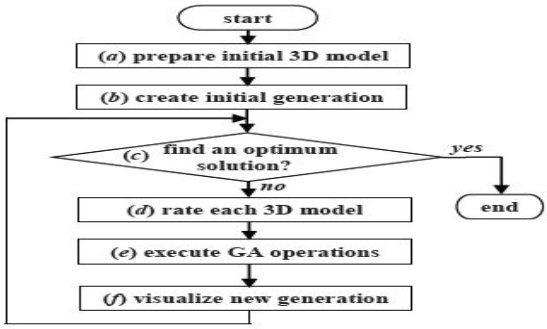

Fig. 2: Flowchart of iGA-Based 3D fmodeling.

D. *Data compression*

Pietro Zanuttigh et al. [13] provide predictive compression method for the visualization of 3D model at remote side. This method reduces the download time and control the flow of 3D data. Main goal of predictive schema is to compress and transmit prediction error. For the compression of transmitted data it is necessary to packed scatter pixels of data in an array. Author presents various algorithms for the remote visualization of 3D models.

Here author Aranha and group [14] discuss technique which minimizes computation and time for the rendering of more graphics on mobile devices. Ray tracing is one of the techniques which doesn't need more pixel as compare to desktop. As it uses client server concept so first it establish the communication between client and server using TCP/IP, then data has been compress at server side to reduce amount of transmitted data and decompress at client side. It also uses cost function to reduce rendering time of pixel on mobile device.

V. ANALYSIS

While transmission of complex data from client to server and vice versa through wireless network for visualization on mobile devices, various aspects are consider like Bandwidth, Threshold, Frame rates, Throughput, Fetch time, Latency, Pixel rates, Screen and image Resolution etc.

A. *Common aspects required in wireless network for 3D visualization on mobile devices*

1) *Bandwidth:* Bandwidth in a networking denotes a network levels. As the bandwidth increases frame might be reduced.

2) *Threshold:* Threshold indicates the point of outset. It is nothing but a boundaries or given minimum and maximum values. For efficient and accurate filtering it is necessary to set suitable relevance threshold and also for other techniques.

3) *Frame rates/ pixel rates:* Frame rates measure the frequency with which an image or a frame can be generated by a visualization system. It is measure of smoothness and fidelity.

4) *Throughput:* Throughput denotes the final result or output. It depends on the device capabilities.

5) *Screen and image Resolution:* Resolution is a function of image or screen height and width. Considering the mobile device resolution it is difficult to achieve good frame rates and image quality.

B. *Analysis of various techniques considering applications, attributes, parameters and their aspects is given in Table I.*

Table I

pplications	Methods	Parameters	Related attributes	Aspect s
Geographic data and earth map 3D visualization [7]	Roaming step length control	Roaming step length	Rotation degree, Distance from earth, Time of 3D rendering	Rendering,
	Motion blur	Dynamic roaming, 3D terrain mesh, Geographic scene	Small patches, Reduces triangles	3D visualization, Rendering
	Triangle strips division	Preprocess 3D meshes, Divide 3D meshes into triangle strip	Reduces 3d rendering time	Rendering
	Data check And transmission	Data updating mechanism, Correctness of data	Spatial indexes, Timestamp of patches	Wireless data transmission
	Asynchronous refreshment	Data scheduling, Loading rough data before accurate	Release mobiles data catch load, Smooth roaming	Data resolution, Efficiency, Speed, Frequency,
	Dynamic catching	Data loading and organization	Represent Current sense with inferior data	Speed and Space limit, 3D roaming
Complex stream based data like video games etc. visualization [8]	Distributed cluster based rendering and streaming using Chromium framework	Event scheduler, streaming, rendering Event generator, Frame decoder	Visualize interface during OPENGL API. Run graphic applications and manages communication	Fast network connectivity, Frame rates, screen resolution, time, stream quality, network traffic
3D models like vehicle at remote side [9]	Interaction/ Interfacing/rendering	Mobile interaction, handles events Render lines i.e. Boundaries, Ridges, Valleys, Silhouettes	Extract synchronize bitstream, handle packet loses, decode compress frames	Bandwidth. Reduce network traffic ,Frame rates transmission time
	Controller	Manage client server interaction, converts 3D into 2D	Transmission, HTTP protocol	Wireless communication
To access ambient intelligent environment	Ambient control and The Dynamic User Interface Creator[10]	Dynamic 3D visua-lization, user interface creation, and context retrieval, interaction synchronization etc.	Controllability, Document and device access is integrated in same user interface.	Error tolerance, efficiency, gateways, sensor tube.
Visualization of image data.	Image Tilling, Multi-resolution Streaming, Zooming and rotation [12]	Interactive visualization on mobile, encoder, Multi threaded pull model	Interactive visualization using structure, multi-resolution images, tile images, preprocess image.	Internet delivery, Multi-resolution, Streaming, decoder
To view 3D virtual reality data, city map, medical data etc[2, 13, 14]	Data compression	Requires minimum computation and memory resources at client, Reduces the download time and control the flow of 3D data	Visualization of complex data on mobile device in distributed environment. Low compression rate for slow mobiles and high compression for powerful mobiles	Data transmission rate, Compression quality and bandwidth.

VI. CONCLUSIONS

While using client server approach for 3D visualization on mobile devices there is use of wireless network. Before transmitting data from mobile to server or server to mobile some visualization techniques such as clustering, controller etc. are used at server side to manage large complex data and to view such data on small screen some techniques or tools are used at clients side (mobile). Some common aspects such as bandwidth, frame rates etc. are discuss in this paper which are responsible for remote 3D visualization on mobile devices.

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