A Characterization of Ten Hidden-Surface Algorithms

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This paper discusses the hidden-surface problem from the point of view of sorting. The various surfaces of an object to be shown in hidden-surface or hidden-line form must be sorted to find out which ones are visible at various places on the screen. Surfaces may be sorted by lateral position in the picture (XY), by depth (Z), or by other criteria. The paper shows that the order of sorting and the types of sorting used form differences among the existing hidden-surface algorithms To reduce the work of sorting, each algorithm capitalizes on some coherence property of the objects represented. "Scan-line coherence," the fact that one TV scan line of output is likely to be nearly the same as the previous TV scan line, is one commonly used kind of coherence. "Frame coherence," the fact that the entire picture does not change very much between successive frames of a motion picture can be very helpful if it is applicable.

By systematically looking for additional kinds of coherence and untried sorting orders and sorting types, the paper is able to suggest two promising new approaches to the hidden-surface problem. The first, a combination of three existing algorithms, is promising because it would capitalize on both frame and scan-line coherence The second new approach would sort in the order Y, Z, X, $\cdots$ the only sorting order for which an existing algorithm could not be found

Key words and phrases hidden-line elimination, hidden-surface elimination, sorting, coherence, computer graphics, raster-scan, perspective transformation, analysis of algorithms

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I. INTRODUCTION

While it is relatively easy to produce a perspective picture of a transparent object made up only of lines, it is rather more difficult to produce a realistic rendering of an opaque object. The opaque object is more difficult to show because one must decide not only where each part of the object will appear on the picture, but also whether to show any part at all Some parts of an opaque object will be concealed in any view of it; a computer programmed to make pictures of opaque objects must be able to decide which parts are visible in the chosen view and thus must be shown, and which parts are hidden and thus must be omitted.

The task of deciding which parts of an object should be shown and which parts should be omitted was originally known as the "Hidden-Line Problem," because it amounted to finding and eliminating--or making dashed--all of the lines in an output drawing which were hidden by other objects. Now that shaded pictures are being produced by computer, a variant of the problem, the "Hidden-Surface Problem," has become important. In a shaded picture one must include or omit entire surface areas rather than just the lines representing edges. Because the hidden-line and hidden-surface problems are very similar, we have chosen to treat them together in this paper.

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