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GENERATION OF LANDSAT 8 MOSAIC FOR ONLINE VISUALIZATION

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The method of automatic generation of mosaic from multitemporal Landsat 8 satellite imagery for online visualization on the web is being proposed.

Key words: mosaic, remote sensing and Earth observation, Landsat 8, visualization, geoinformation systems.

Formulation of the problem. At present, Earth remote sensing (ERS) technologies are widely used to solve applied problems related to environmental monitoring and agriculture. An important niche in this area is occupied by Landsat 8, as it provides global coverage at any time of the year and has a sufficiently high spectral and spatial resolution. The data obtained with Landsat 8 are used to classify vegetation cover, determine the state of crops, monitor deforestation, geological mapping, and so on. [1]. Most of the tasks listed above require information on significant areas, the shooting of which includes several space images, which for convenience of use must be combined into a mosaic. However, combining images and their subsequent processing is a resource-intensive process. There is a need for preliminary processing and visualization of the mosaic to simplify the process of selecting scenes for subsequent analysis. The actual task is to construct a mosaic of satellite images Landsat 8 for online visualization.

Analysis of recent research and publications. In recent years, there has been a trend towards an increase in the popularity of geoinformation systems (GIS) on the Internet. This is due to the continuous increase in the volume of geospatial data and, consequently, the need for their storage and processing directly in the cloud. With the help of web GIS users can view, edit and analyze spatial data in ordinary web browsers. To standardize the created GIS-services and to provide access to them from various applications, developers adhere to the standards of the Open Geospatial Consortium consortium. For example, the Web Map Service (WMS) protocol [2] is used to work with layer collections as well as cartographic raster images.

The dissemination received online services for visualization of satellite imagery presented in free access to Amazon S3 [3-5]. These services allow you to visualize both historical and recent satellite imagery from existing remote sensing satellites in the browser: Terra and Aqua

(MODIS product), Landsat 7, Landsat 8, Sentinel-2. Sinergise has developed a separate web service for building a mosaic of satellite imagery [6], including Landsat 8, but the flexibility of the system is limited to the final set of parameters, and the algorithm for selecting scenes for building a mosaic can not be adapted to suit one's needs.

Formation of the purpose of the article. The aim of the work is to develop a method for constructing a mosaic from Landsat 8 satellite imagery for visualization in the web interface. The input raster data is supposed to be received via the WMS protocol, requesting layers with scenes of Landsat 8. It is required to implement the method in the form of an API for generating tiles using the slippy map OpenStreetMap (OSM) [7]. The developed method should provide the solution of the following tasks:

1. Scene search according to the specified criteria.
2. Select the scenes to display.
3. Requesting scenes via WMS protocol and forming an output raster.

Main part. As search criteria were chosen: 1) time interval (the range of shooting dates); 2) cloudiness (minimum and maximum percentage of clouds for the scene); 3) position of the Sun (height of standing of the Sun above the horizon); 4) shooting time (day or night scenes).

For Landsat 8, the equatorial repetition cycle is 16 days. The width of the capture strip is 185 km. The time of crossing the equator is $10:00 \pm 15$ minutes [8]. Visualization of the coverage of the earth's surface by Landsat 8 images in one day is shown in Fig. 1. The area of overlapping of images from neighboring orbital paths increases in the direction towards the poles and is minimal closer to the equator, which is due to the fact that the satellite is in the circumpolar orbit (inclination 98.22°). In Fig. 2 the coverage of the territory of Ukraine with Landsat 8 images is presented. Full coverage of the territory of Ukraine takes place within 16 days.

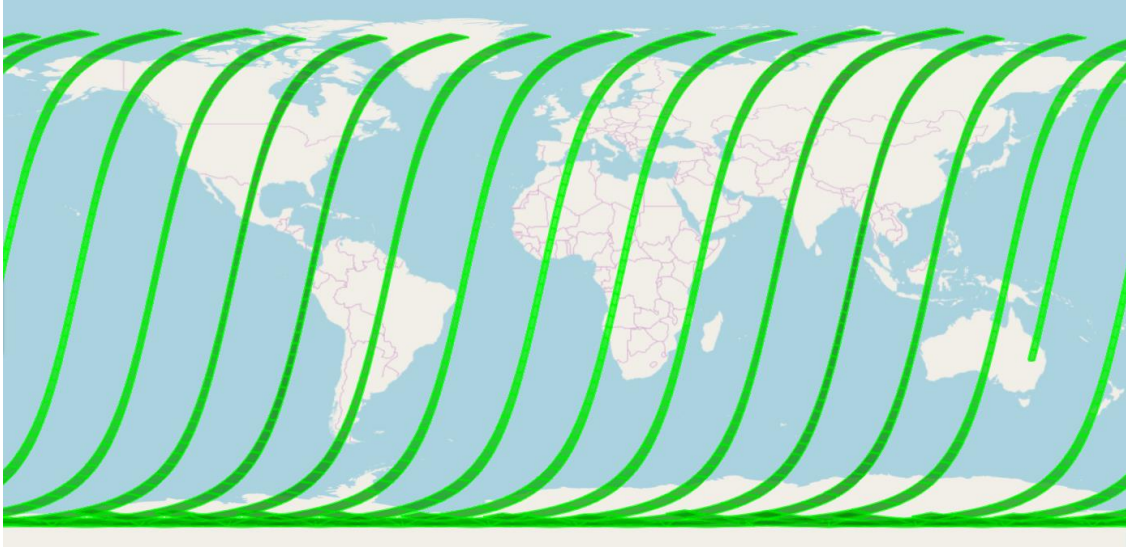


Fig. 1. The model of coverage of the Earth's surface by a satellite of Landsat 8 for one day (October 20, 2017), built by the CEOS Visualization Environment tool [9]

Within the framework of this work, the search for scenes was carried out by means of queries to the search service [10]. Since the search for scenes by the polygon representing the geometry of the tile OSM is a computationally heavy operation, it is inefficient to search for the geometry of the requested tile for each request. It was decided to search for tiles one - further base - scale (zoom) and cache the search results. Thus, if the scale level of the requested tile is greater than the base level, it is sufficient to calculate the base-level tile index that covers the area of the specified tile and request a search only for this tile. Further, it suffices to filter the search results by the geometry of the requested tile. If the scale level of the requested tile is less than the base one, it is necessary to request a search for 4 ($z \cdot b_z$) tiles of the base level, where z is the scale level of the requested tile, b_z is the base scale level. Combining search results is equivalent to searching the original geometry for the requested tile.

For Landsat 8, the scale level 8 was chosen as the base level, since at this level an optimal ratio of the number of requests and the response speed of the search API is achieved. To get an idea of the number of scenes that intersect with the tile OSM at different scale levels, you can compare the overlap of the Landsat 8 scene and tiles (see Figure 3).

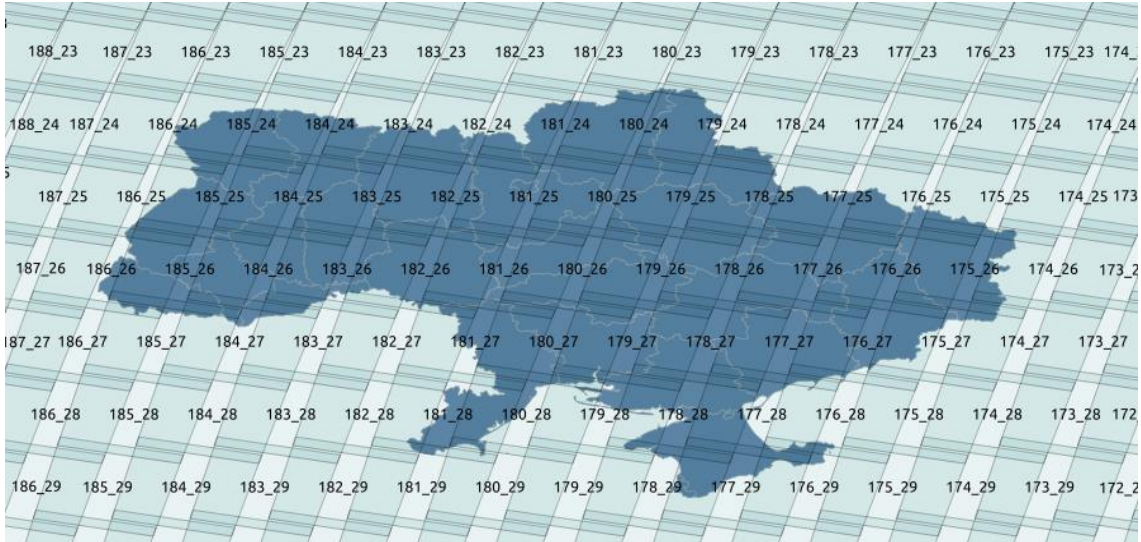


Fig. 2. Covering the territory of Ukraine with satellite images Landsat 8 according to the scheme of the reference system WRS-2

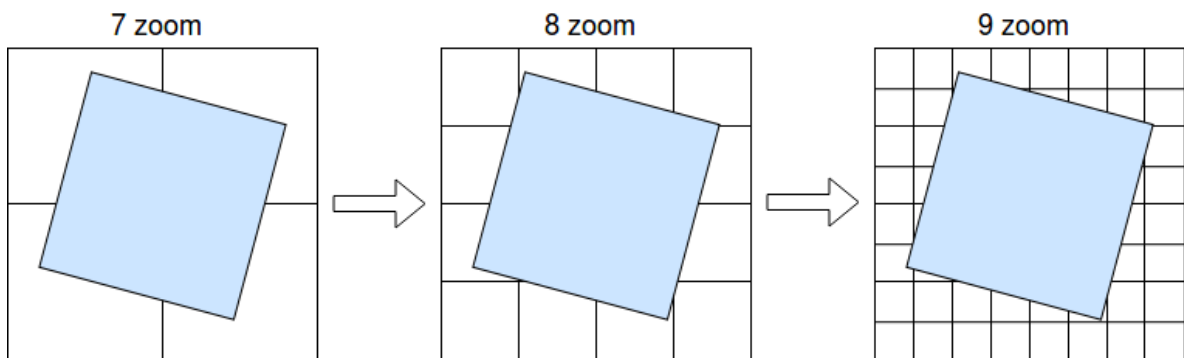


Fig. 3. The relationship between the geometry of the Landsat 8 scene and the tile geometry of the OSM at different scale levels in the EPSG projection: 3857 at mid-latitudes

After the search results are received, it is necessary to select the scenes that are directly involved in the mapping. In the framework of this work, the algorithm for selecting scenes is implemented, which consists in sorting the scenes by the date of shooting so that the fresh scenes are on the top layer of the mosaic. The software implementation of this stage is included in a separate module, it is possible to introduce other algorithms for ordering search results.

The final stage of building a mosaic is the formation of the resulting image. To do this, for each of the scenes selected in the previous step, an area corresponding to the extent of the tile is requested over the WMS protocol. In the request to WMS, you must specify the image format, which limits the window and the name of the layer for visualization. The available WMS options (layer names, styles, image formats, etc.) depend on the service provider and can be requested through the GetCapabilities operation [11].

Using the calculated order of scene overlay, the resulting raster tile of the mosaic is formed by overlaying images received from the WMS server. The overlay algorithm can include mathematical per-pixel operations between the layers of the mosaic (for example, it is possible to select the darkest pixel among overlaid raster images, which allows to achieve the effect of cloudless mosaic). Optional edge processing (blending, minimum energy seam search).

Conclusions. The developed method for constructing a mosaic of time-dependent satellite imagery Landsat 8 allows you to get an idea about covering the territory of interest with a small amount of time and resources and to assess the suitability of available scenes for solving specific applied problems. The advantage over ready-made solutions lies in the flexibility of the system and full control over the algorithms used for searching, filtering and displaying scenes.

The method is implemented as an API for generating raster tiles of the mosaic according to the prototype of the slippy map. The software implementation is implemented in Python using the GDAL / OGR libraries for working with geospatial data and Pillow for working with images. The WMS provider of the source raster data is user-defined. The development uses a modular approach, which makes the system easily supplemented.

Literature

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ПОБУДОВА МОЗАЇКИ СУПУТНИКОВИХ ЗНІМКІВ LANDSAT 8 ДЛЯ ОНЛАЙН ВІЗУАЛІЗАЦІЇ

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У роботі запропоновано метод автоматичної побудови мозаїки з різночасових супутникових знімків Landsat 8 для онлайн візуалізації в веб-інтерфейсі.

Ключові слова: мозаїка, дистанційне зондування Землі, Landsat 8, візуалізація, геоінформаційні системи.

ПОСТРОЕНИЕ МОЗАИКИ СПУТНИКОВЫХ СНИМКОВ LANDSAT 8 ДЛЯ ОНЛАЙН ВИЗУАЛИЗАЦИИ

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В работе предложен метод автоматического построения мозаики из разновременных спутниковых снимков Landsat 8 для онлайн визуализации в веб-интерфейсе.

Ключевые слова: мозаика, дистанционное зондирование Земли, Landsat 8, визуализация, геоинформационные системы.