

it can take up to several days. As the result of program work, we obtain: filtered FIT files, multiple DAT files with linear coordinates, intensity and other parameters of found objects. The large number of files for each plate (from 10 to 40 depending on the size of the source file) is generated due to limit of 20,000 objects per output file. DAT files contain information about objects on a strip of width of 500-700 pixels with an overlap of 50 pixels. After completing the program *00PLATE*, we again use *full_pl* program to restore the primary file names and copy all DAT files to Windows PC.

3. Stars identification

Using folder with DAT files on Windows PC, we run the program *dat2dir* for gluing strips of each processed plate in one file and for create the structure layout of data on disk. The program generates and executes the script that creates a folder XXXX by number of plate, then creates a sub-folder with the numbers from 1 to 6, in which the glued file *3000001.dat* is formed using the original DAT files (up to 43 strips on the plate).

For each record in the folder 1, we create file *coord.txt* with the initial coordinates of the plate center and the epoch of observation. In case of their absence, these values are entered by operator at the start of the program *plate_gr*.

In the folder with the number 1, we run the program *plate_gr* (Protsyuk, 2014), which is designed for identification of stellar images processed in the MIDAS package using the TYCHO2, UCAC4 catalogs (or another one). The program makes analysis of the quality of identification, taking into account the specific characteristics of the photographic observations in NAO, and calculates the coordinates of objects registered on the photographic plate. The program generates the sky image obtained on the plate in the left window and the image of the same area from the catalog in the right window by using the original DAT file and reference catalog. The brightness and size of stars in the windows is adjusted to achieve a visual correspondence between both images. The program may carry out:

- elimination of the image defects, such as spots, scratches, inscriptions,
- identification of stars in the image,
- allocation and exclusion from further processing of stellar images obtained during the second and the third exposures,
- exclusion of diffraction satellites of bright stars for images obtained with a diffraction grating,
- control of identification,
- reduction using models with different equations,
- analysis of the results.

After completion of data processing in folder 1, we use the script *2copy* to transfer data of identification and selection of exposure or diffraction satellites to folders with names from 2 to 6. In these folders, we also execute program *plate_gr*. Since they already have identification with the first folder, the abridged processing is carried out, which includes only cleaning of the image from defects and accurate snap of identified stars from image 1 to the current image. After that we made reduction of the current plate and exit the program.

When we make changes to the program or improve processing algorithms, all previously processed data can

be reprocessed in a batch mode for a time from a few seconds to a few minutes for each frame according to the number of objects on the plate. We historically use the separate program for the final astometric reduction.

4. Astrometric reduction and usage of results

To carry out reduction of all processed plates in batch mode, we create file *lim.txt* in the root folder of all sub-folders with plate data. File *lim.txt* includes the input parameters for subsequent use by the program *00plate.exe* (Protsyuk, 2014), which makes final reduction. In root folder, we run the script *run00*, which performs the sequence data processing of all plates sub-folders by program *00plate*.

The obtained data can be used to compile catalog or to determine the coordinates of a selected object in a series of plates. For example, to create a catalog of positions of all stars in plates and to conduct data analysis we used *mid_an* program. To create a catalog of positions and proper motions of the two plates with a large difference of epochs, we used *plate_in_cat* program. Search for a specific object on all plates and determination of its average coordinates as well as the coordinates at the moment of observation, we implemented by programs *findobj* and *midobj*.

Also in the package of programs, we have a program for visualization of the magnitude equation, the systematic errors of the scanner, the functional connection of various parameters, aberrations of telescope optics, residual error of scan processing, etc.

5. Conclusion

We created the package of programs for image processing with the following parameters: images with resolutions from 600 to 2400 dpi, image size up to 20000x20000 pixels and up to 400,000 objects on the plate, field of view up to 20 degrees. PC with 2GB of RAM is enough to work in full mode.

The package has been successfully used for creation of several catalogs (Protsyuk, 2014) and determination of the coordinates of the planets of the Solar system.

References

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