Image Segmentation Using Electromagnetic Field Optimization (EFO) in E-Commerce Applications

Pankaj Upadhyay, National Institute of Technology Kurukshetra, Kurukshetra, India
Jitender Kumar Chhabra, National Institute of Technology Kurukshetra, Kurukshetra, India

ABSTRACT

Image recognition plays a vital role in image-based product searches and false logo identification on e-commerce sites. For the efficient recognition of images, image segmentation is a very important and is an essential phase. This article presents a physics-inspired electromagnetic field optimization (EFO)-based image segmentation method which works using an automatic clustering concept. The proposed approach is a physics-inspired population-based metaheuristic that exploits the behavior of electromagnets and results into a faster convergence and a more accurate segmentation of images. EFO maintains a balance of exploration and exploitation using the nature-inspired golden ratio between attraction and repulsion forces and converges fast towards a globally optimal solution. Fixed length real encoding schemes are used to represent particles in the population. The performance of the proposed method is compared with recent state of the art metaheuristic algorithms for image segmentation. The proposed method is applied to the BSDS 500 image data set. The experimental results indicate better performance in terms of accuracy and convergence speed over the compared algorithms.

KEYWORDS
Clustering, E-Commerce, Electromagnetic Field Optimization, Image Segmentation, Meta-Heuristic

1. INTRODUCTION

In the present era of advanced technologies, Internet has influenced every aspect of human life. Emergence of e-commerce has changed whole ways of buying and selling, known earlier. Buying and selling of commodities using e-commerce sites have increased manifolds during the last decade. In 2012, first time in the history, e-commerce sales surpassed $1 Trillion mark. As the number of Internet users is increasing day by day, e-commerce is also growing at a fast pace. Images play an important role during online shopping and image recognition is one of the most important applications in e-commerce. In e-commerce image-based product search is gaining popularity, but is a very challenging task. Image recognition plays an important role in content-based search, fake logo identification and customer sentiment analysis. The results of image recognition are highly dependent on efficient image segmentation.

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Image segmentation is the process of breaking an image into different homogeneous parts based on some similarity features like intensity or color (Balla-Arabe et al., 2013). Image segmentation is an essential and important phase for almost every computer vision application. A segmented image provides a much simpler representation of an image and is further used to extract the features. The context of image segmentation varies from one application to another. Object localization and identification is a crucial part of image recognition (Guoying et al., 2015). Image segmentation methods can be classified into two broad categories: (i) traditional methods; and (ii) soft computing methods. The traditional methods are simple and easy to implement and further classified according to their nature of working as: (a) thresholding; (b) clustering; (c) region growing; and (d) edge based segmentation. But the traditional methods are unable to handle real-world complexity, imprecision, and uncertainty. It has been reported that the soft computing methods prove to be superior in handling imprecision and uncertainty (Mylonas et al., 2015) and can be used to efficiently solve image segmentation problem. Over the last few decades, various metaheuristic techniques have been proposed for image segmentation, and each has its own merits and demerits.

This article presents a physics-inspired electromagnetic field optimization (EFO)-based image segmentation method. The proposed approach is physics inspired population-based metaheuristic that exploits the behavior of electromagnets. EFO maintains a balance among exploration and exploitation using the nature-inspired golden ratio between attraction and repulsion forces and converges fast towards a globally optimal solution (Abedinpourneshotorban et al., 2016).

2. RELATED WORKS

In recent past, various nature-inspired, bio-inspired and physics inspired optimization algorithms have been proposed for clustering and applied to image segmentation. In the last decade, significant progress in automatic clustering algorithms has been done. In particular, different evolutionary bio-inspired metaheuristics have been proposed to obtain near-optimal solutions for cluster analysis. These metaheuristics mimic the natural phenomenon of evolution, social behavior of swarms, physics-inspired behavior of objects. Bandyopadhyay et al. (2002) proposed a genetic algorithm with a variable length string. They used the Davies-Bouldin index as an objective function to evolve the clusters automatically and demonstrated the improved performance on real and artificial data sets. The proposed algorithm is named as GCUK for unknown k. (Omran et al., 2006) proposed particle swarm optimization-based clustering approach named as DCPSO. Initially, it partitioned data set into larger clusters and then used PSO for optimal cluster evolution for image segmentation. Mukhopadhyay & Maulik (2011) proposed a variable string length genetic fuzzy clustering-based image segmentation for T-1 and T-2 weighted brain MRI images.

Bhandari et al. (2015) proposed a modified Artificial Bee Colony optimization algorithm-based satellite image segmentation. The proposed algorithm provided an improved exploitation over other optimization algorithms. Mlakar et al. (2016) proposed a hybrid differential evolutionary optimization approach for multilevel thresholding. Sun et al. (2016) proposed a hybridized Gravitational Search Algorithm using Genetic algorithm operator for multilevel thresholding. Integration of these two concepts was introduced to deal with the problem of premature convergence. Li et al. (2017) proposed a modified quick Artificial Bee Colony optimization for multilevel thresholding, which was reported to be computationally faster. Resma and Nair (2018) proposed a Krill Herd optimization algorithm for multilevel thresholding. Authors claimed that the proposed algorithm reduced the computational time. Jiang et al. (2017) proposed a Bayesian Honey Bee Mating optimization method for multilevel thresholding, which was reported to reduce the computational complexity and curse of dimensionality. Muangkote et al. (2017) proposed differential evolution based multilevel image segmentation. Recently another nature-inspired multilevel thresholding method has been proposed by Abd el Aziz et al. (2017), using whale optimization and moth-flame optimization. Sarkar et al. (2015) proposed one minimum cross entropy and differential evolution based multilevel thresholding for color images. A
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