View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

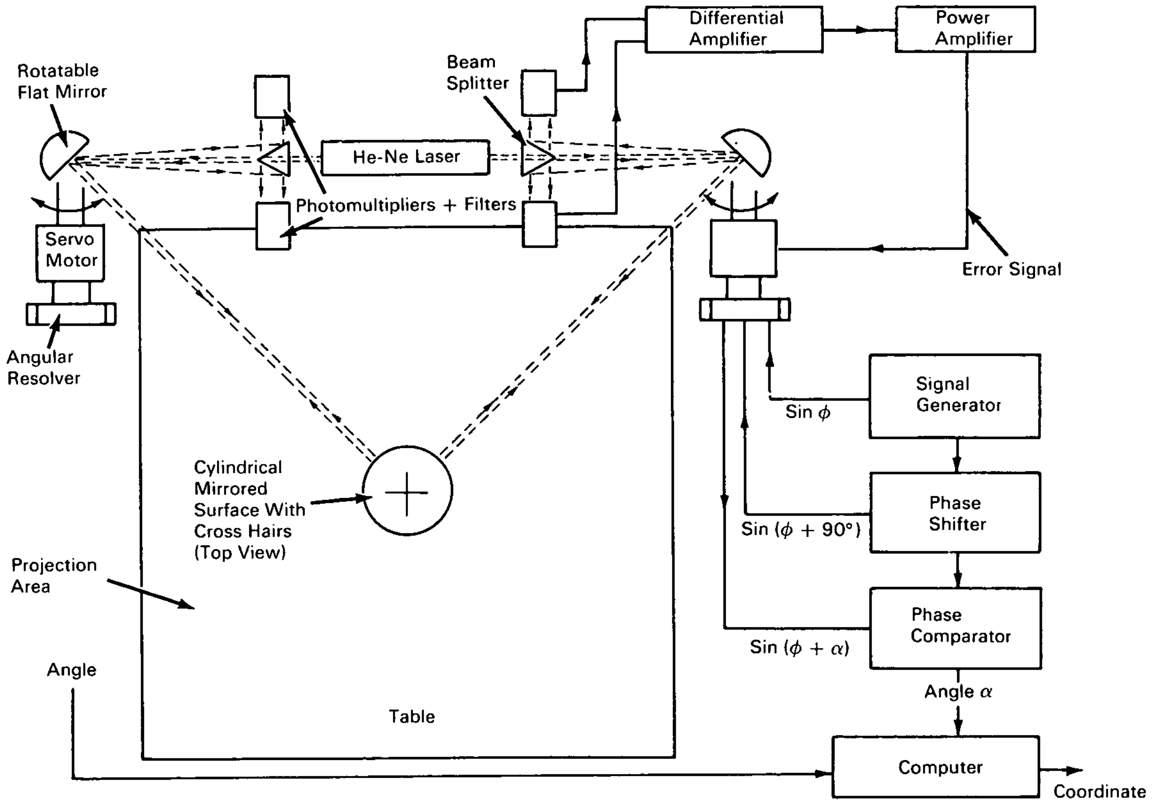
provided by NASA Technical Reports Server

December 1966 Brief 66-10560

AEC-NASA TECH BRIEF

AEC-NASA Tech Briefs describe innovations resulting from the research and development program of the U.S. AEC or from AEC-NASA interagency efforts. They are issued to encourage commercial application. Tech Briefs are published by NASA and may be purchased, at 15 cents each, from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

Laser Measuring System Accurately Locates Point Coordinates on Photograph



The problem:

To develop an accurate, easily operated optical measuring system to replace the drive wire measuring system used to determine point coordinates on a photograph. The length of the connecting wires of the drive wire system restricts the area on measurement. Furthermore, the positioning of the wires for a series of points is often a tedious and time consuming operation. The accuracy obtainable from the drive wire system is ±0.0014 inch. Higher accuracy is desirable.

The solution:

A laser activated ultraprecision ranging apparatus interfaced with a computer. A helium-neon gas CW laser provides collimated light for a null balancing optical system. The system permits accurate determination of the location of a series of points on a

(continued overleaf)

This document was prepared under the sponsorship of the Atomic Energy Commission and/or the National Aeronautics and Space Administration. Neither the United States Government nor any person acting on behalf of the United States Government assumes any liability resulting from the use of the information contained in this document, or warrants that the use of any information, apparatus, method, or process disclosed in this document may not infringe privately owned rights.

photograph with no mechanical connection between the ranging apparatus and the photograph.

How it's done:

The measuring system consists of a measuring table, a manually positioned cross hair cylindrical mirror, a helium-neon CW laser and associated optical system, an electro-optical servo system, and an angular measurement and readout system.

A circular beam of light emitted from the laser first passes through a small hole running through the beam splitter placed next to the emission end of the laser. The beam is directed at a front-surface flat mirror mounted on a rotatable shaft. This mirror reflects the beam out to the projection area where it strikes a cylindrical mirror surface which has cross hairs to position it over the point to be determined. The cylindrical mirrored surface reflects the incident beam of light back, but due to the curvature of the surface the beam is now elliptical rather than circular. The elliptical beam travels back along the same light path to the mirror on the movable shaft and then back to the beam splitter. The elliptical beam is of significant cross section so that the beam splitter divides the beam into two halves.

The split beam is then directed by the beam splitter through an optical filter to the photocathodes of photomultiplier tubes. The photomultiplier outputs are fed to the input of a differential amplifier where they are compared. An error signal proportional to their difference is amplified and fed to a servomotor attached to the rotatable shaft mirror. The error signal serves to move the mirror so that the beam locks on the cylindrical mirror. As the mirrored cylindrical surface is moved manually around the projection area, the rotatable shaft mirror moves to the position where the photomultiplier outputs are balanced. The shaft angle of the rotatable mirror then gives a line of position for the center cross hairs of the mirrored cylindrical surface.

The shaft angle is determined by a transformer-type resolver. Two sine waves separated in phase by 90 degrees are used to drive the quadrature windings of the resolver stator. The resultant sine wave from the resolver stator is phase dependent on the mechanical angle of the shaft. This resultant sine wave is then compared for phase to one of the stator sine waves. The in-phase component is directly proportional to the mechanical angle of the shaft. The resultant angle is presented as a scalar on a counter which is interfaced to a computer for the actual angle determination. Since one angle is insufficient for position determination, another beam of light and flat mirror is used to triangulate the position of the cross hairs. The computer, given the angles of the two shafts and the fixed distance between the shafts, then determines the coordinates of the cross hairs.

Notes:

1. Preliminary results indicate that the shaft angle can be resolved to within ±0.0009 mechanical degree, which will yield a point position accuracy of ±0.000377 inch (for a distance of 1 foot between the flat and cylindrical mirrors).
2. It is possible to use other high intensity, narrow beam light sources in place of the laser light source.
3. Inquiries concerning this innovation may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 S. Cass Avenue
   Argonne, Illinois 60439
   Reference: B66-10560

Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

Mr. George H. Lee, Chief
Chicago Patent Group
U.S. Atomic Energy Commission
Chicago Operations Office
9800 S. Cass Avenue
Argonne, Illinois 60439

Source: R. H. Vonderohe—Applied Math Division,
J. H. Doede—High Energy Physics Division,
Presently with ASI
Computer Division of Electromechanical
Research Corp., Minneapolis, Minnesota
and C. W. Lindenmeyer—Central Shops
(ARG-74)