ELECTRONIC CORRELATION OF IMAGE DETAIL IN THE STEREO MODEL

By R. W. Hutchins

The Automatic Scanning Correlator (AUSCOR) developed by Mr. G. Hobrough of the Photographic Survey Corporation of Toronto is a system of electronics and electro-mechanics that may be attached to a conventional photogrammetric stereo-plotter to perform the following functions automatically:

(a) Determine the x- and y-parallax at any point in the model.
(b) Correct the y-parallax during orientation by actuating the appropriate camera movement.
(c) Correct the x-parallax at all times by actuation of a z-movement of the floating mark.

The prototype instrument (AUSCOR Pattern I) was first demonstrated early this year. It is generally known that several firms have been, and still are, working on this problem, mostly under research and development contracts of U.S. Government agencies. Statements by representatives of these agencies confirm that AUSCOR provided the first successful demonstration they have seen on actual aerial photographs. As a result, negotiations are under way with several parties regarding its future application in both the commercial and military fields.

The AUSCOR Pattern I was installed on an old Kelsh instrument that happened to be available at the time. An improved version is now being built as an engineering model, and can be installed on any double-projection plotting instrument such as the Nistri Model 6 Photomapper or the Kelsh 11012-1-A.

Description

The principal units comprising the AUSCOR Pattern I system consist of:

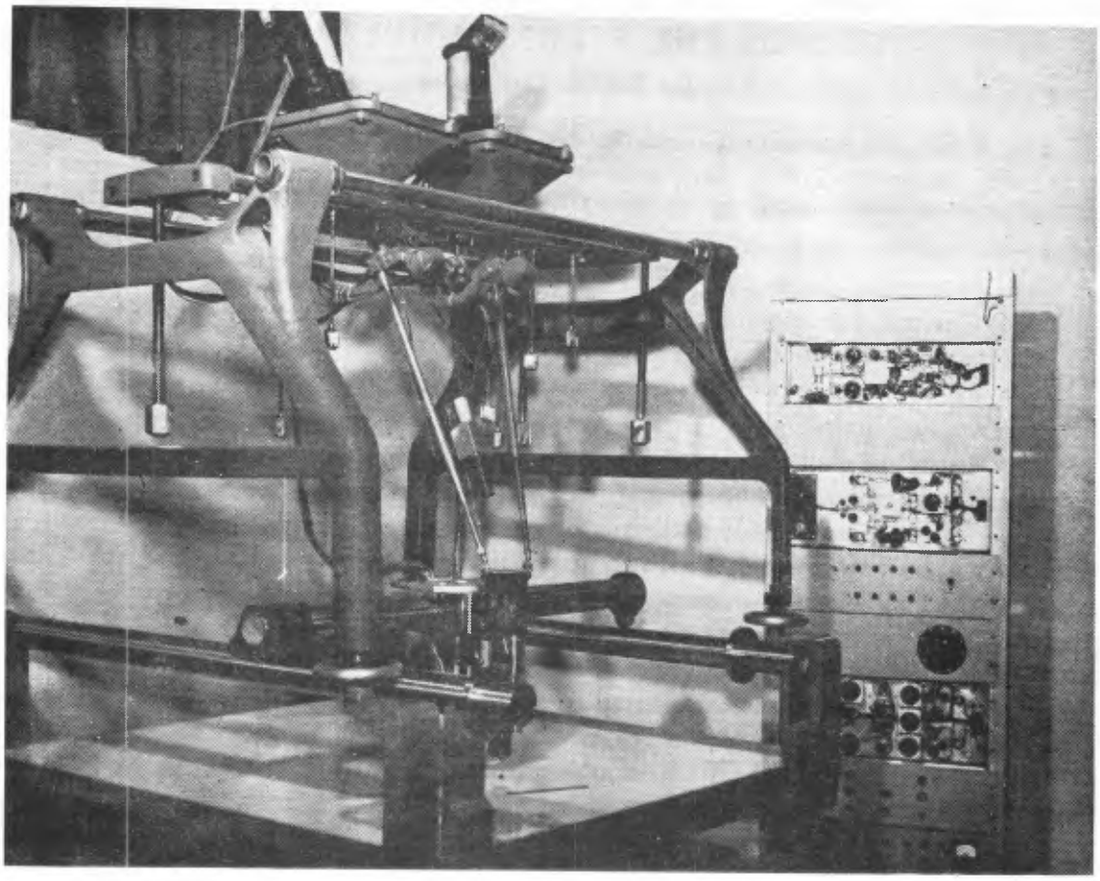
(a) A stereo-plotting instrument of a double projection type
(b) Projector assemblies
(c) A scanning head
(d) Coordinatometer
(e) Camera orientation motor drives
(f) Electronic console with operating controls
(g) Inter-connecting cables and connectors
(h) Red-green anaglyph viewing spectacles

Certain of the above units are modified and attachments made thereto as follows:

(A) The light projectors supplied as part of the original plotter are removed, and the AUSCOR projector-photocell assemblies fitted.
(B) Servomoters are attached to the camera units of the stereo plotter so as to provide automatic actuation of all axes and motions required during the relative orientation operation, in response to y-parallax error signals generated by the electronic scanning process.
(C) Additional clearance is provided between the cameras and the working surface of the plotter to accommodate the increased height requirement of the scanning unit. This unit replaces the projector table with its floating mark.
(D) The coordinatometer is installed on the working surface of the plotter so as to provide scanning action and, in a subsequent version, automatic drawing of contour lines. The scanning head is attached to the coordinatometer so as to allow x, y, and z movements to be executed both manually and automatically. The three axes are separately motorized to provide automatic profiling and, it is hoped, contouring.
(E) Remote readout to punched cards, punched paper tape, magnetic tape, or an electric typewriter can be provided. This feature is of course required in certain applications such as profile milling of a wax model, or where the data are to be processed in an electronic computer, such as in highway design work.

Functioning of Units

The scanning head contains a cathode ray tube (C.R.T.) with a blue phosphor. The model is projected on the white surface of the C.R.T. and is viewed with red-



green anaglyph spectacles. Red-green rather than red-blue anaglyph colours are used in order to mask the blue scanning pattern produced by the C.R.T. During normal operation, the area of image scanned is sufficiently small (½ millimeter) to allow the operator to monitor the operation through his spectacles. Should precise positioning be required for reading spot heights, the flying spot on the cathode ray tube can be stopped by depressing a button, and the resulting dot then becomes the floating mark, which the operator can position precisely in the place required. Upon release of the button, the dot commences scanning the area, and the resulting electrical impulses generated by the photocells in the projector assemblies are processed through the associated electronic circuitry in such a way that a D.C. output signal is produced proportional to the magnitude and sign of the x-parallax. This signal then actuates the z-axes servomotor, which adjusts the height of the cathode ray tube in the model so that the parallax is removed. A second D.C. output signal is produced, which is proportional to the magnitude and sign of the y-parallax. This signal is used to actuate the appropriate camera orientation motor during relative orientation.

The projector assemblies provide viewing light for the operator, and contain the photocells that are sensitive to the blue light from the cathode ray tube. The two light channels, one for viewing, and one for the machine, are separated by a system of dichroic mirrors.

The electronic console contains the balance of the electronic circuitry and controls, including power supplies; scanning generator circuits, which provide scanning voltages for the cathode ray tube; servo-amplifiers; and the registration discriminator and resolver, which are circuits operating on signals from the projector units to derive the x and y alignment error.

Installation and Operation

AUSCOR must be installed in a darkened area completely free from fluorescent or incandescent illumination, except through a series OA safelite filter or equivalent. Diapositives should have a density range between .1 and 1.0 and should be dodged or unsharp masked. Mask unsharpness should be between 2 millimeters and 5 millimeters, and may be produced by using a separation of about 2 millimeters between the negative mask during printing. A similar separation between the phosphor and negative should be used in dodging printers of the "Kelowat" type. "Logetronic"

printers should employ a spot size of about 5 millimeters on diapositives.

Performance

Performance of AUSCOR is limited by the small aperture of the Kelsh machine, but is continually being improved. From a technical point of view, instruments such as the Zeiss Stereoplanograph would offer the highest order of precision and speed, as the optics would not prove a limiting factor. The figures given below represent the last series of tests on a Kelsh machine.

Static Precision

The area of the scanning pattern adjusts itself in the terrain. In general, the scanning pattern diameter will be between 0.5 millimeters and 1.5 millimeters at model scale. Since the z value is averaged over the scanning area, a small pattern is desirable, particularly in rough terrain. Increased contrast will, in general, produce a smaller pattern size. During the initial set-up, the pattern will occupy the entire face of the tube – about three inches – and will lock on and shrink as the cathode ray tube adjusts itself to the proper height in the model.

The y-parallax during relative orientation is cleared to 0.02 millimeters or better at model scale. The x-parallax, with stationary floating mark (not profiling), is also cleared to 0.02 millimeters or better.

Speed

Maximum z-motion velocity is 20 millimeters per second. The x and y velocity is not less than 100 millimeters per second, subject to the restrictions imposed during profiling. Relative orientation is complete per station in 10 seconds maximum. In actual practice an elapsed time of 5 minutes was measured between the initial insertion of the diapositives in the cameras, and the final clearing of the y-parallax throughout the model.

In addition to the static errors above, all servo systems are subject to additional errors that are proportional to velocity. Z-motion velocity error of 0.1 millimeters at 10 millimeters per second represents a reasonable value for servos of the type used.

Profiling

The x and y scanning velocity during profiling is reduced in inverse relation to the z velocity. In this way profiling speed over relatively flat areas is maximized without losing precision in areas having increased relief. A constant of proportionality between z and 1/x or 1/y is adjustable by the operator to provide the best compromise between z velocity error and profiling rate.

Ambiguity

In general the machine will not operate to maximum precision in areas where height ambiguity exists, such as partial tree cover or small, relatively tall buildings. AUSCOR is capable of resolving detail of lower contrast than human operators, provided the detail is not completely masked by film granularity.

The Photographic Survey Corporation is in the final stages of licensing a U.S. manufacturer to produce AUSCOR for various models of stereo-plotting instruments. The principle has other obvious applications in the military field, such as optical range-finding systems, automatic navigation systems, and certain other processes where recognition of similar or identical detail in different images is required.