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Automated real-time processing of GPR images by using the Canny edge detection operator in the first stage of the algorithm

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Canny edge detection is a multistage processing method that can be employed to detect edges in an image while suppressing noise. This edge detection operator was proposed by Canny in 1986 and is nowadays used for the real-time analysis of images in several application areas, including facial expression recognition, traffic management, tracking of unmanned aerial vehicles, public safety, and more.
Ground Penetrating Radar (GPR) systems are most often used to detect buried targets. Small circular-section targets (such as tubes and cables, tree roots, landmines, concrete rebar, etc.) translate into radargrams as hyperbolic-shaped signatures. Considering the large quantity of GPR data that can be acquired during a field campaign, the manual detection and localization of hyperbolas in radargrams can be a lengthy task, which becomes impracticable in large-scale surveys. Moreover, the manual detection may be unfeasible in real-time applications. For these reasons, various research teams have been recently working at the development of quick and automated algorithms for the detection of hyperbolas in radargrams.
In this work, we investigate the applicability of the Canny edge detection operator in the GPR area. In particular, we use Canny edge detection as the first step of a processing algorithm for the real-time detection of hyperbolic reflections in GPR images. Particular efforts were done to reduce the time needed to detect edges in a radargram. Several criterions were proposed and analysed, to eliminate unwanted edge pixels and extract those points that actually belong to the sought hyperbolic reflections. The optimized edge image is passed to the subsequent steps of the algorithm, which estimate the position of the relevant targets.
The proposed processing algorithm was implemented in Matlab and it was tested on synthetic and experimental radargrams. The open-source finite-difference time-domain simulator gprMax was used to generate the synthetic radargrams, whereas the experimental radargrams were obtained by field survey.