NATURAL ANGULAR COORDINATE SYSTEM FOR VISUAL SPACE

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Introduction

Matter, Space, Time are the physical basis of reality. Of this Space and Time are given to human consciousness in a few different ways such as the Galilean or Newtonian View, Relativistic View and, much more intimately, as the Sensory View of our day to day existence.

Physics as a science is very much complete in our Newtonian View as well as in our Relativistic View. However, the systematic study of our Sensory View as a province of science is gaining respectability only in very recent times: that by virtue of our inwardly expanding knowledge of our own brain, as well as our presently universal endeavor to understand our own consciousness. (Nizam, 2002)

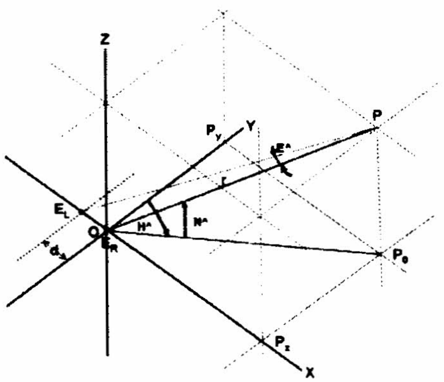

Fig. 1. Angles in human vision

Scientists in exploring the human brain and its sensory modalities have thus far taken a Newtonian View of Space and Time in their attempt to map out the Neuronal Basis of Spatial Perception in human mind. Almost always a standard XYZ rectilinear coordinate system or Cartesian coordinate space has been employed in grasping the reality of space in human perception.

However, herein we propose a novel and natural alternative based on the Body Frame of Reference in terms of Angular Rotation of Head (H^), Angular Tilt of Nose (N^) and Angle of Attention of the Eyes (E^). Refer Figure 1.0.

Methodology

Figure 1.0 shows the view of point P from eyes E_LE_R – the Fovea Axis. We make a fundamental assumption here that the Fovea Axis approximates to an arc of a circle through E_L and E_R with centre P. Thus the fundamental relationship that d, fovea axial distance, is equal to r times E^, the Eye Angle of Attention.

Thus the perceived visual distance of P from eyes is given by

$$r = d / E^{\wedge} \qquad \text{(I)}$$

Head Angle H^ gives the turn of the head from straight-forward direction and Nose Angle N^ gives the tilt of nose from straight-forward position in directing attention to point P.

Thus any position in space can be specified by our three fundamental angular (space) coordinates H^, N^ and E^.

Our main goal is to find the feasibility of applying the aforesaid three angle system to computer graphics.

Observations

Human angle view is different in horizontal and vertical plane. While the horizontal angle of view is roughly about 210°, vertical angle is only about 150° (Nathan, 1997). When we look at an object the image falls on the foveae. While the object we look at is seen clearly, the objects at the periphery of our vision becomes blurred. (Wikipedia[1])

Most people have a dominant eye. Even though you use both eyes to look at an object, you use your dominant eye more. This phenomenon is known as Ocular Dominance or eye dominance. The other eye looks at the object at a slight angle, thus helping to understand the distance to the object. For most people (approx. 75%), right eye is the dominant eye. Therefore, in this study, right eye is considered as the dominant eye. (Wikipedia[2])

Equations

From Figure 1.0 it is clear that the Newtonian coordinates of point P are:

$$x = r \cos(N^{\wedge}) \sin(H^{\wedge}) = (d/E^{\wedge}) \cos(N^{\wedge}) \sin(H^{\wedge}) \quad \text{(II)}$$

$$y = r \cos(N^{\wedge}) \cos(H^{\wedge}) = (d/E^{\wedge}) \cos(N^{\wedge}) \cos(H^{\wedge}) \quad \text{(III)}$$

$$z = r \sin(N^{\wedge}) = (d/E^{\wedge}) \sin(N^{\wedge}) \quad \text{(IV)}$$

Analysis

The fovea axial distance, d, is determined using empirical methods. It is possible that d could vary within a small range from person to person as well as in the same person over edge regions of the field of vision. In this paper we shall take d, for example, as 6cm or 0.06m for convenience.

The Angle of Attention E^ is the principal concern of our immediate analysis here. From observing one's own eyesight and vision one can realize that E^ has a lower limit and an upper limit.

Next in the case E^ > E_0, normal Binocular Vision of seeing a single object breaks down and we begin to see double that's normally of little or no use in life.

Discussion

One can suggest that this 'Neuro-dynamic' approach to human view is a subclass of medical studies. However our interest is in applying this new approach to computer graphics. As this new method is much closer to the natural human view, implementing such system will have many benefits.

Once this method is used for 3D engines (e.g. 3D Game engines), it will be easier to render than the Euclidian method. Also the graphics will be much more realistic.

There is no need to calculate the distance to an object that that will make an E^ $\approx$ 0. All such distant objects may be depicted as flat objects. Items in the periphery of vision can be made to look blurred. No complex calculations will be necessary to determine whether something is near the periphery of vision. Items that are closer, i.e. E^ > E_0 will be blurred and doubled.

This method can be easily adopted to simulate the vision of myopic people.

References

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Nizam, A., (2002). On the Neurodynamics of the Attentive Brain, Journal of Theoritics. *www.journaloftheoretics.com/articles/4-6/an.pdf*

Wikipedia[1], Fovea Centralis – The Yellow Spot of the Human Eye *http://en.wikipedia.org/wiki/Fovea_centralis*

Wikipedia[2], Ocular dominance *http://en.wikipedia.org/wiki/Ocular_dominance*