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Structure Oriented Hybrid Filter for Enhancing Seismic Edges and Channels

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ABSTRACT

Seismic edge detection attributes are often used to assist interpretation of faults, channels, fractures and other stratigraphic events. Noise reduction of seismic data prior to edge detection is critical to ensure accurate interpretation of subtle geologic features. Among various methods developed for spatial noise removal, structure oriented bilateral filter become most popular and is routinely applied prior to computing edge detection attributes due to its ability to preserve the discontinuities effectively while improving signal-to-noise ratio. However, bilateral filter fails to eliminate certain noises such as impulsive non-Gaussian addictive and salt-and-pepper type noises. It is also ineffective for coherent noise removal. To overcome bilateral filter deficiencies, we introduced a third filter (trilateral filter) to eliminate noises that are immune to bilateral filtering. Our study shows that the trilateral filter can successfully remove non-Gaussian addictive noise but it also damages the structure information that is otherwise preserved by using bilateral filter only. To take advantage of the benefits of bilateral and trilateral filters, a combination of these is conceived and investigated. We propose a hybrid filter that integrates both bilateral and trilateral filter (alpha-mean, or median filter etc.) to take advantage of good features of both filters. The hybrid filter is defined as: Hybrid filter = α (bilateral filter) + β (trilateral filter) Where $\alpha + \beta = 1$. The control parameters α and β can be adjusted to generate different hybrid filters according to signal-to-noise ratio of the data. The special case, $\alpha=1$, $\beta=0$ gives a bilateral filter and a trilateral filter can be obtained with $\alpha=0$, $\beta=1$. The advantage of the hybrid filter is preserving structure oriented feature while removing non-Gaussian addictive noise without compromising the structure information. We applied the proposed hybrid filter ($\alpha=2/3$, $\beta=1/3$) and bilateral filter to smooth the seismic data and then compute edge attribute in two field cases. The case studies show that hybrid filter is superior to bilateral filter in removing seismic noise and enhancing edges and channels as well as delineating geological features with negligible extra computation cost.