Geophysical data fusion of ground-penetrating radar and magnetic datasets

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Talk Abstract

Geophysical data gathered in archaeological sites have a lack of perceptibility regarding buried structures, i.e., it is not possible to recognize useful information related to structures in the signal. This issue might be caused by soil conditions, which raise the signal to noise ratio and limit proper interpretation of the results. A beginning hypothesis was proposed to overcome this problem: low perceptibility data may contain useful information that is intermingled with background noise and may be revealed by combining two geophysical datasets taken at the same location. Data fusion is a concept that allows two input datasets to be combined to create a new dataset that is more informative, sharper, and of higher quality than the inputs alone. This method is commonly utilized in brain tumor identification in medical imaging methodologies. When used to geophysical datasets, data fusion can improve the information extracted from the results. The suggested geophysical data fusion method was applied to datasets gathered at an archaeological site using ground-penetrating radar (GPR) and vertical magnetic gradient (MAG) [1]. The technique employs the 2D Wavelet transform [2,3], multiresolution singular value decomposition [4], and image gradient [5]. This is a decision-level data fusion technique used in the transformed domain. The results of the testing reveal that the suggested data fusion approach yields a more detailed output with higher clarity and quality than the input data alone, even when processed using standard processing operations with the best user parametrization. The increase in sharpness and quality was graphically validated and monitored in different stages by calculating the sharpness and BRISQUE quality index.

Keywords: Geophysical data fusion, 2D Wavelet transform, multiresolution singular value decomposition, image gradient, GPR and MAG datasets.

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References

[1]Oliveira, R. J., Caldeira, B., Teixidó, T., Borges, J. F., & Bezzeghoud, M. (2022). Geophysical data fusion of ground-penetrating radar and magnetic datasets using 2D wavelet transform and singular value decomposition. Frontiers in Earth Science, 2089.

[2]Mallat, S. G. (1989). A theory for multiresolution signal decomposition: the wavelet representation. IEEE Transactions on Pattern Analysis and Machine Intelligence, 11(7), pp. 674–693.

[3]Naidu, V. P. S., & Raol, J. R. (2008). Pixel-level image fusion using wavelets and principal component analysis. Defence Science Journal, 58(3), pp. 338–352.

[4]Naidu, V. P. S. (2011). Image fusion technique using multi-resolution singular value decomposition. Defence Science Journal, 61(5), pp. 479–484.

[5]Yang, Y., Huang, S., Gao, J., & Qian, Z. (2014). Multi-focus image fusion using an effective discrete wavelet transform based algorithm. Measurement Science Review, 14(2), pp. 102–108.