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Extraction of Superficial and Volumetric Features from 3D Color Images

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***Abstract* - The three-D objects in the physical structure connected computer Games area unit hollow plane figure meshes with textures applied to them. On the other side, volumetric data illustration not solely stores the outer surface options for example visualization of 3D MRI/CT known ledge is all about within the elements too. This needs additional video memory. Most of the particular 3D volume data generation particularly by MRI scanners area unit grey-level pictures. In this paper proposed a technique to make colors for grey images.**

1. INTRODUCTION

Three-dimensional (3-D) digital images are acquired by scanners like Computed Tomography (CT) system, Magnetic Resonance Imaging (MRI) system, Positron Emission Tomography (PET) system, Ultra Sound Imaging (USI) system, 3-D optical/electron microscope, 3-D co focal microscope, Range Image Sensor (RIS) system, Synthetic Aperture Radar (SAR), Scanning Ground Penetrating Radar (SGPR), to name a few. The 3-D digital image data obtained using such sensors are essentially the characteristic reflections of various components under the scanning area of specific interest.

A 3-D image as seen on a monitor is a bunch of light intensities and one will not be able to visualize the hidden parts in order to make meaningful interpretations. In this context, processing the 3-D image data is Nothing but extraction of physical, morphological and structural properties of the hidden parts of the image. For example, the MRI image data of say a human heart is processed to extract hidden details, mostly visual in nature, about various parts of the heart like pulmonary artery, aorta, thoracic chamber, tricuspid and mitral valves, auricles and ventricles. Precise details about these parts could be obtained only when the processing techniques are reliable and robust.

A 3-D digital image data consists of voxels, each voxel exhibiting a specific property like light intensity, pressure, and temperature. The voxels are arranged in the form of a 3-D number array. So, 3-D image processing ultimately turns out to be updating of the numbers in the 3-D array using a formula or algorithm developed in a formal mathematical or logical framework.

Many researchers have been trying to develop methodologies and algorithms to process 3-D digital images. From most of whatever has been reported in the literature one would be able to infer that no algorithm or methodology could be accepted as a universal tool to process all kinds of 3-D image data. In fact, one would feel the necessity of having different algorithms for carrying out a particular operation on different data which are obtained using a sensor or different sensors.

Three dimensional digital image processing is an important area of research that has numerous applications in the fields of medical imaging, seismology, meteorology, remote sensing and material sciences. Depending on the requirement for solving a specific problem, one has to identify various features of three dimensional images while applying suitable algorithms. For example, the quantitative analysis of anatomical structures in MRI/CT images requires extraction of volumes and shapes of certain parts of human body. In order to do this, there is a need for detecting features such as points, lines, contours, surfaces, wireframes, textures and skeletal forms from three dimensional images. All these 3D images are basically gray images and they do not exhibit color information. In fact, the 3D scanners do not provide color images. Transforming the gray images to color images is a tedious work and most of the time people end up in pseudo coloring. Present day software packages do not support this facility. Moreover, detecting superficial and volumetric features of three dimensional images has always been a difficult task and there is little progress made and found in literature. These two problems are the actual motivating factor behind the work proposed to be carried out.

1.1 Objective of the research

The main objective of this research is to visualize 3D color images in a computer monitor and to find feasible

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solutions to some of the problems discussed so far by developing technologies, strategies and robust and error-free algorithms for detecting superficial and volumetric features of three dimensional digital images.

'Superficial features' means surfaces, points and lines. 'Volumetric features' means contours, edges and skeletal forms. In order to carry out the operations of extracting these features from three dimensional images, it is proposed here to make use of either mathematical morphological algorithms or cellular logic array processing (CLAP) algorithms. Further details about these two paradigms are given below.

1.2 Paradigms to be adopted in the research

1.2.1 Processing of 3-D images using morphological methods

The basic morphological operations involved in extracting superficial and volumetric features are 3-D erosion and 3-D dilation. It is to be noted here that the shape and structure of a processed 3-D image depends exclusively on the shape and structure of the structuring element used while carrying out these operations. There is no formal method to generate three dimensional structuring elements of different shapes and structures. The research carried out and reported in this thesis, however, makes use of algebra called 'Geometric Algebra (G-Algebra)' and introduces certain algorithms developed in that algebra for generating structuring elements in '3-D Lattices'. In chapter 5 basic details of G-Algebra and its use in generating 3-D structuring elements is explained.

1.2.2 Processing of 3-D images using cellular logic methods

There is another novel paradigm called 'Cellular Logic Array Processing (CLAP)' introduced by E. G. Rajan, in which one can develop fast algorithms for processing digital images. Cellular Logic Array Processing is a logico-mathematical framework developed using the fundamental notions of Markov's 'Normal Algorithms' and von Neumann's 'Cellular Automata'. Normal algorithm is an idealized serial processor like a Turing machine and a cellular automaton is an idealized parallel processor. CLAP is a logical

technique of realizing cellular automata using normal algorithms as shown in the Fig 1.

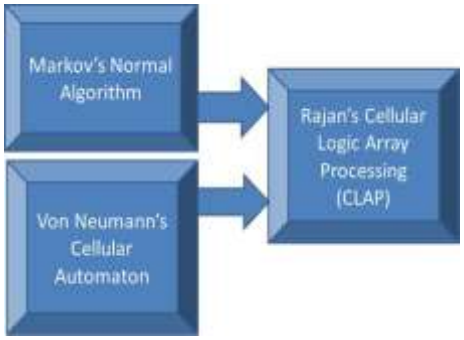

Fig 1: Cellular Logic Array Processing (CLAP)

1.3 Areas covered in the research

The areas to be covered while carrying out research in Detecting the Superficial and Volumetric features in 3-D Digital Images' are Computer Graphics, Image Processing and Theory of Computation. Visualization of 3-D images on a 2-D monitor and their rotation, scaling and spatial transformation making use of various tools and concepts on computer graphics. Processing of 3-D images in the frameworks of mathematical morphology and Cellular Logic Array Processing (CLAP) paradigm and various concepts of image\ processing. Fig 1.2 shows areas to be covered in this research for processing 3-D images.

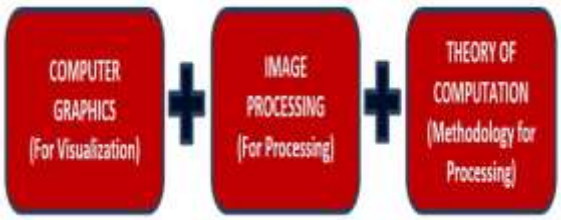

Fig 1.2: Areas covered in this research

1.4 Scope of the work

The intended research would provide a method of visualizing color 3D images and their processing using CLAP based algorithms. Results would be compared with the results of applying standard algorithms available in the general literature to sample 3-D images.

1.5 Possible Research Outcome

Significant results are expected due to this research.

• To develop Cellular Logic Array Processing (CLAP) based algorithms for detecting the following features from 3-D color images:

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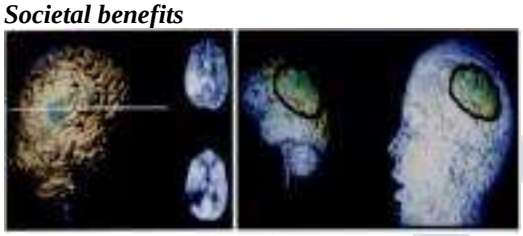
- ❖ 3-D Points
- ❖ 3-D Edges
- ❖ 3-D Surfaces
- ❖ 3-D Thinned forms
- ❖ 3-D Skeletal forms
- ❖ 3-D Directional Textures

1.6 Expected Research Impact

The research output would open up new avenues for developing a prototype product and whose future versions would be used in various 3-D image processing applications like Medical Image Processing', Mineral Exploration, Archeological Excavations and 'Defense Applications'. Some of the imminent benefits of this research are envisaged as outlined below.

Societal benefits



• Radiologists, medical professionals can identify various features from 3-D images for diagnostic purposes.

• Prediction of damaged tissues/organs in less time without going for surgery or biochemical test.

• Useful for researchers in analyzing the 3-D structures in various fields like oncology, geology, zoology, aviation, geophysics, and protein modeling etc.

• It is useful for detecting unexploded landmines, where layer wise 2-D images of particular land are obtained by Ground Penetrating Radar devices.

• It is useful for knowing the position of archeological objects under the ground so that objects are not damaged while excavating from the ground.

Economic benefits

• Oil companies spend lots of money in digging wells to explore the presence of oil. The 2-D image of the layers of the earth can be obtained by using ground penetrating radar (GPR) device. The sequence of these 2-D images can be reconstructed to form a 3-D image called Vertical Seismic Profile (VSP) and such 3-D images can be processed to obtain information about the presence of oil or other elements of interest. By using this technique oil companies can have a priori knowledge about a site and then go for a rig which means saving of money.

• Similarly medical professionals and other people like 3-D film producers who make use of 3-D image processing and analysis can get their jobs done effectively, reliably and with reduced cost.

CONCLUSION

This paper introduces a novel technique for monotone coloring of 3D gray images and their processing using cellular logic array processing.

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