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# Chaotic target representation for robust object tracking

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## Abstract

In this paper, a new object representation method is introduced as an appearance model based on chaos theory. For robust object tracking, the theory is used to extract a deterministic model from irregular patterns of pixel amplitudes in a target region. The object tracking algorithm that accompanies the proposed method involves two steps. First, fractal theory is applied to a compressive sensing method intended to embed an image into a two-dimensional state space during tracking by detection. After an object representation is extracted from an instance, the fractal dimension of the state space is assigned to the importance weight of the instance for efficient online multiple-instance learning. Second, a chaotic map approach is adopted to update the appearance model. Such updating is a crucial step in selecting discriminative and robust features. To highlight the advantages of the algorithm put forward in this work, its accuracy is validated on a large dataset. Results show that the proposed algorithm is more efficient than state-of-the-art tracking algorithms, with the former outperforming the latter under rotation, illumination, and scale changes.

**Keywords:** Chaos theory, fractal theory, online multiple-instance learning, object tracking.



### 1. Introduction

Object tracking, which is a highly practical approach to motion analysis, traffic monitoring, and video analysis, is a topic of considerable interest in computer vision research. The field of visual object tracking has recently attained substantial achievements, such as the development of the context-aware exclusive sparse tracker [1], adaptive multi-task feature learning [2], and sparse appearance model [3]. Nevertheless, designing a robust tracking system remains a challenging task because of appearance-related variations, including fast motion, occlusion, illumination, scale, and rotation [4]. Under these challenging conditions, a key component in object tracking is visual representation, which is categorized into two schemes: local and global representation [5]. Global representation reflects an object's global statistical characteristics, including raw pixels, optical flows, histograms, covariances, wavelets, and active contours [6]. This scheme is a simple and efficient method for real-time object tracking, but it is sensitive to global appearance changes, such as variations in illumination, deformation shape, rotation, and partial occlusion [7]. Local representation, on the other hand, extracts local structural appearance characteristics as interest points that are used to encode appearance information. These local characteristics are classified on the basis of local templates, segmentation, scale-invariant feature transformation, maximally stable external regions, speeded up robust features, corners, and feature pool-based [8]. Despite the robustness of local representation against global appearance changes, however, representations suffer from noise disturbance and background distraction. The use of local feature extraction methods also increases computational costs [9]. To reduce complexity and noise disturbance, compressive sensing methods [10] are used to obtain a low-dimensional representation on the basis of correlation reduction in object tracking. The drawback of these methods is that they do not consider the dynamic information contained in data for compression, thereby causing the loss of important samples for signal recovery.