148

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CNTOUR

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## I. Introduction

The CNTOUR program plots an intensity relief map of an image which is read from tape, disc, or from either vidisector camera. It is used to examine vidisector images. It may also 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. The program is available both in a time sharing and a non time sharing version.

## 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. An up to date copy of the time sharing version will always be kept on tape IMAGE 2, in the drawer labeled KRAKAUER. It will be found filed under the name CNTOUR nDMP, where n is the latest version number (currently 21). As of this writing, the non TS version has not been run in many months. Turn on the vidisector power and 2 or 3 sunguns, and, for the old vidisector, turn off the fluorescent room lights to reduce noise. Set the vidisector focus to approximately the correst

distance, and adjust the lens aperture. For the old vidisector, 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 GO$G. ($= ALT. MODE). Select the vidisector desired by typing 0< for the new vidisector (TV-C) or -1< for the old vidisector (TV-B). The new videsector is initially selected. Steps 3 and 4 may be skipped, but will very probably result in better contours.

3. Type an H to obtain a histogram. In TS, the program will type DISPLAY BUSY if it is.

4. Type |E (CONTROL E).

5. Type C to plot the contours. When this processing is completed, an * is typed. To turn on the display, type D. To turn it off, type N, and to de-assign it, type |N.

6. To see the contours one at a time, type 1P, then 0 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 recognized, 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 recognize, 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.

When using the old vidisector, typing a |F causes transfer to a focus routine. Vidisector readings are taken along a short horizontal line, whose position is indicated by a letter R (for "Read") displayed on the scope. A plot of the values read is also shown. The position of the line and density of the points can be adjusted from the small pot box.

The user must begin my supplying a list of thresholds at which he wants contours plotted. This list may contain up to 36 entries, numbered 1 through 36. A number k specifies the total number of contours to be plotted, so that a contour will be plotted for list entry 1 thru list entry k. 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, $k'=\max(n,k)$. k may also be set directly by the command nK. The command mL is equivalent to k+1,mL.

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 console 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 $R-((R-L)/(n-1))i$, $(0 \leq i \leq n-1)$, where L and 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 histogram of light intensities may be plotted, by typing the command H (Histogram). The result will be a graph whose x-axis is minus the log of the values read from the vidisector, and whose y-axis gives the number of points in the image for which that particular value was read. Note that higher numbers indicate brighter points, so that on the x-axis, brightness increases to the right. The number of times the value 0 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. 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 10 (decimal) units. Just to the right of this line is a two digit number indicating the percentage of points above the dark cutoff. Two vertical lines indicate the values in 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 |H plots a histogram just as H does, except the values are taken from a picture in the memory, rather than from the vidisector. In order to use |H, a picture must have been previously read by the C or |C commands (see below).

The command |E is the same as E, except that the upper and lower bounds are not taken from the testword switches. Rather, the highest and lowest values obtained in the last histogram are used. H or |H must be run before |E.

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. An * will be typed 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. 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 36-i of the mask register causes display of the ith contour. Numbers may be inserted into the mask register by the command nP (Put into mask register). Thus, a "1P" causes display of the first contour, a "2P" causes display of the second contour, a "4P" causes display of the third contour, and a "7P" causes display of the first three contours together. 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.

The command n|Cn1 n2(car. ret.) causes a picture to be read from tape n, file names n1 n2, instead of directly from the vidisector. If n is less than or equal to 0, disk |n| is specified. If an error is made while typing the file names, type rubout and restart the file names. If the argument n is omitted, the last tape used will be assumed. Similarly, if a carriage return is typed immediatly after the |C, the last file names typed are used. The contours are then plotted as for the C command.

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 (octal) times, and then turn off the display again. This feature, currently available in the non-time sharing version only, is 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 way, nS, where n is not 0, 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.

When the image is read from a vidisector, the vidisector must be first selected by typing the command n<, where n is -1 or 0. -1 specifies the old vidisector (TV-B), 0 the new (TV-C).

The location of the image read is given by four numbers, set by four commands. nX and nY set the x and y coordinates of the lower left-hand point of the rectangular area to be read, and n|X and n|Y set the coordinates of the upper right-hand corner. nR sets the courseness of the scan; that is, the number of units between points. These numbers are

taken as being in the coordinates of the vidisector currently selected.

The command nU adds n to both the lower and the upper x coordinates, and nV does the same for the y coordinates. This allows a shifting of the picture region without a change in its area.

Typing a Q (Query) causes two vertical and two horizontal lines to appear, the intersection of which indicates the area specified by X, Y, |X, |Y, and R, projected onto the contours already being displayed. By watching these lines as these numbers 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.

Typing |D causes a description of the image on the tape last read to be typed out. The high and low x and y points and the x and y densities are given in both old and new vidisector coordinates.

The contour tracing routines normally suppress contours whose perimeter is below a certain length, to supress contours caused by noise. This length is initally set at 20 (octal), but may be changed by typing nG (Gronk all contours less than n). The command G alone (or 0G) 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.

In the non-time sharing version, typing an M returns control to Macdump, and typing a T sends control to ddT. In the TS version, typing a

form feed causes a form feed to be typed back in order to clear the screen on the GE consoles.

## 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. |
| n\|Cn1 n2 | Contours | Read an image from tape and trace the contours. |
| D | Display | Turn on the display. |
| \|D | Describe | Describe the picture on tape or disc which was last read. |
| nE | Enter | Read an upper and lower bound from the switches and enter n thresholds between them. |

| | | |
|---|---|---|
| n\|E | Enter | Enter n thresholds between the highest and lowest values read. |
| nF | ofF | Turn off the contours indicated by n |
| \|F | Focus | Transfer to focus routine. |
| nG | Gronk | Eliminate contours smaller than n. |
| H | Histogram | Plot a histogram from the vidisector. |
| \|H | Histogram | Plot a histogram from the image in core. |
| nI | IOR | Turn on the 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 the value m as contour threshold number n. |
| M | Macdmp | Go to MACDMP (non TS only). |
| N | No display | Flush display (TS only) |

| | | |
|---|---|---|
| \|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 to be read. |
| nR | Raster | Set the raster spacing to n. |
| S | Single display | Display briefly for photography (non TS only) |
| T | ddT | Go to DDT (non TS only). |
| nU | | Add n to lower and upper x limits. |
| nV | | Add n to lower and upper y limits. |
| nW | Write | Plot contours on CALCOMP plotter, magnified by n. |
| n\|Wn1 n2 | Write | Write out image as file n1 n2 on tape n. |
| nX | x | Set lower x limit to n. |

| | | |
|---|---|---|
| n\|X | x | Set upper x limit to n. |
| nY | y | Set lower y limit to n. |
| n\|Y | y | Set upper y limit to n. |
| n< | | If n=1, set to use old subroutine. If n=0, set to use new subroutine. |

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