# A METHOD OF FINDING GRADIENTS FROM AIR PHOTOGRAPHS WITH NO CONTROL

*A. R. Robbins, M.A., Lecturer in Surveying, Oxford University*

THIS article presents a simple solution to a problem which the writer has recently had offered to him—namely, with a simple stereoscope and parallax bar only, of finding the best value possible for the gradient of a slope from a stereoscopic pair of photographs of a mountainous area which has no maps, or only maps of a very poor quality. It is put forward in the hope that it may prove of use to foresters or any who may be interested in soil conservation projects.

As pointed out in the writer's article on Parallax, the formulae evolved can only be exact for a perfect stereo-pair but, if the tilt and inclination of the air base are small, the nearer the top and bottom of the slope being measured are to each other on the photographs, the more nearly equal will be their effects at each of the points and the more accurate will be the result.

The notation to be used is the same as that of the previous article already mentioned, with the additions of $d_{AB}$ which represents the distance between $A$ and $B$ as measured on the minor control plot, and R.F. which is the Reference Fraction or scale of this plot.

First, a minor control plot for the two photographs must be drawn at a scale corresponding to the height of the principal point of the right-hand photo —that is to say the plot is drawn in the usual way starting with the left-hand photo and using $p_2'$ as a scale point. If $A$ and $B$ are the bottom and top respectively of the gradient to be measured, their positions should be fixed by intersection on this plot and $d_{AB}$ may then be measured at its unknown scale.

Then Gradient

$$= \frac{\Delta h_{AB}}{d_{AB}/\text{R.F.}}$$

$$= \frac{\Delta h_{AB}}{d_{AB}} \times \frac{f}{H - h_{p_2}} \left(\text{because R.F.} = \frac{f}{H - h_s}, \ s \text{ being the scale point}\right).$$

$$= \frac{f}{d_{AB}} \times \frac{\Delta p_{AB} f}{p_A + \Delta p_{AB}} \times \frac{H - h_A}{H - h_{p_2}} \quad \text{(using equation 4 of the previous article)}$$

$$= \frac{f}{d_{AB}} \times \frac{\Delta p_{AB}}{p_A + \Delta p_{AB}} \times \frac{fB}{p_A} \times \frac{p_{p_2}}{fB} \left(\text{because } p = \frac{fB}{H - h}\right).$$

and finally, Gradient

$$= \frac{f}{d_{AB}} \times \frac{\Delta p_{AB}}{p_A + \Delta p_{AB}} \times \frac{b_2}{p_A},$$

$b_2$ being the photo-base of the left-hand photo.

(If preferred $p_B$ may be written for $(p_A + \Delta p_{AB})$.)

In this formula $p_A$ is found from both principal points as usual, $f$ is known and everything else is measurable on the photographs or minor control plot, the scale of which need not be known. It may readily be seen however that the last factor is a scale factor, allowing for the difference between the scale at (or parallax of) $P_2$—at which the measurement $d_{AB}$ is made—and the scale at (or parallax of) $A$—from which the gradient is required. Thus, with no control and no knowledge of $H$, the only inaccuracy in the result will be that due to the existence of tilt and inclination of the air base.

# THE FACTORS IN HUMAN VISION APPLICABLE TO PHOTOGRAMMETRY

*M. H. Salzman, Photogrammetric Cartographer,*
*U. S. Navy Hydrographic Office, Washington, D.C.*

## INTRODUCTION

MOST present day writers in the field of photogrammetry have either ignored or given such scant treatment, to the visual requirements of modern photogrammetry, as to leave a gap in our essential knowledge.

When Mr. Eliel quoted Mr. Cottrell on "5 second eyes," at the Fifteenth Annual Meeting of the American Society of Photogrammetry, he aroused interest and discussion about visual and stereoscopic acuity which indicated that many misconceptions, concerning the various kinds of "acuity," prevail among a large number of photogrammetrists.

The following article is an attempt to survey the existing knowledge of vision, giving some background material but treating only those phases which could conceivably be applicable in the field of photogrammetry. This paper is to be followed by another, currently in preparation, dealing more specifically with how this knowledge could possibly be adapted to photogrammetry. Many readers may not wait for it, determining their own applications in the interim. An excellent recent example of applying visual knowledge to photogrammetry is H. C. Ryker's article, "The Human Eye as a Center of Perspective," in PHOTOGRAMMETRIC ENGINEERING, Vol. XIII, No. 1, March, 1947, pp. 115–119.

New terms will be defined as they are introduced in the article.

## VISUAL SENSITIVITY AND VISUAL ACUITY

Visual sensitivity is the ability to respond to stimuli, that is, the capacity the eye has for continuing to respond to light as the intensity of that light is slowly changed. The terminal case of sensitivity involves what the psychologists and physiologists call "threshold of illumination," that is, the least perceptible light to which the eye will respond.

Visual acuity, however, is the ability to continue to see separately and unblurred the details of the visual object as those details are made smaller and closer together. It involves what the physicist and optician call "resolving power."

### THE PUPIL

The functions of the pupil are twofold in that: 1) it must fix the immediate illumination of the retina, if it can, at a value above the threshold of stimulation and below the point of dazzlement or injury; 2) it must restrict the perceived light-pencil, as much as possible, to the center of the lens.

### THE DIOPTRIC MEDIA

The cornea (the transparent part of the coat of the eyeball which covers the iris and pupil and admits light), the aqueous humor (the limpid fluid occupying the space between the cornea and the crystalline lens of the eye), the crystalline lens, and the vitreous humor (the clear colorless transparent jelly which fills the