ABSTRACT

The word fractal was given by Mandelbrot in 1975 to study various irregular natural objects and complex physical systems possessing some degree of self similarity. The most prominent and fascinating features of fractals are self similarity, repetitiveness, fractional dimension and having infinite details irrespective of magnification. The natural patterns such as trees, clouds, mountains, forest horizons etc are best approximated by fractals. A fractal is also defined as a fixed point or an attractor of an iterated function system (IFS) based on contraction maps. Hutchinson laid the mathematical foundation of an iterated function system which contains a collection of finite contractive maps on a complete metric space. The theory of IFS has been found to be useful in the study of many complex phenomena observed in different domains of sciences and engineering.

Different aspects of fractals and iterated function systems are investigated in the work reported in this thesis besides presenting the necessary mathematical background. The theory of IFS is defined in the novel settings of some general spaces such as G-metric, G₀-metric, fuzzy metric and intuitionistic fuzzy metric spaces and various results regarding fractals as an attractor of some iterated function systems are established. Besides defining a Suzuki type contraction (S-contraction) in fuzzy metric spaces (FMS), some existence and uniqueness results generalizing some of the recent results reported in the literature are also derived. The Hutchinson Barnsley theory is extended in intuitionistic fuzzy metric space with Suzuki type contraction and the concerning collage theorems are obtained. The concept of IFS is also extended in the settings of V-variable by defining the intuitionistic fuzzy super iterated function system. The results obtained generalize many of the recent results reported in the literature.

Further, we explore fractals for application in encryption compression and classification of images. Three novel fractal based encryption compression schemes are proposed. In the first scheme, dual chaotic map with a number theoretic approach is employed for combined encryption compression of gray scale images. In the second scheme, we use a chaotic map along with Julia set for encryption and Chinese remainder theorem for compression of the images. The concept of iterated function system and Chinese remainder theorem is used for combined encryption compression in the third algorithm. For classification of medical images, an improved version of multi-scale generalized fractal dimension (GFD) method is proposed. The efficiency of the technique over the classical GFD for the classification of EEG signals is obtained from the images of the signals of seizure and seizure free patients. The results are suitably verified by statistical methods and it is concluded that the proposed method of improved GFD provides better classification at all scales.