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Integrating the ZGSC and PPM at the Galileo Telescope for On-line Control of Instrumentation

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Abstract. The usage of catalogs is extremely important for efficiently observing with up-to-date instrumentation. In the work described in this paper, GSC sources are cross-correlated with entries in the PPM catalog, and used as an input to the control software of the Galileo Telescope (TNG). A graphical user interface (GUI) based on IDL has also been built. The system will be used during observing time at the TNG.

1. Background

The Guide Star Catalog (GSC) was created by STScI to support HST observations. With positions and magnitudes for about 20 million objects, it is by far the biggest all-sky catalog to date. The GSC is a unique tool for many astronomical applications, however, its utility is somewhat hampered by its format. The two CD-ROMs make for relatively slow access times. Maintaining the catalog on-line requires either two dedicated CD-ROM drives (or a jukebox), or over 1GB of hard disk space. Furthermore, the actual data in the catalog is not easily accessible. The sky is divided into regions of a complex organization, with the data for each region stored in a separate FITS table. The coordinates are given in one standard system (J2000.0).

The GSC sources can be cross-correlated with entries in a number of astrometric catalogs. One of the best of them is a family of PPM catalogs, namely: the Catalog of Positions and Proper Motions; the Catalog of Positions and Proper Motions - South; the Bright Stars Supplement to the PPM and PPM South Catalog, Revised Edition; and the 90000 Stars Supplement to the PPM Star Catalog (Roeser & Bastian, 1988; Roeser & Bastian, 1993; Roeser et al. 1993). These four PPM catalogs give J2000 positions and proper motions for 468861 stars altogether. Their main purpose was to provide a convenient, dense, and

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accurate net of astrometric reference stars that represents the IAU coordinate system on the sky.

The Galileo telescope (TNG) is currently in its testing phase. Some efforts are currently being directed towards using specific GSC2 fields for commissioning purposes; this paper deals instead with the development of tools to be used at the telescope when observing with TNG instruments, and in particular with the Low Resolution Spectrograph, also known as DOLORES (Device Optimized for LOw RESolution).

2. GUIDARES and the ZGSC

To help solve the problem of GSC data retrieval, the Guide Star Catalog Data Retrieval Software, or GUIDARES (Malkov & Smirnov 1995), has been created. This is a user-friendly program which lets one easily produce text samplings of the catalog and sky maps in Aitoff or celestial projections, given a rectangular or circular region in any standard coordinate system. Originally developed for the PC, the low-level GSC access routines of GUIDARES have since been ported to a variety of Unixes, and equipped with a GUI developed using IDL widgets.

We have created a compressed version of the GSC, called ZGSC (Smirnov & Malkov 1997a). By using a binary format and an adaptive compression algorithm, the GSC was losslessly compressed by a factor of 6, giving the ZGSC a total size of about 200 Mb. This makes it entirely practical to keep the ZGSC on-line on a hard disk and gain a dramatic improvement in access times.

An extensive software package, derived from the GUIDARES project, was developed to work with the ZGSC. This includes a suite of IDL routines that retrieve data from the ZGSC into IDL arrays, and supporting C libraries for on-the-fly decompression of the catalog. The software facilitates retrieval of circular regions, specified by center and size. Four coordinate systems are supported: equatorial and ecliptic (any equinox), galactic and supergalactic. The software also allows retrieval of objects of a particular type and/or in a particular magnitude range.

3. The XSKYMAP application

The XSKYMAP software is an IDL widget application for retrieval, visualization and hard copy of ZGSC samplings. The applications of the XSKYMAP are finder charts, GSC studies (Malkov & Smirnov 1997; Smirnov & Malkov 1997b), *etc.* XSKYMAP is fully integrated with ZGSC and provides easy access to all retrieval options of the ZGSC. It also allows for mouse-based catalog feedback (i.e., objects may be selected with the mouse, directly on the map, to view their corresponding full catalog entries). The software provides mouse operations for zoom in/out and recenter region, click-and-drag for computing angular separation and positional angles, and tracking of mouse coordinates with dynamic display of sky coordinates and separation/positional angle relative to center of area. The user can interactively change the map legend (i.e., symbol and color used for each type of object), and selectively display and label particular types of objects.

XSKYMAP uses a custom map projection routine, one which allows plotting of truly rectangular areas even in polar regions, and supports arbitrary rotation of the map relative to North on the sky. An instrument's field-of-view box may also be plotted on the map. XSKYMAP can also display a 2D image (e.g., directly from the instrument), and overplot the catalog map on top. Hard copy in PostScript format is also provided, both in map-only mode, and in image+map overplot mode. Another useful feature of XSKYMAP is built-in coordinate system conversion. For example, the user can start exploring the catalogs using the galactic system, and once the necessary sky area is obtained, the coordinates may be switched to a different system (e.g., the native system of the telescope), while preserving the same area on the screen. The necessary map rotation (to compensate for orientation of different systems relative to each other) is computed and introduced automatically.

Recently, XSKYMAP has been extended with a module to access the PPM catalog. For this purpose the PPM catalogs were reformatted to have the same file structure as the GSC. It is now possible to execute a query on both catalogs (ZGSC and PPM) simultaneously, and view the objects plotted on the same field. Objects from the PPM are plotted using a different symbol or color; their complete catalog entries can also be accessed by clicking the mouse over them. Thus, GSC's depth of field can be combined with PPM's extremely high astrometric accuracy, all within one plot. This development has led to a restructuring of the XSKYMAP software. Data access will now be handled by generic modules with a well-defined interface. Thus it will be possible to easily add capabilities for access to other catalogs in addition to the ZGSC and PPM. To this end, XSKYMAP is being overhauled to take advantage of the new object-oriented features of IDL 5.0.

4. Integrating with the Galileo instrument software

The integration of a new instrument with Galileo is a rather smooth effort, since WSS, the Workstation Software System (Balestra et al. 1991), takes care of all communications with subsystems, information and data management and handling, and its tabular structure simplifies any addition of new configurations. Newer versions of WSS support complete integration with IDL (Balestra 1997), thus guaranteeing the possibility of binding XSKYMAP with the control of TNG instruments. The Observation Software (OS) for the instrument, if properly integrated in WSS, is guaranteed access to all facilities related to TNG control and information handling.

This work is dedicated to the Observation Software for DOLORES, the TNG low resolution spectrograph and imager. The ZGSC and PPM catalogs will be accessed by means of the GUIDARES and XSKYMAP for a number of different purposes including:

- choice of field to be observed;
- assistance to the observer, both in "blind" mode (direct access to the catalog) and in "guided" mode (comparison with observational data taken in imaging mode);
- setup of the MOS systems:

– positioning of the slitlets;

– commands to be sent to the punching machine.

The compactness of the compressed versions of the catalogs and the efficiency of the access software allows the system to be installed within WSS and to perform operations while observing, with no need for local or external network connections to databases or data centers.

Access to ZGSC and PPM is supported by tools and procedures integrated with IDL and WSS. Therefore the system, although built specifically for DOLORES, can be used with instrument-specific modifications for any other TNG instrument controlled by WSS.

The system is planned to be available within the Archives At the Telescope (Pasian 1996), so as to guarantee a reference version on the mountain. In the case of problems, the system can be downlinked from the Archive Server to the Instrument Workstation and installed by means of an automatic procedure at WSS re-start time.

The system is not a general-purpose one, and is dedicated to on-line use during observing time. It is planned to also make it available within the DOLORES Observation Support Software, and will be distributable via the network. At the level of observation preparation, however, network connections with other facilities and/or data centers (e.g., VizieR at the CDS) may be also advisable and supported by the Galileo Observatory.

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