CS232 Project Proposal

Shape Recovery on Low-Quality or Missing Image

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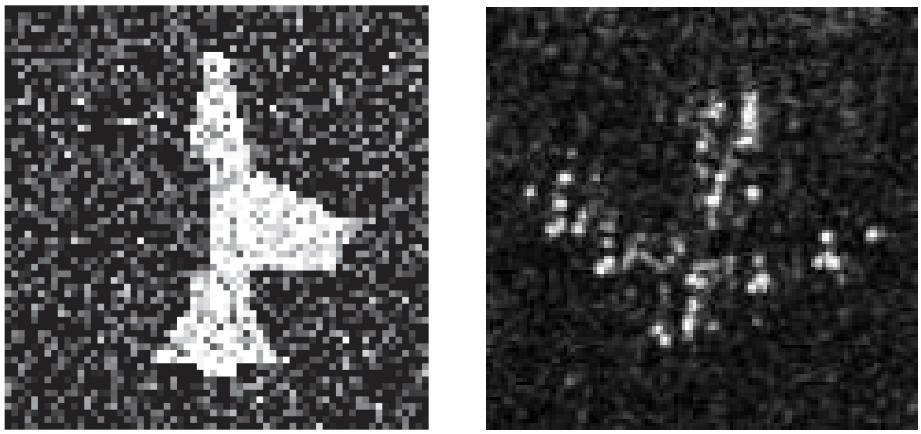
Motivation

Shape segmentation or recovery is an essential task in image processing, especially in remote sensing imagery. Due to the complicated imaging conditions, satellite images are usually noisy and blurred, which makes it challenging to recognize the actual shape of ground objects[1,2]. In this project, we aim at recovering shape of remote sensing objects (e.g. aircraft) based on MCMC sampling and operations learned from class.

Dataset

In this project, we plan to perform experiments on two datasets: aircraft, and SAR remote sensing dataset. The aircraft dataset [3] includes 11 synthetically generated binary aircraft images as shown in Figure 1. We use this dataset to test our implementation of MCMC sampling algorithm. The SAR dataset contains aircraft images obtained from A Synthetic Aperture Radar (SAR). These images are noisy and blurred. Our goal is to recovery the aircraft's shape from this low-quality imagery.



(a) (b)

Figure 1. (a) An example input image from the aircraft dataset. (b) An example input image from the SAR dataset

Methodology

1. MCMC Shape-Sampling Model

We adopted the MCMC shape-sampling model developed by Erdil et al. [4]. To identify and segment the object from a given image, the model estimates the boundary of a set of possible target objects from training images, and evaluates whether the boundary of the foreground in the new image matches the boundary of any target objects. Particularly, rather than finding a single best match of the object identity, the current model takes a Bayesian approach and estimates the posterior distribution on all possible object identities. Also, to deal with discontinuous and occluded foreground objects, the model first evaluates the identity of shapes on subregions and finally combine the results to form the complete output. The model

was validated on target objects with both small shape variance (the aircraft dataset) and huge shape variance (the MNIST[5] dataset).

2. Preprocessing and Postprocessing

To facilitate and enhance performance of the shape recovery algorithm, the ideal input image should consist of clear continuous foreground and background, and the ideal output image should contain one unified target shape. To achieve these criterions, in the preprocessing stage, different thresholding methods, such as Otsu's thresholding, locally adaptive thresholding, and MSER, and noise-removal filters, such as median filters or averaging filters, will be utilized to separate the foreground object clearly from the background and reduce the impact of noise. Model outputs often contain discontinuous regions and holes. Hole filling and small region removal techniques will be used to form a unified shape. Lastly, several image processing techniques, such as sharpening filters, will be applied to improve final image quality.

This project will not make use of an Android device.

Reference

[1] He, Chu, et al. "Weakly supervised object extraction with iterative contour prior for remote sensing images." EURASIP Journal on Advances in Signal Processing 2013.1 (2013): 19

[2] Zhang, X., B. Xiong, and G. Kuang. "Aircraft Segmentation in SAR Images Based on Improved Active Shape Model." ISPRS-International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences (2018): 2331-2335.

[3] Kim, Junmo, Müjdat Çetin, and Alan S. Willsky. "Nonparametric shape priors for active contour-based image segmentation." *Signal Processing* 87.12 (2007): 3021-3044.

[4] Ertunc Erdil, Sinan Yildirim, Tolga Tasdizen, Mujdat Cetin, "MCMC Shape Sampling for Image Segmentation with Nonparametric Shape Priors", Computer Vision and Pattern Recognition, CVPR 2016, Las Vegas.

[5] LeCun, Yann, et al. "Gradient-based learning applied to document recognition." *Proceedings of the IEEE* 86.11 (1998): 2278-2324.