Photogrammetric Brief

WILLIAM H. SCOTT
W. H. Scott Company
Omaha, Nebr. 68102

Helicopter Photography

FIG. 1. Fairchild Cartographic camera mounted underneath a helicopter.

A previous article suggested a practical camera installation.

INTRODUCTION

THE AMERICAN SOCIETY of Photogrammetry's PHOTOGRAMMETRIC ENGINEERING has been valuable to the office of Wm. H. Scott, Co., Consulting Engineers throughout the past six or seven years, and the October 1967 issue was of particular practical value. At the time the issue was received, the firm was faced with a difficult problem: its own airplane had been placed in the shop for its annual check-up with its photographic mission unfinished. As a helicopter was available, the article by Robinson* and Withem appeared to be the answer.

Figure 1 shows a Fairchild Cartographic camera mounted on the helicopter ready for use one month after the article appeared, and Figure 2 is a close-up view showing the details of the mount consisting of simple angle iron members and four hanger straps fastened to the struts of the aircraft.

INSTALLATION

The advantage of the helicopter mount is that no major alterations of the aircraft are needed. The camera is suspended from the aircraft strut system which does not require rerouting any cables nor altering the aircraft frame. In this installation the camera is powered by an auxilliary 24-volt battery because the aircraft system is 12 volts.

MAPPING REQUIREMENTS

The immediate objective was photography of a timbered area from 3000 feet, 60 percent forward overlap, for mapping at a scale of 100 feet per inch at a contour interval of 5 feet. Other objectives were low-level photography, possibly from 300 feet, for a map scale of 10 feet per inch, and from 600 feet for 20 feet per inch. Some difficulty was experienced in flight planning at these low altitudes because the existing file of photographs were all at 500 feet per inch. Also the intervalometer charts did not extend down to the speed of this particular aircraft, and the office personnel were unfamiliar with the chart scales. However, these charts were eventually redrawn, and standard templets were devised to facilitate low-altitude planning in the future.

It was important at this time to be able to fly at lower altitudes for greater accuracy, and also to have an aircraft available when the higher-altitude equipment was not in service.

It is intended that the helicopter may be used for inspection work, low-altitude mapping, traffic surveys, diagrams of road intersections, "one-shot" photography, precision stereo pairs in complex areas of less than 20 acres. On the other hand, a Piper or Cessna is for use at altitudes ranging from 6,000 to 12,000 feet where an intervalometer can be used effectively.

OPERATION

In the operation of the helicopter, the first stereo pair had good attitude control in the *X*- and *Y*-directions (i.e., wing up, *X*-tilt; and nose up (*Y*-tilt). This control was affected by level bubbles in the cockpit of the plane itself without adjusting the camera controls; that is, the camera was levelled

* F. W. Robinson and L. I. Withem, "Helicopter Photography and Mapping," PHOTOGRAMMETRIC ENGINEERING, Vol. 33, No. 10, page 1167, October 1967.

FIG. 2. The helicopter mount is relatively simple, consisting of angle iron members, and straps suspended from strut.

relative to the ground by adjusting the attitude of the helicopter itself. The adjustment for crab was affected by dry-running the site, landing, adjusting the crab control of the camera, taking off and photographing the area, using the intervalometer. Probably the crab control will be arranged through a gear system so that it can be controlled remotely from the cockpit during flight.

The initial flight of the helicopter was delayed until a 12-volt vacuum pump could be provided to obtain the 4 inches of suction for the camera. The vacuum pump was powered by the battery system and was controlled by a special switch in the cockpit (Figure 3) to insure that the vacuum existed whenever the camera was in operation.

The equipment was first applied on January 3, 1967, over a timbered area at an altitude of 3000 feet. Also, one filling station site on a new Interstate Highway was photographed at various altitudes for planning purposes.

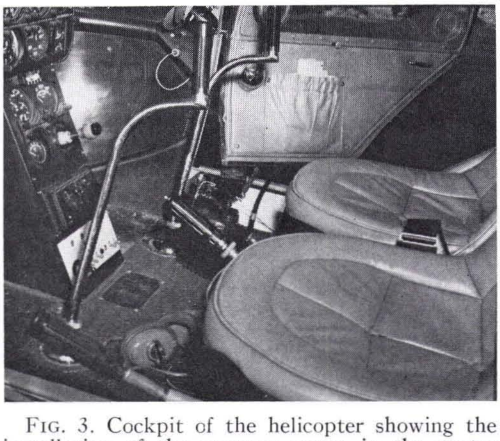

FIG. 3. Cockpit of the helicopter showing the installation of the vacuum pump in the center background.

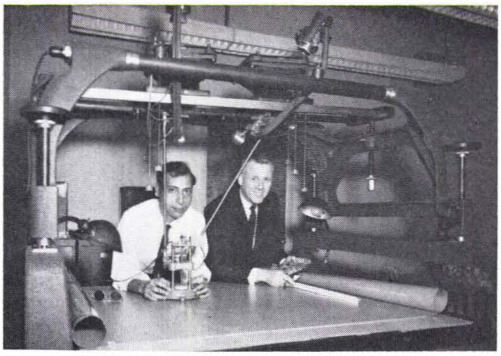

FIG. 4. Mr. William H. Scott (right), author, and Mr. Om Patney, Civil Engineer, with a pair of photographs oriented on a Kelsh Plotter.

The mount was approved by the Federal Aviation Agency of Lincoln, Nebraska. Notice that the center of gravity of the camera installation is directly beneath the center of the rotor, and the pilot reports that no particular problem is present relative to the operation of the helicopter.

CONCLUSIONS

The first flight tests scheduled at the two sites were satisfactory. The second flight contained seven sites of which two were in the morning. One was a highway accident survey at an intersection photographed from 600 feet, giving a photo scale of 100 feet per inch to be enlarged to 20 feet per inch for court

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TABLE 1. ELEVATION DISCREPANCIES OBTAINED FROM HELICOPTER PHOTOGRAPHS TAKEN FROM 3000 FEET AND OBSERVED WITH A KELSH PLOTTER

Sta.	*Ground Elev. USGS*	*Aerial Spot Reading*	*Difference*
0+00	1293.10		
1+00	1288.1	1289.0	+0.9
2+00	1281.42	1282.2	+0.8
3+00	1274.6	1276.1	+1.5
4+00	1267.92	1269.3	+1.4
5+00	1260.6	1260.6	0.0
6+00	1251.8	1252.5	+0.7
7+00	1244.4	1245.1	+0.7
8+00	1237.6	1237.3	−0.3
9+00	1238.8	1237.5	−1.3
10+00	1245.5	1244.7	−0.8
11+00	1253.9	1253.6	−0.3
11+79.2	1259.5	1258.9	−0.6

Note: The finished product is to be a map having 5-foot contours and a scale of 200 feet per inch.

The rectification of the photographs was made from working sheet number 1, finding the best fit to the controls, and the result is given by Figure 2. The rectification was performed on a mylar sheet permitting copies of blueprints or sepias.

The second working sheet underwent a further reduction as far as the elevation of the points is concerned. The elevations of objects determined by the Kelsh-plotter were referred to the elevation of clear zone slope as zero regardless of their locations. Consequently, the elevations of objects located in the area of transitional surfaces needed to be modified so that the transitional surface is at datum, or the zero plane. This modification was performed graphically by constructing a graph to read the elevation difference between the elevation of clear zone slope at an object in question and the elevation of transitional surface at that location. After this reduction of elevations, all the information of the second working sheet was scribed and a copy was made on a transparent sheet of film.

The final result consisted of the sheets of rectified photographs on mylar film, and the second working sheet on transparent film, as an overlay. These two were identified by the location of ground controls, and their correct matching was indicated by crosses at the corners. This final result is given by Figure 2.

Evaluation and Conclusion

The rectified photographs as well as the elevations determined were checked at the completion of the job. It was found that the accuracy was very close to that expected. It was found that on the rectified photographs the maximum deviation in location exceeded the 1/10 inch in some extreme cases. This discrepancy, however, had no effect on the positive identification of the point given by the elevation.

The elevations were correct to the nearest foot for most of the 500 points determined. At some points, such as narrow trees where the top of the crown could not be easily judged by the plotter operator, the discrepancy exceeded ± 1 foot.

Economical evaluation of the work has been performed by comparing the actual man-hours invested during the photogrammetric process to that estimated for a conventional survey. Man-hour requirements were distributed as follows:

Field survey and presignalization	166 hours
Photogrammetric instrument work	56 hours
Rectification, scribing, and copying	96 hours
Total	318 hours

This compares to the 2700 man-hours which was estimated would be required if a conventional survey had been utilized with the same density as the photogrammetric work. As a final conclusion therefore, it can be pointed out that the photogrammetric process is considerably more economical than the conventional survey, and furthermore, the details presented by the photogrammetric method far surpass that obtainable by conventional methods.

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exhibit purposes. The second one was of an emergency set of flood drainage photographs with stereo pairs to determine relative water heights.

Figure 4 indicates the modest tilts of the helicopter plates oriented in a Kelsh Plotter. Table 1 indicates the vertical errors obtained from the 3000-foot altitude.

One particular future job planned by Scott Engineering for helicopter photography is a map at 20 feet per inch of a busy city intersection which includes a cafe parking problem.

We believe that this technique has a future and we are interested in comparing notes with fellow engineers and photogrammetrists on this type of application.

We wish to acknowledge with appreciation, in addition to Messrs. Robinson and Withem for their article in PHOTOGRAMMETRIC ENGINEERING magazine, the creative assistance in making the camera installation of Mr. Vern Bishop, aircraft engineer mechanic at Woodaire, Omaha, Nebr. We also wish to acknowledge the help of Chuck Tingley, Platte Valley Helicopters, Omaha, Nebr.