Data Visualization Assignment 3

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I. Introduction

At times visualizing 3D dataset would be very useful in understanding the dataset. The aim of this assignment is to perform 3D Volume rendering on the Indian Oceans data.

II. Data

The data is obtained from Indian National Centre for Ocean Information Services(INCOIS). The data is provided in a csv file which has velocity in x and y direction for every x,y in $90 \times 60 \times 24$ grid. The velocities corresponding to land is given as 9999.0.

III. Visualization algorithms

A. Isosurface Extraction

For each grid we compare the salinity value at each vertex with the salinity value of the isosurface we want to find. Based on the comparisons perform a bit mapping and generate the bit code of that cube. Lookup for the code from the triangle lookup table and display all the triangles. Repeat this for different salinity values. Triangle lookup table contains the triangles that correspond to ease case which occurs. This method is called the Marching Cubes algorithm.

B. Slicing

Viewing one slicing of an entire volume helps to visualize and understand the 3D volume easier. Given an equation of the plane $ax + by + cz + d = 0$ the algorithm finds all the points in the volume that lies on the plane. For each edge present in the entire 3D grid, find all the edges which intersects with the given plane. For each edge which intersects with the given plane find the point of intersection and salinity at the point of intersection. The point of intersection can be found using the formula:

let $v_1 = (x_1, y_1, z_1)\ and\ v_2 = (x_2, y_2, z_2)$ be the points of the edge which intersects with the plane.

The line which is described by the edge is $l = v_1 + t(v_2 - v_1)$, t is a parameter.

$l = (\ x_1 + t(x_2 - x_1),\ y_1 + t(y_2 - y_1),\ z_1 + t(z_2 - z_1))$

The point of intersection of the line and the plane can be found by finding a t such that the point lies on the plane.

We get $a(x_1 + t(x_2 - x_1)) + b(\ y_1 + t(y_2 - y_1)) + c(z + t(z_2 - z_1)) + d = 0$. Solve for t and and substitute back into the equation l to get point of intersection. Salinity at that point can be found using linear interpolation on the line l.

C. Color Map

Color map is used to see the change of values. Color map is provided for both isosurface extraction and slicing. The color map used is:

$r = 0$

$g = 1 - (salinity - minsalinity)/(maxsalinity - minsalinity)$

$b = 0.25$

Both for isosurface and slicing the max and min salinity are the global maximum and minimum.

IV. Conclusion

The visualization obtained can be used to understand the following aspects:

1) Whats the salinity distribution at x distance from land.
2) Whats the salinity distribution at x distance below land.
3) Whats the salinity distribution at different longitudinal value.
4) Which all regions have the same salinity. This can help to find specific species in the ocean.

V. References

1) http://mathinsight.org/distance_point_plane_examples
2) http://paulbourke.net/geometry/polygonise/