UDK 004

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GENERATION OF A LANDSAT 8 MOSAIC FOR ONLINE VISUALIZATION

ABSTRACT: The method of automatic generation of a mosaic from multitemporal Landsat 8 satellite imagery for online visualization on the web is being proposed. The method is implemented as an API for generating raster tiles of a mosaic. The input raster data are requested from the user-defined WMS server.
Keywords: satellite imagery mosaic, remote sensing, Earth observation, Landsat 8, visualization, geoinformation systems.

Introduction. Today remote sensing technologies are widely used to solve applied problems related to environmental monitoring and agriculture. Landsat 8 imagery fills an important scientific niche in this area, as it provides seasonal coverage of the global landmass at a spatial resolution detailed enough to characterize human-scale processes such as urban growth, agricultural irrigation, and deforestation. The data acquired with Landsat 8 is often used to classify vegetation cover, determine the state of crops, perform geological mapping and so on [1]. Most of the aforementioned tasks require continuous coverage of large areas, so several images captured from different orbits must be merged into a mosaic. However, preprocessing satellite images and color balancing, which are required to generate a mosaic, are compute-intensive tasks. Hence, the need arises for preliminary visualization of a Landsat 8 mosaic to simplify the process of scenes selection for further processing.

Survey of previous work. Recently with the growth of the amount of geospatial data stored on the cloud, the popularity of web-based geoinformation systems (Web-GIS) is constantly increasing. This is due to the opportunity of processing geospatial data directly in the cloud, more quickly, with no need to download the data or maintain computational infrastructure. Web-GIS allow users to visualize, process and analyze spatial data in ordinary web browsers. The interoperability of Web-GIS is provided by means of Open Geospatial Consortium (OGC) standards. For example, the OGC WMS (Web Map Server) standard specifies the interface and parameters to dynamically request maps from a server.

Online services for visualization of satellite imagery, available on Amazon S3, had been developed [3-5]. These services allow one to visualize both historical and up-to-date satellite imagery from operating remote sensing satellites in a web browser: Terra and Aqua (MODIS product), Landsat 7, Landsat 8, Sentinel-2. Sinergise had developed a web service for generation of satellite imagery mosaics [6], including Landsat 8, but the flexibility of the system is limited by the finite number of options, and the algorithm of scene selection cannot be personalized.

Formulation the problem. The purpose of the paper was to develop a method of a Landsat 8 mosaic generation for visualization on the web interface. The input raster data were received using the WMS protocol, requesting layers of Landsat 8 scenes. The method was implemented as an API that returned raster tiles using OpenStreetMap (OSM) Slippy Map notation [7]. The following tasks were accomplished:

1. Imagery search according to the specified criteria.
2. Selection of the scenes to display.
3. Generation of a mosaic raster tile from raw data received from the WMS service.

The basic material. Landsat 8 has 233 orbit cycle and covers the entire globe every 16 days (except for the highest polar latitudes). Equatorial crossing time is 10:00 a.m. +/- 15 minutes [8]. The visualization of the orbit daytime swaths is shown in Fig. 1. The area of the overlap between images captured from different orbital tracks increases towards the poles and is minimal at the equator, which is due to the fact that the satellite follows a circumpolar orbit. In Fig. 2 the coverage of the territory of Ukraine with Landsat 8 imagery is shown. Landsat 8 covers the entire territory of Ukraine every 16 days.

The following search criteria were chosen: 1) time range (dates of acquisition); 2) cloudiness (percentage of cloudy pixels in a scene); 3) the Sun elevation angle (an angular height of the Sun); 4) acquisition hours (day or night).

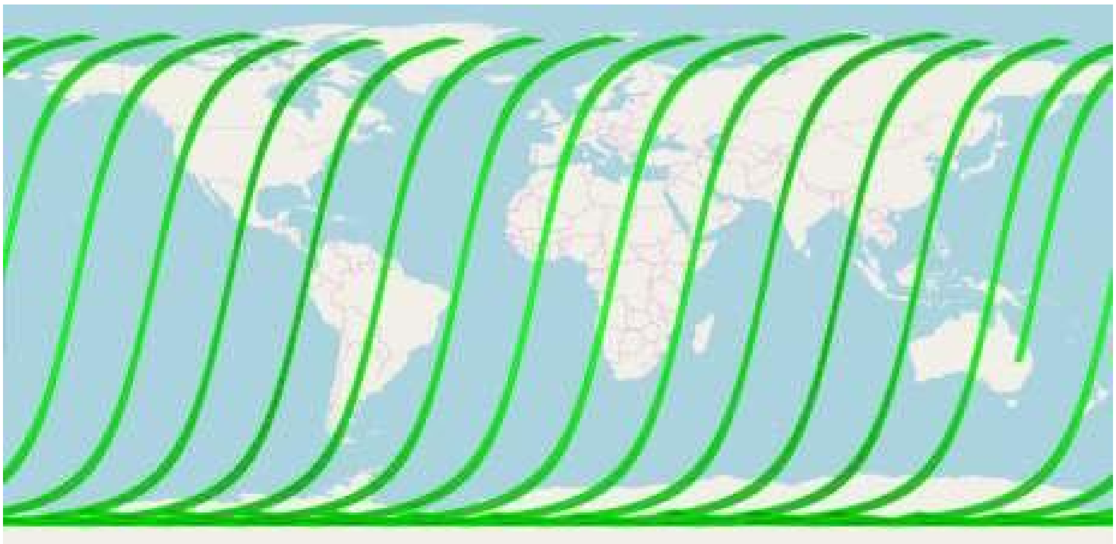

Figure 1 - Example committee on Earth Observation Satellite Visualization Environment tool modeled orbit daytime swaths for 20 October 2017 shown in the geographical projection [9]

In the paper the search of the imagery was carried out by means of the search service [10]. The search of the imagery interacting with some geometry is a computationally expensive task. Hence, it would have been inefficient to perform the search by the geometry of the OSM tile on each tile request. Thus, we performed the search only for tiles at the "base" zoom level and cached the search results for further usage. The base zoom level is such a zoom level at which the optimal ratio of number of requests and the response time of the search API was reached. For Landsat 8 a zoom level 8 was chosen as the base zoom level. To get an idea on how many tiles interact with a Landsat 8 scene at different zoom levels see Fig. 3.

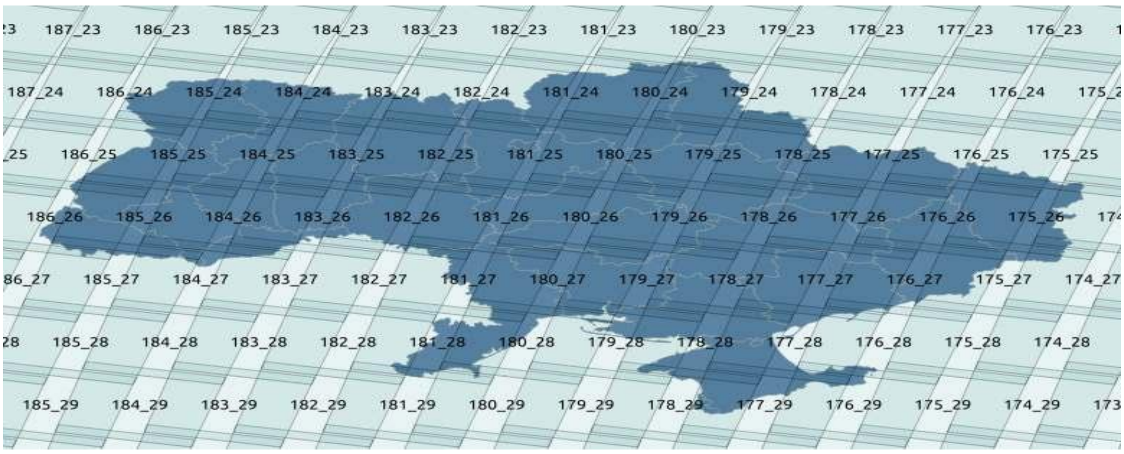

Figure 2 - Visualization of the coverage of the territory of Ukraine with Landsat 8 imagery following WRS-2

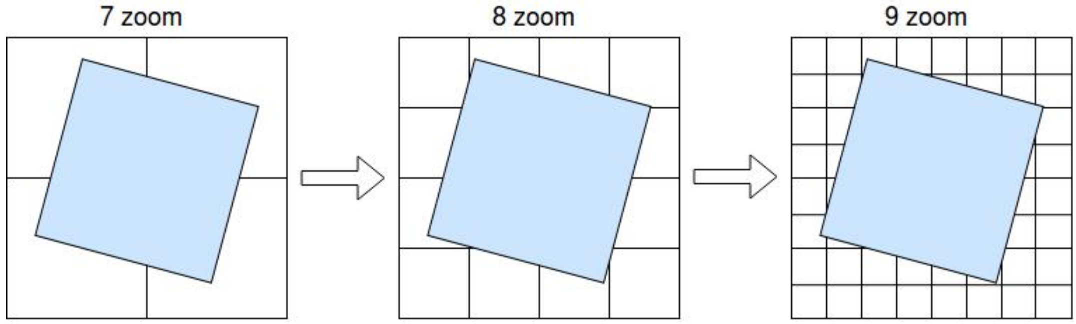

Figure 3 - Interaction of a Landsat 8 scene with OSM tiles at different zoom levels, in projection EPSG:3857 at the middle latitudes

Thus, if a zoom level of a requested tile is greater than the base zoom level, it is sufficient to determine an index of a tile at the base zoom level, which covers the area of the requested tile, and perform the search only for this tile. After that, filtering of the search results by the geometry of the requested tile should be performed. If a zoom level of a requested tile is less than the base zoom level, it is necessary to perform the search for 4(z-bz) tiles of the base zoom level, where z is a zoom level of the requested tile, bz is the base zoom level. Then union of the search results is equivalent to the search by the original geometry for the requested tile.

After the search results are obtained, the selection of scenes to display on a resulting mosaic raster can be done. In this study, a sample algorithm of scenes selection was implemented, which sorts the scenes by an acquisition date, so that the newest scenes are placed on the top layer of the mosaic. The minimal amount of scenes covering an entire tile’s area is calculated to minimize the number of the WMS requests.

For each of the scenes raw raster data can be retrieved via GetMap request to the WMS server, which serves Landsat 8 scenes as layers. In the request an image format, a bounding box, representing tile’s extent, and the name of a layer must be specified. The available WMS options (layer names, styles, image formats etc.) depend on the WMS vendor and can be obtained via GetCapabilities request [11]. The final step of a mosaic tile generation algorithm is merging the images. In this paper, the resulting raster tile of the mosaic is obtained by simply overlaying the images received from the WMS server. Optional edge blending can be applied.

Conclusion. The method of automatic generation of a mosaic from multitemporal Landsat 8 satellite imagery for online visualization on the web was proposed. The method allows one to quickly visualize a Landsat 8 mosaic to simplify the process of scenes selection for further processing. The advantage of the proposed method lies in the flexibility of the system and full control over the algorithms used.

The method is implemented as an API for generating raster tiles of a Landsat 8 mosaic. The software implementation is written in Python using the GDAL/OGR libraries for working with geospatial data and Pillow for working with raster images. The WMS provider is user-defined. The software implementation is divided into modules, which makes it easy to introduce different algorithms for scenes search, selection and generation of the resulting raster. For example, mathematical per-pixel operations between the layers of the mosaic (i.e. selection of the darkest pixel among overlaid raster images etc.) can be performed.

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