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A real-time framework for fast data retrieval in an image database of volcano activity scenarios

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Explosive Activity at Stromboli Volcano (Aeolian Islands) is continuously monitored by INGV-OE in order to analyze its eruptive dynamics and specific scenarios. In particular, the images acquired from thermal cameras represent a big collection of data. In order to extract useful information from thermal image sequences, we need an efficient way to explore and retrieve information from a huge amount of data. In this work, a novel framework capable of fast data retrieval, using the "metric space" concept, is shown. In the light of it, we implemented an indexing algorithm related to similarity laws. The focal point is finding objects of a set that are “close” in relation to a given query, according to a similarity criterion. In order to perform this task, we performed morphological image processing techniques to each video frame, in order to map the shape area of each explosion into a closed curve, representing the explosion contour itself. In order to constitute a metric space, we chose a certain number of features obtained from parameters related to this closed curve and used them as objects of this metric space where similarity can be evaluated, using an appropriate “metric” function to calculate the distances. Unfortunately, this approach has to deal with an intrinsic issue involving the complexity and the number of distance functions to be calculated on a large amount of data. To overcome this drawback, we used a novel abstract data structure called "K-Pole Tree", having the property of minimizing the number of distances to be calculated among objects. Our method allows for fast retrieval of similar objects using an euclidean distance function among the features of the metric space. Thus, we can cluster explosions related to different kinds of volcanic activity, using "pivot" items. For example, given a known image sequence related to a particular type of explosion, it is possible to quickly and easily find all the image sequences that contain only similar explosions. Our framework is able to both classify each new explosion and dynamically insert the corresponding object into our tree data structure. This approach is able to cluster the entire data space, ensuring that objects with similar features are grouped and classified together.