AN ANALYTICAL PLOTTER ATTACHMENT FOR THE REFLEX MICROSCOPE

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ABSTRACT

A new development is described which allows the Reflex Microscope to be adapted as a stereo plotter for measuring from pairs of photographs. A software suite is being implemented on a microcomputer.

INTRODUCTION

The advantage of the Reflex Microscope over photogrammetry is that observations are made directly on the object with no photography, photographic distortion or photogrammetric reconstruction. Its limitations are that the object must be (i) small, (ii) stationary and (iii) available. There is thus a compelling reason for developing the modification described here, which allows the Microscope to be converted quickly into an analytical stereo-plotter, which can measure from stereoscopic photographs of a large building or a moving animal or a museum specimen which cannot be brought to the Microscope.

MECHANICAL AND OPTICAL MODIFICATIONS REQUIRED

The Reflex Microscope[1] is similar to stereo-photogrammetry in operation: the operator guides a virtual measuring mark around a three-dimensional model. In photogrammetry the model is created in the observer's mind from a pair of two-dimensional projective views (photographs). In the Microscope the object is viewed directly, from two slightly different view points, down the two separate light paths of the stereoscopic binocular viewing head. A single light spot is reflected into both light paths.

It is possible to direct the two light paths outside the Microscope, as shown in Figure 1. A simple mirror stereoscope device causes the observer to see points A and B with the left and right eyes respectively, instead of the single point C. If we now put the two stereoscopic photographs in the positions P_1 and P_2, we will see a three-dimensional image exactly as in a stereo-plotter. We can already see the measuring mark of the Microscope, and we therefore have the basic optical requirement for modifying the Microscope into an analytical plotter.

The X and Y slides of the Microscope are already under the motor control of the IBM PC. The direct current motors are coupled with the slides through a gear box and a rack and pinion. The slides have an entirely separate linear grating encoder. The Microscope interface has its own Z 80 micro-processor which drives the motors and monitors the encoders. The IBM monitors the operator controls (trackball and rotary encoder) and calculates the required position of the slides, passing these desired positions to the interface when requested.

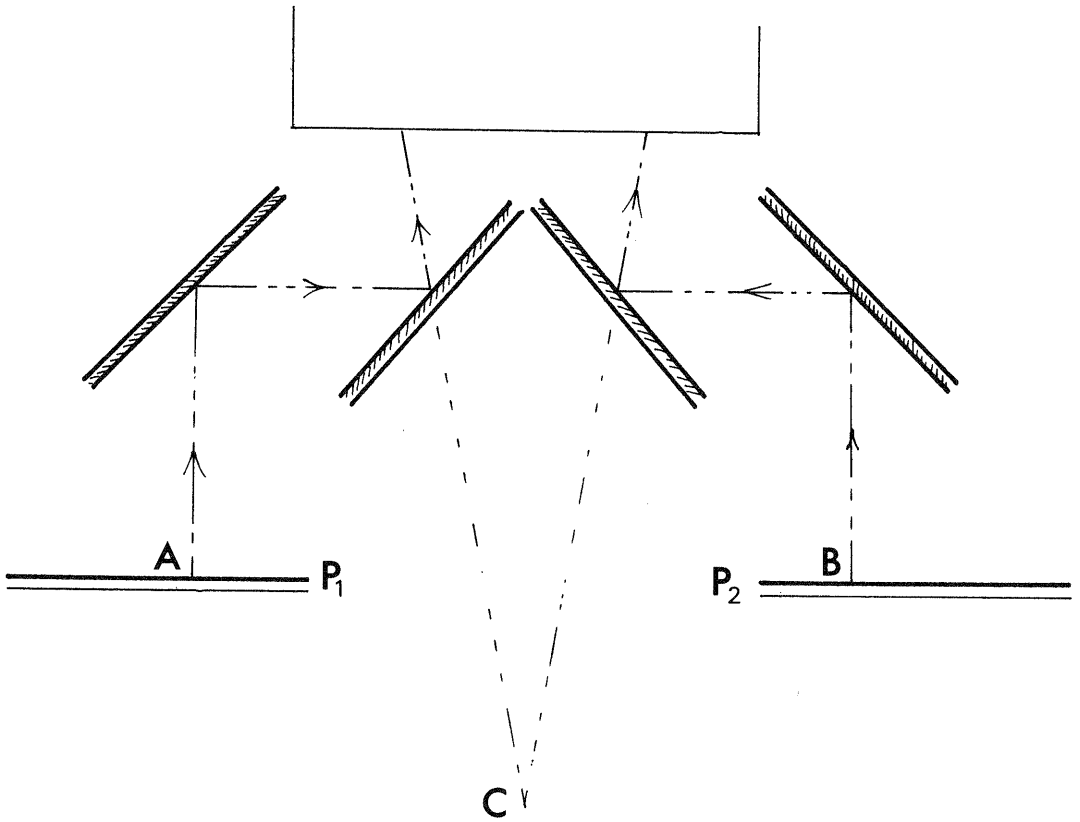

Figure 1. Beam splitter for viewing stereo-photographs.

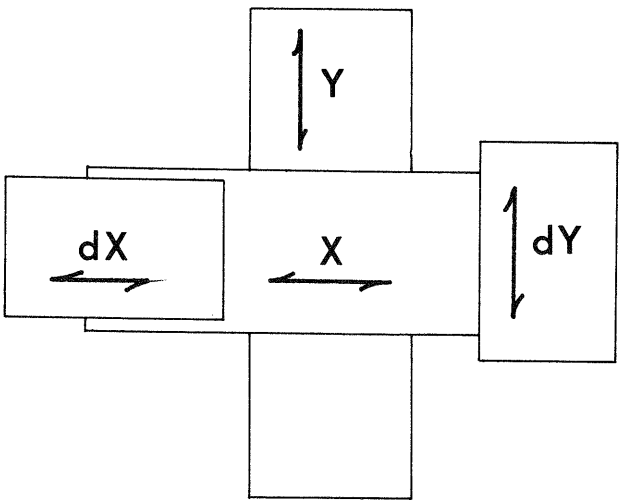

Figure 2. The slide arrangement for the pair of photographs.

For the stereo-photographs, two light stages are carried on their own subsidiary slides - the left picture stage is carried on a secondary (or differential) X slide mounted on top of the XY stage, as shown in Figure 2, while the right hand stage is carried on a secondary Y slide. There is sufficient information from these four movements to deduce left and right photo co-ordinates.

With the stereoscope, and the two light stages on their motor-driven secondary slides, we have the necessary mechanics, optics and electronics for a simplified analytical plotter - there is no facility for zoom or image rotation, although a simple dove prism may later be added.

The software suite for the analytical plotter is being created in Fortran on an IBM PC. The suite contains camera calibration routines, especially with non-metric cameras in mind. Full relative and absolute orientation routines then bring the photographs back to the state of the Reflex Microscope - trackball and rotary encoder instructions result in three-dimensional movement about a model, and XYZ coordinates can be used in the standard software routines of the Microscope. Geometrical results or graphical plots are created according to the operator's commands. Since this instrument is not intended as an air survey plotter, no bridging or block adjustment programs are planned at present. Our work is mainly in the field of medical research, where single picture pairs are used, and scale is the only absolute value of interest to the operator.

The relative and absolute orientation routines have been written, and the standard three-dimensional processing and drafting routines already exist. Successful tests of the optical components have been carried out. The assembler language routines have been written for us by the company who designed and built the interface and drives. Routines have been devised for calibrating the drives when the instrument is changed from a Reflex Microscope into a stereo-plotter. We hope that these routines will be simple enough for a medical researcher to set up the plotter, since we intend the errors in linearity, orthogonality etc. to be corrected in the mathematics of the software, rather than by actual mechanical adjustment.

REFERENCE

Scott, P.J. The Reflex Plotters: measurement without photographs. Photogrammetric Record, Vol. 10, No. 58, pp. 435-446. 1981.