Novel 3D Visualization Techniques for Image Data on Mobile Devices

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ABSTRACT
Old mobile devices were less powerful and did not support various functions. Therefore complex data visualization with different structure was impossible with old devices. Recent mobile are more powerful having high resolution, more colors, large screen, fast connectivity, various tools than old one, but still visualization on mobile devices has remained a challenging task. Even though current mobile devices have high resolution but it is small as compared to desktop. In such situations visualization of image data on mobile devices takes a lot of efforts. Researchers are working on lot of image visualization techniques on mobile devices. In this paper discussion is on such novel image visualization techniques on mobile devices and their analysis.

Keywords
Image data, visualization, mobile devices, resolution in pixel, fps

1. INTRODUCTION
Image visualization on mobile devices can be local or remote. In case of local visualization images store into mobile devices memory and can be visualized with the help of various techniques. Some times mobile device visualizes image transmitted from server that is remote visualization. Server may be at any distance therefore there may be wired or wireless connection between server and mobile clients. Wire and wireless network considers various parameters like network bandwidth, frame rate, time interval, transmission time and delay. Both local and remote visualization of image on mobile devices focuses on image and screen resolution and frames rate to compare mobile devices computational capacity.

This paper analyzed the different types of input data used for visualization, expected frame rate, mobile devices configuration with screen resolution and image resolution.

2. RELATED WORK
Generally images are of high resolution therefore it is complex task to visualize it on mobile devices. Various types of images are considered for 3D visualization on mobile devices. G. M. C. F. Aru et al. considers panoramic images of different shape like cylinders, spheres and cubes [1].

Jeong-Ho Park et al. [2] visualizes 3D maps on low powered mobile devices. Some images like DEM and raster are decompose into parcel data structure which further can visualized with the help of OPENGL ES. It also establishes climbing guidance system which is built up 3D maps on mobile device.

Luca Chittaro et al. [3] proposed animation of 3D anthropomorphic agents and visualization on PDA with the help of Mage-AniM system. By considering the limitation of mobile devices such as CPU, memory and graphics acceleration, real time 3D animation with high frame rates is difficult. Therefore to obtain a smooth animation authors significantly reduce the size in embodied agent triangle.

To produce inter and intra object ambient occlusion there is use of fast real time method for visibility sampling using volumetric data [4]. Volume sampling technique can be used for primitive or screen order rendering. Sampling can be used for ray tracing and ray marching.

Ran Zask et al. [5] presents simple and efficient implemental algorithm for incremental 3D modeling in real time environment, which creates a textured-mapped polygonal mesh model on the basis of sequence of images or monocular video. Due to the use of isosurface of a common 3D occupancy grid, algorithm becomes more simple and efficient. Isosurface based renovation offers low matrix accuracy, helps in filtering measurement noise and also offers rapid construction of a 3D visualization.

Tse-Wei Chen et al. [6] proposed a system which can be used for photo search and retrieval on mobile devices. This new system also found the better mean average precision by implementing image segmentation and k means clustering.

3. IMAGE VISUALIZATION TECHNIQUES

3.1 Dendrogram matrix
Clustering hierarchy can be visualized with the help of dendrogram which is then integrated with reordarable matrix for pattern identification. Here Jin Chen et al. proposed new method and concise overview of dendrogram and their organization with detail view. New proposed technique provides theatrical improvement of information overload. It increases scalability and quality of data abstraction on dendrogram. Also performs the study of data at arbitrary level of details. Dendrogram matrix technique proposed by authors provides visualization of large number of elements on limited screen space. It also provides coexisting access to context and focus. This method also has a drawback that users have to exchange overviews and detail views. [7]

3.2 GPU based illustrative volume rendering
Most of the illustrative techniques are applied to volumetric data such as medical CT and MRI images. Author Roy van Pelt et al proposed a GPU based illustrative volume rendering. A flexible practical based approach is chosen to achieve rendering and parameterization. A Framework proposed by author is the VolFileGPU framework shown as below.

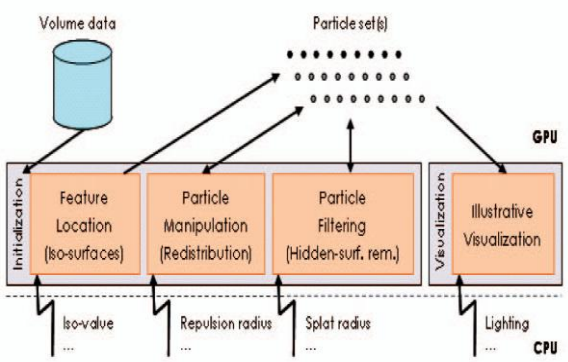

Figure1. The VolFliesGPU framework

Above framework includes feature location algorithm using volume as input and generates initial particle set as output. Other is redistribution which moves the particles to actual isosurface location. Hidden surface removal is the third algorithm to visualize particles which generates the off screen color buffer. Further processing is done on off screen color buffer and particle to get the visible particles. It also generates frame rates for increasing particles [8].

3.3 Edge extraction and detection for video streaming

To connect the resolution gap between streaming video and mobile device screen Hong-Han Shuai et al. [9] proposed new system architecture for up sampling of high quality image data i.e. MobiUP. This new architecture includes client server concept. At the server side useful data is extract from HD video by considering both spatial and temporal information and at the client side this data and computation is reduced. Image filtering is also the part of this system which uses edge extraction to detect short boundaries. Edge detection technique can be used at client side to reduce visual objects but due to limited computation power of mobiles this technique is not suitable. Also the original frames are not match with up sample frames. To solve these two problems and to get the boundaries and other information, edges are extracted from HD video.

Client of MobiUP system is implemented on windows mobile 6.5 smart phone having 800x480 screen resolutions. MobiUP server includes the three types of visual features to prioritize the edge block by considering the less and temporary computation resources at mobile side. Three visual features are clarity I, edge blocks (*b*) and level of restorationI therefore clarity of edge block is calculated with gradient magnitude as

$$c = |\nabla I| = \sqrt[2]{G_x{}^2 + G_y{}^2}, \mathbf{\nabla I} = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial I}{\partial x} \\ \frac{\partial I}{\partial y} \end{bmatrix}$$

For the adjustment of relative importance of c, b, r three parameters are used i.e. α, β and γ i.e. which calculates importance of edge blocks

$$\mathrm{IEB} = c^{\alpha} \times b^{\beta} \times r^{\gamma}.$$

MobiUP also provides the visual quality and avoid prominent artifacts. But it provides satisfactory image quality which can be enhanced and can be reduced Meta data.

3.4 3D binary image warping technique

In [10] Sylvain Faisan et al. proposed 3D binary image warping technique in accordance with continuous and one to one mapping. Warping is nothing but an image transformation process, in which warping image M can transform to image T by means of two ways, considering each point of M whose coordinates in T and other considering each point of T and whose coordinates in M.

In this paper Sylvain Faisan et al. consider each point of transform image whose coordinates in M. Hence the optimization framework is given to define cost function. 3D binary image of size 256x256x256 is consider for warping which takes too much time and also expensive.

3.5 Audio video streaming

Maciej Panka et al [11] proposed a number of approaches for video which is centered in distributed datasets and comprehend in mobile environment. A system is developed in which data is processed remotely on available server and such data converts into digital images. At server side video codec compression is used to compress the frames and it is combined with audio video signals capture by users camera. All these computations are reduced at mobile client side only decompression is performed for the visualization of video of size 320x240 and 640x480. For testing three different types of mobile clients are considered such as Samsung, HTC desired, iPad. To get smooth video it is encoded at 15 FPS.

To visualize and manipulate remote large data in real time on mobile devices M. Panka et al. [12] proposed a remote interactive visualization on mobile devices with the help of distributed system. All data are rendered on given servers of this system and compress while transmission using video codec. This compress data is send to mobile client as single video stream of good quality with high frame rates. Data can be 2D, 3D and animated 3D. In distributed system server accept input from client, process and encode it, send compress data to client. Client take compress data decompress it and visualize on mobile screen. This system is also responsible to decrease network latency for interactive visualization on mobile devices.

3.5 Compressive rendering

Pradeep Sen and Soheil Darabi perform ray tracing rendering to utilize wavelet based final image using compression algorithm. Ray tracing is done only in subset of pixel samples in the spatial domain. Accurate elevated quality image (1024x1024) is found in approximately 10 minutes with just about 75 percent pixel samples using non-adoptive sampling [13].

4. ANALYSIS

There are various visualization techniques discussed above some of those are analyzed as follows. Frame rates achieve by these techniques are shown in following table

TABLE I. COMPARATIVE STUDY OF MOBILE DEVICES ARCHITECTURE

Techniques	**Input data**	**Display device**	**Display device screen Resolutions (pixels)**	**Configuration of display device**	**Output Average Frame rates per second**
Animation modeling process[3]	Embodied agent of 6000 triangle	Dell Axim X50V packet PC	----	624 MHz processor having 64 MB of main memory and Intel 2700G graphics processor with 16 MB of video RAM.	10fps
Edge extraction and detection for video streaming [9]	Large resolution Videos of 384kbps	windows mobile 6.5 smart phone	800x480	HTC HD2 with 1-GHz CPU	30fps
Audio video streaming [11]	video streams of 320x240 and 640x480 pixels	1) 7" Samsung Galaxy Tab tablet 2) 3.7" HTC Desire cell phone, 3) 10.1" Apple's iPad	----	Samsung and HTC running the Google's Android 2.2 operating system, Apple's iPod equipped with the iOS 4.3, standard 802.11g wireless	15 fps
Interactive video streaming [12]	video stream of 320x240, 800x480 and 1366x768	tablet and cell phone	800x480 320x240	equipped with Android 2.2 system, 3G network's	25fps
3d rendering of real time scenes [14]	Complex3D Scenes	Apple iPod Touch	640×480	4G at 1 GHz with 256 MiB RAM.	10fps
Remote volume rendering [15]	Medical images	notebook	1280x 800	Intel Core2 T7200 CPU and Nvidia Geforce Go 7400 graphics	---

5. CONCLUSION

This paper discusses novel 3D visualization techniques for image data on mobile devices. Various types of data can be used for visualization on mobile devices but commonly image data is used for 3D visualization on mobile devices. Also paid attention on analysis of mobile devices and 3D visualization techniques with input and output parameter.

It is shown that different types of image data visualization on mobile devices are used in various applications for various purposes by means of various techniques. These images are visualized on different mobile platforms such as Android, Symbian, Windows mobile, J2ME, iOS etc which are of latest configuration. Frame rate indicates the frequency with which image can be generated by visualization system. Therefore various mobile devices performance is compared by achieving FPS on mobile devices.

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