Convolutional neural network for Iceberg Classifier

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ABSTRACT: Image classification has been a popular research field in computer vision, and we employ convolutional neural network to solve a practical problem that is iceberg classifier. Iceberg classifier is critical import to keep the ship safe in the ocean, because the ships can program another routine after they detect the iceberg. When radar detects an object, it cannot separate it from ship or any other solid object. The radar images contain the shape, size and brightness features. There are several ways to solve the iceberg classification problem: (1) Hough transform \cite{1} (2) convolution neural network \cite{2}. Convolutional neural network can obtain image features that are invisible for human beings. Convolution neural network has achieved expected performance in many image classification problems. Our experiment shows that convolution neural network can classify the iceberg from any other object and we get accuracy 96% and F1 score 96%. Support vector machine \cite{3} achieves accuracy 79% and F1 score 78%.

CCS Concepts
\begin{itemize}
  \item Computing methodologies \rightarrow \textbf{Artificial intelligence} \rightarrow \textbf{Computer vision} \rightarrow \textbf{Computer vision problems} \rightarrow \textbf{Object identification}
\end{itemize}

1. INTRODUCTION
In this paper, we apply convolutional neural network to iceberg classification problem. Iceberg detection makes a great contribution to help the ship from voiding crashing into an iceberg. The radar is used to collect image data which have two channels: HH (transmit/receive horizontally) and HV (transmit horizontally and receive vertically) over the sea. This contains key features, because objects tend to reflect signal differently. At first we apply gauss filter to reduce the noise in the images. And then, to improve the generation of the model, rotation and rolling-over are used to generate new images, hence the data volume in the extended data set is six times as large as that before the expansion. At last we use convolutional neural network and support vector machine to detect the iceberg. The result shows an expected accuracy, and convolutional neural network has a higher score than the support vector machine.
2. Related Work
Image classification has attracted many researcher’s interest. At beginning, features are manual work, it takes a lot of time to design the filters to get the important features from images [4]. Convolutional neural network [5] has receptive fields that can learn features even better than human beings. Convolutional neural network always has convolutional layers, pooling layers, fully connected layers and normalization layers [6].

3. Data Preprocessing
The original data is radar data, that is a solid object will appear as a bright spot since it reflects more radar energy than other things surrounding it. The solid object can be land, islands, sea ice, icebergs and ships.

Fig. 1. HH image

Fig. 2. HH image
3.1 Image Preprocessing

From the three sets of data of data visualization, the image recognition degree synthesized by HH and HV data is higher. Through from human observation, it can be found that some pictures can easily distinguish whether it is an iceberg or a ship, but some pictures are difficult to distinguish whether it is an iceberg or a ship even if they are carefully observed. The main reason is that when the ship or iceberg is small, the difference after imaging is very small, which is also the most critical and difficult part of the whole classification work.

In addition, it can be found that the area of the HV image of the iceberg is smaller than that of the HH image, while the area of the HV image and the HH image of the ship does not change much.

3.2 Gauss Filter

In order to reduce the noise of the synthesized image, the Gauss filter is used to reduce the noise of images at first [7].

Gauss filtering is a linear smoothing filter, which is suitable for removing Gauss noise and is widely used in image processing. Generally speaking, Gauss filtering is the process of weighted averaging of the whole image. The value of each pixel is obtained by weighted averaging of its own and other pixel values in its neighborhood. The specific operation of Gauss filtering is to scan every pixel in the image with a template (or convolution, mask), and replace the value of the central pixel of the template with the weighted average gray value of the pixels in the neighborhood determined by the template.
3.3 Data Augmentation

In order to achieve better training results and avoid over-fitting problems, the data set has been expanded. The specific expansion method is: rotate the original image (90 degrees, 180 degrees, 270 degrees) and flip (upside down, left and right flip). The amount of data in the data set after expansion is six times that before the expansion.

4. Model

4.1 Model Architecture

In this paper, the implementation of CNN uses a 4-layer convolutional layer, a 4-layer pooling layer, and a 3-layer fully-connected layer. We call this convolutional neural network Iceberg-Net that is pretty simple but efficient and fast in iceberg classification.
4.2 Model Parameters
These parameters were used to train the model: loss function is binary cross entropy; optimizer is Adam Optimizer; learning rate is 0.0001; batch size is 25; epochs number is 100.

5. Experiment

5.1 Result
We synthesize images from origin radar data including two channels. After that gauss filter is used to reduce the noise of the images. To improve model’s generalization ability, rotating and flipping are applied to the images, hence more images can be used to train the model. At last, we propose a convolutional neural network model to classify iceberg, and get an accuracy of 95%. It will help a lot by automatic detecting iceberg without taking too much human’s time.

![Confusion matrix](image)

Fig. 8. Confusion matrix

Validating a classification method by confusion matrix [8] is a very efficient way. It shows the items which classified to the right classes and wrong classes. And it will help us find out the connections between the classes and datasets.

|      | Precision | Recall | F1-score | Support |
|------|-----------|--------|----------|---------|
| 0    | 0.93      | 0.97   | 0.95     | 379     |
| 1    | 0.98      | 0.95   | 0.96     | 557     |
| Avg/Total | 0.96 | 0.96   | 0.96     | 936     |

5.2 Analysis
The result shows that the experiment has achieved an expected result. Limited by the quality of the images, there are many images hard for human to classify them. Even worse, there are many images that the objects are very small spot, the icebergs have not so many differences with other objects.

6. Conclusions
In conclusion, convolutional neural network can be employed to solve the iceberg classification problem.
In future work, we will try more image preprocessing method to reduce the noise. And more data argument mechanism will be used to get more training data, so the model will have a better generalization ability to classify the iceberg from other objects.

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