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4D Visualization

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Abstract— The main concept of Visualization is to Visualize objects in biology and medicine extend across a vast range of scale, from individual molecules and cells through the varieties of tissue and interstitial interfaces to complete organs, organ systems, and body parts. The practice of medicine and study of biology have always relied on visualizations to study the relationship of anatomic structure to biologic function and to detect and treat disease and trauma that disturb or threaten normal life processes. Traditionally, these visualizations have been either direct, via surgery or biopsy, or indirect, requiring extensive mental reconstruction. The potential for revolutionary innovation in the practice of medicine and in biologic investigations lies in direct, fully immersive, real time multi-sensory fusion of real and virtual information data streams into online, real time visualizations available during actual clinical procedures or biological experiments. In the field of scientific visualization, the term "four dimensional visualization" usually refers to the process of rendering a three dimensional field of scalar values."4D" is shorthand for "four dimensional"- the fourth dimension being time. 4D visualization takes three-dimensional images and adds the element of time to the process. The revolutionary capabilities of new three-dimensional (3-D) and four dimensional (4-D) medical imaging modalities along with computer reconstruction and rendering of multidimensional medical and histologic volume image data, obviate the need for physical dissection or abstract assembly of anatomy and provide powerful new opportunities for medical diagnosis and treatment, as well as for biological investigations. IN contrast to 3D imaging diagnostic processes, 4D allows doctor to visualize internal anatomy moving in real time. So physicians and sonographers can detect or rule out any number of issues, from vascular anomalies and genetic syndromes. Time will reveal the importance of 4d visualization as it grows with time.

***Keywords**—4D VISUALIZATION, advantages of 4D, 4D Techology ,scope of 4D Visualization*

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I. INTRODUCTION

A. Higher-Dimensional Space

Our general surroundings exists in 3-dimensional (3D) space. There are 3 sets of cardinal headings: departed and right, forward and in reverse, and all over. Every single other heading are basically mixes of these essential bearings. Numerically, these sets of bearings relate with three direction tomahawks, which are routinely marked X, Y, and Z, separately.

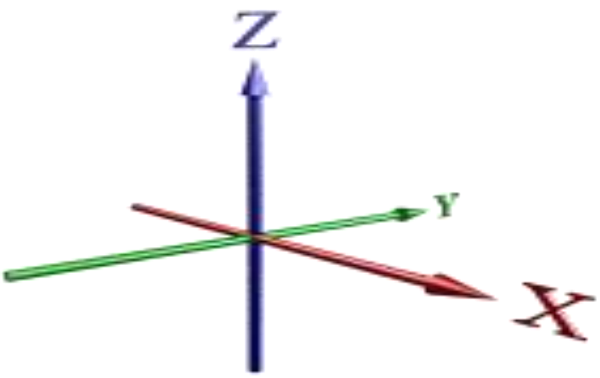

Figure I:axis in 3D

The arrows in the diagram indicate which directions are considered numerically positive and which are negative. By convention, right is positive X, left is negative X, forward is positive Y, backward is negative Y, and up is positive Z, and down is negative Z. We shall refer to these directions as +X, -X, +Y, -Y, +Z, and -Z, respectively. The point where the coordinate axes intersect is called the *origin.*

To the extent we know, the space we possess comprises of these 3 measurements, and no more. We may imagine that space must be 3-dimensional, that it can't in any way, shape or form be whatever else. Physically, this might be valid, yet numerically, there is nothing extraordinary about the number 3 that makes it the main conceivable number of measurements space can have. It is conceivable to have measurements lower than 3: for instance, 1D space comprises of a solitary straight line extending off to interminability at either end; and 2D space comprises of a level plane, reaching out long and width uncertainly. Notwithstanding, nothing about geometry limits us to 3 measurements or less. It is very conceivable—and numerically direct—to manage geometry in more than 3 spatial measurements. Specifically, we can have a fourth spatial measurement that untruths opposite to every one of the 3 of the recognizable cardinal bearings in our reality.

The space depicted by these 4 measurements is called 4-dimensional space, or 4D space for short.

In a 4D world, there is another directional pivot which is opposite to the X, Y, and Z tomahawks. We might mark this pivot W, and call the heading along this hub the fourth bearing. This new pivot likewise has positive and negative headings, which we might allude to as +W and - W.

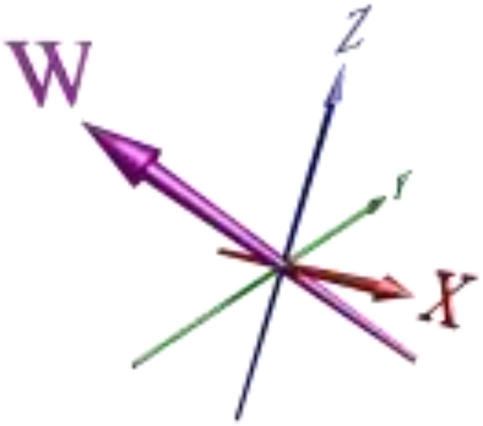

Figure II: different axis in 4D

It is important to understand that the W-axis as depicted here is perpendicular to *all* of the other coordinate axes. We may be tempted to try to point in the direction of W, but this is impossible because we are confined to 3-dimensional space.

II. *WHY* Bother?

Why try attempting to imagine a higher-dimensional space that we can neither experience nor get to specifically? Other than unadulterated interest, 4D representation has a wide assortment of valuable applications.

Mathematicians have since quite a while ago thought about how to envision 4D space. In math, an extremely valuable technique for comprehension capacities is to diagram them. We can plot a genuine esteemed capacity of one variable on a bit of chart paper, which is 2D. We can likewise plot a genuine esteemed capacity of two variables utilizing a 3D diagram. In any case, we keep running into issue with even the least complex-esteemed capacity of 1 complex contention: each mind boggling number has two sections, the genuine part and the nonexistent part, and requires 2 measurements to be completely delineated. This implies we require 4 measurements to plot the chart of the intricate capacity. However, to see the subsequent chart, one must have the capacity to imagine 4D.

Einstein's hypothesis of Special Relativity proposes that space and time are interrelated, shaping a space-time continuum of 3 spatial measurements and 1 worldly measurement. While it is conceivable to envision space-time just by regarding time as time and inspecting "depictions" of space-time objects at different focuses in time, it is additionally valuable to treat space-time geometrically. For instance, the separation between two occasions is the separation between two 4D focuses. The light-cone additionally has a specific shape that must be sufficiently envisioned as a 4D object.

Moreover, Einstein's hypothesis of General Relativity depicts shape in space-time. While it may not really be an arch into a physical spatial measurement, it is useful to envision it all things considered, with the goal that we can perceive how space bends in 4D as a 3-complex. On the off chance that space in the universe had positive ebb and flow, for instance, it would be fit as a fiddle of a 4D hyper sphere—however what precisely does that resemble?

Numerous other intriguing numerical questions additionally require 4D perception to be acknowledged completely. Among them are 4D polytopes (4D counterparts of polyhedra), topological protests, for example, the 3-torus and the Real Projective Plane which must be inserted without self-crossing point in 4D or higher, and the quaternions, which are valuable for speaking to 3D revolutions. It is hard to completely welcome these items without having the capacity to see them in their local space.

III. IS IT POSSIBLE TO VISUALIZE 4D?

Some believe that it is impossible for us to visualize 4D, since we are confined to 3D and therefore cannot directly experience it. However, it *is* possible to develop a good idea of what 4D objects look like: the key lies in the fact that to see N dimensions, one only needs an (N-1)-dimensional retina.

Even though we are 3D beings who live in a 3D world, our eyes actually only see in 2D. Our retina has only a 2D surface area with which it can detect light coming into our eye. What our eye sees is in fact *not* 3D, but a 2D *projection* of the 3D world we are looking at.

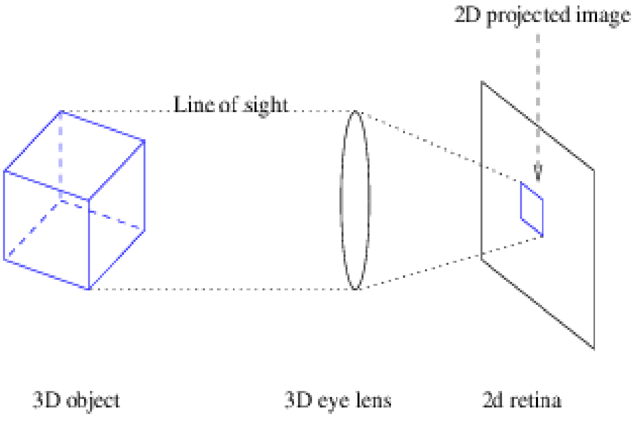

Figure III : Projection of 2D image

In spite of this, we are quite able to grasp the concept of 3D. Our mind is quite facile at *re-constructing* a 3D model of the world around us from the 2D images seen by our retina. It does this by using indirect information in the 2D images such as light and shade, parallax, and previous experience. Even though our retina doesn't actually *see* 3D depth, we instinctively *infer* it. We have a very good intuitive grasp of what 3D is, to the point that we are normally quite unconscious of the fact we're only seeing in 2D.

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Similarly, a hypothetical 4D being would have a 3D retina, and would see the 4D world as 3D projections.

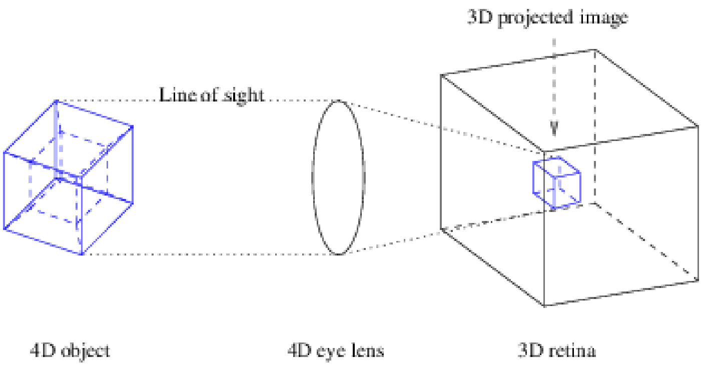

Figure IV: Projection of 3D image

It would not *directly* see the 4th dimension, but would *infer* it using indirect information such as light and shade, parallax, and previous experience.
The key here is that what the 4D being sees in its retina is *3-dimensional,* not 4-dimensional. The 4th dimension is *inferred*. But since *we* have a good intuitive grasp of 3D, it is not that difficult to understand what a 4D being sees in its retina. From there, we just need to learn how to *infer* 4D depth.
The rest of this document will describe in detail the basic principles of 4D visualization, as well as provide a number of examples of 4D objects. We shall take a purely geometrical approach and treat all 4 dimensions as *spatial* dimensions

IV. 4D-THE MODERN DIMENSION

i. "4d" is shorthand for "four dimensional"- the fourth dimension being time. 4d visualization takes three dimensional images and adds the element of time to the process.

ii. In contrast to 3d imaging diagnostic processes, 4d allows doctor to visualize internal anatomy moving in real time. For example: movement patterns of fetuses allow conclusions to be drawn about their development; Increase of accuracy in ultrasound guided biopsies thanks to the visualization of needle movements in real time in all 3 planes. So physicians and sonographers can detect or rule out any number of issues, from vascular anomalies and genetic syndromes

V. . 3D GIVES LIFE TO 4D

Bolted inside 3¬D biomedical pictures is critical data about the items and their properties from which the pictures are inferred. Endeavors to open this data to uncover answers to the riddles of structure and capacity are framed in the space of picture preparing and perception. An assortment of both standard and advanced strategies have been produced to handle (adjust) pictures to specifically improve the perceivability and quantifiability of sought article components and properties. For instance, both realismpreserving and perception modulating ways to deal with picture show have essentially propelled the reasonable handiness of 4¬D biomedical imaging. Numerous life-threatening maladies and/or quality¬of-life distresses still require physical mediations into the body to decrease or evacuate illness or to lighten destructive or agonizing conditions. However, insignificantly obtrusive or noninvasive mediations are presently inside achieve that adequately expand doctor execution in capturing or curing disease; diminish hazard, agony, inconveniences, and reoccurrence for the 3/27/2016 4D Visualization | Seminar Report and PPT for CSE Students http://www.seminarsonly.com/computer%20science/4d¬visualization-seminar¬report¬ppt¬pdf.php 2/3 patient; and diminish human services costs. What is yet required is engaged decrease of later and proceeding with advances in perception innovation to the level of practice, so they can give new devices and strategies that doctors "must have" to treat their patients and enable researchers in biomedical investigations of structure to capacity connections. Framing a picture is mapping some property of an article onto picture space. This space is utilized to imagine the item and its properties and might be utilized to portray quantitatively its structure or capacity. Imaging science might be characterized as the investigation of these mappings and the advancement of approaches to better comprehend them, to enhance them, and to utilize them gainfully. The test of imaging science is to give propelled abilities to procurement, preparing, perception, and quantitative examination of biomedical pictures to increment generously the unwavering extraction of helpful data that they contain.

VI. Concept Of 4D Visualization

In the field of scientific visualization, the term "four dimensional visualization" usually refers to the process of rendering a three dimensional field of scalar values. While this paradigm applies to many different data sets, there are also uses for visualizing data that correspond to actual four dimensional structures. Four dimensional structures have typically been visualized via wire frame methods, but this process alone is usually insufficient for an intuitive understanding. The visualization of four dimensional objects is possible through wire frame methods with extended visualization cues, and through ray tracing methods. Both the methods employ true four space viewing parameters and geometry.

The ray tracing approach easily solves the hidden surface and shadowing problems of 4D objects, and yields an image in the form of a three-dimensional field of RGB values, which can be rendered with a variety of existing methods. The 4D ray tracer also supports true four-dimensional lighting, reflections and refractions. The display of four dimensional data is usually accomplished by assigning three dimensions to location in three space, and the remaining dimension to some scalar property at each three dimensional location. This assignment is quite apt for a variety of four -dimensional data, such as tissue density in a region of a human body, pressure values in a volume of air, or temperature distribution throughout a mechanical object.

VII. 4D VIEWING VECTORS AND VIEWING FRUSTUM

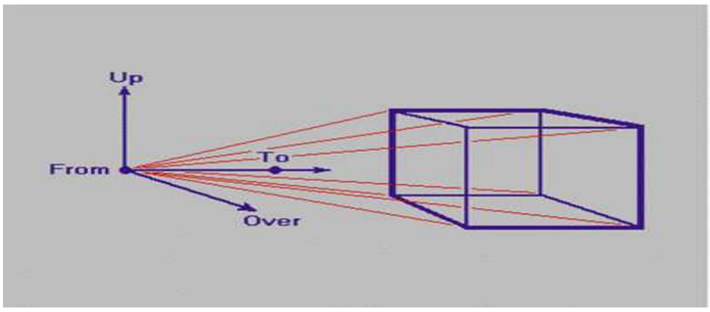

Figure V :4D viewing axis.

The viewing angle is defined as for three-dimensional viewing, and is used to size one side of the projection parallelepiped; the other two sides are sized to fit the dimensions of the projection parallelepiped. For this work, all three dimensions of the projection parallelepiped are equal, so all three viewing angles are the same.

VIII. RAY TRACING ALGORITHM

Raytracing takes care of a few rendering issues in a straightforward way, including concealed surfaces, shadows, reflection, and refraction. What's more, retracing is not confined to rendering polygonal meshes; it can deal with any article that can be investigated to discover the crossing point purpose of a given beam with the surface of the item. This property is particularly pleasant for rendering four dimensional articles, subsequent to numerous N¬dimensional items can be effortlessly depicted with understood conditions

IX. 4D IMAGE WARPING

For robustly measuring temporal morphological brain changes, a 4D image warping mechanism can be used. Longitudinal stability is achieved by considering all temporal MR images of an individual simultaneously in image warping, rather than by individually warping a 3D template to an individual, or by warping the images of one time point to those of another time point. Moreover, image features that are consistently recognized in all time points guide the warping procedure, whereas spurious features that appear inconsistently at different time points are eliminated. This deformation strategy significantly improves robustness in detecting anatomical correspondences, thereby producing smooth and accurate estimations of longitudinal changes. The experimental results show the significant improvement of 4D warping method over previous 3D warping method in measuring subtle longitudinal changes of brain structures.

X. METHOD

4DHAMMER involves the following two steps: (1) Rigid alignment of 3D images of a given subject acquired at different time points, in order to produce a 4D image. 3D-HAMMER is employed to establish the correspondences between neighboring 3D images, and then align one image (time t) to its previous time image (t1) by a rigid transformation calculated from the established correspondences. (2) Hierarchical deformation of the 4D atlas to the 4D subject images, via a hierarchical attribute based matching method. Initially, the deformation of the atlas is influenced primarily by voxels with distinctive attribute vectors, thereby minimizing the chances of poor matches and also reducing computational burden. As the deformation proceeds, voxels with less distinctive attribute vectors gradually gain influence over the deformation.

XI. CONCLUSION

Advanced medical imaging technology allows the acquisition of high resolved 3D images over time i.e.4D images of the beating heart. 4D visualization and computer supported precise measurement of medical indicators (ventricle volume, ejection fraction, wall motion etc.) have the high potential to greatly simplify understanding of the morphology and dynamics of heart cavities, simultaneously reduce the possibility of a false diagnosis. 4D visualization aims at providing all information conveniently in single, stereo, or interactively rotating animated views.

XII. REFERENCES

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