Practical Paper

Techniques for Acquisition of Aerial Video Imagery

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ABSTRACT: Aerial video imagery provides an inexpensive, quick turnaround alternative to conventional aerial photography. Resource managers and researchers alike can easily acquire this imagery. Mission planning activities similar to those performed for conventional aerial photographic missions can aid in planning the video imagery mission. Consumer grade VCR and monitor are key components to the imaging and viewing system. A video camera may be leased or purchased to complete the system. All equipment is powered by 12 volts DC and is easily mounted in a single-engine aircraft. The audio track on the video tape can be used as a flight log and locational aid. Post-flight location utilizes the counter on the VCR to develop flight maps of areas imaged. Cataloging and duplicating tapes provide data security and organization.

INTRODUCTION

FOR TWO DECADES following World War II, remote sensing centered around the acquisition and use of many types and formats of vertical aerial photography. The early seventies saw the advent of aircraft and satellite-borne non-photographic sensors. Resource managers were given a more synoptic view from space than was ever available from aerial photographs. Machine processing of non-photographic data has provided resource managers with additional means to assess and monitor changes in the abundance and distribution of resources.

With the advent of airborne video imagery in the eighties, another system became available to the resource manager for remote evaluation of resources. Many remote sensing specialists accustomed to interpreting aerial photography or analyzing digital images now have a moving window with which to view the dynamic resources they are responsible for inventorying and managing.

The purpose of this paper is (1) to provide practical suggestions to practicing resource managers for the in-flight acquisition of aerial video imagery and (2) to recommend procedures for its viewing, cataloging, storage, and retrieval. Experiences and procedures relating to pre-flight planning, in-flight data recording, and post-flight data handling will be described.

PRE-FLIGHT PLANNING

MISSION PLANNING

The authors have planned and flown many remote sensing missions to acquire vertical aerial photography. Applying what was learned on these missions to those on which video imagery was acquired was a natural evolution.

Pre-flight mission planning involved identifying the area to be flown and delineating it on a base map such as a U.S. Geological Survey 7.5-minute (1:24,000-scale) quadrangle map. With aerial photography, scale is determined by several factors: camera focal length, flying height, and photographic product format. With video imagery, scale is of less concern and is more difficult to ascertain; therefore, resource managers who are less comfortable with non-photographic remotely sensed products will be more concerned with the number of acres or hectares covered by the path width of a video camera. For example, while using a video camera with a 2/3-inch tube and an 8.5-mm focal length lens flying at an altitude of 5,300 feet, the resulting image will cover a ground path that is 5500-feet wide and when still framed the length of the image will be 4125-feet, which will capture an image that covers 520.8 acres.

Once the size of the area to be imaged was determined, a mission planning chart was consulted which identified the necessary altitude, focal length, air speed (Meisner, 1985), and the resulting area covered by a single flight line (Meisner and Lindstrom, 1985). Utilizing this information, flight lines were drawn on the quadrangle maps, allowing sufficient sidelap (20 percent – somewhat less than for a typical aerial photographic mission) between flight lines to ensure total coverage.

EQUIPMENT INSTALLATION

The equipment used was a color infrared video camera manufactured by E. Coyote Enterprises, Inc. and distributed under the name Biovision.* The camera was developed in the Remote Sensing Laboratory at the University of Minnesota under the direction of Mr. Douglas E. Meisner. The Biovision video camera can be equipped with automatic zoom lens or fixed focal length lenses. The zoom lens can provide an advantage of a variable focal length (i.e., the opportunity to zoom in and see selected ground objects at greater detail to aid in photointerpretation), but with it also comes the liability of changing spectral sensitivity (Palmer *et al.*, 1987). The Biovision camera senses in the near-infrared (900 nanometre) range of the electromagnetic spectrum and records data to standard NTSC 1/2-inch or 3/4-inch video tape. The camera can be operated on 12 volt direct current (DC) or 110 volt alternating current (AC). The data are recorded on a consumer grade 1/2-inch format, four head, video cassette recorder (VCR). For in-flight viewing of the data being recorded and to serve as a view finder, a JVC 5-inch color monitor was used. Both the recorder and monitor were 12 volt DC powered. The camera, recorder, and monitor were all linked together for 12 volt DC power by using a series of male and female cigarette lighter-type adapters and then powered through a cigarette lighter receptacle on the console of the aircraft. On one flight, the aircraft being used had a 24 volt DC power supply instead of the needed 12 volts, and on this mission an automobile battery was used as a power supply.

*Description and use of this product does not constitute endorsement.

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An alternative to the automobile battery is a step down transformer which will convert the 24 volt DC to the required 12 volts.

A Cessna 172 with 12 volt DC power supply and an aerial camera port located beneath the co-pilot's seat was adapted to accommodate the video camera. The VCR and monitor were placed on the floor near the video camera which was oriented to have the image of the area being recorded move across the monitor in the same direction as that of the flight path of the plane to facilitate flying the correct lines.

Equipment Check-Out

Prior to takeoff, a complete check of all equipment and supplies should be made. Checking the equipment with the engine running is important because fluctuations in the electrical current can cause interference on the image being recorded. Focus the camera on a ground target beneath the airplane, and record a few minutes of data to become acquainted with the operation of the automatic light meter and VCR capabilities. Once the recording is finished, rewind and play the tape back to check the operational status of each piece of equipment.

Also, before takeoff, be certain to have an adequate supply of high-quality consumer grade video tapes, such as those labeled Extra High Grade (EHG) or Ultra High Grade (UHG). Investing in extra tapes is cheap compared to running out of tape over the target area. Unwrapping tapes prior to takeoff saves unnecessary frustration in the confines of a small aircraft.

IN-FLIGHT OPERATIONS

Due to the narrow field of view of the video camera, referencing the image on the viewfinder (monitor) to a basemap is a challenge. Every effort must be made while in flight to record information concerning the present location of the aircraft. Unlike vertical aerial photography, the image being recorded is constantly moving and, because of the small field of view, it is difficult to keep oneself located on the flightmap.

Because a voice track is available for recording while the video data is being imaged, there is an extra locational aid not available for the vertical aerial photography mission. A lapel microphone can be used by the camera operator to record information concerning present location with reference to the flightmap. This information is useful for constructing post-flight coverage maps. If the videotape is completely rewound prior to recording any data, and the VCR counter is reset to zero, the counter may be read periodically and recorded on the audio track. This recording can serve as a flight log, but it is also advisable to maintain a hardcopy flight log during image acquisition to supplement the audio flight log, because in some instances aircraft noise or the tendency of people to mumble into a microphone may make it difficult to understand in-flight voice recordings. Even in light of the aforementioned aircraft noise, the microphone should be left on at all times to record all conversations by members of the flight crew. In many instances, these conversations have aided in post-flight location of areas of interest that were seen during the flight, but were difficult to find on the tape during post-flight analysis.

A 35-mm camera using color print or slide film can serve as an additional aid to track the path of the video camera. If the camera port in the plane is large enough, the 35-mm camera may be mounted vertically alongside the video camera. If not, then hand-held oblique pictures taken through the window may suffice. These photos provide yet another aid in post-flight analysis. Record the VCR counter reading and the 35-mm frame number on the audio track, as well as on the hardcopy flight log, each time a 35-mm photograph is taken. Though the scheme for determining the counter units on VCRs varies from one manufacturer to another, and the readings will vary if one VCR is used for in-flight operations and another is used during ground analysis, the VCR counter recordings will aid the image analyst to locate, approximately, objects of interest on the tape. Additionally, or in lieu of the 35-mm photographs, 9-inch format aerial photographs at a scale smaller than that of the video imagery will be helpful in post-flight flight mapping and data analysis operations.

Standard 1/2-inch NTSC standard video tapes can record two hours of data each (T-120 length), with the VCR set to SP (the setting that uses the most tape to store the highest density, best quality data.) Each image acquisition target in a mission may take less than two hours to fly, so one tape might record all the data necessary for the entire mission. It is advisable, however, to record data for each target area on a different tape, even if the tape is not fully utilized. This is a precautionary measure; should one tape be damaged, you have not lost the data for the entire mission. It also allows analysis by individuals at different locations. If the data are stored on separate tapes, the necessity for duplicating tapes is reduced and concurrent analysis is facilitated.

Use the adhesive peel-off labels provided with the tapes to annotate project name, flight altitudes, date, and crew names. The in-flight hardcopy flight log should be cross-referenced to the tapes by a cataloging number and stored along with the tapes. Each tape should be numbered, i.e., 1/2, the first number denoting the current tape and the second number denoting the total number of tapes used during the photo mission. This numbering system will also aid in cataloging and accountability during data analysis.

Duplicating video tapes is possible but the quality of data is degraded during the duplication process. When imaging areas of extreme importance, thought should be given to re-flying them immediately to produce a back-up tape. The extra time and flying expense may be trivial compared to a damaged or accidentally erased tape.

To prevent accidental re-use of a previously recorded tape, break off the record protect tab from the rear of the cassette tape. This should be done immediately after the tape is removed from the recorder. It will prevent confusion brought about by working in the close confines of small airplanes. Should it be necessary to re-use a video tape once its erase protect tab has been removed, a piece of masking tape placed over the tab location will facilitate its re-use.

POST-FLIGHT ANALYSIS

When a conventional 9- by 9-inch vertical aerial photo mission is complete, a flight map is prepared to identify the location of each photograph. A similar procedure can be followed to develop a flight map for video imagery. Rewind the video tape fully, reset the counter on the VCR to zero, play the tape, and compare it to the map on the which the planned flight lines were drawn. As is done for flight mapping with conventional photography, locate the area covered in the image on the map. Once the ground area recorded on the video image is located on the map, note the counter number shown on the VCR and record it on the flight map. Other VCR counter numbers worth noting on the flight map are (1) the beginning and end of each flight line, (2) areas where the focal length was altered such as those where a zoom lens was used, (3) study areas which were recorded on a single tape, (4) any portion of the tape which was bad, and (5) any special interest areas. Once again, keep in mind that VCR counters may vary from one VCR to another and the numbers recorded on the flight map may vary somewhat.

Even though duplicate tapes are of lower resolution than originals, backup copies should be made and labeled as duplicates using the same tape number as the original (i.e., Montgomery, 1985, 1/2D). These tapes should be stored in a separate location from the originals to guard against loss of data.

Because quite an investment has been made for data acquisition, proper storage is a small cost to maintain data quality. An inexpensive VCR tape cabinet, similar to those used to store home movie cassettes, is suitable. Prepare and attach to the cabinet a cataloged listing of each tape and a check in/out procedure to prevent loss of tapes. At all times, keep tapes a safe distance from magnetic fields such as electric motors, induction coils, and magnets. These will tend to degrade the quality of the image or possibly erase it.

CONCLUSIONS

The procedures described in this article outline a methodology for the aquisition of video imagery by individuals other than image acquisition professionals. The ease of acquisition of this imagery coupled with its low cost and rapid turnaround gives this imaging system the potential for use when conventional aerial photography is unavailable or unsuitable.

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Publications Available

Final Report on the Joint Test on Gross Error Detection of OEEPE and ISP WG III/1, by Wolfgang Förstner. Official Publication No. 18 of the European Organisation for Experimental Photogrammetric Research. Available from the Institut für Angewandte Geodäsie (Aussenstelle Berlin), Stauffenbergstrasse 13, D-1000 Berlin 30, Federal Republic of Germany. No price given.

Quoting from the introduction, "The scope of the test was twofold: 1. The first aim was to find out the present status of strategies used for error detection, especially to develop information on how efficiently large gross errors could be found. 2. The second aim of the test was to find out the sensitivity of existing error detection procedures to separate small gross errors on one hand and random and systematic errors on the other hand."

Proceedings, International Workshop on GIS, Beijing '87. Available for $45.00 (including airmail postage) by check, payable in U.S. dollars through the Bank of China, to Mr. Yuan Xiansheng, Laboratory of Resource & Environment Information Systems, Institute of Geography, Chinese Academy of Sciences, Building 917, Datun Road, Anwai, Beijing, People's Republic of China.

The IGU Commission on Geographical Data Sensing and Processing, in conjunction with the Laboratory of Resource and Environment Information Systems of the Chinese Academy of Sciences, recently sponsored the first Workshop on GIS in the People's Republic of Chine. The *Proceedings* of the Workshop (in English) contain over 500 pages of technical and descriptive papers which provide the first unified examination of GIS activities in the PRC.

Proceedings, Second International Symposium on Spatial Data Handling. Available for $35.00 (including shipping) by check, payable to "IGU Comm. on Geog. Data Sensing & Processing," from IGU Commission on Geographical Data Sensing & Processing, Department of Geography, The Ohio State University, Columbus, OH 43210.

The *Proceedings* of the Second International Symposium on Spatial Data Handling, held in Seattle, Washington in July 1986, contain nearly 50 technical articles in an over 600-page volume. Included, among others, are papers from sessions on "Quadtree Representations of Spatial Data," "Automated Name Placement," "Storage and Accuracy of Digital Elevation Models," "Relational Database Approaches to GIS," and "Expert Systems for Spatial Data."

Proceedings, First International Symposium on Spatial Data Handling (1984). Available for $40.00 (including shipping) from Prof. Kurt Brassel, Geographisches Institut, Universität Zürich — Irchel, 8057 Zürich, Switzerland.