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COMPUTING

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AN EYE ON THE COMPUTER

Reviews: MicroSight, OMNIS, Epson Utility, Spellbinder

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An Eye for the Computer?

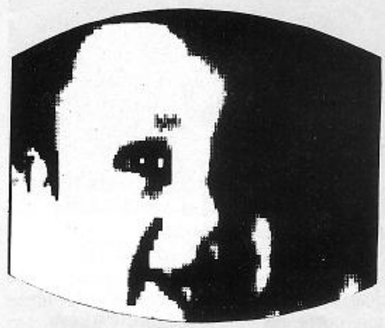
Digithurst's Microsight imaging system

by Pradeep Luther

Have you ever wished you could display on your computer the kind of fancy pictures that dealers use to show off high-resolution displays? Well, if you own a Sirius or an Apricot, not only is this possible – but a whole new world of image analysis and manipulation is opened for you.

Microsight 1 is an all-you-need package from Digithurst for capturing images from a TV camera. The total cost of £900 includes an interface box, a CCTV camera, all cables, driver programs (and much more software, all written in fast assembler) and even a small tripod for the camera.

About the author: Pradeep Luther works in the Biophysics Section at Imperial College. He uses the electron microscope to study the 3-dimensional structure of vertebrate muscle, especially in fish and frogs. Because the molecular structure of these muscles is regular, the image can be enhanced by several techniques. In his early research, he used laser-based optical methods. He was introduced to more powerful computer methods in a collaborative computing project in Cambridge on the 3-dimensional reconstruction of biological materials. While waiting for 2 years for an in-house VAX computer (the *de facto* computer for research), he has been using a Sirius to develop image-analysis programs.



Microsight runs under MS-DOS and requires 256KB memory. It's set up by connecting a cable from the interface box to the control port of the computer (that's a multi-way PCB slot inside, accessed by removing the cover of the system unit – we have in preparation a Workshop giving full details of this little-used and poorly-documented facility).

The video camera is plugged into the interface and a monochrome monitor (which is not part of the package, and which will cost you something between £100 and £250 at best).

Using the disk supplied, you load and run the program VISION; the screen will

Figure 1: Vision display

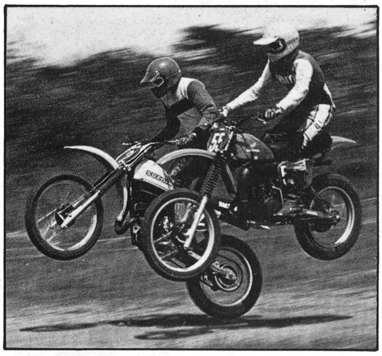


Figure 2: Photograph

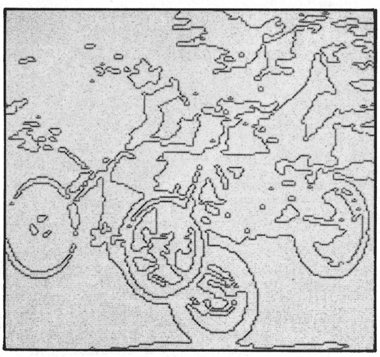
clear with the bottom line displaying options corresponding to the function keys.

Working with Microsight

The TV camera can now be set up by pointing to a (well-lit) picture or object with the monitor being used for focussing and positioning. When you have a clear picture, selecting the GREY option key will present a new function-key menu: press REFRESH and the bottom lime displays 'Reading camera...'. After five seconds the image starts appearing on the computer's screen, strip by strip from the right.

Figure 1 is an example photographed from a Sirius screen. The original is in Figure 2.

Figure 3: Boundary



And that's basically how an image is captured: the TV signal is digitised by the interface box and a representation is put on to the display. Of course there's much more to it: the hierarchy of menus is provided is shown in Figure 4. From the main menu at the top, the arrows point to the sub-menus – the REFRESH function is part of the GREY sub-menu.

REFRESH overwrites any previous image, so the camera lens aperture and lighting can be adjusted to improve the image before you stick with it. To reduce the effects of electrical noise caused by the video signal interface, the MERGE function can input a new image which is recursively averaged with the previous image.

The image is digitised to a resolution of 254 x 256 pixels ('picture elements', effectively defined as the possible dot positions which can be illuminated or not to build up a picture). Each pixel can be set to any one of 256 levels of grey. Since a pixel on the computer's screen can be on or off (which means two 'grey' levels), groups of 3 x 2 screen pixels are employed to represent seven grey levels in the Microsight image as shown in Figure 5.

Because of the way this grouping fits on the Sirius and Apricot screen, which has a maximum resolution of 800 x 400 pixels, the full 26 x 256 image which Microsight can in theory generate can't in practice be displayed: you get only 256 x 190. (With 256 pixels horizontally each taking three

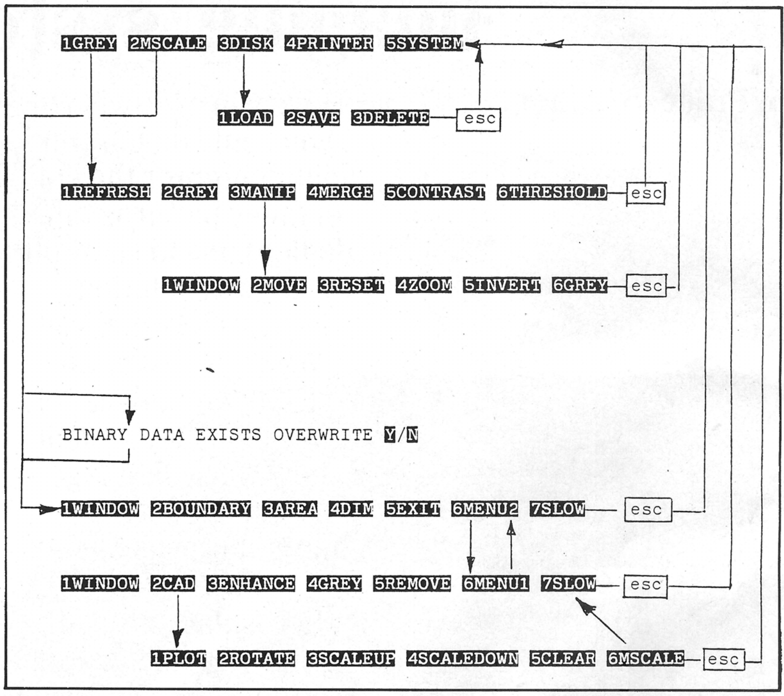


Figure 4: Command overview

Figure 6: Zoomed from Vision

Figure 8: Printed with standard characters to simulate grey levels

Microscale

A previous version of VISION had two more functions within the MANIP option: BOUNDARY displayed only the edges of features above the selected grey level (Figure 3), BINARY displayed the image only in two grey-levels above and below the threshold value.

These are now incorporated in the Microscale option (MSCALE in the main menu), a program that has to be purchased separately at £495. Its main use is to measure dimensions and calculate the areas and perimeters of objects within the image. Detailed description of the Microscale features would require an article to itself – suffice to say that some people would obtain the Microsight package just for the purpose of using Microscale, as say in morphometry, which involves many such measurements in aerial photographs, over microscope images of tissues, etc.

Some applications

This review is based on experience with the system linked to a Sirius which we've been using in the Physics Department at Imperial College for over a year.

○ **PRINTER OUTPUT** As mentioned, Vision has a screen-dump option; but the copy has only seven grey levels as on the screen. That's often inadequate for a computer-generated image, and we have improved it by using a printer matrix of 6 x 4 points to represent an image pixel instead of Vision's 3 x 2.

This way up to 25 grey levels are possible, and you get a print double the size of that produced by Vision...though this does take 15 minutes! As an example of the improvement possible, Figure 7 shows an enhanced grey scale printer output from an Epson printer: compare this with the zoomed image in Figure 6 from Vision, photographed from the screen.

Finally, some (older) readers may recall the fun line-printed *Mona Lisas* that used to be produced on mainframe computers. The print here uses standard character symbols to simulate 11 grey levels in the same way; in this type of illustration, more grey levels are possible by overprinting of characters.

○ **IMAGE ENHANCEMENT** Considerable manipulation of an image can be achieved by comparing the eight pixels surrounding a central one over the whole image. To 'smooth' a picture, for example, you can add twice the value of a central pixel and the values of the eight neighbouring pixels: divide by 10: and replace the result in the centre. This is multiplication with the matrix shown in Figure 9.

1	1	1
1	2	1
1	1	1

Figure 9: 3 x 3 matrix for smoothing an image

−1	−1	−1
−1	9	−1
−1	−1	−1

Figure 10: 3 x 3 matrix for edge-enhancement.

Our cover shows a smoothed image displayed on a colour monitor (using the Io Research Pluto board). In this case each grey level is shown in one of eight colours.

Figure 11 is an example of edge-enhancement. This tends to suppress the slow variations in density as in the background; here the eight neighbours are averaged and then subtracted from the centre point, which is equivalent to multiplying with the matrix in Figure 10. The results of these manipulations are stored back over the raw image area in memory. Then the new image can be displayed using Vision – in fact Vision is a fast graphics alternative for image-type graphics, much faster than GW-Basic or Graphix.

Electron microscopy

At Imperial College our main use of Microsight is for Fourier Transform analysis from electron microscope data. For this we've written programs in compiled Basic and Fortran 77 to calculate the forward transform, calculate the lattice parameters, and allow spatial filtering and inverse transformation. We don't use the camera supplied since the image captured tends to be darker around the edges; we have a Hitachi VK-C2000E solid-state camera, available from Digithurst (about £1000) and some video stores (shop around for a better price).

Figure 5: Grey-level rendition on the Sirius screen. Each image pixel uses 3 x 2 screen pixels; grey levels are simulated by changing the number of lit screen pixels within the 3 x 2 block.

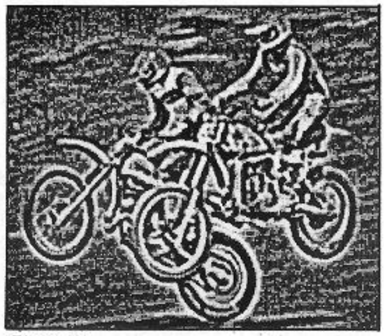


Figure 11

pixels for the grey scale, this gives 256 x 3 = 768 along the line: and the 190 pixels each two pixels deep gives 190 x 2 = 380 vertically. Obviously 768 x 380 can be accommodated within the computer's 800 x 400 display.)

The raw image in memory is always kept with the 256 grey-level resolution, so a better display facility can show a greater range of density on the image – more on this later. For now, it's worth noting that the centre of the grey scale and the contrast step can be varied to provide the best display on the screen.

The MANIP (manipulate) function key opens up a fun world. Selecting INVERT from the sub-menu almost instantly reverses the displayed image by inverting every pixel on the screen – handy if a negative is used to input the image. (A negative or transparency is preferable to a print because film has a much greater density range.)

In this mode a small cursor appears in the centre of the screen. It can be moved in any direction (in large steps or by pixel-by-pixel) using the numeric keypad.

Selecting WINDOW opens up a small box centred at the cursor, and pressing the plus-sign key enlarged it (the minus sign subsequently reduces it). The ZOOM option now redisplays the part of the image enclosed in the window across the whole screen...though unlike the zoom lens of a camera this involves no increase in resolution, so zooming in on a small window produces a coarse image with unacceptably large pixels as illustrated by Figure 6.

Using the number keypad the image within the window can be moved across the screen and redisplayed. Actually we've found no use for this function, but perhaps an architect could use it to manipulate features across a plan.

More main-menu options

Pressing the Escape key returns you to the main menu. Apart from GREY, the options here are MSCALE (a separate extra-cost program – see the panel); DISK; PRINTER; and SYSTEM.

PRINTER gives an extra hard-copy of the display on Epson-compatible printer. This comes out like Figure 7, 16 x 12 cm in size; it takes about two minutes to print. Unfortunately these prints are never per-

```
10 PRINT: PRINT TAB(20) "SHOWVIS"
20 PRINT: PRINT "Display an area of a Vision image": PRINT
30 DEF FNV(X,Y) = X + Y*256
40 '-- specify start of image segment
50 DEF SEG = &H2000
60 PRINT:INPUT "Coordinates of centre : ", X,Y
70 FOR JY = -7 TO 7
80       FOR JX = -7 TO 7
90          PIXEL = PEEK(FNV( X+JX, Y+JY))
100         PRINT USING "££££"; PIXEL;
110         NEXT : PRINT
120      NEXT: PRINT
130 INPUT "Again ? (Y/N) ",Q$
140 IF Q$ = "N" OR Q$ = "n" THEN END ELSE GOTO 60
```

Listing 1

```
10 PRINT:PRINT TAB(20)  "INVERT"
20 PRINT:PRINT "Reverse a Vision image "
30 DEFINT A-Z
40 DEF FNV(X%,Y%) = X% + Y%*256
50 DEF SEG = &H2000
60 PRINT:PRINT "Processing line no : ";
70 FOR JY = 0 TO 254: PRINT JY;
80       FOR JX = 2 TO 255      'jx=0 & 1 used by Vision
90          PIXEL = PEEK(FNV(JX,JY))
100         POKE FNV(JX,JY), 255-PIXEL
120         NEXT
130      NEXT
140 END
```

Listing 2

Figure 7: Enhanced grey-scale Epson print

fect because the line feed tends to vary slightly, which is why most of the illustrations here were photographed from the screen.

DISK saves or loads the raw image (not the screen display) on a disk in Drive B. It's fast – the whole image, which is around 64KB in size, is saved or loaded within a few seconds. As with the rest of the package, there are good error messages and easy recover procedures. 'Disk full' is the most likely error: a single-sided Sirius disk has a respectable 600KB capacity but can hold only nine Microsight images.

Beyond Vision

For most users the 'exit to System' option would be the end of interaction with this package. For us it's just the start. The raw image is still sitting happily in RAM starting at segment 2000 hex (a disk-saved image could also be used but accessing RAM directly is much faster); a user program can now access the data and manipulate it in any way.

Basic is well suited for this purpose. Two simple examples are given in the listings; in each case, the start of the image segment is specified first with the statement DEF SEG=&H2000 and subsequent PEEKs and POKEs are offset relative to this address.

Listing 1 displays a block of memory 15 x 15 square centred at a user-defined origin. For a well-digitised image, there should be a good spread of densities from 0 to 255: poor scanning would result in a narrow range of values, say between 200-225.

Listing 2 is a simple example of how this data could be manipulated. It reverses the image by poking into a pixel location the number 255 minus the value of the real pixel. To display the new image in this case, the following procedure (which we discovered by accident) is used: run Vision, select 1GREY, then 3MANIP and then 6GREY. Unlike the INVERT function of Vision, the reversed image can now be saved to disk. (Because of the large amount of data it's essential to use the Basic compiler to speed up the programs.)

Competition

Comparable commercially-available packages cost more than the Microsight; a salesman from one such supplier who saw our system was much impressed – and was completely floored to learn that Microsight includes a complete listing of the source code.

Prior to Digithurst's arrival, the only video input system we knew of was the Digisector board for the Apple. This only digitises to 128 x 128 x 6, though. There are cheaper 'frame grabbers' around, like SNAP for the BBC Model B which sells for £130. But this produces only two grey levels, not 256 as in Microsight 1, and software has to be used to improve the grey level rendition.

Anyhow, there are two real benefits in using the Sirius or Apricot – large memory (much needed for image analysis programming) and the availability of the fast 8087 numeric processor (for programs written in languages like Microsoft Fortran).

The numeric processor is not actually used by Vision, but would make little difference to its speed since Vision mainly users integers smaller than 225 bytes in size. The 8087, which costs about £500 (on a board) from ACT for the Sirius and some £200 for the Apricot, comes into its own with a number-crunching program like our Fast Fourier Transform in Fortran; there is a fivefold gain in speed over compiled Basic (which does not use the 8087).

Last words

For the money, Microsight represents an impressive package – everything you need for digitising an image and several facilities for manipulating it. Given the impressive level of user-friendliness and error-handling, it must represent excellent value. Ω

UNDER REVIEW:	Microsight 1
DESCRIPTION:	Image digitising system, including CCTV camera, interface and software
SUPPLIER:	Digithurst Ltd Leaden Hill Royston Herts SG8 5QH
TELEPHONE:	0223 208926
UK PRICE:	£900, plus £495 for Micro-scale option
CONFIGURATION:	Sirius with MS-DOS 1.25 and 256KB; or Apricot with MS-DOS 2.11 and 256KB
CONCLUSION:	**Impressive and inexpensive, especially by comparison with large-computer image analysis packages**