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論文 / 著書情報
Article / Book Information

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種別(和文)	論文要旨
Type(English)	Summary

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（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	Information Processing 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 (Engineering) Doctor of
学生氏名： Student's Name	Lu Yan	指導教員（主）： Academic Supervisor(main)	Masahiro Yamaguchi
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

The dissertation "Small-sized object detection via hyperspectral data" consists of 6 chapters.

Chapter 1 [Introduction] presents the background and the motivation of small-sized object detection using hyperspectral data. The goal of our research is given, which is to propose small-size object detection methods with limited training data, high tolerance of illumination variations, and high accuracy.

Chapter 2 [Object detection on the hyperspectral dataset] briefly introduce the hyperspectral data and conventional approaches such as supervised, unsupervised methods, and semi-supervised methods for object detection. We also introduce in detail several conventional methods such as spectral unmixing, anomaly detection, endmember extraction that will be used in the following thesis.

Chapter 3 [Semi-supervised approach] we propose a semi-supervised method for human detection on the sea surface and the results have been discussed. Small size object detection in a vast ocean plays an important role in rescues after accident or disaster. However, due to the limitation of the sensor's resolution, an interesting target might occupy only several pixels or less in the image, it's difficult to detect the small object, moreover, the sun glint of the sea surface makes it even more difficult. In this chapter, we propose an image analysis technique suitable for the computer-aided detection of small objects on the sea surface, especially humans. We firstly separate objects from the background by adapting a previously proposed image enhancement method using principal component analysis. And then apply a linear unmixing method to define the endmember's spectrum. At last, we use the spectral angle mapping method to classify presented objects and thus detect small size objects. The proposed system provides the following results for supporting the detection of humans and other small objects on the sea surface, an image with spectral color enhancement, alerts of various objects, and the human detection results. This multilayered approach is expected to reduce the oversight, i.e., false-negative error. Results of the proposed technique have been compared with existent methods, and our method has successfully enhanced the hyperspectral image, and detect the small objects from the sea surface with a high human detection rate, shows the ability to further detection of human in this study). The result is less influenced by sun glint effects. This study helps to recognize small objects on the sea surface, and it leads to advances in the rescuing system using aircraft equipped HSI technology.

Chapter 4 [Effect of saturated signal restoration] is proposed as we discovered that the effect of saturated pixels will have a bad influence on the detection method's performance. Thus, we propose a spectral restoration method to improve the detection results. In hyperspectral imaging, the captured signal is often affected by saturation due to specular reflection or a peaky spectrum. In this chapter, we propose a restoration method for saturated hyperspectral signals. Our algorithm is based on principal component analysis to obtain the reconstruction basis and then solve a linear constrained least square problem to calculate the coefficients of each basis. We discuss the problems that saturated signals might cause and apply our method to two sets of real hyperspectral images and a set of hyperspectral images with simulated saturation. The results show that our method helps increase unsupervised object detection by remaining the true positive rate while reducing the false-positive rate. We also test our method on color reproduction experiments using hyperspectral data, results show our method improves high-fidelity color reproduction.

Chapter 5 [Deep Learning based approach] propose a novel 2-stage deep learning-based hyperspectral small-sized object detection method. This method combining spatial and spectral information of hyperspectral data. Pixel-wise spectral information is used in the first stage to obtain 1st-stage classification results, and then the results are combined with spatial information to help eliminate unlikely regions, thus, improving the detection accuracy. An ablation study is also performed to show that two-stage are both needed for accurate detection. As our neural network is small, thus even use limited training data, the performance is outstanding. Also, because the neural network is small, the training is fast and easy to converge. The proposed method is tested on a dataset of real-world airborne hyperspectral images, and its performance is compared with those of several conventional methods such as convolutional neural networks, random forest, and support vector machines. The results show that the proposed method outperforms current state-of-the-art methods. And the receiver operating characteristic curve shows our proposed method performs better.

Chapter 6 [Conclusion and Future Prospect] ends this thesis by drawing conclusions and giving some prospects for future work. Deep learning has the large potential to be used in such small-sized object detection, such as super-resolution method, few-shot or zero-shot learning, attention mechanism, etc.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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