ICEBERG DETECTION IN SATELLITE IMAGES

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1.Introduction

1.1. Overview

Icebergs present serious hazards for ship navigation and offshore installations. Consequently, there is a large interest to localize them timely and over vast areas. Because of their independence of cloud cover and daylight, satellite Synthetic Aperture Radar (SAR) images are among the preferred data sources for operational ice conditions and iceberg occurrences.

High resolution Synthetic Aperture Radar (SAR) is regarded as one of the most suitable sensors for object detection and environment monitoring in the field of space technology. It offers wide coverage and ability to scan regardless of weather or time of day. The SAR images are characterized as having high resolution capability, not being dependent on the weather condition and independent of flight altitude. SAR always provides quality images at any condition because of their self-illumination ability. SAR images have a lot of applications in remote sensing and mapping of different surfaces of any planets including the earth.

1.2.Purpose

To build an algorithm which automatically identifies whether a remotely sensed target is an iceberg or not. Often times an iceberg is wrongly classified as a ship. Ship detection is an important topic in the field of remote sensing. At present, many object detection methods have been developed in the pattern recognition community. However, many of the proposed systems have computationally intensive problems for high accuracy performance.

2.Literature Survey

2.1.Existing Problem

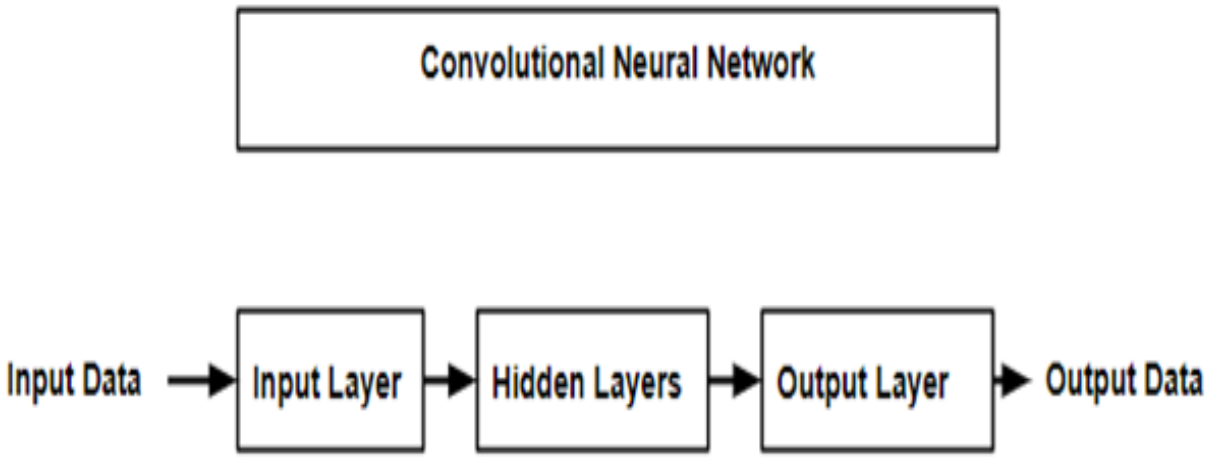
Icebergs present serious hazards for ship navigation and offshore installations. Consequently, there is a large interest to localize them timely and over vast areas. Because of their independence of cloud cover and daylight, satellite Synthetic Aperture Radar (SAR) images are among the preferred data sources for operational ice conditions and iceberg occurrences. The image spatial resolution mostly used for iceberg monitoring varies between a few and 100 m. Processed SAR data are characterized by speckle noise, which causes a grainy appearance of the images making the identification of icebergs extremely difficult. The methods of satellite monitoring of dangerous ice formations, like icebergs in the Arctic seas represent a threat to the safety of navigation and economic activity on the Arctic shelf.

2.2.Solution

To build an algorithm which automatically identifies whether a remotely sensed target is an iceberg or not. Often times an iceberg is wrongly classified as a ship. The algorithm had to be extremely accurate because lives and billions of dollars in energy infrastructure are at stake. As it is a tedious process to record live radar images we can create a web applcation where user can upload available radar images. This uploaded image is analysed by the model which is built and prediction is showcased on the UI.

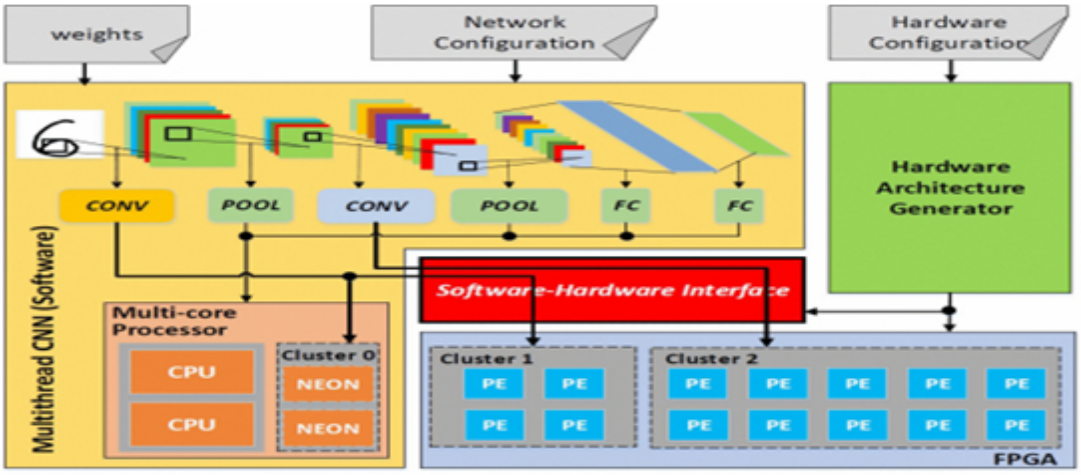
3.Theoritical Analysis

3.1 Block Diagram



3.2. Hardware /Software designing

The model is designed using Jupyter notebook in Anaconda which is a open-source distribution of the Python and R programming languages for scientific computing, that aims to simplify package management and deployment.The application building is done using flask which is a web framework that provides tools, libraries and technologies that allow the developer to build a web application. This web application can be some web pages, a blog, a wiki or go as big as a web-based calendar application or a commercial website.



4.Experimental Investigations

From several exprimental analysis conducted and observed on the Icebergs in the Eurasian Arctic during the year of 2006 it was found that the Icebergs in the Eurasian Arctic seas are significantly smaller than those in the Antarctic and Greenland.

The average length and width of icebergs in the Barents Sea amounts to:

•64 m and 46 m according to ship observations, and

•103 m and 16 m, according to air reconnaissance data

Their maximum sizes amounts to:

•180 m and 30 m according to ship observations, and

•700 m and 50 m according to air reconnaissance data

They are huge and they float low in the water which can cause danger to the ships. They tend to flip over at times. When they flip over the energy is so great it can cause tsunamis and on occasion can trigger earthquakes.

Icebergs in the Eurasian Arctic

North-eastern Barents Sea, April 16, 2006

North-eastern Barents Sea, April 17, 2006

North-western coast of Novaya Zemlya, April 17, 2006

FJL, Salm island, April 25, 2006

Overview of satellite data types

Optical data

• Landsat ETM+

• Resolution: 15 m panchr., 30 m multich. Pixel size: 12.5 m / 25 m

• Swath: 180 x 180 km

• Terra ASTER:

• Resolution & pixelsize: 15 m panchr/multichan. Swath: 60 x 60 km

SAR data

• ENVISAT ASAR: Wideswath: 75 m pixels, 400 km swath

• Alternating Polarisation: 12.5 m pixels, 100 km swath

• RADARSAT ScanSAR Narrow: 25 m pixels, 300 km swath

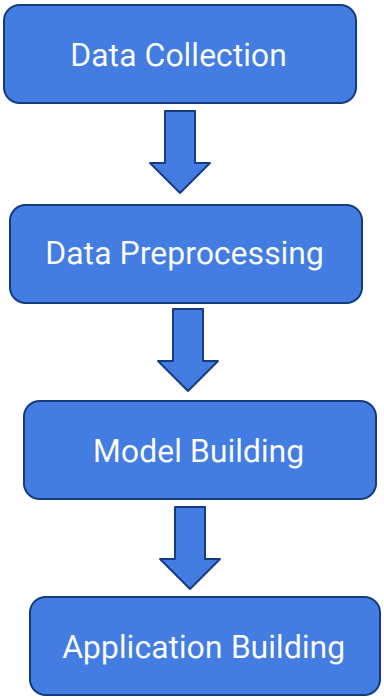
Based on all the above reading there were three situations

1. Icebergs in open water: icebergs will show bright spots against dark background for both optical and SAR, higher wind reduces the contrast between open water and icebergs

2. Icebergs in drifting ice: iceberg will create tracks in the drifting ice if there are larger floes of consolidated ice. Difficult to distinguish icebergs from background both for optical and SAR if only backscatter information is available

3. Icebergs in fast ice near calving areas: optical data shows shadows against background, stationary ice means possible to identify icebergs over longer time periods

5.Flowchart



6.Results

The model underwent 10 epochs leading to the accuracy of 94% which leads to a very accurate model.The model was integrated to a flask web application where after the image is uploaded the model will predict if the image is that of an iceberg or a ship.

7.Advantages and Disadvantages

7.1.Advantages

- Automatically detects the icebergs in the oceans without any human supervision.
- CNN is more efficient in terms of memory and complexity.

7.2.Disadvantages

- CNN do not encode the position and orientation of object.
- Lack of invariant to be spatially invariant to the input data.

8.Applications

- Image recognition
- Video analysis
- Natural language processing
- Anomaly Detection
- Drug discovery
- Health risk assessment and biomarkers of aging discovery
- Checkers game
- Time series forecasting

9.Conclusion

This model is one of the very interesting examples where deep learning can be used to solve a challenging real-world problem. If we are able to detect and segment icebergs in an image, it would be of great help to the logistics and transportation team in northern countries like Sweden, Norway and Canada. It could bring a whole new dimension of transport for container ships and vessels by tracking icebergs from satellite images and videos in real-time.At the same time,this can also reduce the accidents in seas and oceans.

10.Future Scope

The extraction of the road networks from the satellite imagery can be used in

a. Digital cartography updating: with the increasing availability of the remotely sensed imagery the need for reliable and up-to-date maps is growing. The bottleneck in the production of cartographic data lies in the manual processing applied to the data.

b. Multi-temporal change analysis: Change analysis from remotely sensed data has been studied for more than thirty years by the Digital Image Processing and Pattern Recognition communities. High resolution imagery raised new difficulties: occlusions, projective distortion, detail profusion or the presence of shadows, create “apparent changes” which do not correspond to real changes of the scene, and therefore make the interpretation difficult.

c. Content-based image indexation: The task of automatic image labelling and classification is becoming crucial with the exponential increase of the amount of available images and their variety in terms of acquisition sensor and resolution.

11.Bibilography

- https://en.wikipedia.org/wiki/Convolutional_neural_network
- https://www.quora.com
- https://www.google.com
- https://www.kaggle.com/c/statoil-iceberg-classifier-challenge
- http://earth.esa.int/seasar2008/participants/36/pres_36_alexandrov.pdf
- https://towardsdatascience.com/