Control of Dynamic Noise in Transcendental Julia and Mandelbrot Sets by Superior Iteration Method

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ABSTRACT

Researchers and scientists are attracted towards Julia and Mandelbrot sets constantly. They analyzed these sets intensively. Researchers have studied the perturbation in Julia and Mandelbrot sets which is due to different types of noises, but transcendental Julia and Mandelbrot sets remained ignored. The purpose of this article is to study the perturbation in transcendental Julia and Mandelbrot sets. Also, we made an attempt to control the perturbation in transcendental sets by using superior iteration method.

KEYWORDS

Additive Noise, Superior Iteration Method, Transcendental Julia Set, Transcendental Mandelbrot Set

1. INTRODUCTION

Noise is primarily responsible for the image deformation. And it is usually interfering in a dynamical system hence it is known as dynamic noise (Argyris, Andreadis, Pavlos, & Athanasiou, 1998). Argyris et al. (1998; 2000a; 2000b; 2002), Andreadis et al. (2010), Sun et al. (2016), and Wang et al. (2007; 2009) have studied the perturbation in fractal sets. Rani (2010) introduced a novel approach called as superior iteration method for the analysis of fractal models. The superior iteration method can be defined in the form of equation as \( x_n = \beta_n f(x_{n-1}) + (1-\beta_n) x_{n-1} \), where \( 0 < \beta_n \leq 1 \) and \( \{\beta_n\} \) is convergent away from 0. The superior Mandelbrot and Julia sets have been created firstly by Rani and Kumar (2004; 2016) via superior iteration method. Then the more researchers like Agarwal and Agarwal (2012), Negi and Rani (2008), and Rani and Agarwal (2010a; 2010b; 2010) introduced the impact of noise on superior fractal models like Mandelbrot and Julia sets.

The research on reverse engineering process has been introduced first time by Rani, Jha, and Agarwal (2016) using analytic noise. Further Jha and Rani studied the identification of dynamic noise in the Mandelbrot map via perturbation analysis. The controlling behaviour of noise has been studied by Rani and Agarwal (2010a; 2010b) via \( \beta \) parameter. A few attempts have been made to identify amount of noise by analyzing perturbation in it (2016; 2017). Bhatija et al. (2016) have developed a modified non-linear diffusion approach for multiplicative noise, Dey et al. (2012; 2015) have created a parameter optimization for local polynomial approximation based intersection confidence interval filter using genetic algorithm and also a comparative study between Moravec and Harris corner

DOI: 10.4018/IJNCR.2018040104
detection of noisy images using adaptive wavelet thresholding technique, and Jain et al. (2012) have developed a versatile denoising method for images contaminated with gaussian noise.

The purpose of this paper is to identify the amount of additive noise in transcendental Julia and Mandelbrot sets by analyzing perturbation in it. Further, controlling on perturbation due to noise has been shown via superior iteration method. The required background work for the above purpose is given in Section 2. Sections 3 and 4 includes the perturbation controlling method and noise quantifying method in transcendental Julia and Mandelbrot sets respectively. The conclusion of the paper is given in Section 5.

2. PRELIMINARIES

The generation of transcendental Mandelbrot set is very similar to the Mandelbrot set obtained from standard quadratic equation. The transcendental Julia and Mandelbrot sets are obtained from following equation:

\[ z_{n+1} = \sin z_n^2 + c \]  \hspace{1cm} (1)

where \( z, c \in \mathbb{C} \) (set of complex numbers) (cf: 2012). Researchers have given the concept of creating cubic and biquadratic transcendental Julia and Mandelbrot sets using superior iterates (2012). Bharti et al. (2017) generated transcendental Julia and Mandelbrot sets in Noor orbit.

Mean Square Error (MSE): To calculate the perturbation due to noise in an image following formula is used:

\[ MSE = \frac{1}{n} \sum_{i=1}^{n} (R_i - M_i)^2 \]  \hspace{1cm} (2)

where \( R_i \) is the particular pixel in the reference image, \( M_i \) is the corresponding pixel in the perturbed image, and \( n \) is total number of pixels in the reference image. We choose this because it has some attractive features such as simplicity, freeness, memory-less and inexpensive to compute (2009).

Definition (Superior Iterates). Let \( X \) be a non-empty set of real or complex numbers and \( f: X \rightarrow X \).

For an \( x_0 \in X \), construct a sequence \( \{x_n\} \) in the following manner:

\[ x_{1} \beta f(x_{0}) + (1 - \beta_{1})x_{0}, \]
\[ x_{2} \beta f(x_{1}) + (1 - \beta_{2})x_{1}, \]
\[ \ldots \]
\[ \ldots \]
\[ x_{n} \beta f(x_{n-1}) + (1 - \beta_{n})x_{n-1}, \]  \hspace{1cm} (3)

where \( 0 < \beta_{n} \leq 1 \), and \( \{\beta_{n}\} \) is convergent away from 0. The sequence \( \{x_n\} \) constructed above was called as superior sequence of iterates, denoted by \( SO(f, x_{0}, b_{n}) \). At \( b_{n} = 1 \), \( SO(f, x_{0}, b_{n}) \) reduces to function iterates (2012). In all that follows, we take \( b_{n} = b \).
Analysis of Neural Network of C.elegans by Converting into Bipartite Network
*International Journal of Artificial Life Research* (pp. 10-21).
[www.igi-global.com/article/analysis-neural-network-elegans-converting/65072?camid=4v1a](www.igi-global.com/article/analysis-neural-network-elegans-converting/65072?camid=4v1a)

Artificial Immune Systems as a Bio-Inspired Optimization Technique and Its Engineering Applications
[www.igi-global.com/chapter/artificial-immune-systems-bio-inspired/19638?camid=4v1a](www.igi-global.com/chapter/artificial-immune-systems-bio-inspired/19638?camid=4v1a)