Photometric reduction of point sources (ALG-AP-003a)

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History:

- 2013-Jul-30 - Draft
- 2013-Nov-05 - Baseline
- 2016-Mar-23 - modifications due to change in software (Astrometrica rather than SExtractor)

Description:

Photometric calibration involves taking the instrumental photometry produced by the source detection routines and transforming them into calibrated photometry based on the observation of standard stars. Calibration of photometry to be based on OCAMS observations of solar-type standard stars (for lightcurve, phase function, color and natural satellite search photometry) and field stars with entries in photometric stellar catalogs (also for natural satellite search photometry since scattered light from Bennu may preclude the use of OCAMS calibrations for accurate photometry).

Parameters:

infile

– for natural satellite search - internal Astrometrica files, OCAMS MapCam radiometric characteristics

– for Bennu and satellite color index, phase function and rotation period determination
- magnitude zero point values for each filter to be determined by the APWG from OCAMS MapCam Solar Twin and Star Cluster calibration observations

outfile

– for natural satellite search - internal Astrometrica files feeding into Moving Object Detection algorithm,

– for Bennu and satellite color index, phase function and rotation period determination - Bennu and satellite photometry files

Algorithm equations:

$$flux = sum - (area * msky)$$

$$mag = zmag - 2.5log10(flux) + 2.5log10(itime)$$

$$error = sqrt(\frac{flux}{epadu} + (area * stdev^2) + (area^2 * \frac{stdev^2}{nsky}))$$

$$mag_{err} = 1.0857 * \frac{error}{flux}$$

where flux is the total amount of signal from Bennu or a natural satellite;

area = the area of the photometric aperture in pixels;

msky = the mean flux of each background sky;

mag = the apparent magnitude of Bennu or a natural satellite;

itime = integration time of an OCAMS exposure in seconds;

error = the 1-sigma error of the flux;

epadu = readout noise in electrons;

stdev = standard deviation of the flux;

nsky = number of pixels in the background sky annulus

mag_err = the 1-sigma error of the apparent magnitude.

Proposed software:

Astrometrica and IRAF will be used to obtain apparent and absolute photometry. Both tools are COTS products and have an extensive history of use supporting ground-based and space-based observation and analysis of astronomical point sources. Astrometrica was also used by the NASA Dawn mission in support of their search for natural satellites around the asteroid Vesta (McFadden et al. 2016). The algorithms used by Astrometrica for the photometric calibration of point sirces have been tested and proven over ~20 years of asteroid study. Since the software is

extensively used and has been vetted by the astronomical community, the algorithms to be used do not need to be specifically presented here.

Additional references:

Henden, A.A. and Kaitchuck, R.H. 1990. Astronomical Photometry. Willman-Bell, Inc., Richmond, Virginia, 394 pps.

McFadden et al. 2016. Vesta's missing moons: comprehensive search for natural satellites of Vesta by the Dawn spacecraft. Icarus 257, 207-216.

Warner, B. 2006. A Practical Guide to Lightcurve Photometry and Analysis. Springer, 294 pps