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ADVANCED RESEARCH PROJECTS AGENCY
WASHINGTON 25, D. C.

October8, 1959

MEMORANDUM FOR COMMANDER, AIR RESEARCH AND DEVELOPMENT COMMAND, ANDREWS AFB, MARYLAND

SUBJECT: IDA-IM-122, dated 11 September 1959

Forwarded herewith for your information is a copy of report IDA-IM-122, dated 11 September 1959, entitled "The Uses of Color in Aerial Reconnaissance." This report indicates that there are certain advantages to be gained in aerial photography for technical intelligence through the utilization of photographic records in two different spectral regions.

The technique of utilizing separately filtered monochrome images is potentially applicable to both readout and recovery systems, merely requiring that two successive photos of the same area be taken with different filters. If it is desired to secure stereo coverage for height-finding purposes, only another filter need be added to the system.

The other technique suggested, successive exposures on panchromatic and near-infrared films is more difficult, but even more useful results might be obtained. Alternatively, it might be worthwhile to consider a small, low-resolution camera system in the near-infrared spectrum to serve as an interpretation key for the higher resolution panchromatic record.

It is suggested that this report be studied in connection with advanced versions of the SAMOS project. Any comments which you would care to make will be appreciated.

SIGNED

G. P. Sutton
Chief Scientist

Attachment

cc: Assistant Secretary of the Air Force (R&D)
Commander, AFBMD
Director, AFDAT

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IDA-IM-122

11 September 1959

THE USES OF COLOR IN AERIAL RECONNAISSANCE

By: J. S. Goldhammer

Advanced Research Projects Division, Institute for Defense Analyses

Under Contract to the Advanced Research Projects Agency

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THE USES OF COLOR IN AERIAL RECONNAISSANCE

Color films of high fidelity or of known color imbalance, so that actual colors can be determined, are useful for a number of reconnaissance applications. Among those in which color has been successfully employed are the following:

1. Underwater depth determination at beaches.

2. Classification of raw material stockpiles (ores, coal, limestone, etc.)

3. Classification of vegetation to establish soil condition, drainage, load bearing characteristics, trafficability, etc.

4. Identification of chemical process plants by smoke and/or effluvient liquid color.

5. Crop yield estimates by foliage color at appropriate times in the growth cycle.

In addition, a very specialized form of color material has had some success in camouflage detection. This product is a two-layer emulsion, one sensitized panchromatically and the other in the near infrared. The infrared region has a green dye associated with it, and the panchromatic layer has a red dye-coupler. The principle of operation is that living foliage is a good reflector of infrared, whereas dead foliage (within 24 hours of cutting), and paints are poor infrared reflectors. As a result, grasses crushed by wheeled vehicles or frequent passage on foot, cut foliage, and painted surfaces will show up as red in the final image, while living foliage will be green. In addition, freshly turned moist earth will absorb infrared to a greater extent than unturned soil, so that entrenchments, open ground torn up by tanks, etc. may be detected.

A number of obstacles preclude the use of color or dye-coupled camouflage detection films in a recovery satellite system.

First of all, color films per se cannot be used at high altitudes satisfactorily. In order to determine actual colors, blue exposures are necessary, and atmospheric scatter of blue light is so severe at altitudes of more than a few thousand feet that detail is completely submerged in the non image-forming bluish haze. For this reason, high altitude exposures must be made in the 500-700 millimicron region, and no estimate of actual color can be made.

With regard to camouflage detection film, the dye-coupled form would pose a severe handicap from very high altitudes by virtue of its low inherent resolution. (The dye is formed by interaction of the dye coupler in the region around the developed silver halide particle, with the developer reaction product diffusing from the silver particle.) As a result, the color image is of low resolution compared to the original silver image, which is subsequently bleached out. However, there is no reason why two separately filtered monochrome images could not be used to produce the same result by relative brightness comparison, or even by color television or color printing or projection techniques after recovery. There is considerable hope of achieving some measure of camouflage detection by this technique. The following difficulties must be overcome:

1. On a long focal length lens, there is a considerable difference in focal plane position between the visible and infrared spectral regions. This implies some sort of beam splitter or optical wedge, with consequent light losses and exposure increase.

2. The lens cannot be achromatized for so great a spectral range; infrared resolution will therefore be considerably poorer than in the visible spectrum, unless visible spectrum resolution is to suffer as well.

3. Because of much lesser energy in the infrared region, and the difficulty of film sensitization in the infrared, a much grainier (i.e., faster) film having lower resolution than the panchromatic emulsion must be used, further degrading image quality.

CONCLUSIONS:

1. Color films are not of value in this situation.

2. Panchromatic-near infrared simultaneous exposures may prove useful. However, considerable additional optical and camera complication is necessary, and the panchromatic image, by virtue of light losses and image degradations introduced by the beam-splitter will not be as good as if no attempt were made to make the infrared exposure. The technique is equally applicable to readout and recovery systems.

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Memo for Cmdr ARDC - IDA-D4-122, dtd 11 Sep 59, 1cy, w/Att.
IDA-D4-122, dtd 11 Sep 59 The Uses of Color in Aerial Reconnaissance, By J.S. Goldhammer 1cy

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