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7-1/2' MAP-IMAGE EXTRACTION FROM PRECISION PROCESSED LANDSAT MULTISPECTRAL SCANNER (MSS) AND THEMATIC MAPPER (TM) IMAGERY USING A MICROCOMPUTER AND ORIGINAL EROS CCTs

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SUMMARY

The Nebraska Remote Sensing Center (NRSC) has developed a low cost, flexible and user friendly microcomputer image analysis system code named HOT LIPS for Home and Office Techniques for Local Image Processing Systems. As part of this development a unique approach to accessing Landsat satellite imagery has been implemented. This paper explains the straight forward processes by which the HOT LIPS user extracts and geo-encodes a multispectral 7½' map-image from CCTs of precision processed Landsat Multispectral Scanner (post 1978 MSS) or Thematic Mapper (TM) images.

A map-image is that portion of a multispectral image exactly matching the area of the particular specified map, e.g. a 7½' USGS map. It can be stored on a floppy disk or on a computer tape. Subsequently it can be displayed to a selected scale in black and white, color or other pseudocolors and thus it is similar to an orthophoto map except that it is derived from non-photographic satellite images. The first step of the map-image extraction process is to determine the geographic location of the desired 7½' map by entering its map and state name into the HOT LIPS CRT terminal. Alternately, the user may extract an unknown 7½' map by entering the latitude and longitude of a single ground point in the area of interest. Under either option HOT LIPS searches through the map-name disk files and returns the latitude and longitudes of the four corners for the selected map. The map-name files currently contain the locations of the more than 9000 7½' maps for the areas of 9 states constituting the Upper Missouri River Basin.

The four corners retrieved from the map-name file are next used to identify all the available Landsat coverage of the selected map. HOT LIPS searches the NRSC Landsat tape holdings disk file based on the scene's geographic corners and identifies on the CRT terminal any available full or partial coverage for the map selected. Alternately the user may request that HOT LIPS use the four corners of each map to search the two disks containing all the EROS Data Center holdings of the nine state area since 1972 (60,000 scenes). This variant will identify and display any available scene containing full or partial coverage of the selected map for ordering from EROS and subsequent use.

Next the user chooses a date and type of Landsat CCT from the list which best fits his analysis objectives and mounts it on HOT LIPS's low cost tape deck. Once the tape is mounted HOT LIPS continues on automatically to read the geographic reference tickmark information from the annotation record on the CCT. This information is used to convert the latitude/longitude of the four corners to line/column numbers in the specific CCT using the 'PIXGEO' computer program. 'PIXGEO' was developed by the EROS Data Center staff for conversion of geographic latitude/longitude coordinates to and from scene picture element (pixel) coordinates on a Burroughs 3000 computer and was modified for use in HOT LIPS at the NRSC.

Once HOT LIPS defines the line/column numbers of the four map corners in the selected scene it fast forwards the tape to reach and extract the desired subarea to memory and/or floppy disk. The rotation angle needed for resampling the original picture elements from the inclined Landsat grid on the tape is also computed. Using this angle a nearest neighbor or 1:1 resampling is applied to the original pixels as they were extracted so as to reorient or rotate the map-image grid to N/S and E/W. The full process from map

selection to completion of the single band display or multiband floppy disk file takes on the average 10 to 15 minutes respectively. The exact time for the extraction depends upon the position of the map-image in the tape, the number of tape volumes for the scene, etc.

Unfortunately the data provided in the CCT annotation record does not provide a basis for locating the exact boundaries of the 7½' map within the scene. The geometric rectification of the precision processed MSS scene does not precisely geo-encode the cells in the image although the rectification appears quite accurate. This position or geo-encoding inaccuracy is confirmed by NASA and the EROS Data Center and leaves a residual N/S and E/W translation error in the Landsat scene and thus in the map-image. The mislocation of the average scene and map-image extracted automatically as described is about 15 cells N/S and E/W with a variation of about 1 to 30 cells. At least one case has been encountered where the annotation record mispositions the geo-encoding of the scene by 200 cells.

A simple map-image calibration procedure has been developed to overcome this difficulty and exactly position the map-image (+/-1 pixel). First the preliminary map-image is extracted from the tape to floppy disk with the automated procedure using an option which extracts a somewhat bigger area than is estimated from the location of the actual map-image. The resulting oversized map-image is displayed in color (TM) or color IR (MSS) or in black and white. Two control pixels which can be readily located on the appropriate 7½' map are identified on the display screen. Next the location of these two points on the 7½' map are identified by a low cost X-Y digitizer interfaced to the system. This provided HOT LIPS with the necessary control information with which to compute the transformation between the rectilinear X-Y grid overlaying the map and the rectilinear row/column grid of the pixel display. Finally the two opposite corners of the 7½' map's boundary are input by the user with the digitizer and HOT LIPS computes these boundary locations in the geo-encoded pixel grid using the geographic corners of the map retrieved from the map location file. HOT LIPS then trims the disk file to the exact map-image which can be used in any of its available menu selected image analysis routines or written on a CCT to be used to produce a color, ink-jet, plotter at a 7½' scale.

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