

Kathmandu University
Department of Computer Science and Engineering
Dhulikhel, Kavre



Assignment 1

Submitted by:
Paribartan Timalina(56)

Submitted to:
Mr. Dhiraj Shrestha
Department of Computer Science and Engineering

Submission Date:2024/03/18

1.Explain different applications of Computer Graphics?

Computer graphics is the activity in which we represent the information and data using the digital views such as images which are stored and displayed using computers in convenient way. The concept of computer graphics can have wide range of applications from simpler design to the creation of real image using volume rendering and giving new ideas to different products. The computer graphics has given us the idea about how the ideas can be used accurately using different algorithms to describe how process takes place in 3D space. The concept of computer graphics can be used in various fields such as medical imagery, scientific simulations, in the field of agriculture, transportation and education. There are different applications of computer graphics and they are described as:

In medical fields:

The computer graphics can be used in the field of medical science to visualize different things and also for creating virtual environments for education that helps students to learn more efficiently and effectively and also help the sector of healthcare to improve status. The application in medicine includes medical diagnosis and treatment, procedures training, preoperative planning, telemedicine (delivery of health care from long distance using electronic info and technology) and many more. In the field of medicine we have to visualize the volume of the tissue, cells or any parts and for that the algorithms for filtering and segmentation, volume visualization, image fusion, tissue modeling is used.

In meteorology:

In the meteorology there is the need to do computation of large amount of data and the visualization of large amount of data must be done to predict weather. For this computer graphics can be used as a tool so that the efficient algorithms can be used for drawing data visualization and also the interactive techniques can be used using interactive volume rendering algorithms.

In image processing:

Computer graphics can also be widely used for image processing techniques using Graphic Processing Unit (GPU). The GPU have become very powerful in today's generation computing system and they have parallel processing processors for high utilization of bandwidth. These can be used for editing various kinds of images to be used in different applications. So this is termed to one of the application of computer graphics

In computer arts and drawing

Computer graphics can also be used in commercial arts and it can be used to create different arts for advertising in the televisions and social media platforms. Computer arts can include many things like animations, paintings, cartoons, logo design and many more. Similarly in the field of drawing computer graphics can be used to draw different buildings structure, structure of airplane, automobile and many more. Through this we can add minor details and design with more accuracy.

In virtual reality:

In today's world the techniques of computer graphics not only apply in the field of virtual models, AI, data analytics but this has been also used in the field of virtual reality. The virtualization effect and computer graphics are critical to increase and improve the quality of learning and training. In this process at first the virtual modeling of the 3D models is done using different methodologies and after completion rendering of those virtual models is done using computer graphics techniques like materials painting and texture mapping.

References for question 1

1. Mamurova, F. I., Khadjaeva, N. S., & Kadirova, E. V. (2023, February 21). *ROLE AND APPLICATION OF COMPUTER GRAPHICS*.
<https://openconference.us/index.php/ISPADP/article/view/537>
2. Vidal F.P.,Bello F.,Brodie K.W.,John N.W.,Gould D.,Philips R.,Avis N.J.(2005,November). *PRINCIPLE AND APPLICATIONS OF COMPUTER GRAPHICS IN MEDICINE*
<https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=a739ffd27cbb006f0cb1d6a8abb71a1a4f5289f7>
3. Papathomas T.V.,Schiavone J.A.,Julesz B.(1988,August).*APPLICATIONS OF COMPUTER GRAPHICS TO THE VISUALIZATION OF METEOROLOGICAL DATA*.
<https://dl.acm.org/doi/pdf/10.1145/54852.378538>
4. Marwa C.,Haythem B.,Ezahra S.F.,Mohamed A.(2014).*IMAGE PROCESSING APPLICATION ON GRAPHICS PROCESSORS*
https://www.researchgate.net/profile/Haythem-Bahri/publication/263964963_Image_Processing_Application_on_Graphics_processors/links/54d09c1a0cf20323c217f7d6/Image-Processing-Application-on-Graphics-processors.pdf
5. Tang, Y. M., & Ho, H. L. (2020). *3D MODELING AND COMPUTER GRAPHICS IN VIRTUAL REALITY*. In *IntechOpen eBooks*.
<https://doi.org/10.5772/intechopen.91443>

2. Write a survey report to explain the ongoing research in the field of computer graphics .

Interactive volume visualization

Executive Summary

Volume rendering is defined as the process of displaying the sampled data in three dimensions(3D) into the two dimensional(2D) projection and the visualization of such data has been one of the ongoing research and development for the sake of suitable display of the sampled data. The interactive volume visualization can be used in different topics like medical imagery and different scientific simulations([Westover, n.d.](#)). Similarly there are many applications that deal with the volumetric data in the visualization in which there are certain transfer function to map the data values to the color and opacity or as surfaces that are extracted from volume by some thresholding process. This survey report has explored the ongoing research in the Interactive volume visualization by knowing about the recent developments in rendering techniques and algorithms, challenges in this field, and the future researches and the fields of progress along with showing on how researchers are working for advancements in this sector.

Background and Objectives

Volume visualization plays a crucial role in displaying volumetric data effectively, obtained from various fields such as medical imagery and scientific simulations.

The objectives of this survey are:

1. to understand the current state of interactive volume visualization
2. identify recent developments, challenges
3. future research directions.

Methodology

For finding out the current state and the possibility of future advancements in interactive volume visualization a review of literature and research papers were done. Similarly different kinds of academic resources were also explored to find out the informations. After the collection of information it was thoroughly analyzed and results were discussed.

Results

Volume visualization can include different forms of the representation of volumetric data specification to a volumetric image including color combination, shading information and opacity so that the users can effectively view it. The volumetric data are generally obtained from medical imagery, different kinds of simulations in scientific fields and other different multidimensional datasets. The term interactive in the volume visualization is used because this provides the user a real time volumetric analysis of the sampled data. The interactive speed in volume rendering can be achieved using different algorithms like forward mapping algorithm, successive refinement, table driven mappings for shading and filtering and the avoidance of complex machine classification. Similarly the techniques used in the volume rendering are object-order, image-order, domain based and hybrid techniques ([Kaufman & Mueller, 2003](#)).

In the image order rendering the algorithm used iterate over the pixels in the target image focusing on the generation of final image rather than the elements in scene. In contrast the object order rendering is technique where the algorithms iterate over the elements of the image to be rendered and focus on rendering element rather than pixels in target image ([Image and Object Order Rendering, 2020](#)).

In this survey report we have discussed about the current situation of data visualization techniques and development in this sector which is increasing day by day. The domain based rendering directly transforms the volume space into image rendering using the techniques of Fourier transform. This is simpler and efficient process of transforming data into different representations. Lastly the hybrid rendering techniques can apply more than one rendering techniques. In this technique there may be more techniques than one like as using the object rendering for certain portion of image and then image rendering in other portion ([Kaufman & Mueller, 2003](#)). It provides more flexibility than other techniques.

In the previous days there were many failed attempts to visualize the volumetric data because the data size was very large and there were many complex algorithms which needed huge amount of calculations but after the development of the machines speed and the memory capacity there was ease in the visualization of data and the research proved that the intermediate surfaces can be hidden and the models can directly be used for displaying the volume data. This process is called backward and forward mapping. In the backward mapping the image plane is traced into data using rays where rays are obtained from each pixel into data and tracing is stopped when it becomes opaque. In the forward mapping data is traced directly into image plane using the algorithms such as Z-buffer and painters. For the object order rendering forward

mapping techniques is used where the volume data is mapped onto the image plane and for the image order rendering backward mapping technique is used where rays are cast from each pixel in the image plane through the volume data to determine the final pixel value([Westover, n.d.](#)).

As a large amount of computation is required for volume visualization a parallel algorithm is desired and much of the rendering should be table driven. In the table driven rendering there is a precomputed tables or arrays that stores the relevant information and those information is extracted whenever rendering tasks are carried out. This technique improves efficiency and also the speed and is useful for doing less computation. Similarly for the interactive volume visualization the rendering algorithms and computations isn't enough rather there should be development of interaction techniques as well. For this in the ongoing research the researchers are finding ways to increase user participation with rendering like implementation of advanced navigation methods, touch interface and also gesture detectors. This increases the user participation as well as also helps to explore and identify complex structures.

Challenges:

As there has been the significant development and many researches in the interactive volume visualization there are still some problems like the high demand of high resolution datasets. These challenges are being overcome through the optimization techniques, parallel computing and leverage advancements in GPU architectures. Similarly there is also the challenge of tradeoff between simplicity and functionality as the interactive design that provides efficient and user friendly nature is very important for the interactive volume visualization([Westover, n.d.](#)).

Future advancements in interactive volume visualization:

In the future there is a great chance that further innovations will be carried out in this topic. The scientists are working for the integration of machine learning with the volumetric data for understanding and interpretation of data. If this works well then the feature extraction, classification and detection can work well and assist user to identify various features from data. The concept of Augmented reality(AR) and Virtual Reality(VR) into interactive volume visualization is under research. Using this AR and VR environments can provide a new doors for exploration of datasets for training and education([Cheng et al., 2018](#)).

Conclusion

This survey report provides the idea of the ongoing research in interactive volume visualization along with the present condition in the computer graphics. This report has described about all the things from rendering techniques, algorithms that can be used along with the challenges and the future innovations that are going on in this field. As it is very much possible that the technology is expanding the addition of new ideas like machine learning, augmented reality and virtual reality is giving a good shape for the future of interactive volume visualization and unlocking different ideas for new domains.

References

1. Westover L.(n.d.).*INTERACTIVE VOLUME RENDERING*.
https://users.cs.northwestern.edu/~jet/Teach/2002_1win_AdvGraphics/presentations/WestoverVolRender.pdf
2. Kaufman A.,Mueller K.(2003).*VOLUME VISUALIZATION AND VOLUME GRAPHICS*
https://www.researchgate.net/profile/Klaus-Mueller-13/publication/266248612_Volume_Visualization_and_Volume_Graphics/links/55010c6f0cf2aee14b58ebe9/Volume-Visualization-and-Volume-Graphics.pdf
3. Cheng, H.-C., Cardone, A., Jain, S., Krokos, E., Narayan, K., Subramaniam, S., & Varshney, A. (2018 January). *DEEP-LEARNING-ASSISTED VOLUME VISUALIZATION*.
https://www.researchgate.net/publication/322612433_Deep-Learning-Assisted_Volume_Visualization
4. *IMAGE AND OBJECT ORDER RENDERING*. (2020, November 12). *Wikipedia*.
https://en.wikipedia.org/wiki/Image_and_object_order_rendering