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Advanced Image Processing Methods Applied to Enhance the GPR Images

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The main purpose of a geophysical survey is to solve an engineering or exploration problem by obtaining the clearest possible image of the subsurface. For this purpose, data measurement methodologies and capabilities of measuring equipments are continuously improved. On the data processing side, various inversion schemes, usage of different smoothing and/or constraining functionals, plenty of alternative filters, migration operators and many more principal or auxiliary procedures are suggested to achieve the clearest possible geophysical image. Particularly in potential field methods, various filtering processes are applied to the data to highlight some elements in the geophysical image. In any case, the final geophysical model or image is presented by a color coded graphic. User-dependent settings used to create the graphics, such as the selection of color map, amplitude limits, contour interval etc. will affect the detail level of the final image. Choices related to the mentioned parameters may result in the disappearance of details in the model/section/map or the appearance of artificial anomalies.

In this work, a group of image processing methods was applied to ground penetrating radar (GPR) data for the aim of obtaining an enhanced view of the subsurface. The processes are classified into main categories such as de-noising, sharpening, lighting and shading, edge and linearity detection. These processes were realized by the application of convolution filters, transforms (e.g. Hough transform) or gradient tools. The codes that perform the mentioned processes are written in MATLAB language and supported by a user-friendly interface. Thus, the interpreter can choose the best image of the subsurface among the images rendered with all possible processing options. In addition, the data can also be processed within a predetermined workflow. All of the image processing methods mentioned here have been directly applied to numerical data sets instead of a soft copy of an image.

The overall methodology aims to minimize losses and errors based on the user choices about the visualization options. The interpreter will be able to emphasize various structures on the map or the sections by interactively changing the filter or transform parameters. The GPR data used for the demonstration of the study were measured during the extensive archaeo-geophysical surveys carried out in Side and Patara, the two most important cities of the ancient Lycia and Pamphylia regions. The GPR surveys were supported with electrical resistivity tomography (ERT) measurements at anomalous regions. The GPR data were processed with usual steps such as static correction, dewow, band-pass filtering, gain correction, background removal and migration. Time slices of processed GPR data were provided to the available image processing routines in the code. Most options enhanced the final image compared to the original one. This semi-automated process helps the interpreter to highlight the anthropogenic structures seen in the time/depth slices and export the preferred image in different available formats.