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Renewable Resources Inventory

September 1981

EVALUATION OF VICAR SOFTWARE CAPABILITY FOR LAND INFORMATION SUPPORT SYSTEM NEEDS

S. S. Yao

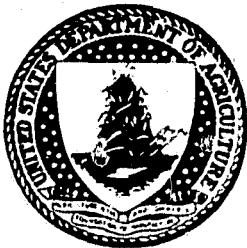
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EVALUATION OF VICAR SOFTWARE CAPABILITY FOR
LAND INFORMATION SUPPORT SYSTEM NEEDS

Job Order 72-542

This report describes activities of the Renewable Resources
Inventory project of the AgRISTARS program.

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| 16. Abstract Four sets of processed Landsat data over the same area on earth were registered together using the VICAR software installed on the EODL computer facility. The registration effort constituted a portion of the task to evaluate the VICAR capability for the proposed Land Information Support System needs. Four specific recommendations were also included. | | | | | |
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1. INTRODUCTION

The Earth Observations Division of the Johnson Space Center, National Aeronautics and Space Administration has installed an image processing software package called VICAR (Video Image Communication And Retrieval). A task was initiated to evaluate the VICAR capability in terms of the proposed Land Information Support System needs. Due to software installation, modification and debugging problems encountered, only limited VICAR capability were evaluated in time. Specifically, four data sets over the same area on earth were obtained, and VICAR was used to compare their geometric and radiometric properties.

2. DESCRIPTIONS OF THE DATA SETS

Four data sets over the Elk River quadrangle in Idaho were obtained. Their common characteristics were that they were all derived from the same Landsat imagery on the same date, and they were all stored on tapes with a variety of formats. The "JSC" data set came from direct Image-100 off-load of the original Landsat frame. The "LARS" data set was the LARS-registered imagery over the quad sheet, while the "ERIM" and "MDP" data sets were registered at ERIM and by the Master Data Processor at Goddard, respectively. The following paragraphs discuss briefly where the data sets were stored, how were they located, their pixel resolutions, prominent radiometric and geometric characteristics, and other outstanding features.

- a. The JSC data set: The Image-100 off-load tape was located on site in universal format. Four Landsat bands were available. Each band was 512 by 512 pixels, with the Elk River Quad data somewhere near the center of the image. A rotation is needed to align the line-pixel direction with the north and east directions. A border of zero value 20-pixel wide is found at the top and left hand side of each image. At the bottom and right hand side there was a seven-pixel wide border. All radiometric values had been doubled to fill the 0 to 255 range. Though data in all four bands were of excellent quality, only band 1 from each data set was used for comparison.

- b. The LARS data set: This image was registered from the original Landsat data by LARS and geometrically corrected to fit the Elk River Quad sheet. The size of each band was 158 by 184 pixels. Resampling was done by nearest neighbor and the pixel size was not modified. The radiometric values also remained unchanged from the original Landsat values. The tape is located at the LARS tape library and the format was the LARS-III tape format.

- c. The ERIM data set: ERIM was contracted earlier to register the same Elk River Landsat image using their special registration software, and a geometrically corrected four-band image of size 193 by 273 pixels was available on site in universal formatted tape. Not only was the resampling done by their "restoration" software to 50 meter by 50 meter pixel resolution, all radiometric values were also scaled to 8-bit, thus filled the 0 to 255 range.

d. The MDP data set: A tape containing an image processed through the MDP software near the Elk River Quad was also located in the LARS tape library. The image size is 301 by 301 pixel. The upper right corner of the Elk River Quad was not in this image. As with all MDP-processed product, a rotation is needed to align the lines and pixels with the north and east directions. The radiometric range remained at the seven-bit level.

Therefore, out of the four images, there was a pair whose radiometric ranges doubled the other pair, and a different pair whose geometric orientation differ from the other pair.

3. PROCEDURE USED FOR COMPARISON

The following procedures were used to compare the four data sets radiometrically and geometrically. Most steps of the procedure was accomplished using VICAR software.

- Step 1: Read the data sets from tapes in blocks and catalog them as files with VICAR labels.
- Step 2: Separate the data sets according to formats into individual Landsat bands and attach VICAR labels for these single-band images.
- Step 3: Histogram the images and print out all band images with normalized grey scale symbols.
- Step 4: Select control points from the four band 1 grey scale printouts to establish geometric relationships between images.

Step 5: Using least squares procedures to weed out incorrectly identified control points. The remaining control points are then called tie points.

Step 6: Select the LARS image as the reference image, register the JSC, ERIM, and MDP images to the LARS image using nearest neighbor re-sampling procedure.

Step 7: Histogram and print out the registered images for visual comparison of both the geometric and radiometric characteristics.

The following paragraphs highlight each step of the procedure:

In Step One, VICAR program READ was used to read in universal-formatted tapes on site. The software automatically determine the tape density, whether it is 800 or 1600 bpi. For tapes stored in the LARS library (the LARS and the MDP data sets), CMS system command FILE INMOVE, FILE OUTMOVE and MOVE were used to read tape data on to disk. The disk files were then transmitted to JSC via the established network using the SEND and RECEIVE command. No actual tape mailing was involved.

In Step Two, VICAR program PRINTPIX was used to examine the file structure, and SAR or VSAR programs was used to separate each data set into the component bands. For the JSC data set which had zero-value borders, SAR program was again used to eliminated the borders, so that each band was of 485 by 485 pixel size.

TERMHIST program was used to print out the histograms of the individual images. DISPLAY program with LINEAR parameter field that accept the radiometric ranges obtained from TERMHIST was used to output normalized grey-level computer printouts of all bands from all the data sets. This accomplished the Step Three processing procedure.

In Step Four, eight control points were carefully selected from band 1 print-out of each of the four data sets, namely, the JSC, the LARS, the ERIM, and the MDP data set. The control points were distributed throughout the common image area covering the Elk River Quad by all four data sets. Table 1 listed these control point locations.

Since control points were selected by eyeballing the grey-level computer printouts, there were possibilities that some of them may be off target. In Step Five, SAS program GLM was used to run least squares regressions among the control point coordinates between different data sets. Only one point from the MDP data set was found to be having substantial residue. That point was re-identified and corrected. All control points were now accepted as tie points to be used in the VICAR registration procedure that followed.

Among the four data sets available for comparison, the LARS-registered data set had the smallest numbers of lines and pixels. To minimize duplication of pixel values, it was chosen as the reference data set where the other three were to be aligned with. The VICAR program GEOMA did the registration processing based on the tie point locations, and the nearest neighbor re-sampling option was selected. GEOMA required that the tie points be in lattice

| IMAGE | LARS | ERIM | MDP | JSC |
|-------|---------|---------|---------|---------|
| 1 | 39,24 | 27,65 | 55,51 | 119,166 |
| 2 | 44,58 | 52,93 | 82,71 | 146,180 |
| 3 | 100,32 | 119,52 | 132,23 | 194,146 |
| 4 | 36,120 | 44,186 | 94,151 | 160,238 |
| 5 | 94,119 | 115,186 | 155,135 | 219,227 |
| 6 | 132,126 | 162,194 | 197,134 | 260,226 |
| 7 | 11,158 | 15,244 | 81,206 | 149,227 |
| 8 | 104,168 | 130,257 | 181,195 | 247,270 |

Table 1.- TIE POINTS LOCATIONS IN (X,Y)

format. Because only eight tie points were available, the ninth one was artificially created based on the coefficients available from the regression runs in the previous step in order to establish the 3 by 3 lattice format by GEOMA. Figure 1 shows the location of these control points.

The final step of the procedure made use of the VICAR programs TERMHIST and DISPLAY again to output four normalized grey-level computer printouts for visual comparison of the geometrically registered data sets. Figures 2 to 5 shows the upper left hand of each of the registered images for comparison.

4. RESULTS AND CONCLUSIONS

Recall that the objective of this study was to evaluate the VICAR software processing capability in light of the proposed Land Information Support System (LISS) needs. Only preliminary evaluation in the areas of image storage, retrieval, display, and registration were accomplished. The problems encountered in VICAR installation, modification and debugging, together with the existence of only a vague LISS requirements definition all contributed to the down-scoping of the study. The following conclusions can be drawn:

- a. VICAR, though a batch oriented system by design, will have substantial interactive capabilities when VTRAN can be modified to run under CMS. It is strongly recommended that this effort be continued.
- b. Input/output and file manipulations are easily controlled with the VICAR software and the newly created VMROUTER machine.
- c. Image display capability other than via terminals or line printer outputs has not been exploited in this study.

d. Initial evaluation of VICAR image registration capability leaves something to be desired. Ideally, when image control points were selected, either by eyeballing or by some automatic correlation schemes, the user should have the capability to test out how well these control points behave under different "rubber sheet" distortion models. This is an interactive procedure. Programs such as the Generalized Linear Estimation (GLE) from the SAS package for least squares regression will come in real handy. An effort should be directed to make them available under VICAR. This is particularly beneficial in the JSC operating environment where VICAR is not considered strictly as a batch machine.

In addition, program GEOMA, the program under VICAR recommended for doing rubber-sheet registration, will accept only lattice-formatted tie points. It would be of great convenience to the user of VICAR if the program can also accept coefficients derived from a given rubber-sheet model because of the following two considerations. First of all people does not ordinarily pick control points in lattice fashion; and secondly, after regression, some lattice points may have to be discarded. However, the coefficients would remain useful throughout.

For the current evaluation using an extra artificial tie point created in Step Six of the procedure, the normalized grey-level computer printouts of the three registered images (ERIM, MDP, and JSC) all look very much like the reference image from LARS. Some discrepancies are:

- a. The original ERIM data set is slightly "shorter" than the LARS data set, causing the registered ERIM image to show a few blank lines at the bottom of the image.
- b. The registered MDP image is missing the upper right corner. The corner was missing from the original MDP image before the corrections of rotation and scaling are applied.

No attempt was made to establish a goodness criterion to evaluate these registered images. Procedures that can be applied to further evaluate the registration include the calling of VICAR programs to normalize image radiant values, subtract images, create edge images, cluster images, etc. It is recommended that these efforts be continued.

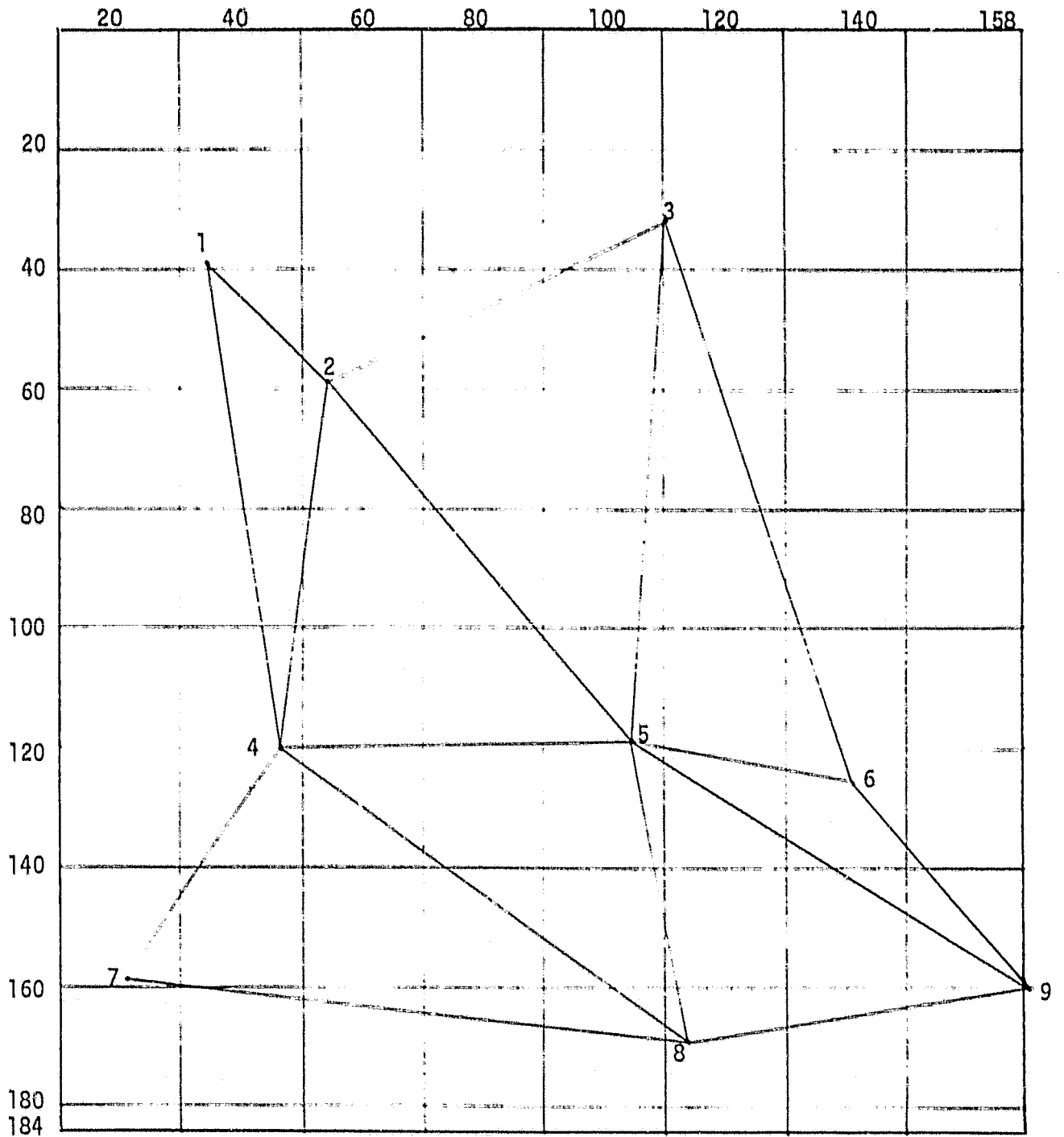
5. RECOMMENDATION

1. It is strongly recommended that the effort to modify VICAR job VTRAN to run under CMS instead of OS be continued. When done, not only will VICAR runs more interactive, it will also save software overhead.
2. It will also be beneficial to NASA/JSC if the current evaluation using the four data sets be continued. Capabilities of VICAR not yet evaluated include image enhancement, classification, and most importantly, on the IBIS software which was recommended as a component of the proposed JSC Geographic Information System.
3. It is recommended that the VICAR program GEOMA be modified to accept not just the lattice tie points, but also rubber sheet models with associated coefficients as inputs.

4. It is recommended that math packages such as the GLE from SAS be incorporated under VICAR to perform least squares regression, etc.

6. ACKNOWLEDGEMENT

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FORMATION

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 2 | 3 | 3 |
| 4 | 4 | 5 | 5 | 6 |
| 7 | 8 | 8 | 9 | 9 |

Figure 1.- Lattice Tie Point Locations on LARS Image.

ORIGINAL PAGE IS
OF POOR QUALITY

Figure 2. - The LARS Image - Reference

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JSC
REF



Figure 3. - The Registered JSC Image



Figure 4. - The Registered MDP Image

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Figure 5. - The Registered ERIM Image