omatt

August 16, 2005

Abstract

Convert a source list from OM detector to sky coordinates, and produce a sky coordinate OM OSW image

1 Instruments/Modes

Instrument	Mode
OM	FAST
OM	IMAGING

2 Use

pipeline processing	yes
interactive analysis	yes

3 Description

This task takes an OM OSW source list, with source positions in pixels, and converts to sky coordinates. These sky coordinates are then used to produce a sky coordinate image.

The task requires the user to enter the name of an OSW source list and its corresponding OSW image. The name of the output sky coordinate image must also be passed to the task, along with a tolerance parameter (see below).

The task first reads the binning factors (BINAX1 and BINAX2) from the FITS header, along with the BPE binning flag (TWIXEL) and the x and y size of the OSW window (in centrioded pixels) along with the x and y offsets of the window. The pixel coordinates of the OSW source list are then converted to the PIXCOORD reference frame (2048 by 2048 centroided pixels).

The OM optics have a small amount of distortion, and the CAL call omDistortion is used to get the offsets of the pixel position from a linear scale. These offsets are then applied to the pixel positions. A CAL to GetPlateScale is subsequently used to convert from pixels to radians. (The center of the detector, i.e. the position of the OM boresight is pixel 1023.5, 1023.5).

The shift and add process is all performed relative to a reference frame (used to find the tracking stars), so a call to OAL_getAttitude is used, with the time of the reference exposure, to get the spacecraft attitude. The CAL Boresight routine is used to obtain the boresight offset matrix, which is applied to the s/c attitude to get the OM boresight direction, which is then rotated by the roll angle about the s/c boresight direction, as are the tangent plane coordinates. The tangent plane coordinates are then converted to sky coordinates.

The source positions, in RA and DEC, are then written to the source list, along with the positional error (the pixel coordinates are retained in the source list).

The second (optional) part of the task employs the USNO SA1 catalogue (if available) to correct the RAs and DECs of the sources for any difference between the nominal pointing direction of the satelliet and the true one. The OM pointing vector and field of view are used as parameters to a search of the USNO, which lists all catalog stars in the field of view. The algorithm sets up a grid of offsets in the x and y directions to be used to match up stars in the source list to those in the catalogue. For each set of offsets a maximum likelihood parameter is computed, and the offsets with the maximum parameter value are taken to be the best offsets. If sufficient stars are matched then a least-squares fit is performed, to yield more accurate astrometry. The fit yields more accurate values for the offsets, and also any small rotation bewteen the two coordinate systems. Error for the parameters are computed by Monte Carlo simulations, in which new data sets are generated and the parameters computed. The mean and standard deviations of all the fitted parameters from the simulations are computed, and the standard deviations are used as the errors. Corrected RA and DEC columns are added to the source-list file.

The final section of the code takes the OM OSW image and rotates and rebins it into sky coordinates. The rotated-pixel coordinates are computed through an iterative process.

4 Parameters

This section documents the parameters recognized by this task (if any).

Parameter	Mand	Type	Default	Constraints
set	yes	string	none	

OM image intermediate filename

sourcelistset	yes	string	none	

OM OSW Source List filename

ppsoswset	no	string	none	

PPS OM OSW FITS sky image filename

usecat	no	boolean	F	

Use the USNO-SA 1 catalog

catfile	no	string	none	

Name of the USNO-catalogue fits file for astrometry correction

maxradecerr	no	real	1.0	

Maximum allowed RA/dec error in astrometry fit.

maxrmsres	no	real	1.5	

Maximum allowed rms residual in astrometry fit.

rotateimage	no	boolean	T	

Create the rotated sky-image

5 Errors

This section documents warnings and errors generated by this task (if any). Note that warnings and errors can also be generated in the SAS infrastructure libraries, in which case they would not be documented here. Refer to the index of all errors and warnings available in the HTML version of the SAS documentation.

diffBin *(fatal)*
Different binning in x and y directions

Could not allocate memory for: <name> *(fatal)*
Memory allocation for the named array failed

Star catalogue not found- no astrometry correction done *(warning)*
Too few sources for astrometry
corrective action:

Need at least 10 stars to do a reliable correction *(warning)*
noCat
corrective action:

No stars in catalogue- catalogue has not been used to correct positions *(warning)*
Cannot do astrometry
corrective action:

No overlap between sources and catalogue stars *(warning)*
Too few guide stars for astrometry correction
corrective action:

Catalogue has not been used to correct positions *(warning)*
Too few sources matched for astrometry
corrective action:

Need at least 10 to do astrometry correction *(warning)*
insuffData
corrective action:

Insufficient number of data for least-squares fit *(warning)*
singularSol
corrective action:

singular solution to astrometric fit *(warning)*

corrective action:

6 Input Files

1. OM OSW source list (as produced by OMDETECT/OMWAVELET)
2. OM OSW FITS image (as produced by OMMODMAP)

7 Output Files

1. OM OSW source list
2. PPS OM OSW FITS sky image.
3. if usecat=true a postscript file will be produced showing the goodness-of-fit of the astrometry correction.

8 Algorithm

```
subroutine omatt

   open output file
   read the OSW window parameters, binning factors from header

   call CAL_GetBoresightMat
   call OAL_GetAttitude (with time of reference frame)

   find OM boresight direction
   rotate by roll angle

   loop over individual source information
      read in individual source information
      extract pixel position
      correct for distortion (CAL_omDistortion)
      call to CAL_omPlatescale to get linear plate-scale
      perform co-ordinate conversion
      (including s/c boresight offset correction and roll angle)
   end loop
   Add columns for the RA and dec of each source to the source-list file.

   if (usecat) then
       read in the catalogue data.
       Set up a grid of offsets deltax and deltay in the x and y directions.
       Sort these offsets into increasing radius order from the origin.
       For each grid shift the stars by deltax and deltay in the x
       and y directions.
```

```
      Try to match each star with one in the catalogue by computing the
      distance between it and the selected catalogue stars and regarding
      it as matched if the distance is less than the specified tolerance.
      For each pair of offsets compute a maximum-likelihood parameter and take
      the pair with the maximum value as the best offsets.
      Use these offsets to repeat the star matching, and then perform a
      least-squres fit to improve the offsets and also determine any small
      rotation between the two coordinate systems.
      Determine errors on the computed parameters by a Monte Carlo procedure
      which generates artificial data sets from the original, computes the
      parameters for each simulation, and then at the end computes the mean and
      standard deviations of all the parameters.
      Correct the RAs and Dec of the sources using the computed paramters.
      Added corrected RA and Dec columns to the source-list file, and also
      information about the fit.

   end if


   Rebin, rotate and correct for distortion the image, and write out to a fits file.

   close OSWSL
   close output file

end subroutine  omatt
```

9 Comments

- none

10 Future developments

References