WILLIAM T. PRYOR*
U. S. Bureau of Public Roads
Washington, D. C.
JOSEPH H. WATSON
Watson Electronics & Engr. Co., Inc.
Arlington, Va.

"Omnistereomeasurer BPR"

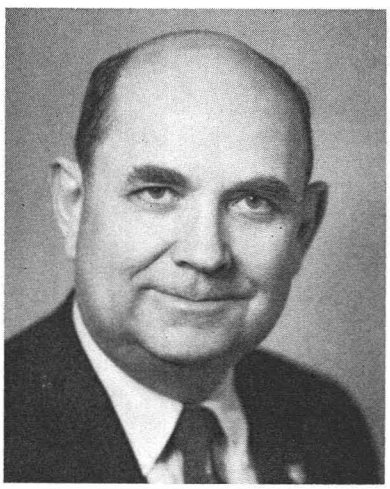
A versatile mapping instrument produces cross sections, profiles, and orthophotographs, from virtually all types of aerial photography.

THE BUREAU OF PUBLIC ROADS of the U.S. Department of Commerce recognizes that many problems yet exist in the highway engineering utilization of photogrammetry. Before such problems can be solved, the actual needs of engineers must be understood. Among such needs is a photogrammetric instrument system which is more versatile than any developed thus far.

Fundamentally, the instrument system must have the inherent capacity for utilizing every feasible format and focal length of aerial photography, in positive or negative form and on glass or film, including color photography. The system must accommodate all such photography, whatever its degree and direction of tilt, provide optimum magnification, assure precision with continued reliability, and be easily operated in making measurements of specific and numerous points and in compiling both planimetric and topographic maps. Other requirements are maximum ratio between photography scale and measurement and mapping scales; adaptability to making point measurements, as needed; to compiling maps and to producing orthophotographs; to correcting for lens distortions, dimensional changes in photographic film, and atmospheric refraction; and to making adjustments for earth curvature. At the time of measurement and mapping, all pertinent dimensional data must be digitally recorded and be compatible with any and all types of electronic computer program requirements. With respect to initial, maintenance, and operational costs, it is further required that the photogrammetric system be well within the economic capabilities of the majority of photogrammetric concerns.

The photogrammetric instrument system completed in 1960 as a prototest model proved the utility and practicability of the underlying concepts, and is called the "Omnistereomeasurer BPR." Since then, engineering design drawings have been prepared for construction of a prototype instrument system fulfilling the foregoing requirements and comprising the subsequently described features and characteristics.

THE INSTRUMENT SYSTEM contains two vidicon cameras mounted so the operational structure of the system and the cameras duplicate the geometry of the aerial photographs



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at positions in space occupied by the aerial camera at the successive instants of negative exposure. All aerial photographs, black and white or color, taken with any camera having a focal length of from 75 mm. to 315 mm. and containing tilt as large as 30 degrees, may be used.

The photographic images from the two vidicon cameras are displayed on a color cathode ray tube viewing screen. The images from one of the cameras are displayed in a blue-green color and from the other in a red color. When observed through color filter spectacles, the anaglyphic display is seen in three dimensions. A small mark at the center of the display tube corresponds with the optical axes of the two vidicon cameras and coordinatograph is provided for orientation perpendicular to a highway centerline or survey base line at any point within the area of the steresoscopic model. Each measurement visually displayed is automatically recorded in digital form for centerline or base line station, y-distance from centerline, and elevation. The control unit for this auxiliary coordinatograph will be attached to the main control console of the instrument.

The basic measurement system constitutes the source of electrical signals. These signals are used in a variety of automatically operating digital recording devices to achieve the flexibility needed to adapt the Omnistereomeasurer BPR to deliver the many kinds of data arising from mapping, and from measur-

ABSTRACT: *Highway engineers need a versatile photogrammetric instrument which utilizes aerial photography of every emulsion type, and each feasible format and focal length. The instrument must be capable of mapping, and of measuring and delineating profile and cross sections; making corrections automatically for lens distortions, changes in photographic film dimensions, and atmospheric refraction; and of adjusting for earth curvature. In addition, the instrument must provide digital data and compile orthophotographs. The "Omnistereomeasurer BPR" is an electronic-photogrammetric measuring and mapping instrument intended to fulfill these requirements.*

becomes the point for measuring the apparent surface of the stereoscopic model.

Motor drives for the X, Y, and Z motions of measurement are controlled from a single universal lever which is mounted at the center of a control panel and is conveniently near the three-dimensional color display on the cathode ray tube. Orientation motions of tilt, swing, and incremental x, y, and z are controlled from the same panel by a keyboard. The display and control panel may be physically located at any convenient position (near or distant) with respect to the basic measurement unit of the system, and will embody a graphic display of the mapping being done, thus enabling the instrument operator to determine his progress without leaving his position at the instrument controls.

THE BASIC MEASUREMENT UNIT of the Omnistereomeasurer BPR will contain a main coordinatograph system from which the digital values of each desired X, Y, and Z measurement are visually displayed as well as electrically recorded. For precision measurement of profile and cross sections, an auxiliary ing specific positions and dimensions, as desired.

The automatic digital recording devices constitute a family of auxiliary equipment units. These units are utilized singly or together according to work required of the instrument system. Designed to date are auxiliary devices for orthographic rendering of the photographic images, with automatic superposition of contours; for digital recording, using separate channels on magnetic tape, continuous or intermittent X, Y, and Z coordinates of all desired ground points; and for delineating, with a precision coordinatograph, topographic and planimetric detail in conventional map form, or profile and cross sections.

THE ORTHOPHOTOGRAPH production device will employ a high intensity cathode ray tube to project each photographic image from either of the two vidicon cameras through an adjustable aperture to form an image in a photographic emulsion. The photographic image projector unit will duplicate, to scale, the X and Y motions of the Omnistereomeasurer BPR and will be programed for scanning

and producing a photograph of the entire stereoscopic model. Since each photographic element is reproduced at its orthographic position, the developed images will comprise a true orthophotograph. Contours will be superposed on this orthophotograph by a series of contacts which alter the intensity of the output of the cathode ray tube projection at the intercept elevation of each successive contour.

The digital data recording unit will permit recording of selected X, Y, and Z coordinates automatically on magnetic tape for subsequent use in electronic computer programs or to prepare graphic presentations by use of plotting devices. This unit will also include provision for automatically recording, on command, all elements of orientation of each stereoscopic model for recovery and reorientation, if needed, and particularly for control bridging and cantilever extension.

To reduce system costs, while preserving system flexibility, the orthophotograph auxiliary unit will employ the same basic coordinatograph used for map compilation from digital data. The control system of this coordinatograph will accept applicable digital data from the measurement unit and will drive, through digital motors, the orthophotograph projection head or a tracing point which can operate as a pencil, pen, or scribing needle.

IN SUMMARY, the overall photogrammetric measurement and mapping system emerging from this design concept consists of:

- The basic measurement system, containing the space geometry of aerial photographs in stereoscopic pairs in optical-mechanical linkage form, the two vidicon cameras for image sensing, the electrical elements for sensing and converting to digital form the positions of all elements of orientation, the main and auxiliary measuring coordinatographs, with digital representation of X, Y, and Z measurements, and the separate master display and control console.
- For attainment of maximum accuracies, the adjustment unit applies the computed values of earth curvature, atmospheric refraction, dimensional changes in exposed photographic film, and lens distortion to the digital data coming from the basic measurement system.
- The mapping coordinatograph, with digital motor drives and position verification sensors, with tracing points for compilation of conventional maps, and for delineation of cross sections and any profile.
- The orthophotograph auxiliary unit, comprising the cathode ray tube and optical projector, plug-in control unit containing the selectable scanning program for the basic measurement system, contour superposition unit, and intensity control.
- The digital data recording device, with associated logic circuitry and control unit attachment for manual entry of auxiliary data, for automatically recording space coordinate positions, and for identifying data.

The Omnistereomeasurer BPR will enable highway engineers to tailor a photogrammetric system to their most pressing problem areas without the capital outlay involved in acquiring an optical train system or a series of separate systems to serve in differing aspects in each separate problem area. Versatility designed into the instrument from initial concepts, applies to the solution of a broad range of problems with the basic unit, and the making of adaptations with the separate auxiliary units, plus providing the ability to expand by adding other output units when and where they are needed and can be afforded. By doing these things, the Omnistereomeasurer BPR photogrammetric system will significantly enhance the position of photogrammetry in highway and other engineering.