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DESCRIPTION OF GRAPHICS TRANSLATION SOFTWARE BETWEEN INTERGRAPH AND TEKTRONIX SYSTEMS

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16. ABSTRACT

The requirement for Marshall Space Flight Center's Photo Analysis to use existing three-dimensional Intergraph graphic files on an existing Tektronix 4129 three-dimensional graphics workstation and the unavailability of an off-the-shelf Intergraph to Tektronix translator required the development of such a translator. Using the output of Intergraph's standard interchange format converter, the three-dimensional graphic information of Intergraph's files are reformatted and compressed. The three-dimensional image is reconstructed using Tektronix's software terminal interface graphic library (STI).

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TECHNICAL MEMORANDUM

DESCRIPTION OF GRAPHICS TRANSLATION SOFTWARE BETWEEN INTERGRAPH AND TEKTRONIX SYSTEMS

INTRODUCTION

A valuable resource of Marshall Space Flight Center (MSFC) Photo Analysis is the ability to use computer-generated three-dimensional wireframe graphic models with film and video images. The computer models can be quickly overlayed onto a projected or digitized image by software, as in Figure 1, allowing precise measurements and increased flexibility in the analysis of two-dimensional images. To meet these requirements, a source of graphic models was needed that could be stored on and used by Photo Analysis' Tektronix 4129 graphics terminal. An existing source of models resided on an Integraph IGDS workstation, and a skilled operator of the workstation was available to update and produce new models. Various hardware and software solutions to the problem of graphic file transfer were explored, but none proved adequate. Therefore, Photo Analysis wrote its own translator to bring Intergraph files to the Tektronix terminal.

OVERVIEW

The translator consists of two programs, Resif and Intek. Resif uses the output of Intergraph's Standard Interchange Format (SIF) converter, which converts Intergraph files into ASCII. The output of Resif is a compressed and reformatted ASCII file which is processed by Intek. Intek reconstructs the model on the Tektronix 4129, and provides a facility for storing the drawing on the terminal's disk drives. Both Resif and Intek are written in VAX FORTRAN. Intek uses the Plot 10 Tektronix Software Terminal Interface (STI) library, which offers an extensive set of useful low-level graphics routines.

RESIF

Program Resif is a preprocessor of data for the Intek program. Resif functions are three fold. The first function of Resif is to remove data that Intek cannot process. This is done by simply not copying the data to the Resif output file. The second function of Resif is to reformat the data so Intek can easily read it. This is done by placing graphic element commands on the line above the data to draw that graphic element. The third function is to compress the data before it is copied to the Resif output file. This is done by not copying the blanks at the end of each line to the output file. Other capabilities of Resif are the ability to not process chosen levels of the Intergraph SIF file. This is done by not copying data to the output file until the next encounter of a level graphics command.

Resif was written to preprocess data from the Intergraph SIF files. However, it is hoped that minor modifications to Resif can be made in order to process data from other graphic computer systems. This is under the assumption that those other computer systems produce an interchange file similar to that of Intergraph's SIF file.

Intek reads commands from Resif processed files. These commands may direct program control to routines which process surfaces of revolution, B-spline surfaces, circular and elliptical arcs, lines, change drawing segments, or alter line characteristics. When one of these commands is encountered, control is transferred to the appropriate routine, which reads all data relevant to that command. Processing segment changes, line characteristics, and drawing lines and arcs is fairly straightforward; however, surface information poses more complex problems. Surfaces of revolution are presented as profiles composed of lines and arcs which are swept about the axis of revolution, generating facets between the starting and ending positions of the profile. Two points, whether the endpoints of a line or somewhere on an arc, are used to define the radii of two circles, with the center point of each circle being the closest point on the axis of rotation to that point. A second set of points is used to define the ending position of the first set after the revolution has been performed. A set of points defining the perimeter of each of the two circles is generated. The first point in one set is matched to the first point in the second set and so forth for each of the points in both sets. The points can then be used to define the boundaries of individual polygons or facets of a surface. The sets are sent to a subroutine to calculate the normals of each facet, then an STI draw facet command is issued to the terminal and a single facet, or a strip of facets, is drawn. This process is repeated for each pair of points defining a section of the profile, for each separate sweep of a profile, and for each surface of revolution. Additional complication is introduced when the axis of revolution is not parallel to the x, y, or z axis. A differential equation must be solved to find the center point of the two circles described above. In both cases, significant data sifting and calculation must be performed to determine critical information such as the axis of revolution, calculation of points defining curved sections of a profile, calculation of points defining the horizontal sweep of each pair of points delimiting sections of the profile, and extensive error checking and correction. The points supplied with a B-spline surface command are used to form a grid of facets. If necessary, the B-spline routines can combine rectangular and triangular facets to form irregularly shaped surfaces. "Folded" facets can also be detected.

FEATURES

All Intergraph three-dimensional graphics files with surface information can be converted, displayed, and stored on a Tektronix 4129 graphics terminal or a higher model capable of three-dimensional and hidden-line display. Program Resif allows the user to decide which of the 63 Intergraph levels will be converted. This feature can be used to eliminate levels that contain unwanted information such as construction lines. It can also be used to break a single file containing many items into several separate files containing only one item. If the user needs to perform pan, zoom, rotate, and hidden line operations with a very complex model, the speed of these operations may be unacceptably slow. To counter this problem, Intek allows the user to adjust the interval in degrees between each point on circles, arcs, ellipses, and elliptical arcs. An increased number of degrees between each point generates fewer points, resulting in less data for the terminal to process during operations on the model. Although the fidelity of the resulting model is lower, the terminal retains its viewing transform, even if the drawing on the screen is deleted. A higher fidelity model stored on the terminal hard disk can then be copied into the exact orientation of the low fidelity model. Thus, the user may manipulate the low fidelity model for

speed, and use the high fidelity model for analysis. Figure 2 is an example of a low-fidelity model with one point every 45 deg, and Figure 3 is the same model at one point per 15 deg. If a drawing needs to be matched to the coordinate system of another drawing, translation and scale operations can be performed on the image before it is drawn, making the object's native position (untranslated and unscaled) match other drawings. Finally, Intek has the capability to omit all information from the drawing that is not surface information, and to draw all surface information as vectors (non-surfaces).

LIMITATIONS

Photo Analysis' requirements for three-dimensional hidden line models made it unnecessary to make the translator capable of processing two-dimensional data. Solid information processing was also eliminated. An attempt was made to convert Intergraph solids to surfaces, but errors in the SIF converter's processing of solids prevented a reliable conversion from being implemented. Because only hidden line renderings were needed, surface shading errors have been ignored. One problem which may need to be addressed is Intek's B-spline processing. Although the B-spline routine is highly reliable, it does not apply curve smoothing functions, which may result in some jagged objects.

SUMMARY

Photo Analysis' translation process has proven reliable and adequate to their requirements. As a generalized translator of Intergraph three-dimensional graphic files containing surface information to the Tektronix format, its capabilities exceed those of any system known to its writers at this time. As long as its limitations are recognized, this translation process may prove useful to other users with similar requirements and compatible hardware.

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OF POOR QUALITY

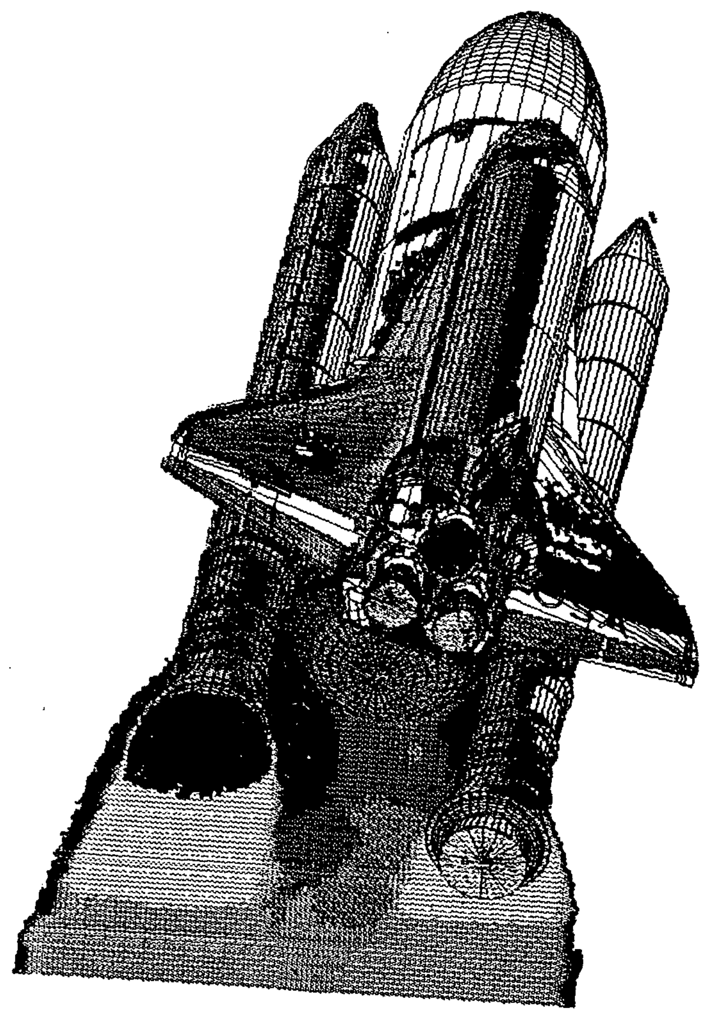

Figure 1. Computer-generated wireframe model overlayed onto digitized image.

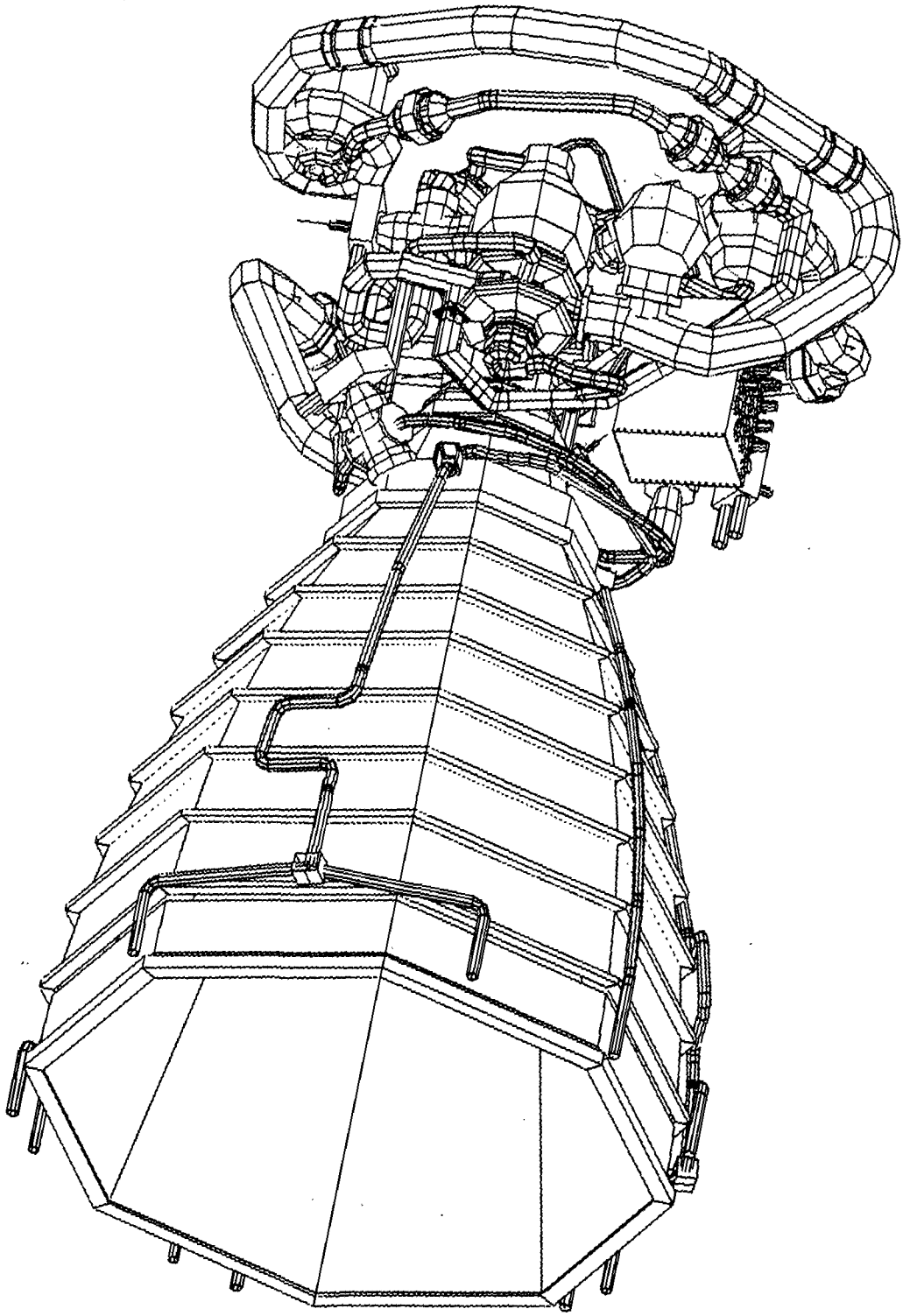

Figure 2. Low fidelity SSME wireframe model.

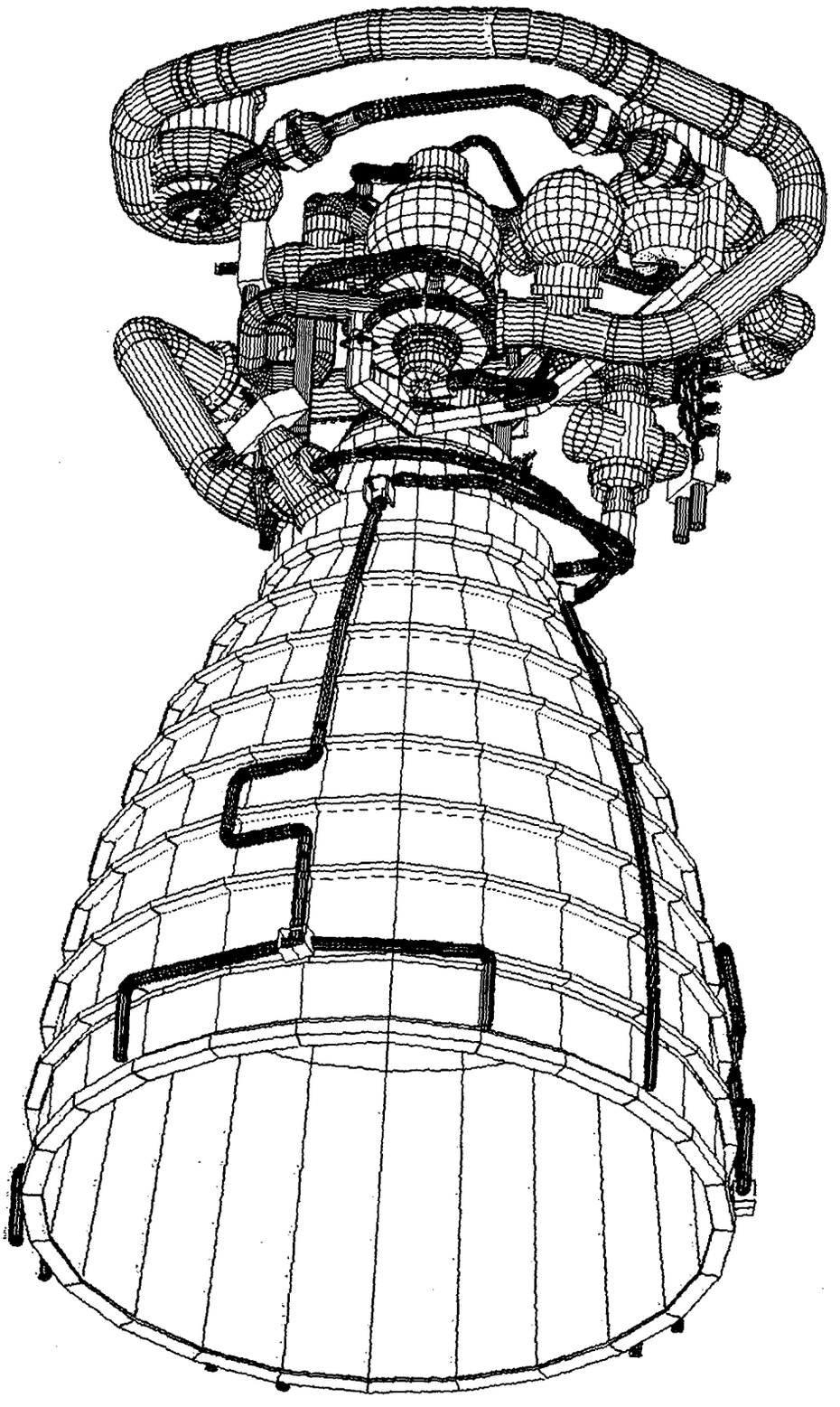

Figure 3. High fidelity SSME wireframe model.

APPROVAL

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The information in this report has been reviewed for technical content. Review of any information concerning Department of Defense or nuclear energy activities or programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

John P. McCarty
Director, Propulsion Laboratory

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