Eff0-UNet: A Novel Deep Learning Architecture for Subsurface Salt Body Segmentation

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Abstract

Salt body identification is one of the crucial steps in seismic data interpretation workflow as it contributes to the exploration of hydrocarbon and understanding of reservoir trapping mechanism. This task has proven to be arduous because of the challenges associated with the size of seismic volume, the labour-intensive and costly manual annotation, poor seismic resolution, and the need for highly supervised human expertise. This necessitates an urgent demand to automate this task for increased efficiency and optimization in seismic interpretation workflow. The existing workflow for seismic interpretation using Convolutional Neural Network (CNN) relies on supervised deep-learning techniques that require ground truths. However, challenges arise from the scarcity of accessible seismic masks and limited publicly available labelled seismic datasets. To address this, our paper presents a novel encoder-decoder CNN architecture, Eff0-UNet, for segmenting salt bodies in seismic data. In addition, we combined seismic denoising, seismic attribute extraction, and threshold-based segmentation to automatically create the salt masks from the images before being passed into the proposed network for learning. The dataset employed was originally used in the TGS Salt Identification Challenge which consists of 4,000 seismic image-mask patches for training and 18,000 seismic image patches for testing. Various image augmentation techniques were applied to improve the model's generalization capabilities. The model performance is evaluated using metrics such as Intersection Over Union (IoU) and a net loss function (Dice Loss + BCE Loss). The model achieves an IoU score of up to 95% and a net loss of 0.23 when compared to the ground truth. These findings underscore the capacity of CNN to automate the process of salt body segmentation in seismic data.