A DATA ANALYSIS FACILITY FOR THE FAINT OBJECT CAMERA

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ABSTRACT

The Faint Object Camera is the ESA instrument to be flown in the Space Telescope. A modern facility is being established to provide the software required to analyse the FOC data. This paper describes the basic hardware and software characteristics of the ESA facility.

INTRODUCTION

The Space Telescope is one of the most ambitious projects in space astronomy presently planned. This 2.4 metre telescope with a performance close to the theoretical diffraction limit will undoubtedly provide great impetus to astronomical research for the rest of this century. A description of the Space Telescope and its astronomical applications can be found in Reference 1.

The European Space Agency's contribution to this programme includes amongst others the Faint Object Camera whose aim is to fully exploit the spatial resolution capability of the ST over a broad wavelength range on the very faintest objects detectable. A full description of the FOC and its scientific aims can be found in Reference 2. In brief the FOC consists of two optical paths each of which produces a magnified image on its own independent, albeit identical, two dimensional photon counting detector.

DATA ANALYSIS REQUIRED

FOC image data are typically in the form of 512 x 512 x 16 bit images or 1024 x 512 x 8 bit images, and these in turn are of three different types:-

- sky pictures
- objective prisms pictures
- slit spectrometer pictures.

In all three, geometric distortion introduced by the Space Telescope and the FOC will be present. Typically pincushion distortion will be of the

C. Jaschek and W. Heintz (eds.), Automated Data Retrieval in Astronomy, 127–129.

order of 1% and S-distortion will be around 5%. So, at the edges of the field of view, the pictures will be distorted by a few tens of picture elements (pixels).

Each pixel contains a number, called a count, which is related to the number of photons incident on the corresponding part of the detector faceplate. This count, however, may be non-linear, especially at high incident photon rates (i.e. at high count rates).

Ground and in-orbit calibration of the instrument will permit the count values to be corrected to within about 1%. Pixel to pixel accuracy will be achieved using ground based results, but accurate absolute calibration will have to await in-orbit observations of reference celestial objects.

The routine, geometric and photometric correction of FOC images will be carried out with software produced as part of the FOC development. This software package will correct for the known imperfections of the FOC and will produce images calibrated to a linear amplitude on a rectangular grid.

In addition to the standard processing described above the astronomer may want to carry out a number of other corrections to the data which however depend on the precise nature of the scientific information being sought. These include for example pixel overflow correction, particle events correction, removal of internal reflection "ghosts" and removal of known blemishes and fiducial marks. Special software will also be required for the various non-imaging modes of the FOC. In the spectroscopic mode there will be a requirement for transformation to wavelength scale, correction of the curvature of the spectrum and precise determination of the position of the slit in the sky. In the objective prism mode a wavelength scale transformation and location of the sources in the sky will be needed.

After completing the tasks described above the astronomer is only at the beginning of the process of scientifically analysing his data, and he may wish to perform a number of additional operations on his data, for example, he may wish to fit model curves to surface brightness profiles in order to determine standard parameters such as "stellar" nucleus size, disk scale length, etc.

To support these routine and non-routine corrections and the task of scientific data analysis operations a basic set of general purpose software will be required. This will include modules that will allow operations to be carried out such as, scaling; panning; blinking; rotation; translation; zooming; adding, subtracting, multiplying, and dividing images by other images; overlaying images; displaying images with different colour schemes etc.

THE ESA FACILITY

In order to allow development of the software described above ESA is establishing a dedicated facility for the FOC in ESTEC. The hardware is based on a VAX 11/780 computer with 1.5 M bytes of memory, two 67 M bytes disk drives, two magnetic tape units (800/1600 bpi), a line printer, two VT100 terminals, a floating point accelerator facility and the FORTRAN IV plus compiler. In addition a colour image display system, the Sigma ARGS, a quick-look hard copy facility and a TV-type camera facility for digitizing photographs are being purchased. A contract has been placed for the development of the system software and major utility programmes which will provide the "skeleton" for the scientific applications programmes.

The FOC Image Processing System (FIPS) software environment provides a user interface designed for the astronomer and a set of system software interfaces for the development and integration of application software. The components that are provided to support both the applications programmer and the end-user are as follows:-

- a systems library of primitive routines for access to image data, primitive routines for access to user supplied parameters and for access to the ARGS.
- a user support package which includes centralized dialogue, command interpretation, also including high level language interpretation.
- an image processing package to provide the basic image processing functions.

FIPS runs under the supervision of the VAX/VMS operating system. The structure is that of multi-processes, whereby each (sub)process communicates with a central control process called gateway which conducts the dialogue with the user. Each user will get his own copy of gateway. User input is decoded and placed in a fixed data array where it can be easily accessed by the gateway process. Gateway is responsible for calling the desired processes into core and transmitting the parameters to the created process. Furthermore gateway accepts, validates and maintains user identification which is used for identification of and protection against corruption of images. Via the gateway process it is possible for the user to move his attention from one programme to another while these run simultaneously (multi-processing). However, the sequence in which programmes can be served with user input is determined by the programmes rather than the user. Gateway also produces a comprehensive log of all dialogue for the user, which is automatically printed at the termination of the session.

The FIPS development is expected to be completed towards the middle of 1982 at which time it will be available to any interested astronomer.

REFERENCES

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2. Macchetto, F., van de Hulst, H.C., di Serego Alighieri, S., and Perryman, M.A.C., The Faint Object Camera for the Space Telescope, ESA, SP-1028, October 1980.