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A Segmentation Method for Grayscale Images Based on the Firefly Algorithm and the Gaussian Mixture Model

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Abstract : In this research, we propose an unsupervised grayscale image segmentation method based on a combination of the Firefly Algorithm and the Gaussian Mixture Model. Firstly, the Firefly Algorithm has been applied in a histogram-based research of cluster means. The Firefly Algorithm is a stochastic global optimization technique, centered on the flashing characteristics of fireflies. In this context it has been performed to determine the number of clusters and the related cluster means in a histogram-based segmentation approach. Successively these means are used in the initialization step for the parameter estimation of a Gaussian Mixture Model. The parametric probability density function of a Gaussian Mixture Model is represented as a weighted sum of Gaussian component densities, whose parameters are evaluated applying the iterative Expectation-Maximization technique. The coefficients of the linear super-position of Gaussians can be thought as prior probabilities of each component. Applying the Bayes rule, the posterior probabilities of the grayscale intensities have been evaluated, therefore their maxima are used to assign each pixel to the clusters, according to their gray-level values. The proposed approach appears fairly solid and reliable when applied even to complex grayscale images. The validation has been performed by using different standard measures, more precisely: the Root Mean Square Error (RMSE), the Structural Content (SC), the Normalized Correlation Coefficient (NK) and the Davies-Bouldin (DB) index. The achieved results have strongly confirmed the robustness of this gray scale segmentation method based on a metaheuristic algorithm. Another noteworthy advantage of this methodology is due to the use of maxima of responsibilities for the pixel assignment that implies a consistent reduction of the computational costs.

Keywords : clustering images, firefly algorithm, Gaussian mixture model, meta heuristic algorithm, image segmentation
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