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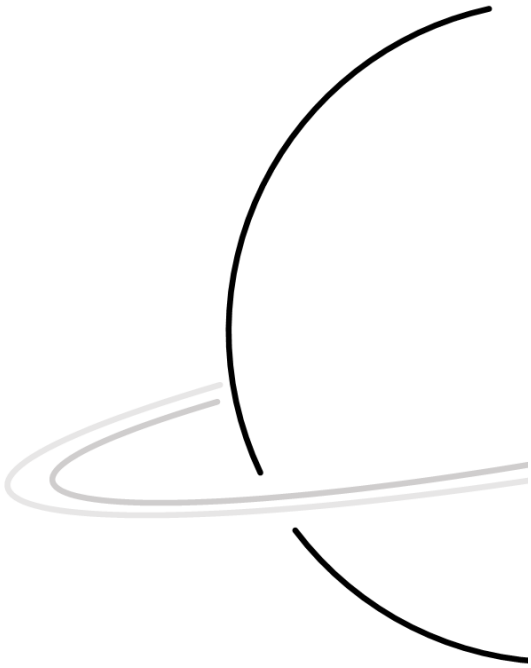
Sentinel Data Processing Pipeline for Automatic Ship Detection

Research Project



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Contents

Acronyms **2**

References **2**

List of Figures **3**

1 Introduction **4**

2 Driving technical requirements **4**

3 Approach **4**

4 Implementation **4**

5 Results and discussion **5**

6 Conclusion **7**

Acronyms

AIS Automatic Identification System. 4–7

API Application Programming Interface. 4

ESA European Space Agency. 4

References

[1] Ais data. URL: ftp://ftp.ais.dk/. Accessed: 18/12/2017.

[2] Copernicus open access hub. URL: https://scihub.copernicus.eu. Accessed: 18/12/2017.

[3] Folium library. URL: https://folium.readthedocs.io/en/latest/. Accessed: 18/12/2017.

[4] Sentinel application platform. URL: http://step.esa.int/main/toolboxes/snap/. Accessed: 18/12/2017.

List of Figures

4.1 Processing Graph for Sentinel-1 Images in SNAP 5
5.1 Example of The Detected Object by The Algorithm 5
5.2 Example of Geo-Visualization for Detected Objects 6
5.3 Histogram of Longitude Distribution of AIS data on November 1, 2017 . . 6

1 Introduction

Nowadays, satellite images are becoming more available and this data can be very useful for businesses and governments. At the same time, the development of artificial intelligence, and in particular machine learning, makes it possible to use this space data effectively for different applications.

One of the promising applications of machine learning on satellite images is ship detection task, because this can be used by government, for example, to prevent illegal fishing or immigration. The goal of this project is to automatize the ship detection on satellite images by development and implementation of the special data processing pipeline.

2 Driving technical requirements

The pipeline shall take satellite images as an input. In this project, the data from Sentinel-1 European Space Agency (ESA) satellite is used. The algorithm for ship detection on these images shall be developed and implemented. To check the accuracy of the algorithm, AIS data should be used. Results shall be visualized and plotted on a geographic map. The output of the pipeline shall be presented as a dataset, which contains the images of the detected ships by the developed algorithm with corresponding information from Automatic Identification System (AIS). The output of the pipeline may be used on the next stages of the project as a training dataset for machine learning algorithms.

3 Approach

The main idea for developing a ship detection algorithm in this project is that if take the difference of two satellite images of the same sea area but of different dates, then all the objects will be filtered by some threshold value except only ships. However, that is not always the case and the additional information, such as AIS data, can be used to set “ship” and “no ship” labels for detected objects. Then, the obtained dataset will be used for training a machine learning algorithm to be able to perform ship detection without using AIS in future.

4 Implementation

The Sentinel data was downloaded from Copernicus Open Access Hub [2] manually, however, the Application Programming Interface (API) for this website exists and can be used in future stages of the project. Downloaded images were preprocessed using Sentinel Application Platform (SNAP) [4] and saved in GeoTIFF format. Processing graph for Sentinel-1 images is shown on Figure 4.1.

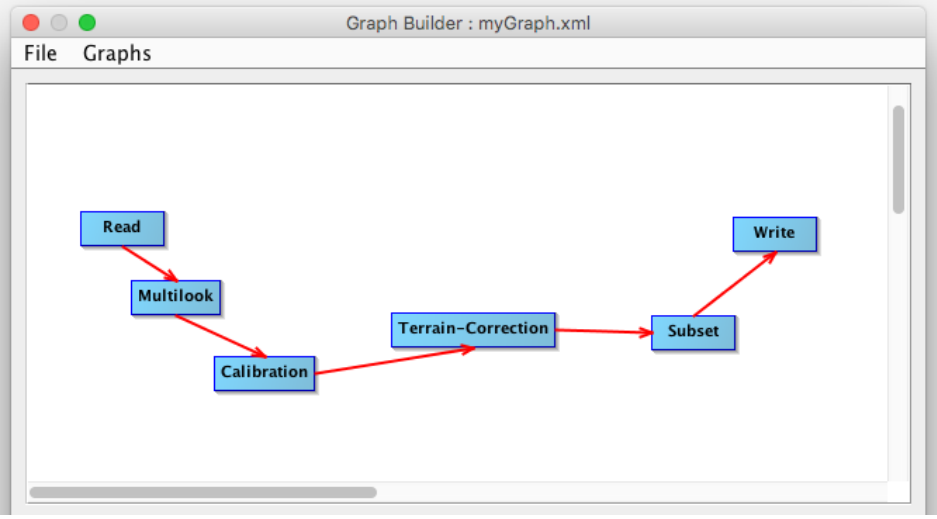

Figure 4.1: Processing Graph for Sentinel-1 Images in SNAP

A simple algorithm for getting difference image and applying the threshold value was implemented in Python. Geo-visualization for detected objects was also implemented in Python by using Folium [3] library. AIS data was taken from [1].

5 Results and discussion

Two areas were chosen for the experiment. One is the sea area near Sakhalin and another is the sea area near Noordwijk. Example of the detected object by the algorithm is shown on Figure 5.1.

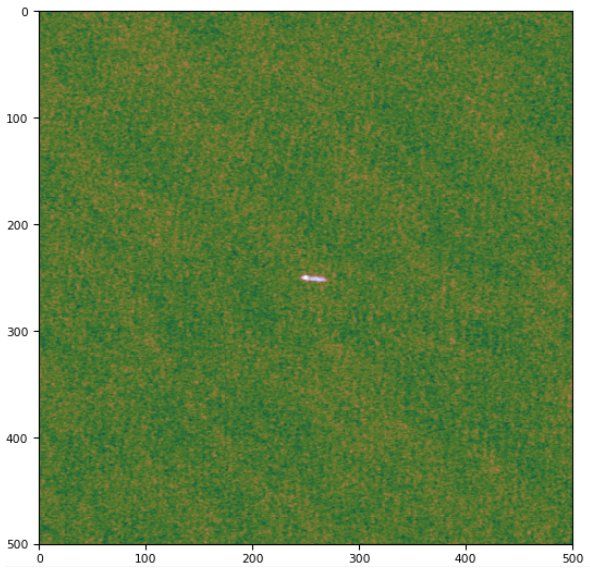

Figure 5.1: Example of The Detected Object by The Algorithm

Example of geo-visualization for detected objects near Sakhalin is shown on Figure 5.2.

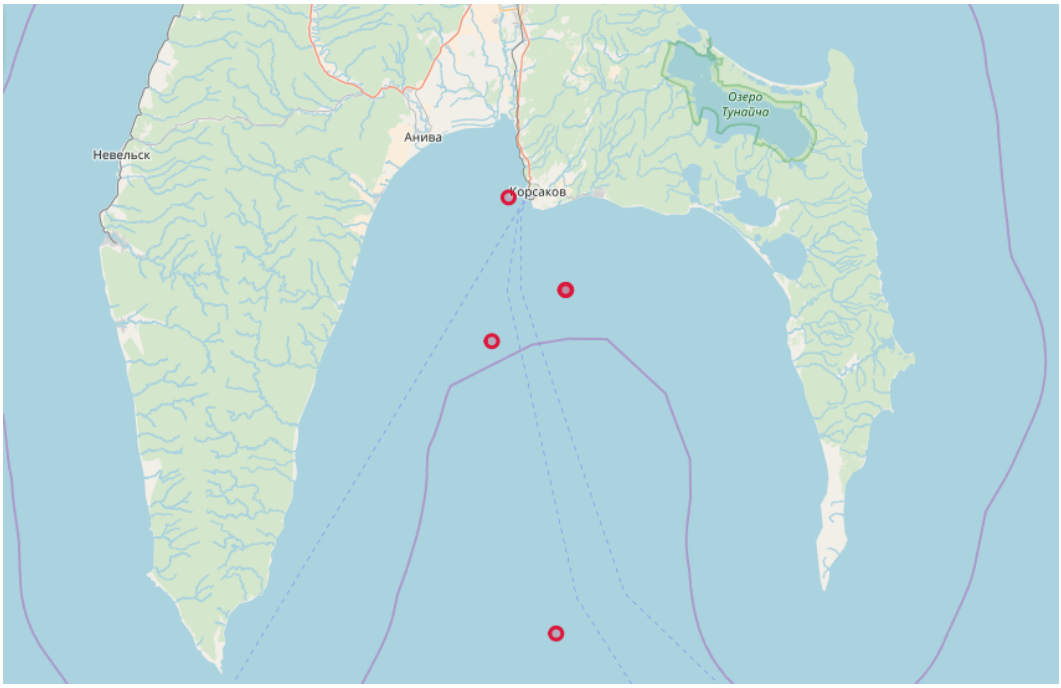

Figure 5.2: Example of Geo-Visualization for Detected Objects

While trying to compare the coordinates of detected objects with AIS data, it was investigated that data source for AIS is incomplete, because it contains the information only for a limited longitude range (see Fig. 5.3).

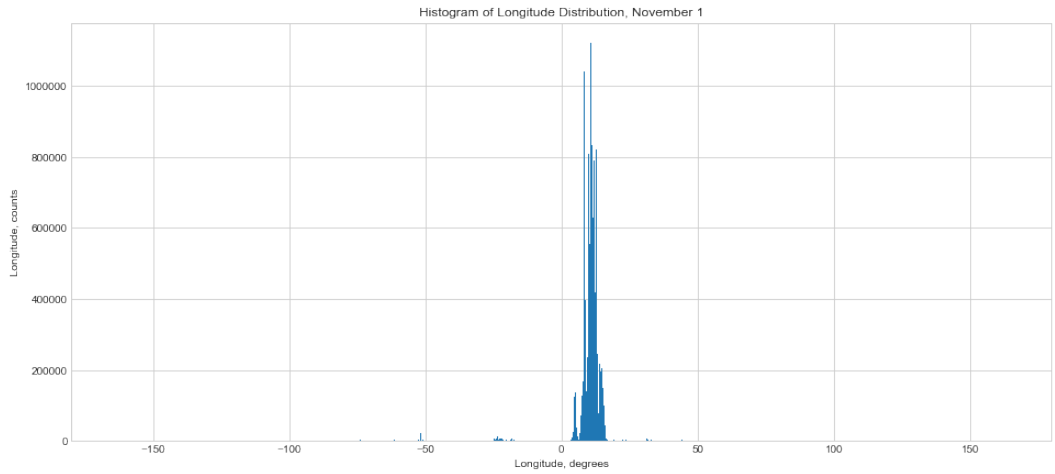

Figure 5.3: Histogram of Longitude Distribution of AIS data on November 1, 2017

As the AIS data was incomplete, so it was not possible to use it for checking the accuracy of the ship detection algorithm. Then, the exploration of available AIS data sources can be considered as one of the task for further research.

6 Conclusion

In this project, the simple algorithm for ship detection as well as the satellite images preprocessing were implemented. The result seems to be promising, however, the considered AIS data source was incomplete and it was not possible to check the accuracy of the algorithm. So, further research of the available AIS data sources is needed for getting "ship/no ship" labels of the detected objects and building a training dataset.

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Moscow, 25/12/2017