

Automated Photometric Calibration Software For IRAF

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Abstract. New IRAF tools for the photometric calibration of optical/IR images are presented. The new tools are standard star catalog and world coordinate driven, requiring both accurate standard star catalog coordinate and accurate image coordinate data. Network access to standard star catalog servers is supported. The new tools are suitable for embedded use in pipeline reduction software.

1. Introduction

The new tools described here were written to support the photometric calibration of NOAO Deep Wide Survey data and are sufficiently general that, with minor modifications, they can be used with any standard star catalog server and applied to any optical/IR image data.

Sections 2 and 3 describe the current standard star catalog and image data requirements. Sections 4 and 5 provide an overview of the software and a summary of its principle features. The current status of and future plans for the software are summarized in section 6.

2. The Standard Star Catalog Requirements

The standard star catalogs must satisfy the following requirements.

- The standard star catalog must be a text file or a catalog server either local or remote. The catalog server must support simple region extraction queries and text output. The standard star text files and catalog servers must provide ids, celestial coordinates, and one or more magnitudes for all the extracted standard stars.
- The standard star catalog coordinates must be defined in a standard celestial coordinate system. The coordinates must be accurate enough to permit unambiguous location of the standard stars in the input image data.
- The standard star catalog magnitudes must be defined in a standard photometric system. Extraction of catalog magnitude errors is desirable but not required.

3. The Image Data Requirements

The input image data must satisfy the following requirements.

- The image coordinate system must be accurate enough to permit unambiguous location of the standard stars in the image. The image coordinate system need not be the same as the standard star catalog coordinate system. The software will transform from one coordinate system to the other.
- The effective exposure time, the effective airmass, the filter name, the effective time of observation, the effective gain, and the effective readout noise must be stored in the input image headers before beginning photometric calibrations.
- Basic CCD reductions including overscan, zero level, dark current, flat field, and fringe corrections must be completed before beginning photometric calibrations.
- Mosaic specific CCD reductions such as crosstalk and interchip gain corrections must be completed before beginning photometric calibrations.
- The photometric zero point must be constant across the images. Variable image scale effects must be removed before beginning photometric calibrations.

4. Scientific Functionality

Given a standard star catalog and an input image list which satisfy the criteria defined in sections 2 and 3, the photometric calibration software performs the following functions. An outline of the calibration software is shown in Table 1.

- Selects a standard star catalog from the list of supported catalogs.
- Selects the images containing standard stars from the list of input images using the standard star coordinates and the image coordinate system.
- Groups the standard star images by filter and time of observation using information in the image headers.
- Creates standard star pixel position and magnitude tables for each standard star image using the standard star coordinates and the image coordinate system.
- Computes aperture photometry for the extracted standard stars using parameter settings appropriate for the instrument and exposure times in the image headers.
- Creates a standard star observations files by combining data for the same field taken through different filters and at different effective airmasses.
- Calibrates the photometry by solving the system of transformation equations defined by the user.

5. Software Features

The photometric calibration software supports the following features.

- The standard star catalog may be either a file or a local or remote catalog server which supports region extraction. The software is independent of the type and format of the standard star catalog and does not need to be modified to support new standard star catalogs.
- Standard star list filtering can be performed by the catalog server as part of the extraction or by the photometric calibration software after extrac-

Table 1. The Photometric Calibration Package

Main Entry Point Tasks	
stdsets	- Group standard star images by filter
stdphot	- Create a standard star observations file
phparams	- Solve the transformation equations
lan4mphot	- Create a Landolt star 4m mosaic observations file
lan4mparams	- Solve the transformation equations using Landolt stars
Individual Tasks	
phlist	- List the photometric processing information
phimfind	- Select standard star images and / or
phimfind	- Extract standard star lists
phfiltpars	- Edit the catalog file filtering parameters
phimsets	- Group standard star images by filter
phshifts	- Compute the relative shifts of images by group
phphot	- Do aperture photometry on standard star images
dpars	- Edit the data dependent parameters
cpars	- Edit the centering parameters
spars	- Edit the sky fitting parameters
ppars	- Edit the photometry parameters
phobsfile	- Prepare a standard star observations file
Individual Tasks Optimized for NOAO 4m Mosaic Data	
ph4mphot	- Do aperture photometry on combined 4m mosaic images
d4mpars	- Edit the 4m mosaic data dependent parameters
c4mpars	- Edit the 4m mosaic centering parameters
s4mpars	- Edit the 4m mosaic sky fitting parameters
p4mpars	- Edit the 4m mosaic aperture photometry parameters

tion. Common filtering operations include changing coordinate systems, imposing magnitude limits, and sorting by magnitude.

- All the standard celestial coordinate systems are supported. The photometric calibration software will automatically convert the standard star coordinates from the standard star coordinate system to the image coordinate system.
- Standard star image selection, standard star list extraction, standard star identification, and standard star measurement are world coordinate system driven and fully automated.
- The image grouping and final calibration steps still require some user interaction mostly in the interests of quality assessment.

6. Current Status and Future Plans

The current photometric calibration software uses a set of catalog access tasks and catalog access API developed for use with astrometric catalogs but not yet part of the standard IRAF distribution (Davis 2000). The code which does the actual aperture photometry, matches the observations, and computes the

photometric transformations is an adaptation of the existing IRAF APPHOT and PHOTCAL packages (Davis and Gigoux 1993).

Although most of the software is automated and runs without intervention by the user, some user input is still required in the areas of grouping the standard star images and interacting with the fitting process to get an optimal fit. More work is required in these areas in order to make the code fully automated in a pipeline environment.

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References

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