STARS OF SKY AND SCREEN

The latest television spectacular features real heavenly bodies. It's an educational channel confined to a few astronomical research centers, but the network will spread.

BY DIETRICK E. THOMSEN

"And now, ladies and gentlemen, for the first time on any television screen, in living color, a real star—Betelguese." It sounds a bit corny, but actually it has been done, and it's not the Miss America contest, but the latest in astronomical observing techniques as conducted at Kitt Peak National Observatory. You can now do astronomical observing by looking at a television screen and telling a computer what information you want from the image, and the computer fishes it up and displays it for you.

The developers of this Interactive Picture Processing System regard it as the culmination of recent trends in astronomical image processing, and in effect it represents a completion of the circle, bringing astronomical data processing back to its original processor, the human visual cortex. This, in the view of Donald C. Wells, one of the developers of the apparatus, is its chief advantage.

Originally, the human eye and brain were the only means of registering and assessing astronomical information. Storage was by written records and sketches. Then photography was invented, allowing an image to be captured for later study and measurement. But still, astronomers were getting cold feet and cold noses in observatory domes.

Now they can sit in a warm room and watch television. It comes about because much of current observation is being recorded by means of optoelectronic devices that convert light to electrical pulses. The devices are used because they can do things simple photography—let alone an eye at the telescope—can't, particularly the enhancement of faint images and compensation for atmospheric distortion.

The images recorded by the optoelectronic devices are stored in digital form on magnetic memory tapes. Astronomers now have to address the problem of processing the stored data to get particular information out. Obviously, with a computer—but what method is best for what purpose? The topic was discussed at the conference on Imaging in Astronomy held at Harvard University at the end of June.

Tom McCord of the Massachusetts Institute of Technology sees a need for three kinds of systems. The first is a batch system, a programmed machine into which cards can be dumped, and in which the same thing happens to hundreds of them. The operator goes away and comes back later for the printout. The second is an interactive system like the one at Kitt Peak. Here the operator observes the work in process and instructs the machine. This is for situations where "you don't know quite what you want to do or how it will come out." McCord's third category is a small portable hardware system to connect directly to telescopes in remote locations.

The systems must be easy for astronomers without computer training to use, and, as they are developed, library procedures for classifying and maintaining the memory materials must be developed. It's housekeeping, but necessary, McCord stresses: "People never seem to worry about library procedures until they're buried in tape." Also necessary is an inexpensive machine to make permanent copies of the transient images that appear on the screens.

But the stars of such systems will be the interactive set-ups, and not merely because of color and glamour. As Wells points out: ". . . often the computer analysis of raster data founders upon the problem that people can *see* pictures, but computers cannot. Humans tend to take visualized pattern recognition capability for granted—we were born with it. But computer programmers are painfully aware of the difficulties of building pattern recognition into programs. . . ."

So the interactive systems display the images being processed on a television screen, and allow the operator to direct the computer step by step. Both Wells and McCord tend to feel that batch processing is best in coordination with interactive processing. One uses the interactive processing to determine what information is needed and how to get it from selected examples of a class of similar pictures and then sets up the batch processor to do exactly that. McCord seems more positive about batch processing, possibly because he belongs to the Planetary Astronomy Laboratory of MIT's Department of Earth and Planetary Sciences, and one of the projects they are engaged in is geologic mapping of the moon. (Differences in the color of the surface indicate what minerals are there.) This kind of activity generates large numbers of pictures from which essentially the same information is to be extracted. Batch processing in this case saves a lot of time.

The interactive processors do a lot of things. They can show an image in real color, both full-color views and shots with a filter in the telescope. They can show pseudocolor images in which contours of a certain quality—say, brightness or density—are exhibited by assigning a different color to each range of value (see cover). They can divide one image by another, giving, for example, the ratio of an object's brightness in blue light to its brightness in red. They are fitted with cursors, a kind of pointer or slicer, that can be moved to a desired place on the image. The computer is then instructed to show a profile or cross section of a particular datum along the cursor.

All of this is done under the control of the human operator, and according to the needs, desires, intuition and inspirations of the operator's mind. It combines human sense with a computer's memory and attention to detail. And it is pleasant for beleaguered, Thurberized homunculi to realize that sometimes people control computers. Wells is, in fact, rather toplofty about it: ". . . the scientist should guide the course of the manipulations to be performed by the computer, aiding it with the superior picture processing 'hardware' of his visual cortex."

So far this kind of installation is not widespread. McCord mentions only Kitt Peak, his own MIT and Kitt Peak's sister observatory, Cerro Tololo in Chile, as centers of the activity. MIT has been doing batch processing for four or five years, and interactive processing for about a year. The portable, hang-on-the-telescope hardware he finds desirable remains to be developed.

Surely a tool as versatile as this will spread. □

Betelgeuse, the red supergiant star in the constellation Orion, photographed by the 4-meter telescope at Kitt Peak National Observatory. The picture is enhanced by a new speckle interferometry technique, then further enhanced by Kitt Peak's Interacting Picture Processing System in pseudocolor to accentuate suspected areas of convection on the surface of the star. Betelgeuse is the first star other than our sun on which surface features have been distinguished. It is so large its volume could contain 40 million of our suns; its diameter could encompass our Solar System out to the orbit of Mars.