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CIRSI Data Reduction System – CIRDR

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Abstract. We report on our on-going software project *CIRSI Data Reduction System*, which has been developed under the IRAF environment. This is a compact infrared processing and analysis software system for a wide-field infrared camera, the Cambridge Infrared Survey Instrument (CIRSI). It contains four subpackages for quick-look analysis during real-time observing, preprocessing, basic reduction and useful tools. This system can handle a large amount of raw data which can be pre-processed and reduced automatically during real-time observations.

1. CIRSI - Cambridge Infrared Survey Instrument

CIRSI is based on 4 Rockwell HAWAII 1024×1024 detectors. It contains no cold optics other than a cold filter wheel inside a dewar. It operates from 0.8 to 1.8 μm (Z to H band) on non-infrared optimized telescopes, with a planned upgrade for K band operation in 1999. The image scales are dependent on the telescopes to be used (e.g., $0\farcs45$/pixel on the 2.5 m Isaac Newton Telescope (INT) f3.3 Prime and $0\farcs32$/pixel on the 4.2 m William Herschel Telescope f2.8 Prime). A single channel CCD controller is used to multiplex the 16 outputs (4 outputs per chip) into a single pre-amplifier and signal processing data chain. The camera control software, *PIXCEL*, runs under Windows 95 (Beckett et al. 1998). There are two read-out modes from the camera which are Reset-Read-Read Sampling (RRR) and Non-Destructive Read or Sloping Sampling (NDR, see Fig. 1, Fowler & Gatley 1991).

2. CIRDR - CISRI Data Reduction System

2.1. General Description

CIRDR is a data reduction and analysis system for reducing and analysing data obtained from CIRSI. It is written under the IRAF environment. The programming languages which are being used in this system are IRAF-CL, IRAF-SPP (IRAF subset preprocessor language), Fortran and C-shell scripts. In the current version (version 0.0.3), there are four packages (see Fig. 2) which are CQLOOK (CIRSI Quick Look Data Reduction Package) for producing rough

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sky subtracted images from sets of dithered observations during an observation run, CPLINE (CIRSI Pipeline Data Reduction Package) for producing second pass/final-version of sky subtracted images, CIRUTIL (CIRSI General Toolkit Package) and CIRCONTRIB (CIRSI General Contribution Package).

On-line help is available in all active subpackages and sub-subpackages. Two on-line introductory user guides, *CIRSI User Guide* and *CQLOOK User Guide*, are also available.

CQLOOK is the most developed package in this system. It is used for producing rough sky subtracted images from sets of dithered observations during an observation run. Because the observations are in the near-infrared, the strong and variable sky background requires dithering of many short exposures and the recombination of the images with careful sky subtraction to produce deep images.

There are two active subpackages which are for basic preprocessing in order to produce *real astronomical* images (CPREPROC) and for quick (first pass) data reduction to produce rough sky subtracted, dithering-mosaic images (CREDUCT), as well as tasks for the first INT run (CINT1).

2.2. Special Functionality

File Handling System. The file handling system uses a *system-level approach* which is an *object-oriented like infrastructure.* The advantages of this design are that it is simple and portable, as well as that it has a compact structure on a solid foundation. The main functionality is in the first level. Handling files from quadrants and/or chips as well as read-out modes are in the second and third levels. The automatic processing is in the 4th level.

Quick Processing. Quick processing tasks can be used during real time observation, normal data reduction at a telescope, or at a home institute. There are two master programs (CNDRPROC, CRRRPROC) to process data automatically for quick look purposes. They can process data from 1 to 4 chips, 1 to 16 quadrants, one selected chip, or one selected quadrant. There are several display tasks to examine fields and two tasks to check saturation levels. Tasks for pre-processing can get raw data from a *data reservoir* in which raw data are stored. There are two tasks for making a mosaic image (dithering or offset) (see Fig. 3). Both are interactive and semi-automatic.

Calibration. Tasks for making flats are based on all currently available methods which are domeflat, twilight-sky flat, and moving-sky flat. There are at least two tasks for making bad pixel masks. For extra flexibility, users may enter their own parameters for making calibration images and sky images. Furthermore, tasks are also available to automatically *suppress* objects in images and to make second pass sky images.

2.3. Topic of interest

Uniform stripe noise appears in images (Fig. 4a). The current correction methods in the system are based on a linear median filtering method. There are two typical problems occurring in the current algorithms which are ghost stripes

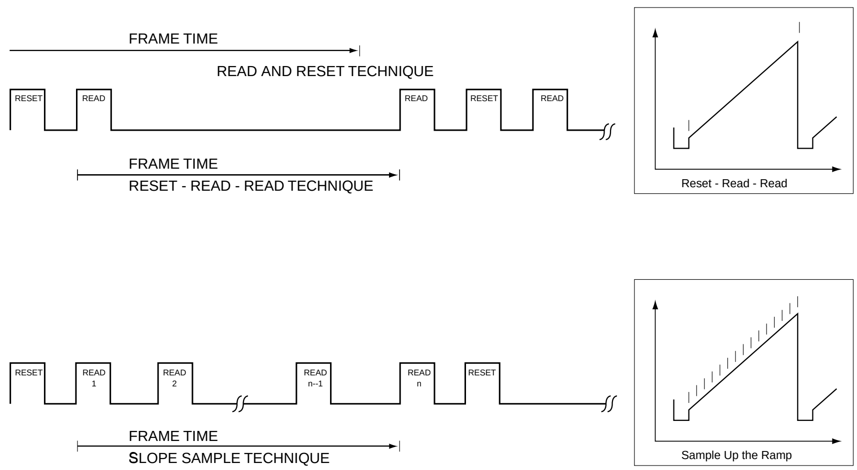

Figure 1. The read-out mode in CIRSI.

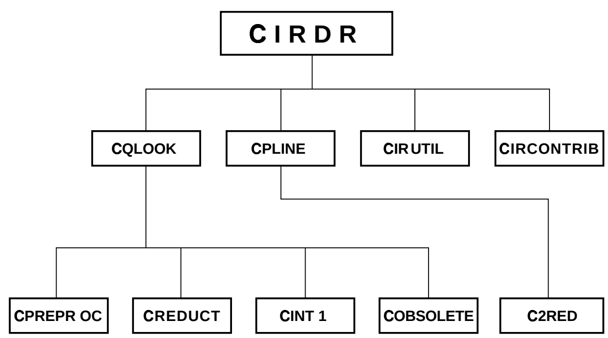

Figure 2. CIRSI Data Reduction System flowchart.

caused by bright objects within images (Fig. 4b) and the size of bright objects are decreased and faint objects are smoothed out (Fig. 4c). An improved method, which can eliminate the above problems, is based on a second pass linear median filtering method (Fig. 4d).

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References

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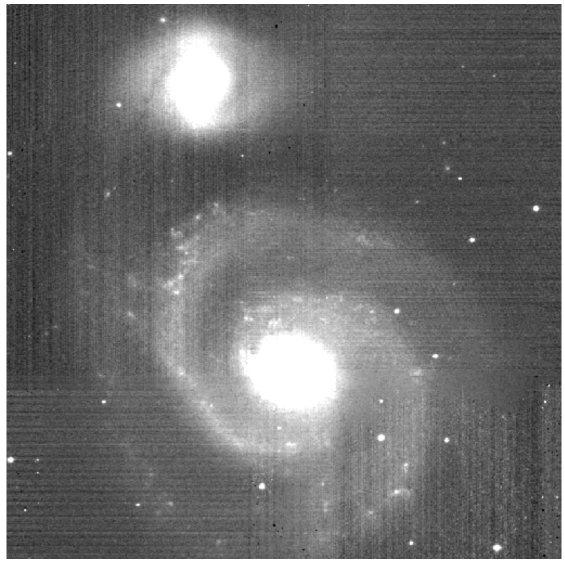

Figure 3. The center field of M51 in the H band. It was obtained during June 1998 CIRSI commissioning run at the INT with 4 offset pointings (447″) and 3 ditherings (23.″5). Exposure time is 12 minutes.

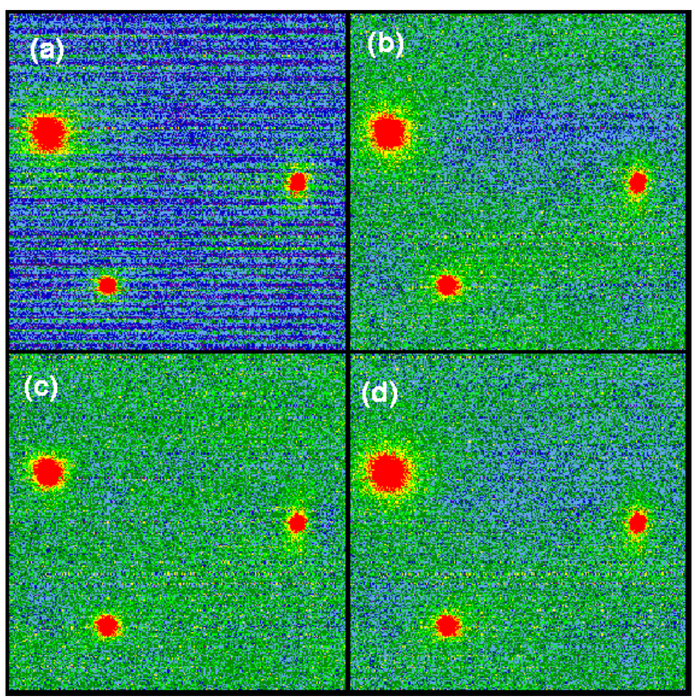

Figure 4. Noise correction: (a). no correction, (b) and (c). current noise correction methods in the system, (d). second pass linear median filtering method.