



Contribution ID: 423

Type: Oral Presentation

Attention-Res-UNet-based WGAN-GP Network to Boost Digital Rock Image Resolution

Wednesday, 24 May 2023 15:00 (15 minutes)

1. OBJECTIVE/SCOPE (25-75 words)

High-quality digital rock porous images are required hours to obtain using micro-Computed Tomography (μ -CT), while low-quality digital rock images only take a few minutes. To reduce the scanning time while keeping the high-resolution pore structures, we propose an Attention-Res-UNet-based Wasserstein generative adversarial network with gradient penalty (WGAN-GP) to rapidly restore noisy μ -CT images to their clean counterparts.

2. METHODS, PROCEDURES, PROCESS (75-100 words)

There are mainly four steps within our workflow. Step 1: We extract numerous subsamples from the original rock image with data augmentation techniques to obtain sufficient training datasets. Step 2: train the Attention-Res-UNet-based WGAN-GP using the low-resolution rock porous images and the corresponding high-resolution rock porous images, in which the generator is composed of a Res-UNet with attention mechanism, and the loss in each layer is extracted to boost the predictivity, as shown in Figure 1. A VGG loss is combined to enhance the capability of capturing important features. Step 3: we conduct high-resolution Navier-Stokes simulations for the generated high-resolution images and the corresponding ground truth to calculate the permeability and relative permeability. Step 4: We then compare the calculated physical properties and the difference maps between the generated images and the ground-truth images. If the physical properties are significantly different and the difference maps contain large errors, we need to check the accuracy of the Attention-Res-UNet-based WGAN-GP.

3. RESULTS, OBSERVATIONS, CONCLUSIONS (100-200 words)

Two datasets on 2D and 3D rock porous images demonstrate that the proposed Attention-Res-UNet-based WGAN-GP can successfully boost the resolution with minor errors. We further compare the performance of the proposed model with traditional Super-Resolution GAN (SRGAN) and Enhanced Super-Resolution GAN (EDSR). Our proposed method achieves the highest accuracy with the same dataset. The Attention-Res-UNet-based WGAN-GP outperforms other models because 1) the individual loss in each layer is combined with the final loss, which helps the network generate better feature representation at each layer; 2) the attention mechanism helps the network capture the most relevant features; 3) the residual block's utilization in Res-UNet alleviates the gradient vanishing problem and boosts information exchange across different layers; 4) the pre-trained VGG network helps the network to extract high-level features, and 5) the use of WGAN stabilizes the training process by surpassing the Jensen-Shannon divergence.

4. NOVEL/ADDITIVE INFORMATION (25-75 words) no more than three sentences

We propose a novel super-resolution approach using Attention-Res-UNet-based WGAN-GP to boost the resolution of 2D and 3D rock porous images, which is superior to the traditional models regarding accuracy and efficiency. This method enables us to obtain high-resolution rock porous images for real-time analysis.

Participation

In-Person

References

MDPI Energies Student Poster Award

Yes, I would like to submit this presentation into the student poster award.

Country

Saudi Arabia

Acceptance of the Terms & Conditions

[Click here to agree](#)

Energy Transition Focused Abstracts

Primary authors: HE, Xupeng; LI, Yiteng (King Abdullah University of Science and Technology); ZHANG, Zhen; Mrs ALSINAN, Marwa (Saudi Aramco); Dr KWAK, Hyung (Aramco); HOTEIT, Hussein (King Abdullah University of Science & Tech (KAUST))

Presenter: ZHANG, Zhen

Session Classification: MS10

Track Classification: (MS10) Advances in imaging porous media: techniques, software and case studies