United States Department of Agriculture

Forest Service

Southern Forest Experiment Station

Research Note

SO-380
September 1995

Correction of Line Interleaving Displacement in Frame Captured Aerial Video Imagery

B. Cooke and A. Saucier

SUMMARY

Scientists with the USDA Forest Service are currently assessing the usefulness of aerial video imagery for various purposes including midcycle inventory updates. The potential of video image data for these purposes may be compromised by scan line interleaving displacement problems. Interleaving displacement problems cause features in video raster datasets to have jagged edges due to pixel offset on adjacent scan lines. Researchers at the Southern Forest Experiment Station, Forest Inventory and Analysis Unit (SO-FIA), have developed a computer program, "Pixshift," written in C, that shifts alternate raster lines (even or odd) to the right or left by a user-specified integer value. The program allows a maximum of four channels to be shifted simultaneously. Improvements in band-to-band registration and rectification to a map base have been observed, and classification improvements are expected.

INTRODUCTION

Video imaging is a developing remote sensing tool that is receiving increased application in resource management (King and Vlcek 1990). Research is being conducted at SO-FIA to investigate uses of aerial video for landcover classifications, forest canopy percent measurements, sub-pixel prediction models for lower resolution datasets, and generation of digital elevation models (DEM's) from video stereo pairs. Operational use of airborne video at SO-FIA has been documented for forest damage assessment resulting from ice storms and hurricanes (Jacobs and Eggen-McIntosh, in press) and for satellite data classification verification (Eggen-McIntosh and Jacobs 1993). Uses of aerial video in forestry are becoming commonplace due to low acquisition costs, the ease of system setup and operation, and digital capabilities to incorporate the imagery into computer databases and geographic information systems (GIS) (Evans and Beltz 1992). Although much research has been done that validates multispectral video as a tool for providing forest inventory data, more research is needed to compare technologies and publish their limitations (Walker 1993).

In each of the previously mentioned applications, traditional digital image processing functions are hindered to some extent by line interleaving displacement problems. Some video frame grabbing software allows the user to capture only one of the two fields comprised by full video frames. This process eliminates the line interleaving problem, but the cost is a 50-percent reduction in data. A typical video scene captured in digital form (fig. 1) has been magnified in order to emphasize the interleaving problem. Interleaving is manifested by a more jagged edge appearance than is normally expected with raster data. In this example, alternate lines in the magnified area are noticeably "out of sync" by a factor of one pixel. Notable problems include difficulty in locating accurate control points for scene registration to a map coordinate system and problems associated with defining training fields for classification purposes, particularly in areas where image features of interest may contain few pixels.

The purpose of this study was to develop the "Pixshift' program and to demonstrate qualitative visual improvement of images and subsequent improvement in band-to-band registration of images after shifting.

METHODS

Captured digital video images used in this study were generated from a four-camera system. Separate images

Southern Forest Experiment Station/T-l0210 U.S. Postal Services Bldg., 701 Loyola Avenue, New Orleans, La. 70113
Forest Service, U.S. Department of Agriculture.
Servlng Alabama, Arkansas, Louisiana, Mississippi, E. Oklahoma, Tennessee, E. Texas, Puerto Rico, U.S. Virgin Islands.

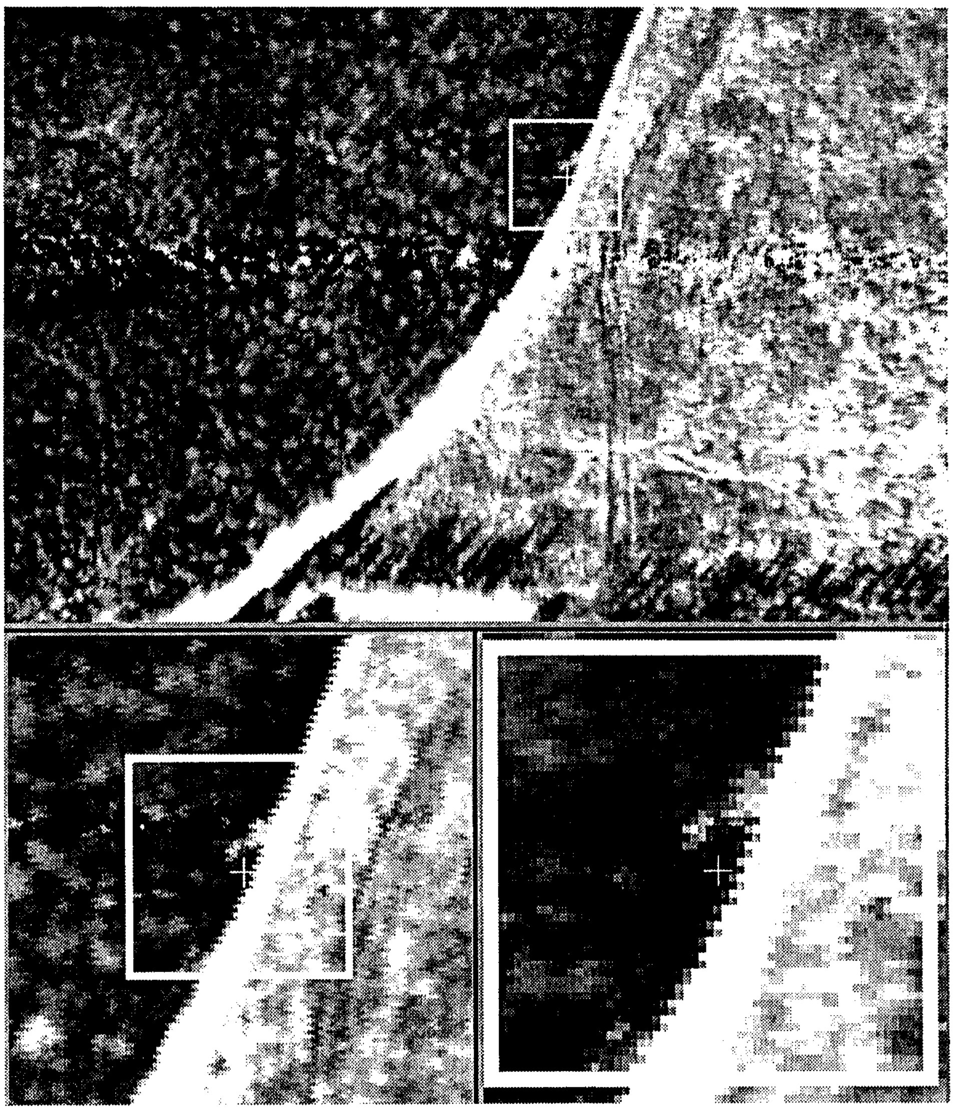

Figure 1 .-*Single frame of uncorrected video data captured in digital form; boxes at the bottom depict various zoom factors applied to the area of interest.*

representing reflectance in the blue, green, red, and near-infrared portions of the electromagnetic spectrum were obtained by lens filtering. Each camera recorded images on a charge coupled device (CCD) sensor capturing 350,000 pixels per spectral image in a full-frame format. Spatial resolution was approximately 1 meter per pixel. The single band images were not registered to each other, and band-to-band registration was performed by the researcher. A primary concern in the registration process was accurate visual depiction of ground features used for control points common to each set of two bands. Correction of the line displacement problem was considered essential to qualitative visual improvement of images and accurate visual depiction of ground features.

The Pixshift program was designed to take a raster image in ASCII format with one to four channels of spectral information and shift either even or odd rows to the left or right by a specified integer value. The resultant image is enhanced from a visual and an analytical perspective. The program should be applied prior to any rectification process.

The Pixshift program requires conversion of video images to ASCII file format as a preparatory step.The ASCII file may contain a maximum of four data channels (bands), and the current maximum number of pixels per line is 5,000. There is no limit on the number of lines other than practical limits of available disk space.

The Pixshift program is currently designed to accept an ASCII file created in ERDAS[1]; however, any generic

[1]Use of company, product, or trade names is solely for information and does not constitute official endorsement by the USDA Forest Service.

Bill Cooke is a research forester, and Allen Saucier is a computer specialist, U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station, Forest Inventory and Analysis, Starkville, MS 39759.

ASCII file of the same design will work as well. The Pixshift program is user interactive. The user must specify the number of channels, the number of pixels (as an integer) and direction (left or right) of the shift, and whether even or odd lines are to be shifted. The output file is an ASCII file of the same size as the input file. A batch routine has been created that automatically calls the ERDAS programs and passes the data to the appropriate program. The original image file is preserved as a binary data file with a ".lan–ori" file name extension. The output file has the same name as the original file.

Subsequent to qualitative visual improvement of images, image registration improvement prior to and after shifting was tested. Comparison of band-to-band registration was performed on a single scene. The green band was chosen as the band to which the other bands were registered. It is impossible to remove all subjectivity from manually choosing control points. Each ground feature's reflectance characteristics are unique to the recorded spectral band. Analyst subjectivity in choosing points common to different spectral bands was decreased by using the same zoom factor (16) for each set of two bands. The same set of control points was used for each registration test. Differences in file coordinates result from initial capture differences, analyst subjectivity in selection, and pixel shifting. A rigorous test of the improvement in band-to-band registration was not the focus of this paper; however, current research will allow comparison of average root mean square (RMS) errors for two adjacent flight lines.

RESULTS

Comparison of the unshifted image (fig. 1) with the shifted image (fig. 2) is indicative of the qualitative visual improvement obtained by using the "Pixshift" program. This image was created by moving every even-numbered line to the left by a factor of one pixel. Quantitative improvement in band-to-band registration for the multispec-

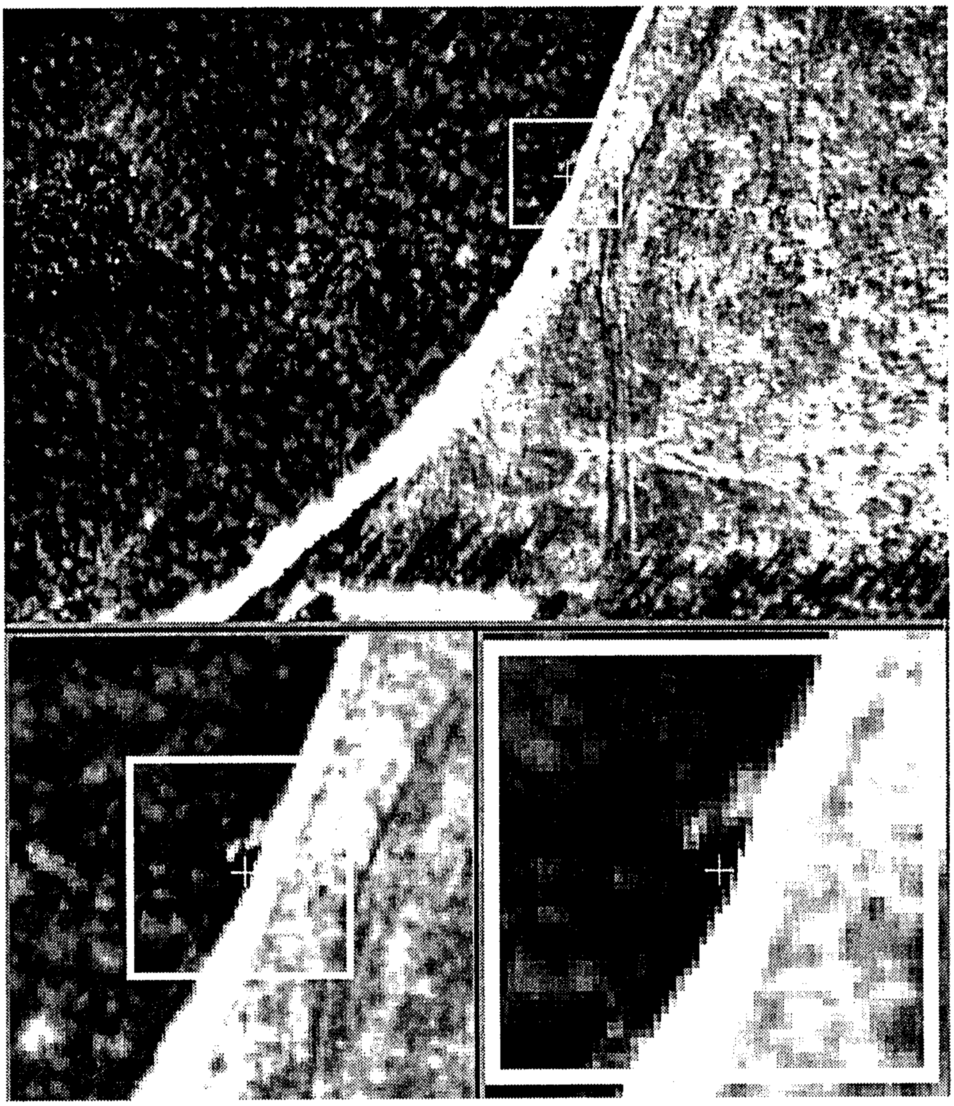

Figure *P.-Single frame of corrected video data captured in digital form; boxes at the bottom depict various zoom factors applied to the area of interest.*

tral video imagery is evidenced by improvement of RMS errors for sets of control points common to the unregistered green and near infrared bands (table 1).

DISCUSSION

The video camera incorporates a trick to fool the eye and reduce transmission band width: the video frame is divided into two fields, half taken at time 1 and half taken at 1/60 second later at time 2 (Lake 1994). Line interleaving displacement in full video frames may be introduced by aircraft vibration, motion, or some combination of the two variables that may occur between field capture.

The Pixshift program is an important preparatory tool for "cleaning up" video imagery that exhibits line interleaving displacement in advance of traditional image processing techniques. Visual improvement of imagery is obvious, and future implications are promising. Classification efforts are expected to improve subsequent to the improved spatial integrity of features. Choice and delineation of training fields for supervised classification of multispectral video data should be more easily accomplished, and increased precision of frame-to-frame registration has been demonstrated. Improvement in automatic generation of OEM's from video stereo pairs is being investigated at this time, and improvement is expected due to corrections made by this program. Measurement work, including stereo modeling for height determination and area measurements, is expected to yield increased accuracy.

Work is continuing on automatic calculation of shift distance and direction parameters. Determination of variable shift factors across an image, based on autocorrelation results, is also being investigated.The Pixshift program, when used in conjunction with traditional image enhancement techniques, should enable Forest Service researchers and others to expand the usefulness of video imagery for a variety of forestry applications. The Pixshift program is available from SO-FIA in Starkville, MS.

Table 1.-*Comparison of root mean square* ***(RMS)*** *errors for unshifted and* ***shifted*** *video* ***imagery*** *using ground control points (GCP)* ***common*** *to both* ***images***

GCP No.	Green		Near infrared		RMS error		Total RMS error
	X	Y	X	Y	X	Y	
			Unshifted video imagery				
1	100.0	72.0	102.0	77.0	0.09	-0.36	0.37
2	326.5	69.5	326.5	96.5	-0.17	0.30	0.35
3	594.7	56.0	597.9	64.0	0.40	-0.23	0.46
4	50.0	235.9	50.9	240.9	0.05	-0.21	0.21
5	294.5	292.0	295.4	299.4	-0.06	0.69	0.69
6	657.6	249.0	659.0	257.9	-0.66	0.17	0.70
7	115.0	425.0	115.1	431.0	0.19	0.25	0.32
S	436.2	469.0	436.0	476.0	-0.42	-0.67	0.79
9	721.4	461.6	722.6	471.2	0.60	0.05	0.61
			Shifted video imagery†				
1	97.0	76.0	101.0	77.0	0.30	-0.06	0.31
2	323.5	92.5	327.5	96.6	-0.56	0.25	0.62
3	590.5	56.9	597.5	63.9	0.51	0.14	0.53
4	46.0	239.0	49.0	240.0	0.17	-0.12	0.21
5	294.0	294.9	295.0	299.0	-0.16	-0.12	0.19
6	657.0	249.0	660.0	257.0	-0.59	-0.33	0.66
7	116.2	428.3	114.3	430.9	-0.02	-0.01	0.02
6	436.0	469.0	435.0	476.0	-0.10	0.33	0.34
9	722.0	461.0	723.0	471.0	0.45	-0.05	0.45

*x,y RMS = (0.46, 0.47), Total RMS = 0.66
†x,y RMS = (0.46, 0.42), Total RMS = 0.52

LITERATURE CITED

Eggen-McIntosh, Susan; Jacobs, Dennis M. 1993. Acquisition of airborne videography of Mexico for verification of FAO forest resources assessment Landsat interpretations. In: Proceedings of the 14th biennial workshop on color photography and videography for resource monitoring; 1993 May 25-29; Logan, UT. Bethesda, MD: American Society for Photogrammetry and Remote Sensing: 135-l 44.

Evans, David L.; Beltz, Roy C. 1992. Aerial video and associated technologies for forest assessments. In: Greer, Jerry D., ed. Remote sensing and natural resource management: Proceedings of the 4th Forest Service remote sensing appplications conference; 1992 April 6-l 1; Orlando, FL. Bethesda, MD: American Society for Photogrammetry and Remote Sensing: 301304.

Jacobs, Dennis M.; Eggen-McIntosh, Susan. [In press]. Airborne videography and GPS for assessment of forest damage in southern Louisiana from Hurricane Andrew. In: Proceedings of the IUFRO conference on inventory and management in the context of catastrophic events; 1993 June 21-24; University Park, PA. International Union of Forestry Research Organizations.

King, Doug; Vlcek, Jerry. 1990. Development of a multispectral video system and its application in forestry. Canadian Journal of Remote Sensing. 16(1): 15-22.

Lake, Don. 1994. Pictures in time: Camera issues when you exploit motion video clips. Advanced Imaging. January: 47-51.

Walker, Kim-Marie. 1993. Airborne digital multispectral imaging. Earth Observation Magazine. April: 66-69.