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ABSTRACT:

The purpose of this project is to create a system for a personal computer that, given data point values on a cartesian coordinate system, generates computerized contour maps. The range on the axes of the coordinate system is the choice of the user.

The software system is intended for the use of the Geology Department of Corpus Christi State University in the creation of weather maps, topographic maps, and other related applications. The system can be used in field work as well as in the classroom environment as a learning tool, and as a means of comparison with hand drawn contour maps.

The contour map generated by this system is drawn on a blank area; the coordinates of the points are adapted so that they utilize the screen to a maximum. The map can be drawn with different detail options selected from a menu. The map can then be saved to be recalled at the convenience of the user.
BACKGROUND:

A map is a two dimensional representation of an area. Usually the area is geographical, and the map is a reduction of all or part of the large-scale spatial area or surface, so that the area can be more easily perceived.

Geologists are trained to read, utilize and create maps. Through maps geologists express and envision dimensional relationships. However, they never know the complete picture of the subsurface since they deal entirely with sampled data from which they must create the map.

Map relationships are expressed in terms of points located upon the map, distances between points, density of points, and values such as barometric pressure, rainfall, altitude, corresponding to those points. Most maps are estimates of continuous functions based on discrete observations at control points.

It is in determining these estimates that each geologist applies his or her geologic interpretation to the raw data contained in the observation points. Their geologic judgement might become biased, and the effects of their bias will detract rather than add to the utility of the map.

More and more geologists, especially oil geologists, are turning to computers since computer
contouring methods are totally consistent, and provide a counterbalance to overly interpretative mapping. Computers can also produce more maps more quickly.

There are two principal methods used to generate computer contour maps: gridding and triangulation. (Robinson, 1982)

Gridding is the most commonly used method. It generates an evenly spaced grid and calculates the inverse distance-weighted-average interpolation, taking into account the data point values, and their relative distance to each new grid value. This way, uniformly spaced values are generated and subsequently connected through contour lines.

Triangulation, on the other hand, connects all points, forming triangles that are not allowed to cross each other, and that are as equiangular as possible. A series of interpolation points over the lines connecting the data points are then found and connected to others of equal value to form the contour lines.

This latter method has the advantage of using the real data values as part of the triangular grids, instead of some approximate values like the ones used in the gridding method. Therefore, the map resulting from the triangulation method is more realistic. Triangulation is also up to five times faster than gridding, and no generalization of the data is assumed.
Mathematically the triangulation process was investigated by Delaunay in 1934, as cited in McCullagh (1981, p. 49): "... for any given data set there is only one solution set of triangles that are the most equilateral possible, although in many cases they may not look it ....". Following Delaunay, other researchers implemented the same triangulation approach and added details that reduced the number of operations from \( n^3 \) to as few as \( n^2 \) making it much faster than gridding. Some of these researchers are: Rhynsburger (1973), using the Thiessen polygon; Brassel and Reif (1979), with another version of the Thiessen method that speeded the process to \( n \log(n) \) operations; and finally in 1980, McCullagh and Ross developed an extended version of the approach of Brassel and Reif. McCullagh and Ross created the Delaunay triangles, using a doubly sorted data structure array. This increased the speed of the algorithm to approximately linear.

In the triangulation method the algorithm time is directly proportional to the number of data points in the data set, but in gridding the algorithm time is related to the square of the size of the grid used.