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A Description of the CUTOUR program

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A Description of the CNTOUR program.

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I. Introduction

The CNTOUR program plots an intensity relief map of an image which is read from the vidisector camera (TV-B). It may be used as a general purpose aiming, monitering and focusing program, especially for high-contrast images, for which it produces something like a line drawing.

II. Operating Instruction Summary

This section gives step-by-step operating instructions for the program. It should be sufficient for most purposes. For more detailed instructions, read section III of this memo.

1. Read in the program. A copy is on the vision library tape named CNTOUR KRAK. Turn on the vidisector power and 2 or 3 sunguns, and turn off the fluorescent room lights to reduce noise. Set the vidisector focus to approximately the correct distance, and open the lens to around f/2. Set the vidisector switch to the "340" position and set the mode switch to either "dim" or "brite" mode. The brite mode is in general useful only for bright, high contrast objects against a dark background.

2. Start the program by typing G$G. ($ = ALT. MODE).

Steps 3 and 4 may be skipped, but will very probably result in better contours.

3. Type an H to obtain a histogram.

4. Set the right half of the switches so that its vertical line has just a few non-zero points to the right of it. Set the left half of the switches so that its line has just a few non-zero points to the left of it. Type E.

5. Type C to plot the contours. When this processing is completed, a bell is sounded.

6. To see the contours one at a time, type 1P, then O or B repeatedly. To see them all at once, type :P. To write out what is being displayed, turn on the CALCOMP plotter, and type W.

Repeat steps 3-6 for further images.

III. Operating Instructions

For the purposes of this discussion, a contour, at a given threshold (or level), is a set of closed curves enclosing all those points in an image whose intensity is greater than the specified threshold. Note that these contours correspond to the contours of a relief map, and not the boundaries of an object, as the word is sometimes used in the vision group. If the image were continuous, the contour at a given threshold would simply be the locus of all points whose intensity was equal to that threshold but since the vidisector image is sampled rather than continuous, this definition does not quite fit. The program assumes all points outside of the image area to be black, and thus to be below the threshold. CNTOUR produces a set of contours at specified thresholds, which may be displayed separately or superimposed upon one another to produce a complete intensity relief map.

The program was designed for studying images as the vidisector sees them. In cases where the image has a very high contrast, as when it consists of white objects on a black field, the contour lines at several thresholds will fall on the boundaries of the objects, just as contour lines on a relief map come together on an abrupt change of altitude, such as a cliff. The result will appear to be an outline drawing of the objects. The objects may thus be quickly recognised, and so the program may be used as a monitor program, and for aiming the camera. It may also be used for focusing the camera, by observing the closeness of the contour lines at a high contrast edge. In the case of images with less contrast, the objects may be harder to recognise, and the contour map thus harder to interpret.

The different sections of the program may be run in almost any order, under typewriter control. Control is by single letter commands, preceeded by zero, one, or two numerical arguments. If there are two arguments, they are separated by a comma. Numbers are taken to be octal, unless they are followed by a decimal point. The character : (colon) is taken as a number, and has the value 1. The typewriter input routines are rather simpleminded, and do not echo a linefeed following a carriage return.

The user must begin by supplying a list of thresholds at which he wants contours plotted. This list may contain up to 36 entries, numbered Ø through 35. A number k specifies the total number of contours to be plotted, so that a contour will be plotted for list entry Ø through list entry k-1. Entries may be inserted into the list by typing the command n, mL (Load), which will insert the threshold m into list entry n. Furthermore, it will update k to take in the list entry just inserted; that is, k' = max (n + 1.k). k may also be set directly by the command nK.

Putting thresholds into the table manually is somewhat cumbersome, however, especially since all one generally wants to do is to display contours for a series of evenly spaced thresholds between an upper and a lower bound. This may be done using the nE command (Enter threshold table). This command actually has three arguments, one typed, and the other two coming from the left and right halves of the switches. k is set to n, and n threshold values are inserted into the threshold table, the lowest being approximately the value found in the left half of the switches, and the highest being the value in the right half of the switches, with n-2 values evenly spaced in between. The actual values used are $s_r - \left[\frac{s_r - s_1}{n-1}\right] i$,

($\emptyset \leq i \leq n-1$), where s_l and s_r represent the numbers in the left and the right halves of the switches respectively, and the computations are done in integer arithmetic. If the command E is used without an argument, the argument is taken to be the last non-zero argument used in front of an E.

In order to be able to know where to insert the thresholds, a historgram of light intensities may be plotted, by typing the command H (Histogram). The result will be a graph whose x-axis is the log of the values read from the vidisector (from $\emptyset$ to 376_8), and whose y-axis gives the number of points in the image for which that particular value was read. Note that lower numbers indicate brighter points, so that on the x-axis, brightness increases to the left. The number of times the value 377 was read is not shown on the histogram, since this value corresponds to all those points which were too dark for the vidisector to detect, and is often a very high number, especially if the vidisector is being run in "bright" mode. The scale of the y-axis is indicated by a short horizontal line just to the right of the graph, which is at a height of 1$\emptyset$ units. Just to the right of this line is a two digit number indicating the percentage of points which the vidisector could detect (i.e., the percentage of points with readings less than or equal to 376_8). Two vertical lines indicate the values of the left and right halves of the switches. Thus, one can pick out the intensity region of interest on the histogram, bracket it with the two vertical lines by setting the testword switches, and do an nE operation to generate the table of thresholds.

The command C (Contours) will now result in the reading of an image from the vidisector, and the level-by-level processing of it to trace the contours. A bell will be sounded when the processing

is complete. The image is read into an image buffer, and the processing generates increment commands which are packed into a display buffer, from which they are fed to the display in interrupt mode. The contours may be displayed singly, or all at once, or in any other combination, under the control of a mask register. A 1 in bit 35. -i of the mask register causes display of the i^{th} contour. Numbers may be inserted into the mask register by the command nP (Put into mask register). Thus, a "1P" causes display of the $\emptyset^{th}$ contour, a "2P" causes display of the first contour, a "4P" causes display of the second contour and a "7P" causes display of the first three ($\emptyset^{th}$ through 2^{nd}) contours. The command :P causes display of all the contours. When a contour is displayed, the value of the threshold for that contour is also displayed in the array at the top of the screen, in a position corresponding to the position of its bit in the mask register. There is no need to elaborate much more about this system, as one gets the hang of it quickly after a few moments of use. Other commands affecting the mask register are: nI (IOR), inclusive OR n to the mask register; nF (oFf), ANDCA n to the mask register, and O (Onward) and B (Backward), rotate the mask register once left or once right, respectively.

At this stage, one may wish to reset the thresholds, and reprocess the same image. The image may be reprocessed, without reading a new image by typing the command A (Again). Any operation such as a histogram display for example, may be halted at any time by typing a J (Jump out), and the display may be resumed by typing a D (Display).

The display may be turned off at any time by typing an N (No display) and on again by typing a D. If the display is off, typing

an S (Single display) will display the contents of the display buffer 20_8 times, and then turn off the display again. This feature may be used for photographing the display, by setting the camera on time or bulb. It will always result in uniform exposures, regardless of the length of the display buffer. By the was, nS, where $n \neq \emptyset$, will display the contents of the buffer n times. For hard copy, the command W (Write) will write the contours out on the CALCOMP plotter. The contours which are being displayed at the time will be written, so that contours may be written, as they may be displayed, singly or in groups. The command nW will enlarge the drawing by a factor of n.

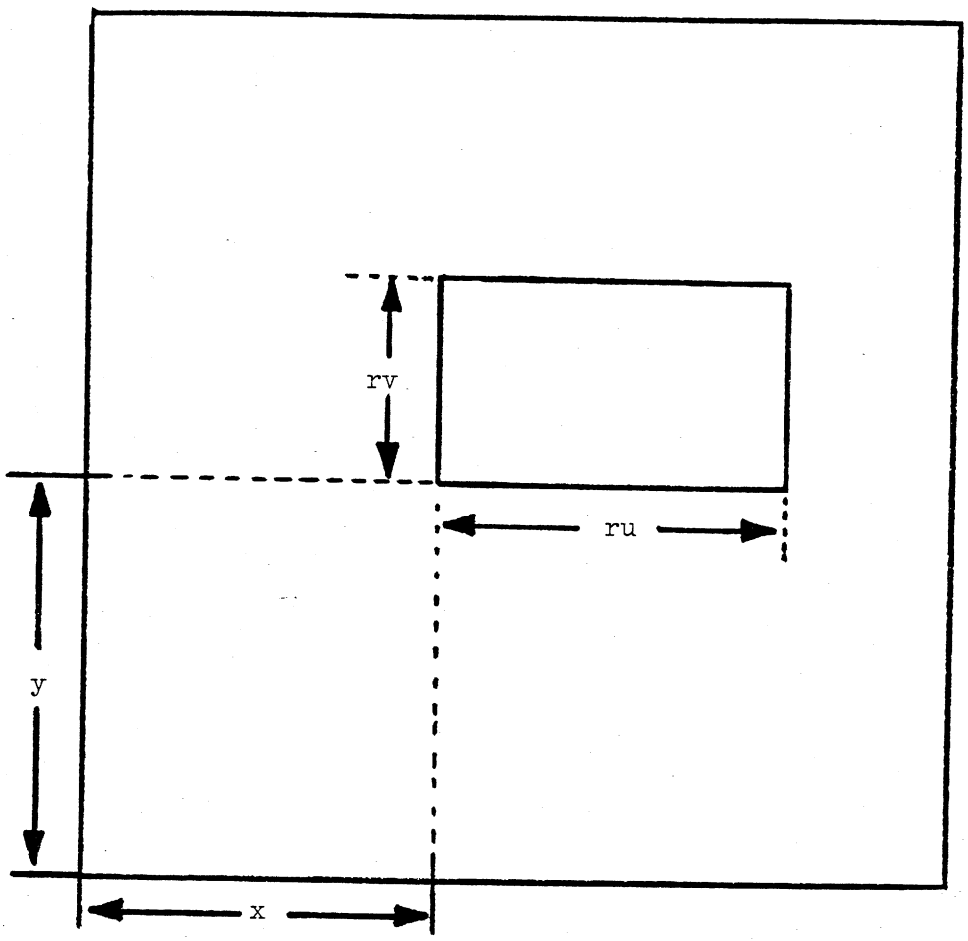
The image is read from the vidisector, of course, but since the vidisector deflection is slaved to the scope deflection, one may think of the image as being read from a certain position on the scope face. This location is specified by four numbers (see figure 1). x and y give the coordinates of the lower left-hand corner of the rectangular area to be read, u and v give the x and y-dimensions of the image array respectively, and r gives the courseness of the scan; that is, the number of scope units between points. x,y, and r may be changed by the commands nX, nY, and nR. In the current version of the program, version 3Ø, u and v may not be changed, but are fixed at u=v=140. In a later version of the program, the commands nU and nV will be added to change u and v, which will involve some dynamic storage allocation.

Typing a Q (Query) causes two vertical and two horizontal lines to appear, the intersection of which indicates the area specified by x,y,u,v, and r, projected onto the contours already being displayed. By watching these lines as x,y, and r are varied, a region of the area under display may be selected for finer inspection. The lines may be turned off by typing another Q.

The contour tracing routines normally suppress contours whose perimeter is below a certain length, to suppress contours caused by noise. This length is initially set at 20_8, but may be changed by typing nG (Gronk all contours less than n). The command G alone (or ØG) will result in the display of all contours present, but this is not advised, as there are normally a large number of very small contours present which are caused solely by vidisector noise.

Typing an M returns control to Macdmp, and typing a T sends control to ddT.

Figure 1.



V. Alphabetical Command List:

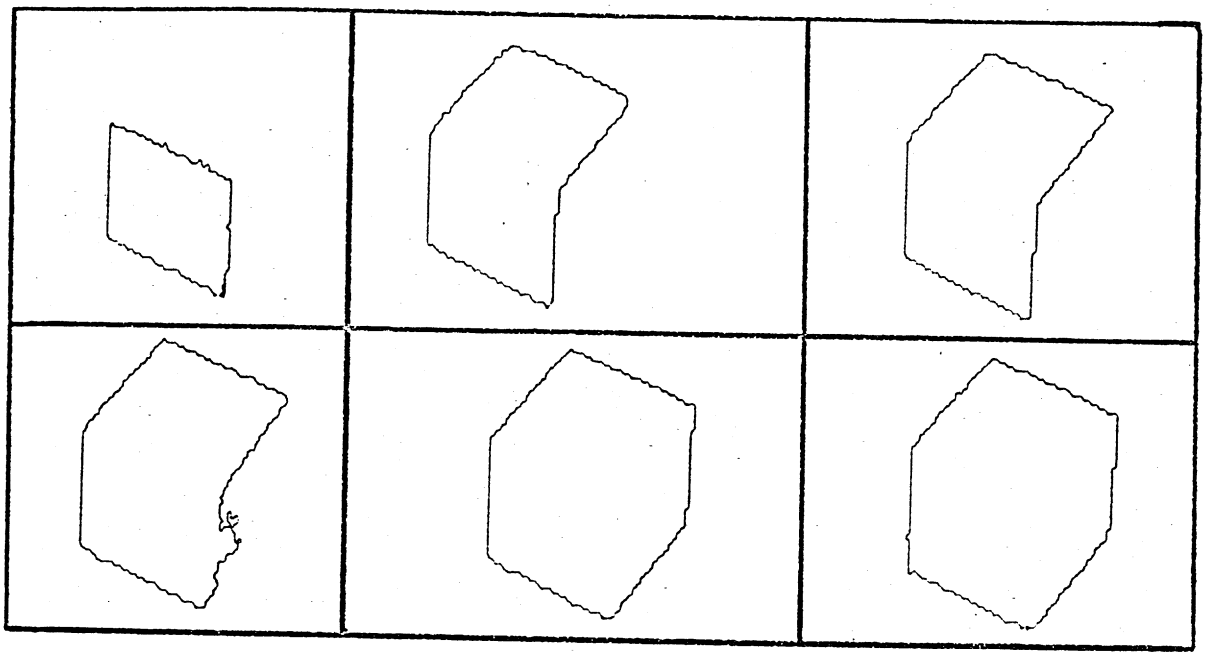
Com.	Mnemonic	Operation
A	Again	Retrace contours without reading a new image.
B	Backwards	Display the previous contour (i.e. rotate the mask right).
C	Contours	Read an image and trace the contours.
D	Display	Turn on the display.
nE	Enter	Read an upper and lower bound from the switches and enter n thresholds between them.
nF	ofF	Turn off the contours indicated by n.
nG	Gronk	Eliminate contours smaller than n.
H	Histogram	Plot a histogram.
nI	IOR	Turn on contours indicated by n.
J	Jump out	Interrupt whatever doing and go to wait state.
nK	k	Enter k, the number of contours to be plotted from the table.
n,mL	Load	Load value m as contour threshold n.
M	MACDMP	Go to MACDMP.

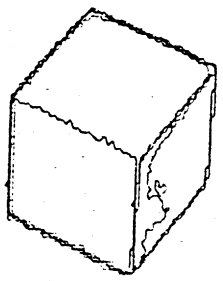
N	No display	Turn off the display.
O	Onward	Display the next contour (i.e. rotate the mask left).
nP	Put	Display contours according to n.
Q	Query	Turn on (or off) lines showing position of next image scan.
nR	Raster	Set the raster spacing to n.
S	Single display	Display briefly for photography.
T	DDT	Go to DDT.
nU nV	Reserved for future expansion.	
nW	Write	Plot contours on CALCOMP plotter, magnified by n.
nX	x	Set x to n.
nY	y	Set y to n.

VI. Examples of Output:

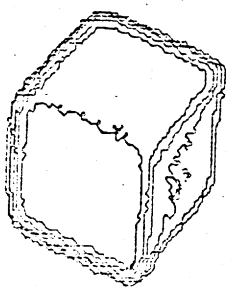
The following were written by the W command:

Single Contours:





Superimposed



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