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Clustering analysis for muon tomography data elaboration in the Muon Portal project

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Clustering analysis is a set of multivariate data analysis techniques through which is possible to gather statistical data units, in order to minimize the "logical distance" within each group and to maximize the one between groups. The "logical distance" is quantified by measures of similarity/dissimilarity between defined statistical units. Clustering techniques are traditionally applied to problems like pattern recognition, image classification and color quantization. These techniques allow to infer the implicit information in the data so they are used as a data mining technique to simplify the complexity of big dataset. In this paper the authors present a novel approach to the muon tomography data analysis based on clustering algorithms. As a case study we present the Muon Portal project that aims to realize dedicated particle detector for the inspection of harbor containers to hinder the smuggling of nuclear materials. Cluster analysis successfully elaborates data in the Muon Portal project, meeting the need to make independents the tracks reconstruction and the visualization of the container's content from the grid and the 3D-voxels. The presence of a three-dimensional grid indeed limits the automatic object identification process. The problem is relevant in scenarios where the threat to be identified has a comparable size (or even smaller) to those of the single voxel and is located in a position not aligned with the grid. Clustering techniques, working directly on points, help to detect the presence of suspicious items inside the container, acting, as it will be show, as a filter for a preliminary analysis of the data.

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