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The Montage Image Mosaic Service: Custom Image Mosaics On-Demand

G. B. Berriman, J. C. Good, A. C. Laity, M. Kong

Infrared Processing and Analysis Center, California Institute of Technology, Pasadena, CA, USA

Abstract.
The Montage software suite has proven extremely useful as a general engine for reprojecting, background matching, and mosaicking astronomical image data from a wide variety of sources. The processing algorithms support all common World Coordinate System (WCS) projections and have been shown to be both astrometrically accurate and flux conserving. The background "matching" algorithm does not remove background flux but rather finds the best compromise background based on all the input and matches the individual images to that. The Infrared Science Archive (IRSA), part of the Infrared Processing and Analysis Center (IPAC) at Caltech, has now wrapped the Montage software as a CGI service and provided a compute and request management infrastructure capable of producing approximately 2 TBytes / day of image mosaic output (e.g. from 2MASS and SDSS data). Besides the basic Montage engine, this service makes use of a 16-node LINUX cluster (dual processor, dual core) and the ROME request management software developed by the National Virtual Observatory (NVO). ROME uses EJB/database technology to manage user requests, queue processing and load balance between users, and managing job monitoring and user notification. The Montage service will be extended to process user-defined data collections, including private data uploads.

1. Introduction

The design of the Montage image mosaic engine has been described by Berriman et al. 2003 and Berriman et al. 2004. It is a scaleable toolkit, written in American National Standards Institute (ANSI) compliant C, that constructs mosaics from FITS-format input files whose footprints on the sky are represented by the World Coordinate System (WCS). The toolkit contains modules for discovering input images for processing, reprojecting the input images, rectifying the background in the reprojected images to a common level, and co-adding the reprojected, rectified images into the final mosaic. As of September 2007, over 300 astronomers have downloaded the code from the project web site at **http://montage.ipac.caltech.edu** and have used it to generate data products, perform scientific research, support quality assurance and generate EPO data products.

This paper describes the functionality and architecture of an on-request image mosaic service that uses Montage to return mosaics meeting user specifications that are submitted through a simple web form.

2. Functionality for Users

Users request a mosaic on a simple web form at **http://hachi.ipac.caltech.edu:8080/montage**. The first release of the service returns mosaics from three wide-area survey data sets: the 2-Micron All−Sky Survey (2MASS), housed at the NASA IPAC Infrared Science Archive (IRSA), the Sloan Digital Sky Survey (SDSS), housed at FermiLab, and the Digital Sky Survey (DSS), housed at the Space Telescope Science Institute (STScI). The first release of the service restricts the size of the mosaics to 1 degree on a side in the native projections of the three datasets. Users may submit any number of jobs, but only ten may run simultaneously and the mosaics will be kept for only 72 hours after creation. These restrictions will be eased once the operational load on the service is better understood. The return page shows a JPEG of the mosaic, and provides download links for the mosaic and an associated weighting file. Large mosaics are automatically tiled and a browse FITS version of the mosaic provided for convenience. Users may monitor the status of all their jobs on a web page that is refreshed every 15 seconds, and may request e-mail notification of the completion of their jobs.

The system is also inherently program−friendly, and specification of the program interface will be released presently. A proof-of-concept program interface has been successfully tested by the Astrogrid project.

3. The Architecture of the On-Request Mosaic Service

3.1. Design Principles

The system provides a pathfinder for projects such as the Large Synoptic Survey Telescope (LSST), who will likely have need for high throughput services at low cost. The system was required to use inexpensive, commodity hardware with portable, open source software, yet be fault-tolerant, scaleable, extensible and distributable.

3.2. System Architecture

Figure 1 shows the system design. It consists of two distinct components: the Montage mosaic engine; and the job request system, called the Request Object Management Envioronment (ROME)(Kong, Good and Berriman 2004). The Montage software runs on each of the cluster machines and is controlled by a simple CGI wrapper that accesses the input images and runs the Montage components. The input images and the mosaics are staged on a 6-TB mass storage disk farm. A processor daemon running on each cluster machine requests jobs from an Enterprise Java Bean (EJB) server and sends status information back to it. The EJB server accepts user requests from a browser, provides a permanent store for the request information and is responsible for enforcing the usage rules. It underpins the job status information returned to the user.

The processor and the EJB server communicate via Hyper Text Transport (HTTP) protocols. This design allows different instances of Montage to reside on multiple, distributed clusters, and will support access to other compute intensive services.

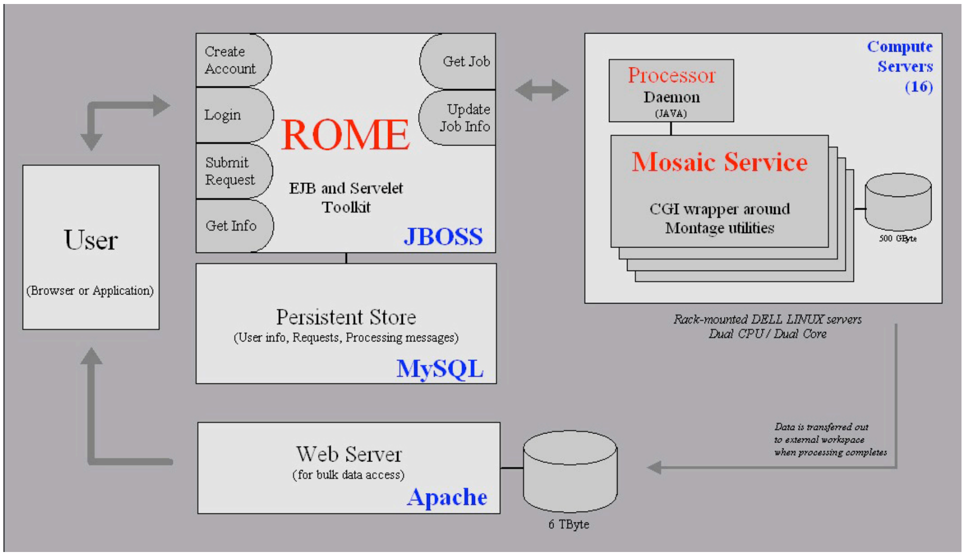

Figure 1. The System Architecture of the Montage On-Request Service.

3.3. Performance

The system resides at the Infrared Processing and Analysis Center (IPAC) and is powered by 15 Xeon 3.2-GHz dual-processor dual-core Dell 2650 Power Edge servers and an Aberdeen Technologies 6-TB RAID-5 disk farm for staging files. The system is capable of processing 60 simultaneous independent jobs with a throughput of 21,000 square degrees a day at arcsecond resolution, equivalent to almost 2 TB of image data each day. Throughput is easily improved by adding more servers to the cluster.

Table 1 shows typical wall clock times, which include data access times and processing times, to generate a mosaic of NGC 5584 with the 2MASS, SDSS and DSS data sets. Data access will ultimately limit the performance of the system as it is put under heavier load and is expanded to support bigger mosaics. Distributed processing will can overcome this limitation.

Table 1. Wall Clock Timing Comparisons - NGC 5584, 0.4 deg x 0.4 deg

Data set and Band	Number of images	Wall clock time (s)
2MASS-J	52	638
SDSS-g	8	184
DSS-R	1	166

4. Planned Functionality

The following functionality is planned for future releases of the on-request mosaic service:

- Cutouts or mosaics for a table of sources
- Mosaics for all WCS projections
- Three-color mosaics.
- Mosaics of user supplied data.
- Mosaics of image data sets accessible through IVO SIA services.
- Cutouts of standard pre-built wide-area mosaics plates of wide-area image data sets

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