R006-55
Zoom meeting B ：11/4 PM1 (13:45-15:30)
14:15〜14:30

Aurora image segmentation with deep PNU learning

#Ryoya Katafuchi[1)],Yoshizumi Miyoshi[2)],Terumasa Tokunaga[1)]
[(1]Kyutech,[(2]ISEE, Nagoya Univ.

All-sky imaging of aurora has been a powerful tool for studying the generation mechanism of aurora and the coupling system of the magnetosphere and the ionosphere. Long-term ground-based optical observations of aurora with ASI (all-sky imaging) systems have generated vast amount of imaging data for several decades. This has led to growing interest in an establishment of computational methods that can automatically quantify the dynamic behavior of the aurora from ASI data.

Image segmentation is the process of separating a digital image into meaningful segments. This process play an important role to quantify the shapes and sizes of aurora arc from ASI data. Recently, several studies have succeeded in developing high-performance aurora classifiers based on deep learnings for ASI data [Clausen and Nickisch, 2018; Kvammen et al., 2020]. Although these data-driven aurora detectors and classifiers will be powerful tools for polar studies, the segmentation task is more challenging: there is no publicly available datasets containing pixel-level annotations that can be used for aurora segmentations.

The present study proposes a novel image segmentation technique designed for smaller training data. Our idea relies on PNU (positive, negative and unlabeled) learning for binary classification of patch images. Sakai et al. [2018] proposed a fundamental framework and demonstrated superior performances of PNU learning for semi-supervised binary classification problems using simple classifiers. In this study, we extend the loss function of PNU learning that makes it possible to apply the backpropagation algorithm for training CNN (convolution neural networks).

Using the THEMIS ground-based All-Sky Imager data (https://data.phys.ucalgary.ca/sort_by_project/THEMIS/asi/stream0/), we performed experiments for automatic segmentation of discrete arcs. Our method consists of two phases: the training phase and the test phase. In the training phase, we prepare 100 positive (discrete arcs) and negative (others) patches. These positive and negative patches are manually extracted from the THEMIS ASI data. In addition, 3,000 unlabeled patches are randomly extracted from throughout the dataset. The three types of data are used to train the CNN model called ResNet18 for binary classification (PNU learning). In the test phase, patch images are extracted by a raster scanning from input ASI data. The extracted patches are classified into “discrete arcs” and “others” using the trained ResNet18. Finally, boundaries of segmented discrete arcs are corrected based on an unsupervised learning using the fully-connected CRF (conditional random field). In the presentation, we will report initial results of our segmentation technique for THEMIS ASI data. Then, we will discuss the further developments of the proposed method towards the integrated analysis tool for ASI data.