Application of GAN to Resolution Enhancement of LWD Real Time Images to Support Decision Making

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Abstract:

In the current scenario of project management, where the agility and optimization of operations have been prioritized, the practice of logging while drilling has gained space compared to traditional wireline logging. In theory, acquiring quality petrophysical properties during drilling brings greater agility in decision making about completion and optimizes operation costs. However, regarding borehole image logs, due to limitations in transmission capacity, the actual available data in real time contain about 50% (for resistivity images) of the full azimuth information, being insufficient for the identification of critical geological structures capable of impacting the communication between production or injection zones, or the quality of cementation, such as fractures, caves, and geomechanical collapse zones. The tool's memory data with the full information may take a few days after the end of drilling to be delivered by the service company, which in some cases is not enough time for fast decision making regarding completion.

In this work, we tested models based on generative adversarial neural networks (GANs) to reconstruct the complete memory data based on real-time input. As in conventional GAN schemes, a generator is trained to receive a real-time input and create a "memory-like" image, while a discriminator is trained to tell real and fake images apart. To regularize the convergence of training, we used an architecture known in the literature as CycleGAN, where another pair of generator-discriminator is trained simultaneously to do the reverse process, recreating the real-time data.

Variations of the training process and data sets were used to generate different CycleGAN models. They were trained using logs of presalt reservoirs in the Buzios Field, and performance was assessed on logging intervals not seen by the algorithms during training. The results achieved so far have been very promising, as in certain intervals, resultant models were able to capture the presence of fractures and caves, as well as the general texture of resistivity LWD image logs, as shown in the figure attached.

This methodology represents a way of circumventing telemetry limitations, where missing information is added indirectly to the real-time data as the artificial intelligence (AI) algorithm learns the main characteristics of a field/reservoir. Therefore, previous knowledge from the field can be used to continuously optimize future operations, efficiently incorporating the available database into the workflow of petrophysicists for the recognition of geological and geomechanical structures in time to support decision making in completion operations.

Bio:

Willian Andrighetto Trevizan received his BSc in Physics from University of Sao Paulo, Brazil, where he also got his MSc degree (working with statistical modeling of biological systems) and PhD degree (working with Nuclear Magnetic Resonance in porous media).

Since 2012, he works in Petrobras' Research Center (Cenpes) where he develops activities and research related to formation evaluation, petrophysics and well logging interpretation, mainly focused on Nuclear Magnetic Resonance Relaxometry and Image logs.

In the field of NMR, he contributed in the development of upscaling strategies for core-log integration, as well as in NMR raw data processing which lead to quality control strategies to ensure good quality LWD data in Petrobras.

More recently, works with the application of AI techniques to anticipate information in real time, such as predicting well logs at the drill bit and enhancing the resolution of real time image logs, and also in predicting patterns in image logs to assist interpretation.