ENGINEERING COMPUTER GRAPHICS

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Computer Graphics is a general term which suggests the use of a computer to process data which at some time in the process is displayed graphically. Work which has been done in this field varies greatly from computer hardware to various graphics topics, each activity contributing to the general area of Computer Graphics.

Most of the work done in this department has been closely associated with Engineering Graphics and progress has been made on most common topics in Engineering Graphics to relate them to the computer. Work has been done in Functional Scales, Nomographs, Harmonic Analysis, Descriptive Geometry and General Projection.

The latter topic on Projection has resulted in programs to process three dimensional data and display this data in any form of coplanar pictorial. One of the earliest developments in this project was the solution of the "Hidden Line Problem" in the Spring of 1967 using the principles of Descriptive Geometry.[1]

This project has been expanded to produce stereo views, movie sequences (with automatic hidden line deletion) automatic determination of projection parameters, data production by algorithms and other special features to make it possible for university students to use various features in a course in Engineering Computer Graphics.

Principles of Projection

In order to produce a two dimensional picture of a three dimensional object three main elements are involved:

1) The details of the object as lines and surfaces.
2) The location of the picture plane.
3) The location of the viewer.

Depending on the relative position of these three elements the resulting picture can be isometric, axonometric, oblique, perspective etc. These pictorials, when viewed from the proper position, represent exactly what the viewer would see of an actual object.

[1] *Quarterly Bulletin, Computer Society of Canada, Volumn 8, Number 1, 1967-8.*

PERSPECTIVE WITHOUT HIDDEN LINE DELETION. LINES OF SIGHT DRAWN TO CHECK INTENDED MOVIE SEQUENCE.

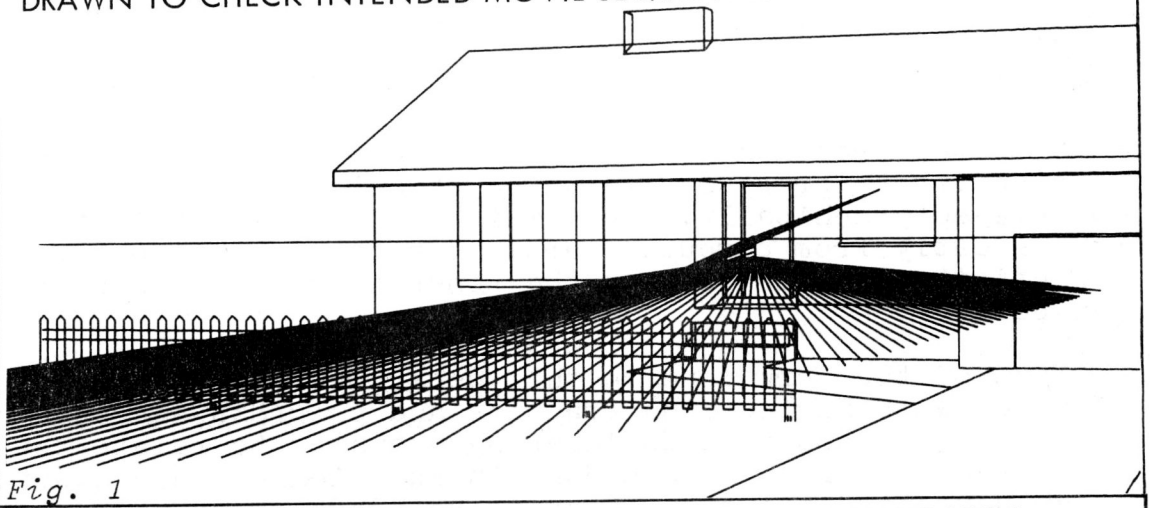

Fig. 1

PARTLY COMPLETED DRAWING. CONTINUOUS LINES HAVE BEEN SEGMENTED BY THE PROGRAM TO DELETE HIDDEN PORTIONS.

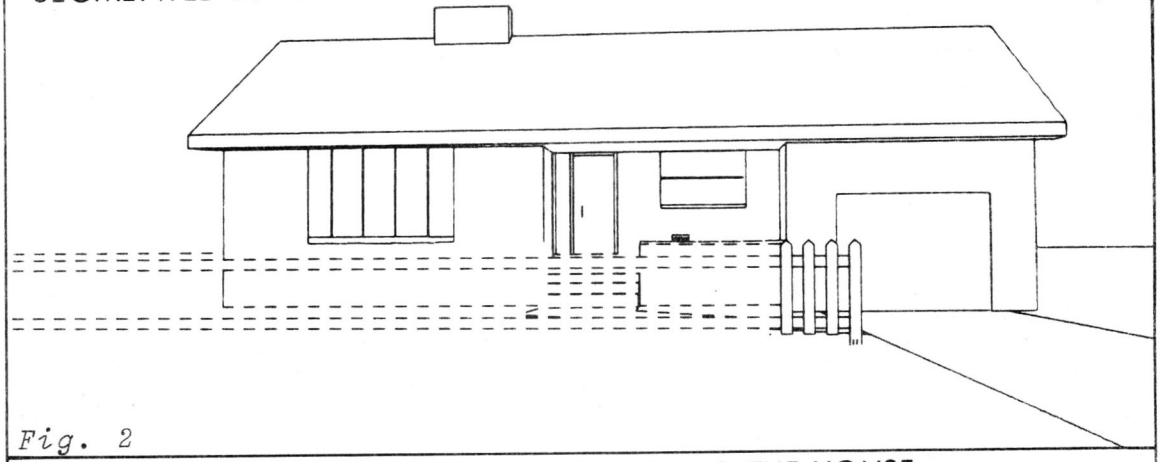

Fig. 2

ONE FRAME OF THE MOVIE SERIES CLOSER TO THE HOUSE.

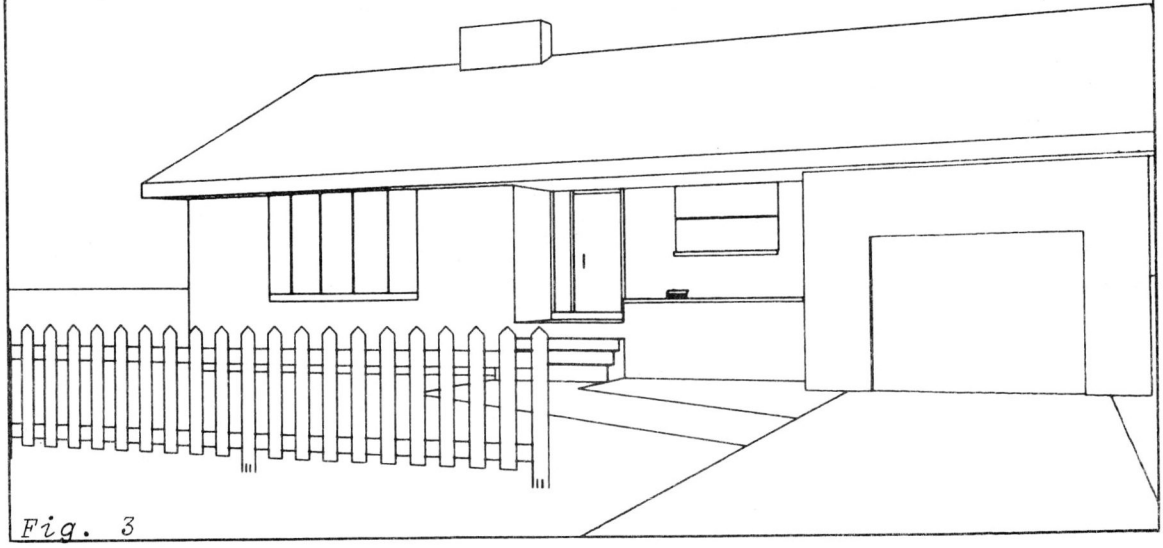

Fig. 3

Movie Series

If, in a series of pictures, there is relative movement between the viewer and the object, then this series can form the sequence of frames for a simulated movie.

A movie sequence has been prepared using the hidden line algorithms to simulate movement between a house and the observer. As an example of difficult data, a picket fence was added so that the program had to delete numerous sections of the lines on the object.

The path of the viewer can be determined on the computer from a series of bench marks and may not only approach a set of objects but also move among them. The picture seen at any position depends on another moveable point called the center of vision. The resulting movie can represent exactly what a viewer would see if he followed a similar path among actual objects and maintained the equivalent moving center of vision. The lines of sight from the viewer to the center of vision also represent lines which can be plotted to check the intended movie sequence. (Figure 1).

Use of the digitizer to obtain data from a drawing.

Originally the six co-ordinates used to describe each line of an object had to be determined by actual measurement from a multi-view orthographic drawing.

The use of a digitizer has greatly simplified this process when used in conjunction with a decoder program which was designed for Engineering Computer Graphics.

Basically the digitizer is similar to a drafting machine with a pointer, the location of which on the drawing is recorded whenever a button is pressed. This is sufficient to obtain data from a two dimensional graph but requires much more logic to interpret a series of locations from a multi-view drawing.

Each end of a line in space requires three co-ordinates and the whole line requires a total of six. The digitizer however only provides two co-ordinates at a time and has no built-in method to indicate what is actually meant by these values.

A program, Digitizer Data Decoder, was developed to determine which two of the six co-ordinates were being located, when to generate or discard a set of line data, and also make it possible to do this from up to seven possible views.

This program, by being more complex makes it possible for the operator to merely point to the ends of lines in a fairly simple sequence. The raw data thus produced is processed on the computer to determine which lines of the object were being

PERSPECTIVE PLOT OF GRAPHITE CRYSTAL. HIDDEN LINE DELETION NOT USED ON BOTTOM PORTION TO ILLUSTRATE WHAT PROGRAM HAD TO DELETE IN TOP LAYER.

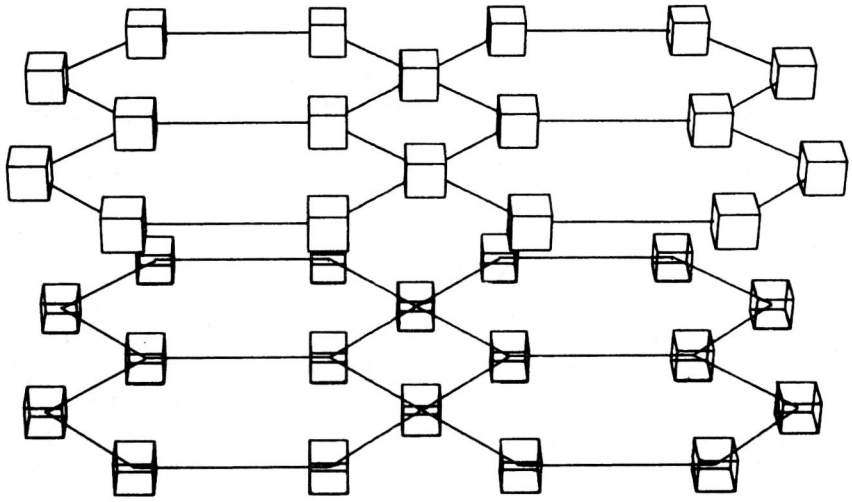

Fig. 4

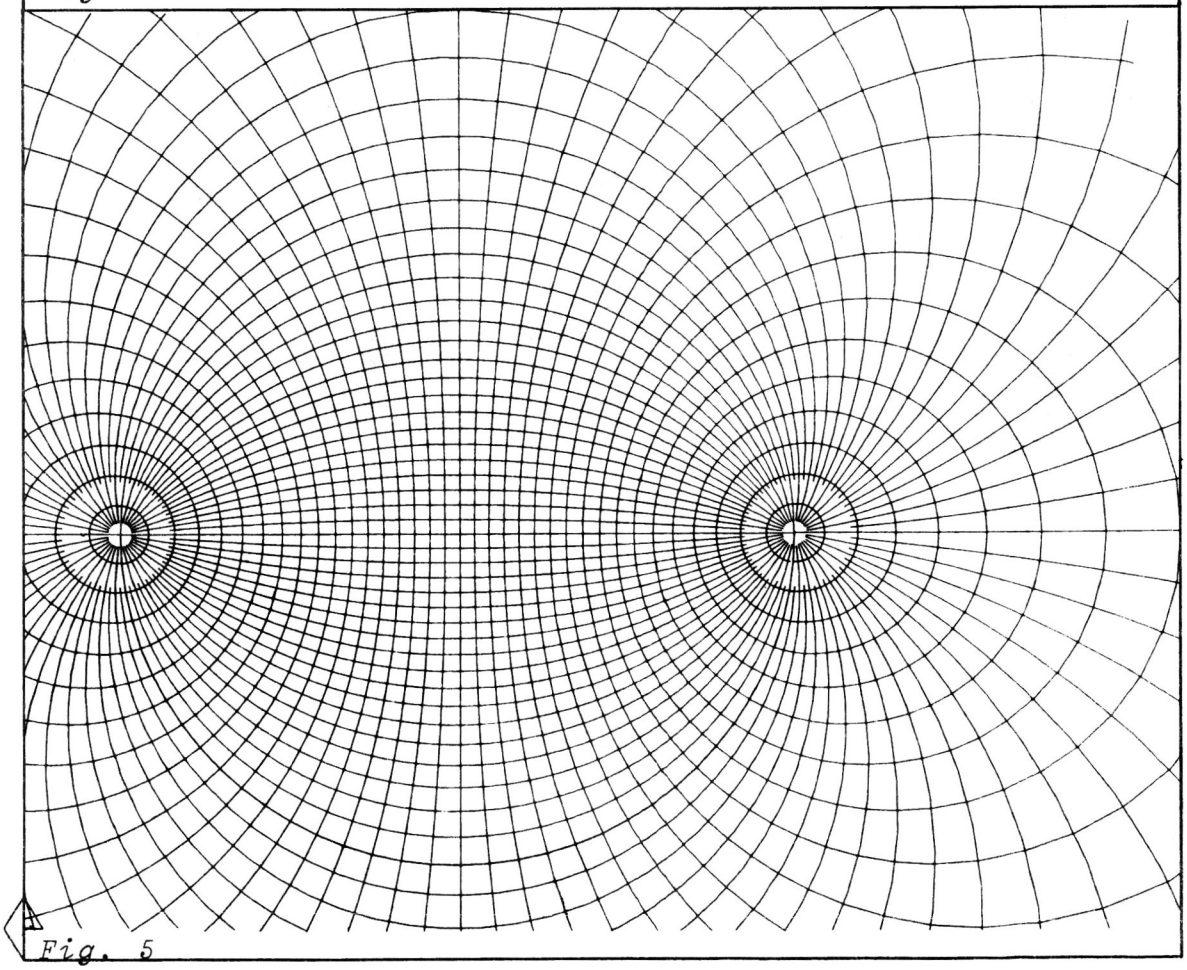

Fig. 5

STEREOGRAPHIC NET PROJECTED FROM DATA OF A COMPLETE SPHERE GENERATED BY AN ALGORITHM.

described and generate a data set for the projection programs. Additional data processing programs can then be used to describe obstructions based on this line data for use on the Hidden Line Deletion Program.

Details of the sequence for use of the decoder program are contained in a manual associated with the program.

Algorithms for producing three dimensional data.

The data for some three dimensional objects can be generated using a suitable algorithm and the Computer Graphics System COGR has been designed to be compatible with such work. A program which has been completed is one which will generate all the latitude and longitude lines for a sphere. All essential parameters are variables so that the diameter, intervals, lengths of line segment etc. can be varied to suit the intended use. A practical use of this generated data has been the production on the computer of a stereonet used in Crystallography and Descriptive Geometry. (Figure 5).

A similar approach can be used to generate the surface of other geometric shapes.

The COGR System

The projection systems can be used either as a set of algorithms or a complete package. A student may use various portions as he becomes familiar with the theory involved and designs his own equivalent programs or it can be used as a complete graphic software package which will handle data for those not involved in computer programming. Details of the format for line data for this program are contained in an article which is available upon request.[1]

[1] *Quarterly Bulletin, Computer Society of Canada, Volumn 8, Number 1, 1967-8.*