Data-flow for the ESO Imaging Survey (EIS)

R. N. Hook[1], L. N. da Costa, W. Freudling[1] and A. Wicenec

European Southern Observatory, Karl Schwarzschild Str-2, D-85748,
Garching, Germany, e-mail: rhook@eso.org, ldacosta@eso.org,
wfreudli@eso.org, awicenec@eso.org

E. Bertin

Institute d'Astrophysique de Paris, 98bis Boulevard Arago, 75014 Paris,
France, e-mail: bertin@iap.fr

E. Deul

Sterrewacht Leiden, P.O. Box 9513, 2300 RA Leiden, The Netherlands,
e-mail: Erik.Deul@strw.LeidenUniv.nl

M. Nonino

Osservatorio Astronomico di Trieste, Via G.B. Tiepolo 11, I-34131,
Trieste, Italy, e-mail: nonino@ts.astro.it

Abstract. The ESO Imaging Survey (EIS) uses the ESO New Technology Telescope (NTT) and the EMMI camera to image several square degrees of sky to moderate depth through B,V and I filters. In later parts of the survey smaller areas will be imaged more deeply in a wider selection of spectral bands. The primary aim of the project is to provide a statistically useful selection of interesting faint objects as targets for the ESO Very Large Telescope (VLT) which will see first light in 1998. This paper gives an overview of the data flow for this project, some comments on the methodology employed and examples of the initial data. Some techniques for attacking the generic problem of mosaicing inhomogeneous overlapping images and extracting catalogues from the resulting coadded frames are described. More information can be found at the EIS Web page: http://www.eso.org/eis/.

1. Introduction

During the second half of 1997 and much of 1998 ESO is conducting a deep, multicolour imaging survey using the EMMI camera on the NTT. The ESO Imaging Survey (EIS, Renzini & da Costa 1997), will generate suitable statistical samples for a variety of astronomical applications, ranging from candidate objects at the outer edge of the Solar System all the way to galaxies and quasars

---

[1]Space Telescope — European Coordinating Facility

at extremely high redshift. EIS data should provide a suitable database from which targets can be drawn for observations with the VLT, in its early phase of scientific operation (from the third quarter of 1998 to approximately the end of 2000). EIS has been conceived as a service to the ESO community and all the data will become public immediately after its completion.

In the initial (EIS Wide) phase of the project many exposures are being taken using a stepping pattern on the sky such that each step is about half of the frame size in both X and Y and on average each point is observed twice. This strategy allows accurate astrometric association between frames and gives an overlap pattern which shows clearly on Figure 3.

Figure 1 gives an overview of the data flow of the project starting with the preparation of "observation blocks" which are the basic unit of telescope execution and working through to the preparation and archiving of catalogues from the final coadded images.

2. Overview of Software Development

The data volume of EIS is considerable and requires a fully automated pipeline for both observation planning and execution and subsequent data handling. There were insufficient resources within ESO to develop the complex software system required for EIS starting from scratch. Instead funds were used to employ visitors who had extensive experience from other, similar, projects to adapt software and integrate it into a complete EIS pipeline. This was run on the ESO "Science Archive Research Environment" (a multi-processor Ultra Sparc server) and is acting as a test case for this system.

There were four areas of software re-use (excluding subsequent science software):

- Standard IRAF tools were used for the initial calibration of each input image which were taken from the ESO archive.

- The DENIS (DEep Near IR Survey of the Southern Sky, Epchtein, 1994) data pipeline, was extensively modified for EIS and used to perform photometric and astrometric calibration.

- The SExtractor object detection and classification code (Bertin & Arnouts, 1996) was modified for EIS and integrated into the pipeline. It was used both to find objects during the calibration steps and also to prepare final science catalogues.

- The Drizzle image coaddition software (Hook & Fruchter 1997; Fruchter & Hook 1997), originally developed for HST, was modified to efficiently handle the EIS geometry and create coadded final output images from the many, overlapping, input frames.

A major aim of this software is to handle the generic problem of mosaicing overlapping images with widely varying characteristics and the extraction of information from the resulting inhomogeneous coadded frames.
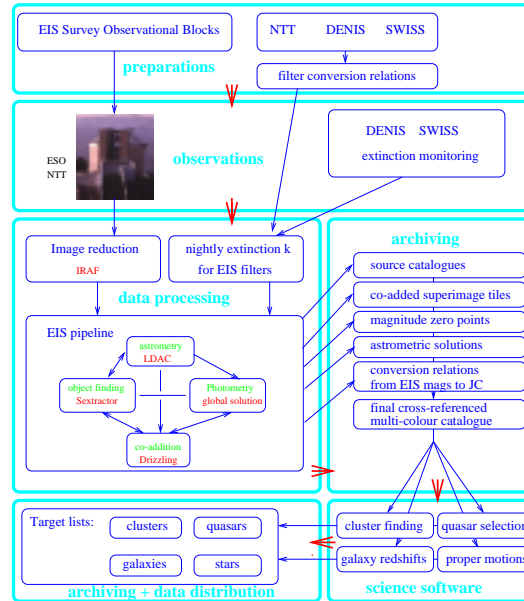
Figure 1.   An overview of the EIS dataflow

3.   Example Data

At the time of writing approximately half of the EIS survey has been completed.
Conditions have not been uniform and hence the resulting coadded images vary
considerably in seeing, transparency and depth. This variation poses many prob-
lem to automatic data analysis, particularly on the coadded images which may
have discontinuities in PSF and noise levels. This problem has been addressed
by creating not just a final data image but also an image with the weight of
each output pixel and another in which the "context" is encoded. The context
is essentially a list of input images which have contributed to a given output
pixel. This allows the PSF and other characteristics of sections of the coadded
image to be reconstructed at each pixel when needed.

Figure 2 gives an example of a subset of an output coadded EIS image.
It covers about 18 arcminutes and is the result of combining about 10 EMMI
images. Figure 3 shows how the weights vary across this image. Image defects
such as dead columns and saturated regions show clearly as does the variation
of weight among the frames.

4.   Future Plans

The primary aim of EIS is to provide data products, both images and derived
catalogues, which will enhance the scientific returns from the forthcoming 8m
telescopes, in particular the ESO VLT. An important secondary aim is to act
as a test-bed for the VLT data flow concept, in particularly the observation
preparation stage and the exploitation of the data within the Science Archive
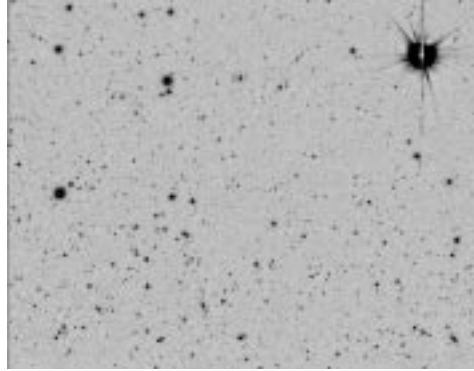Research Environment. The software developed for EIS will act as the basis for

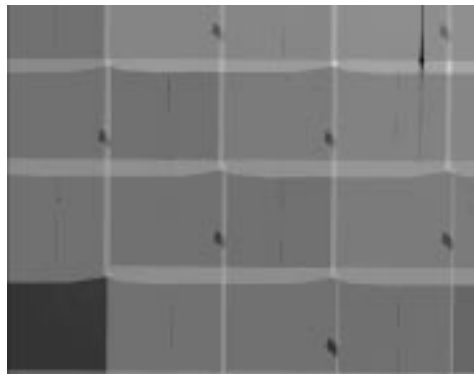Figure 2.   An example of part of a coadded image from EIS Wide.

Figure 3.   The weighting image associated with Figure 2.

a similar imaging survey to be conducted using the ESO 2.2m telescope with a large mosaiced CCD camera and may later also lead into a dedicated imaging survey telescope on Paranal with the ESO VLT.

References

Bertin, E. & Arnouts, S., 1996, Astronomy and Astrophysics Supplement, 117, 393

Epchtein, N., 1994, Astrophysics and Space Science, 217, 3.

Fruchter, A. S. & Hook, R. N., 1997, in Applications of Digital Image Processing XX, ed. A. Tescher, Proc. S.P.I.E. vol. 3164, 120

Hook, R. N. & Fruchter, A. S., 1997, in ASP Conf. Ser., Vol. 125, Astronomical Data Analysis Software and Systems VI, ed. Gareth Hunt & H. E. Payne (San Francisco: ASP), 147

Renzini, A. & da Costa, L. N., 1997, The Messenger, 87, 23