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The iMars web-GIS – spatio-temporal data queries and single image web map services

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Introduction

Web-based planetary image dissemination platforms usually show outline coverages of the data and offer querying for metadata as well as preview and download, e.g. [1]. Here we introduce a new approach for a system dedicated to planetary surface change detection by simultaneous visualisation of single-image time series in a multi-temporal context. While the usual form of presenting multi-orbit datasets is to merge the data into a larger mosaic, we want to stay with the single image as an important snapshot of the planetary surface at a specific time. In the context of the EU FP-7 iMars project we process and ingest vast amounts of automatically co-registered (ACRO) images [2]. The base of the co-registration are the high precision HRSC multi-orbit quadrangle image mosaics [3], which are based on bundle-block-adjusted multi-orbit HRSC DTMs [4]. Additionally we make use of the existing bundle-adjusted HRSC single images available at the PDS archives [5]. A fully functional web-GIS application demonstrating the presented features is available at i-mars.eu/web-gis.

Multi-temporal database

In order to locate multiple coverage of images and select images based on spatio-temporal queries, we converge available coverage catalogs for various NASA imaging missions into a relational database management system with geometry support. We harvest available metadata entries during our processing pipeline using the Integrated Software for Imagers and Spectrometers (ISIS) software. Currently, this database contains image outlines from the MGS/MOC, MRO/CTX and the MO/THEMIS instruments with imaging dates ranging from 1996 to the present. For the MEx/HRSC data, we already maintain a database which we automatically update with custom software based on the VICAR environment [6].

Web Map Service with time support

The MapServer software is connected to the database and provides Web Map Services (WMS) with time support based on the START_TIME image attribute. It allows temporal WMS-t GetMap requests by setting additional TIME parameter values in the request. The values for the parameter represent an interval defined by its lower and upper bounds. As the WMS time standard only supports one time variable, only the start times of the images are considered. Without time values submitted, the full time range of all images is assumed as the default.

Dynamic single image WMS

To compare images from different acquisition times at sites of multiple coverage, we have to load every image as a single WMS layer. Due to the vast amount of single images we need a way to set up the layers in a dynamic way – the map server does not know the images to be served beforehand. We use the MapScript interface to dynamically access MapServer's objects and configure the file name and path of the requested image in the map configuration. The layers are created on-the-fly each representing only one single image. On the frontend side, the vendor-specific WMS request parameter "PRODUCTID" has to be appended to the regular set of WMS parameters. The request is then passed on to the MapScript instance.

Web Map Tile Cache

In order to speed up access of the WMS requests, a MapCache instance has been integrated in the pipeline. For each image entity, a separate tile cache tree has to be generated. In this context the PRODUCTID parameter is configured as an additional dimension of the cache. The complete data flow of the described WMS request and its response is shown in Figure 1.
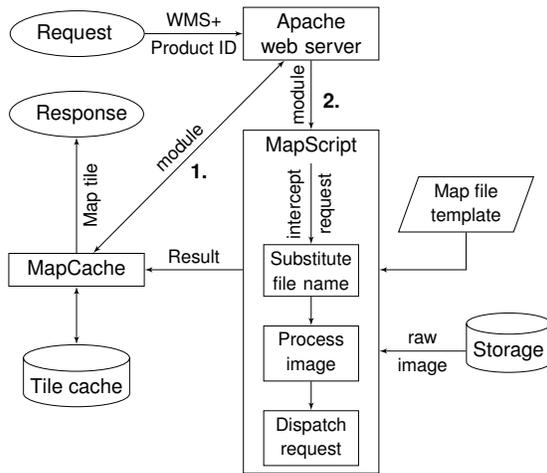
Figure 1: Diagram of the data workflow from the dynamic single-image WMS request to cache lookup to image processing and tile return. The numbers represent possible process paths as explained in the text.

The WMS request is received by the Apache web-server configured with the MapCache module. If the tile is available in the tile cache, it is immediately commited to the client (following path 1). If not available, the tile request is forwarded to Apache and the Map-Script module (following path 2). The Python script intercepts the WMS request and extracts the product ID from the parameter chain. It loads the layer object from the map file and appends the file name and path of the inquired image. After some possible further image processing inside the script (e.g., stretching or colour matching), the request is submitted to the MapServer backend which in turn delivers the response back to the MapCache instance.

Web frontend

We have implemented a web-GIS frontend based on various OpenLayers components. The basemap is a global colour-hillshaded HRSC bundle-adjusted DTM mosaic with a cell size of 50 m per pixel. The new bundle-block-adjusted qudrangle mosaics of the MC-11 quadrangle, both image [3] and DTM [4], are included with opacity slider options. The layer user interface has been adapted on the basis of the ol3-layerswitcher module and extended by foldable and switchable groups, layer sorting (by resolution, by time and alphabeticallly), layer deletion and reordering (drag-and-drop). A collapsible time panel accomodates a time slider interface where the user can filter the visible data by a range of Mars or Earth dates. The visualisation of time-series of single images is controlled by a specific toolbar enabling the workflow of image selection, dynamic image loading and sequential playback of single images in a video player-like environment. We have also added a "Goto lat/lon" control to navigate in the map via text input, and a "Projection switcher" element for changing into polar stereographic projections. During a stress-test campaign we could demonstrate that the system is capable of serving up to 10 simultaneous users on its current lightweight development hardware.

Conclusions/Outlook

We demonstrate a technique to dynamically retrieve and display single images based on the time-series structure of the data. Together with the multi-temporal database and its MapServer/MapCache backend it provides a stable and high performance environment for the dissemination of the various single image products. The web-GIS application serves as an expert tool for the detection and visualisation of surface changes in HRSC images.

Acknowledgements

References

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