Application of Airborne Video Imagery to the Transmission Line Route Selection and Approval Process: The Ontario Hydro and Alberta Power Experience

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Airborne videos have proved to be a useful planning tool at both Ontario Hydro and Alberta Power. Various types of video systems have been used in a variety of route location projects for the inventory and update of existing data and for illustrating sensitive areas to public groups and approval bodies. The nature of video imaging lends itself to numerous applications with advantages of flexibility, versatility, and economy. Based on the observations from past studies, it is evident that this tool will continue to contribute to transmission line route selection projects.

The use of airborne video imagery in transmission line route selection and approval projects is a relatively new process in Canada. This simple technology has proved cost-effective as an interpretive and illustrative tool. Ontario Hydro and Alberta Power are two utilities that have recently applied this technology to specific projects with encouraging results.

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Ontario Hydro was one of the first utilities in Canada to use airborne video imagery for transmission line route selection. In 1983, the Land Use and Environmental Planning Department of Ontario Hydro produced an aerial video to assist in identifying alternative routes for a major line location between Kingston and Ottawa in eastern Ontario. These data proved useful for the update and assessment of environmental and land use data within broad corridors. As well, they were used for illustrating specific concerns to approval bodies during assessment hearings. Based on the success of this project, numerous videos have been produced for subsequent studies.

Alberta Power first used video imagery in 1985 to supplement corridor data for a 240-kV transmission line route location study in the northeastern part of the province. The Transmission Applications Department used these data to compare alternative routes within a defined corridor and to review specific situations along each route segment. Alberta Power has since produced an airborne video for a landowner hearing to illustrate a controversial situation along a proposed route for a 240-kV transmission line east of Edmonton.

Utilities such as Ontario Hydro and Alberta Power have found aerial video data to be an increasingly useful tool in an ever changing environment. As rapid development and land use change take place, it becomes even more critical to update existing base data when assessing transmission line routes. Airborne videos fill this need for supplemental data by providing a current continuous record of the environment being assessed. Conventional means for acquiring environmental data such as published reports and maps, aerial photography, and field investigation cannot be replaced by aerial video—the key, however, to this technology is its roll in supplementing these sources and providing an excellent illustrative tool.

Experience is gained with every application of aerial video data. As each new project is undertaken, improvements are made in image quality and processing, because of the use of the latest in camera and recording equipment. As well, flight patterns, angle of view, and installation criteria are constantly being revised to improve the quality and applicability.

As projects progress through the various stages of planning, the type of application of the video data can also change. It has been found now that the applications can run the full length of the project—not only from the route location aspect but also for the purposes of alignment specifics, approval hearing evidence, public meetings, property acquisition, briefing survey crews, and for monitoring changes to the environment after construction. The following sections will deal with the technical factors of the systems used at Ontario Hydro and Alberta Power and illustrate several of their more recent applications.

Features

There are certain features of airborne videos that provide advantages over other more conventional data sources. These include the adaptability, flexibility, and portability of the recording systems, as well as the acceptability of the medium and the enhanced ability to provide current information.

Adaptability

Video cameras, in general, can be used in a wide range of exterior lighting conditions, ranging from overcast to bright sun. The nature of the sensor and automatic iris controls make the cameras very adaptable for filming through changing weather and daylight situations.

The size and portability of most camera systems (including the new CCD cameras) make them relatively easy to adapt to most aircraft installations.

Flexibility

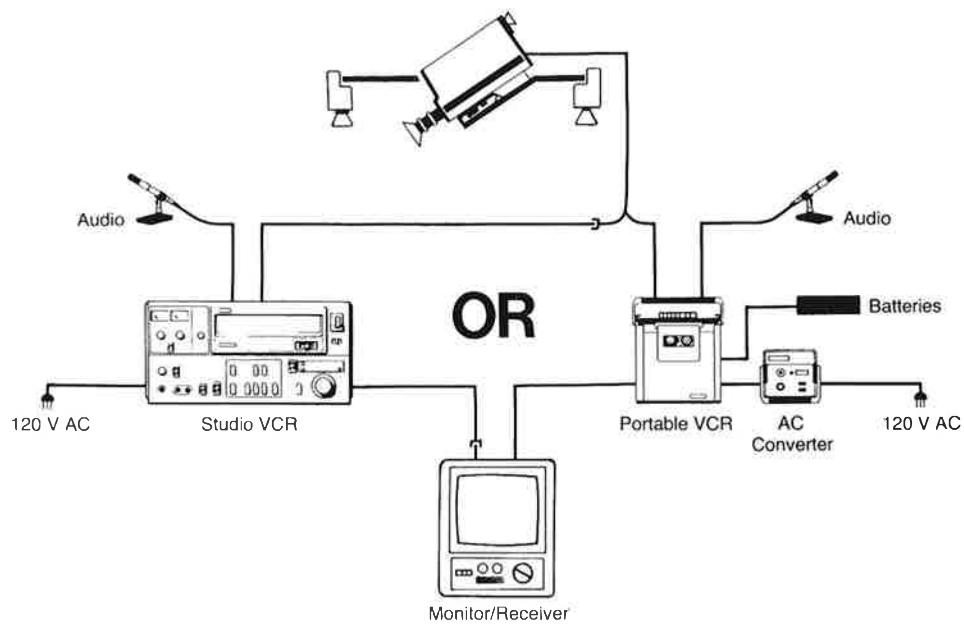
Because video data are recorded in real time (live), it is possible to immediately assess image quality. Errors in aircraft or camera position can be observed on the onboard monitor and rectified as soon as the aircraft can be realigned on the flight line. Annotation in the audio portion of the recording can also be made and reviewed as the images are being recorded. This greatly enhances the applications for field data observation. Hard copy records of the video data can later be acquired if necessary.

The fact that the data are recorded live means that the product is available immediately for analysis. Except for postproduction editing and copy reproduction, there is essentially no processing delay as is experienced with photographic products. This factor alone emphasizes one of the most significant advantages associated with the use of video data. That is, aerial videos can provide the most current source of information for project planning. This can be of great assistance to planners where published data and aerial photography are not up to date—as is often the case because of extended project schedules.

Portability

The compact and lightweight design of video cameras and recorders result in highly portable systems. Videos of short duration can easily be recorded by holding the camera with a variety of viewing angles from the aircraft. The entire recording system and special portable color monitors can be transported and used for viewing and analysis in almost any location and environment, from the office to field sites.

THE AERIAL VIDEO SYSTEM



Familiarity

The general public's familiarity with television makes video imagery an effective demonstration tool. Videos can be shown in meetings and hearings to demonstrate proposed route locations. Under certain conditions this type of medium tends to be more readily understood than drawings or photographs, as it provides a good overall perspective of the situation.

These are just a few of the main advantages that have been achieved through the use of airborne video data. However, as in any technology, there are disadvantages that go along with the advantages. Some of the characteristics that place limitations on video data relate to lower image quality, as compared to more conventional forms of aerial photography. These include the effects of forward image motion, camera and recorder resolution, and exposure time. Given the state of technology of most portable video systems, it is impossible for these devices to approach the quality of aerial photography. In addition, oblique scenes as viewed on a TV monitor, are geometrically distorted and unprocessed video data (nondigital) cannot be reliably used for planimetric applications. The point to remember, however, is that this technology has not been used in place of conventional tools but as a valuable supplemental source of data.

Methods

The characteristics of the video system hardware play a significant role in determining the image quality. Decisions affecting the selection of equipment must be based on the knowledge of the capabilities of the various tape formats, cameras, and recording systems. The following describes the systems used for route selection applications at Ontario Hydro and Alberta Power.

Tape Format and Video Recorders

The term "format" in video usually refers to the size (width) of the recording tape. Generally, the larger the format, the better the quality of the recorded image. The most common and readily available portable systems use small format tapes, which include ¼-inch (8-mm), ½-inch, and ¾-inch systems. Ontario Hydro and Alberta Power normally use the ¾-inch format for route selection applications, because it provides the best quality and is the most suitable for the editing and reproduction of subsequent tapes.

All U-Matic (¾-inch) video cassette recorders (VCR) have a standard threading mechanism, so a wide range of makes and models can be used for portable and studio applications. Recording times for these VCRs are 60 minutes for studio equipment and 20 minutes for portable units. U-Matic systems are also used extensively for editing and postproduction functions. This extends the end use capabilities of the video data for demonstrative purposes. The dual audio track characteristic of the ¾-inch systems allows two sound tracks to be recorded—one during the data acquisition, and another if additional explanatory comments are needed at a later date.

Cameras

There are a wide range of camera types available for airborne video applications. Ontario Hydro and Alberta Power have in the past used a broadcast quality, three tube (saticon) camera for aerial applications. As a result, they have been able to achieve maximal resolution, contrast, and color quality. Solid state (CCD) cameras have also been used in applications where the camera is hand held—as they are smaller, lighter, and less subject to vibration than the standard tube type cameras.

Camera lenses that have been used most successfully include a wide angle, fixed focus, auto-iris lens and a high quality zoom lens with a minimal focal length (9 mm). These lenses should optimize image quality with the required field of view.

Monitors

The video monitor should display the maximal resolution of the image and provide consistent and accurate color. Two types of monitors have been used for airborne video applications. These include a battery powered portable color monitor (5-inch screen) for on-board viewing during image acquisition; and a larger (19-inch screen) high resolution color monitor for display and interpretation. In some cases, large screen (9-foot) projection systems have also been used to present videos to large groups or hearing panels.

Camera Mounts/Platforms/Orientation

Camera mount, airborne platform, and view orientation are variables that are interdependent. The mount determines the available angle of view and the direction of view. Certain mounts are suitable only for specific aircraft types, whether they be of the fixed wing or rotary (helicopter) type. Because the angle and direction of view are probably the most critical variables that the user would like to control, the mount and aircraft type must then be selected to suit.

Ontario Hydro and Alberta Power have used a full range of configurations, from modified aerial survey camera mounts in twin engine aircraft—to the hand held means from helicopters The modified aerial survey configuration has been most suitable for forward oblique angles of view over long lengths of route alignments. This perspective is valuable for synoptic data and the perception of depth. The hand-held method using a side-looking oblique angle is convenient and inexpensive, especially if the video is of a short duration. A stable, adjustable platform, however, will provide the best quality image.

Power Supply

An important requirement for aerial video applications is a dependable regulated source of power for both the recorder and the camera. Voltage fluctuations can trigger sensors in portable VCRs that will automatically shut down the system, resulting in lost data and extra time and cost to refly a missed segment. Abnormalities in the power source can also result in defects in the video image. Either battery power or aircraft power can be used successfully. Aircraft power is the most practical source for extended missions, because most battery packs have a 1- or 2-hour charge limit. However, the importance of "clean" reliable power must not be overlooked, and the installation of all electronic components should be thoroughly tested.

Technical Drawbacks

Despite the success of the use of aerial videos, there have been a number of problems associated with some of the technical aspects of acquisition and production. Both Ontario Hydro and Alberta Power have experienced similar difficulties that relate both to flight planning and "bugs" with the equipment and mount configuration. With regard to planning the missions, the most common problem involves the logistics of coordinating the aircraft, crew, and equipment rental—all in conjunction with the correct timing for the desired ground cover conditions and weather. In most cases, the flexibility as previously discussed will reduce the potential for problems to occur, however, "Murphy's Law" can always prevail.

Other problems encountered have included: difficulty in navigation over remote areas with few distinguishable landmarks, faulty electrical components in the aircraft power supply resulting in voltage fluctuations and image "jitter", and image motion resulting from an unstable mount.

Despite the "simplicity" advantages, each new mission seems to uncover a new minor problem requiring some form of change, whether it relates to the use of a different aircraft, angle of view, camera mount, or complicated flight plan. Consequently, there are some basic recommendations for planning video missions. These include:

- detailed briefing of air crew regarding the route location and the direction of flight;
- scheduling the correct "window" for acquisition with some allowance for unsuitable weather;
- consultation with technical personnel capable of assessing equipment capabilities, power supply, and installation conditions.

Applications

To date, Ontario Hydro and Alberta Power have used video imagery primarily for planning transmission line route locations and in preparing environmental impact assessments. This technology has served well not only as an interpretive tool but as an excellent aid in public meetings and approval hearings.

Airborne video data have been used successfully for various levels of study. Videos have been acquired at several different altitudes ranging between 600 m ASL and 1,500 m ASL, providing ground coverage of approximately 450 m and 1,500 m, respectively. The high altitude, wide coverage has been useful in the initial stages of projects where the comparison of route locations within broad corridors is of concern. The lower flying height, flown at later stages of study, provides much greater detail for examining specific route alignments and for documenting specific contentious issues or areas of environmental concern.

The main types of information that have been extracted from this source are listed below:

- Land use—new development or construction of urban, rural, residential, commercial, and industrial sites; location of structures/and buildings.

- Agricultural land use—assessment of agricultural use, structures, drainage, and fence rows.
- Forest cover—vegetation type; identification of plantations, nurseries; recent clearing.
- Construction constraints—access, drainage, and surface conditions.
- Stream crossings—forest cover, stream banks, and access.
- Wetlands—location, size, and type.

As an illustration tool, aerial videos have been useful at both internal planning meetings and for interaction with the public and review agencies. For internal planning meetings, videos have been used to view portions of routes that may have environmental or construction concerns. Data obtained can provide an up-to-date record of ground features and facilitate the decision-making process. In essence, showing the video simulates taking the project team on an overflight of an area, with the advantage of having a permanent record of the view.

Public meetings and hearings can make excellent use of aerial videos. This technology lends itself well to various forms of public presentation. Route locations and areas of public and environmental concern can easily be shown to large or small groups. A more accurate understanding of given situations can be obtained by actually viewing the areas from a "bird's eye" rather than attempting to relate to detailed descriptions and drawings. This can reduce the chance of misinterpretation of issues or conflicting reports from different parties that could affect the overall perception of sensitive issues.

The preparation of final video presentations can involve extensive editing in order to combine segments of alternative route locations, which make up the final project proposal. During this editing or "post-production" stage, it is possible to add graphics and character annotation to the image. This can take the form of key maps, or highlights of place names or specific areas of concern, for the purpose of viewer orientation. As well, the final product can include a dubbed audio narrative to assist in the orientation and explanation of special features.

Since Ontario Hydro has been using serial video data, over 4,000 km of data have been acquired—at various scales and levels of study. To date these data have been used for corridor evaluation, route location, public presentation, hearing evidence, briefing property agents before negotiation for acquisition, and familiarizing survey crews with field conditions. It is anticipated that these data will also provide a historical record of preconstruction site conditions for reference in the assessment of postconstruction site rehabilitation and mitigation of impacts.

The Future

The success of airborne video imagery applied to the transmission line route selection approval process has led to different levels of commitment for Ontario Hydro and Alberta Power. The Land Use and Environmental Planning Department of Ontario Hydro has invested in a high quality recording and playback system, primarily for interpreting the data. However, because of high costs and constant changes in video technology, acquisition of some of the system components is not practical (e.g., broadcast quality cameras). The Transmission Applications Department of Alberta Power has used the equipment of the company's Public Relations Department, for the most part. In addition, some equipment has been rented as part of an overall data acquisition package. It is perceived that as each utility finds more applications for this technology and develops further enhancements, greater commitments will be made.

Two future enhancements could include: the expanded capability to superimpose graphics on the image; and analogue to digital conversion of video data, for manipulation using computer image analysis.

One potential application would be to use a method for combining graphics with the video image in order to display a simulation of proposed structure locations. This has obvious potential for public presentation purposes. Numerous other annotations could be added by recording images created on a computer graphics terminal.

Recent work in the area of digital image analysis (Frost, 1985; Meisner, 1985; King, 1985) has shown that resource data can be extracted from digitized video images using accepted image analysis procedures. This is based on video data that have been acquired specifically in a multispectral mode, using specialized cameras and filters. This method has considerable potential for contributing to other multispectral data sources that are used in computer enhanced planning environments and geographic information systems.

Conclusion

Airborne video is a tool that can be used by any utility to aid in the planning and approval process. This technology makes available to planners and engineers a data source that can be simple to acquire, cost-effective, and valuable for route analysis and illustration. Both Ontario Hydro and Alberta Power have experienced success in the use of this tool and intend to continue to enhance and develop methods and applications.

This is also a changing technology, and it is not without its disadvantages. As each new mission is undertaken, new experience is gained regarding the approach to be taken and the equipment to be used. It is important that this experience be applied to each new application and that a certain amount of flexibility be maintained. If the simplicity factor is lost, the many advantages that are available could be jeopardized. IRWA

This paper was presented at the Fourth Symposium on Environmental Concerns in Right-of-Way Management, Indianapolis, Indiana, October, 1987.

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