Photogrammetric Brief

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Nonphotogrammetric Plotters for Photogrammetric Applications

Two plotters, the Reflex Plotter and the Contourgraph Plotter, are described.

INTRODUCTION

THE IDEA of these nonphotogrammetric plotters is based on scanning or plotting either directly from the physical object or from its virtual model. Accordingly, no photographs are required for these plotters and, consequently, no inner and relative orientations are needed. Although these plotters are considered nonphotogrammetric instruments, they are designed mainly to solve some photogrammetric problems. The three-dimensional recording of small objects by these plotters is much faster and less expensive than those produced by the conventional photogrammetric-equipments. The Reflex and the Contougraph Plotters are two instruments developed by the author in cooperation with others. The basic principles of each of these two instruments will be explained shortly.

ABSTRACT: *Nonphotogrammetric plotters are mechanical devices used for three-dimensional recording and plotting of small objects. The plotting produced by this instruments is recorded from either the physical object or its virtual model. The concept and design of these plotters are presented.*

THE REFLEX PLOTTER

This Reflex Plotter is shown in Figure 1. The plotting is produced from the virtual model of the object which is formed by a beam splitter. The plotter consists of a beam splitter (semi-transparent glass) and a self-illuminated mark (measuring mark). the object is placed on one side of the beam splitter and the measuring mark on the other side. The observer can see through the beam splitter two imaginary images. These images are the measuring mark image and the object image (object model). The object model is formed by either reflection or (reflection and refraction) by the beam splitter while the measuring mark image is formed by refraction through the beam splitter. The three-dimensional object model can be scanned by the measuring mark image. A unit scale representation of the object is obtained if either of the following two conditions is satisfied:

- The measuring mark image and its corresponding point on the object model are free from distortion.
- The measuring mark image and its corresponding point on the object model have the same distortion.

Actually, neither one of the above two conditions can be satisfied by using a simple beam splitter. The measuring mark image and its corresponding point on the object model are unequally distorted and their relative positions change by changing the observer eyes directions.

The measuring mark image and its corresponding point on the object can have distortion in magnitude and direction if the simple beam splitter is represented by two exact beam splitters with the reflecting surface in between. The distortion of the measuring mark image and its corresponding point on the object, formed by the double beam splitter, can be shown by tracing mathematically or geometrically the rays from the point on the object A_o and its conjugate position of the measuring mark at A_m as in Figure 1. The tracing of the rays from points A_o and A_m have shown that the measuring mark image and its corresponding point on the object, formed by double beam splitters, are distorted equally in magnitude and direction. Accordingly, the monitored coordinates by the measuring mark represent exactly the object coordinates.

Scott and Abdel-Aziz (1980) designed a plotter based on the above principles.

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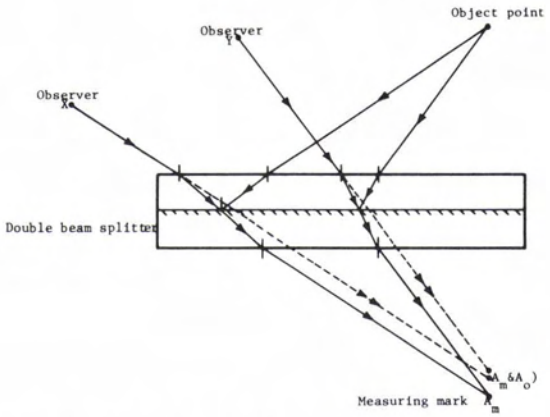

FIG. 1. The passage of rays from two conjugate points of the object and the measuring mark through the double beam splitters.

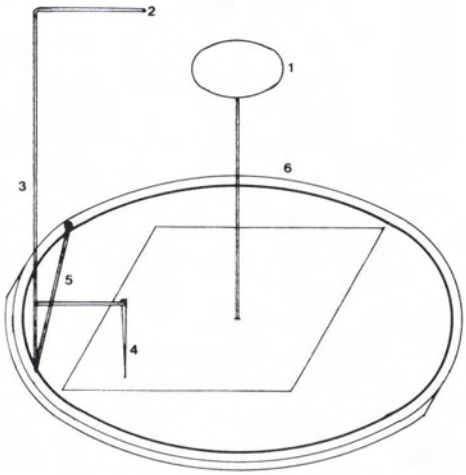

FIG 2. The Contourgraph Plotter.

THE CONTOURGRAPH PLOTTER

The Contourgraph Plotter is shown in Figure 2. The plotting is performed directly from the physical object. The object is placed on a circular disc (1), which is fixed on a vertical rod. The scanner (measuring mark), which is in the form of a small ball-point (2), is fixed at the upper end of another rod (3). This rod has a pen (4) at its lower end. The lower end of the vertical rod is connected to one end of a horizontal bar (5) whose other end is movable along a circular track (6). The ball-point and the tip of the pen are on the same vertical line. As the ball-point traces the object, the pen draws the corresponding contour line. The height of the scanner can be adjusted such that different cross-section can be obtained. Abdel-Aziz and Herron (1974) designed a plotter based on the above principles.

CONCLUSIONS

The Contourgraph and the Reflex plotters have been extensively redesigned and developed at the University of Petroleum and Minerals, Dhahran, Saudi Arabia, for recording small relics. The accuracy of recording achieved by these plotters is comparable to conventional photogrammetric techniques. The main advantages of these plotters are (1) it is possible for an unskilled operator to learn to operate the instruments in a short period, and (2) the capital cost as well as operating costs of the plotters are much less than the photogrammetric instruments.

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