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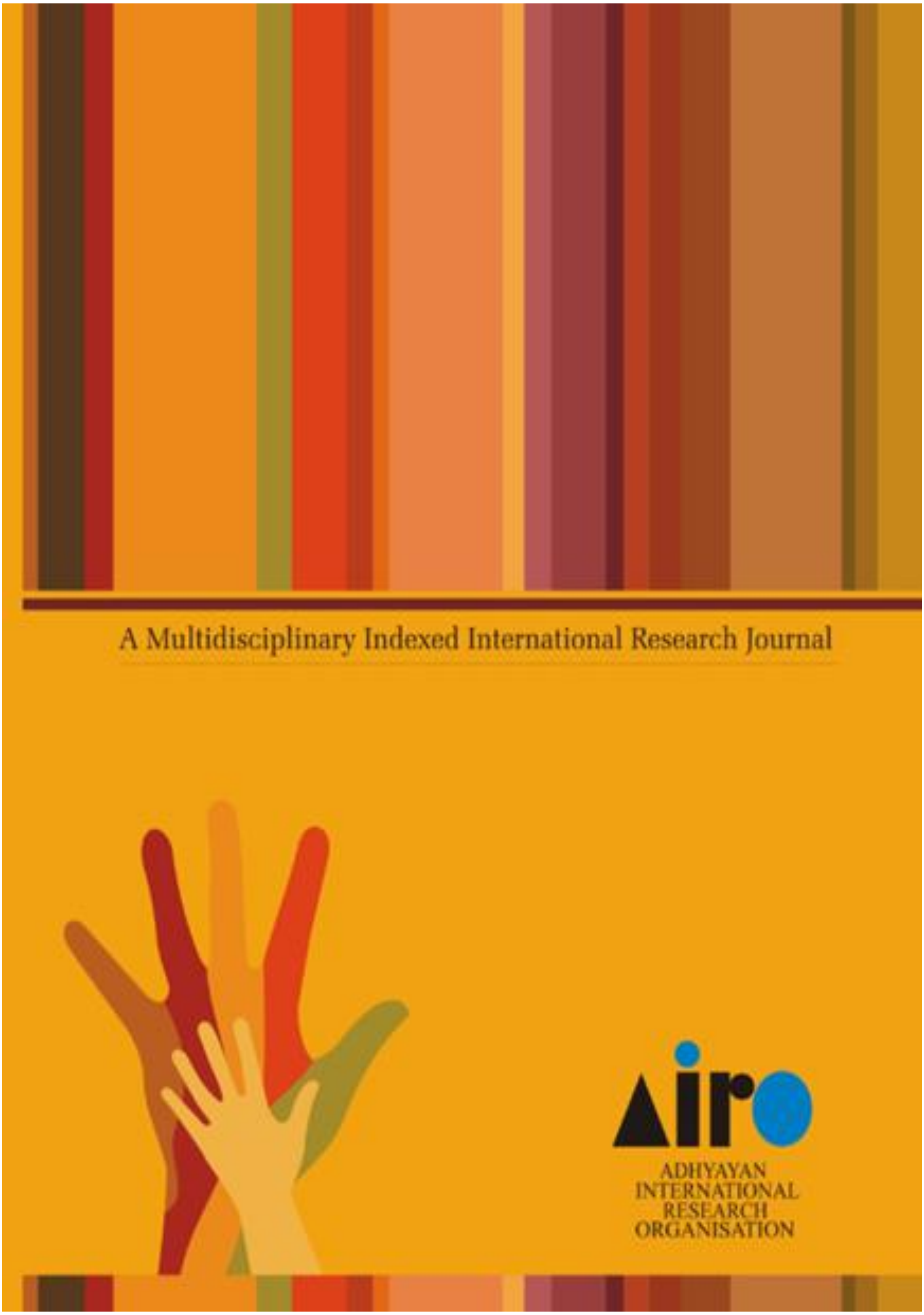

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SIGNAL DETECTION AND RECREATION WITH EMBEDDED NOISE USING DIGITAL CORRELATION TECHNIQUE

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ABSTRACT

Signal Detection and recreation Theory is considered to analyze data coming from experiments where the task is to classified ambiguous stimuli which can be generated either by a known process (called the signal) or be obtained by chance (called the noise in the signal detection framework). For example, a radar operator must decide if what she sees on the radar screen indicates the presence of a plane (the signal) or the presence of unwanted signal (the noise). Sometimes radar operator needs to process the signal by generating the signal continuously. This paper presents the method and theory about the work.

Here we will see the two methods of signal detection and signal recreation. Sampling method is the method of signal recreation. The goal of signal detection theory is to estimate two main parameters from the experimental data. The first parameter, called d 0, indicates the strength of the signal (relative to the noise). The second parameter called C (a variant of it is called β), reflects the strategy of response of the participant of being more willing to say. Signal detection theory is used in very different domains from psychology, medical, to statistical.

In recent years, rapid advances in computer hardware technology, including the development of specialized digital signal processors, have facilitated the development of algorithms whose applications would have been unthinkable only a short time ago. These algorithms allow for real-time application, make use of prior knowledge, can adapt in response to a changing environment, and are designed to achieve near-optimum performance under a broad range of operating conditions. This book examines the application of such algorithms to audio, video, and telecommunications.

Keywords: digital correlation, detection and recreation, embedded noise

INTRODUCTION

The initial point for signal detection theory is that nearly all reasoning and decision making takes place in the presence of some irregularity. Signal detection theory reveals a precise language and graphic presentation for analyzing decision making in the presence of irregularity. The general approach of signal detection theory has direct application for us in terms of sensory simulations. But it also offers a way to analyze many different kinds of decision problems.

Correlation is a mathematical operation that is very similar to convolution. Correlation uses two signals to produce to third signal. This produced signal is called cross correlation of two signals. When a signal is correlated with same signal then the signal is produced is called auto correlated.

The amplitude of each sample in the cross-correlation signal is a measure of how much the received signal resembles the target signal, at that location. This means that a peak will occur in the cross-correlation signal maximized when the target signal is aligned with the same features in the received signal.

What if the target signal contains samples with a negative value? Nothing changes. Imagine that the correlation machine is positioned such that the target signal is perfectly aligned with the matching waveform in the received signal. As sample from the received signal fall in to the correlation machine they are multiplied by their matching samples in the target signal. Neglecting noise, a positive sample will be multiplied by itself, resulting in a positive number. Even if the target signal is completely negative, the peak in the cross-correlation will still be positive.

If there is noise in the received signal, there will be noise in the cross-correlation signal. It is an unavoidable fact that random noise looks a certain amount like any target signal you can choose. The noise on the cross-correlation signals is simply measuring this similarity. Except for this noise, the peak generated in the cross-correlation signals is symmetrical between its left and right.

REVIEW OF LITERATURES

Dynamical reconstruction and time-series prediction are two areas that share a lot in common but differ in the way that overall performance is evaluated. The goal of classical time-series prediction is to achieve an output that is as close as possible to the actual data.

On the other hand, the aim of dynamical reconstruction is to capture the underlying dynamics of the time series, thereby generating an approximate model of the underlying equations that govern the evolution of the dynamics. In fact, prediction is concerned with the short-term evolution of the data whereas dynamical modelling deals with the long-term dynamical behaviour. Our ultimate objective is to apply this underlying model to practical problems like detection.

The last decade has seen an enormous increase in requirements for signal detection and separation in both scientific and engineering applications. The classical solution to the problem of detection is to use a matched filter receiver. The design becomes difficult when the dynamics or statistics of the interference is unknown. As yet, many techniques have been developed to solve some special problems. For example, sea clutter or sea echo refers to the radar backscatter from an ocean surface. Radars operating in a maritime environment have a serious limitation imposed on their performance by unwanted sea clutter. Traditionally, clutter echoes in radar systems were considered as stochastic processes. It was recently shown that sea clutter radar echo has the characteristic of low-dimensional chaos.

A more recent and efficient approach in detecting targets from ocean-based radar is to use a model-based or chaos-based detection algorithm that responds to clutter changes resulting from variations in environmental conditions. Such an algorithm may be described through the building of underlying dynamical equations based on nonlinear prediction.

Theoretically, a model-based detector may give a good detection performance if the measured interference results from a chaotic dynamical system. In the real-life environment, however, it is practically impossible to separate the deterministic component of the dynamical part from the random noise. The measured data always contains some measurement error due to random interference and=or inaccuracies, say, from the measuring device and=or from the analog-to-digital (A=D) conversion. Such data with the unavoidable presence of additive noise or imprecision ads uncertainty to dynamical reconstruction. In particular, if the noise level is too high, it is possible for the continuity criterion to be violated.

A high ‘‘real’’ noise level in the ‘‘chaotic’’ interference thus leads to an unstable underlying equation. The detection will become difficult if the dynamical reconstruction of clutter is not robust. To solve the noise modelling problem, one generally introduces regularisation techniques to minimise the cost function in a neural network. A good algorithm is the forward scheme.

By automatically estimating regularisation parameters from the training data, we can avoid overfits to the noisy data. The underlying dynamical equation may then be applied to build a chaos-based detector. In this paper, we first discuss a weak signal detector based on chaos, nonlinear phase-space reconstitution and RBF neural networks.

We then study the robust behavior of this detector by using computer generated chaotic data and real-life LS chaotic circuit experimental data. We demonstrate that a positive Lyapunov exponent present in chaotic systems amplifies a small target signal so that the signal detection task becomes easier in the presence of chaos.

RESEARCH METHODOLOGY

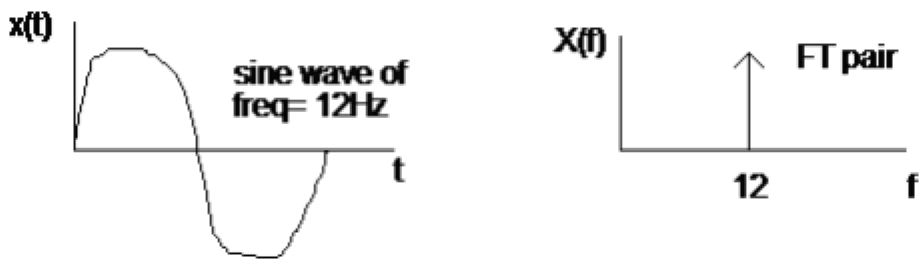
Signal Processing Techniques

The Fourier Transform Baron Jean Baptiste Joseph Fourier was a French mathematician who in his Theories developed the technique known as Fourier Analysis. This technique has proven to have application in many other unrelated disciplines including the analysis of electromagnetic signals. Fourier's Theorem essentially states that the frequency content of any signal can be described as the sum of a specific set of sine waves. The sine wave is the only pure frequency and any distortion of this shape represents harmonics of some fundamental frequency. Thus, any wave, no matter how oddly shaped, can be broken down into its component sine waves.

There are two types of Fourier analysis. The first is Fourier series analysis for periodic signals (i.e. signals that have exactly the same pattern for each cycle, such as quasars, 60Hz wall current noise or regular heart beats -also referred to as “time invariant” signals).

RESULT AND DISCUSSION

Fourier transforms which deals with non-periodic signals such as the human EEG which varies continuously over time. Thus, the Fourier transform of a non- periodic signal produces a continuous transform. When the input signal is periodic (repeats itself exactly with each cycle) its frequency content can be represented by a discrete set of numbers called the Fourier series coefficients. They signify the "weight" given each frequency that is required to reconstruct the original signal. Furthermore, the frequencies that correspond to these different coefficients are harmonically related; each being an integer multiple of some fundamental frequency. This paper will confine itself primarily to exploring the background and application of the Fourier transform since this is the signal processing technique utilized in neuron feedback



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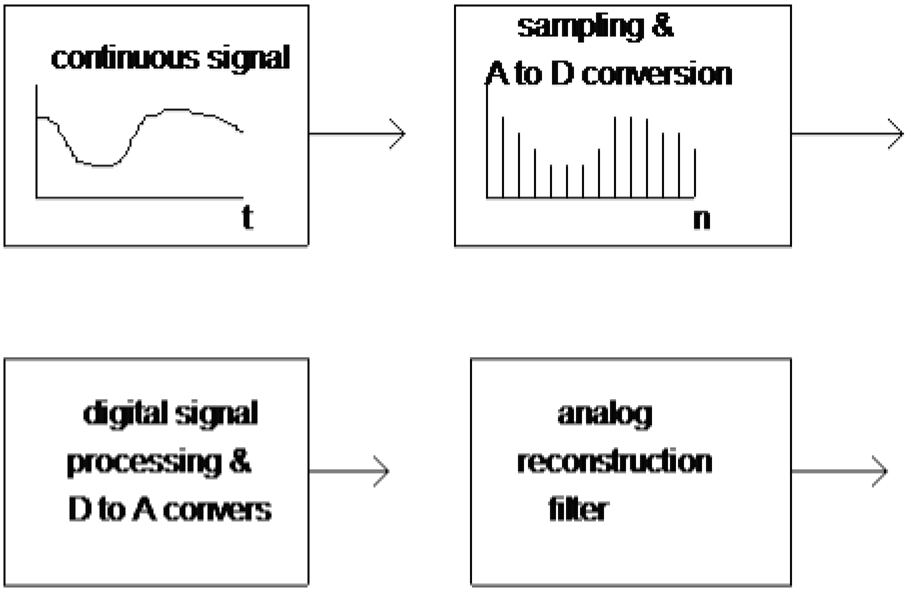
Sampling

Sampling is the process of taking a continuous time signal and representing it by a series of discrete data points. Any (band limited) signal can be represented in this way as long as the samples are equally spaced and are close enough together in time. Sampling theory makes our life easier by efficiently converting a signal from the analog world (A) to the digital world (D) and back again with virtually no loss of information provided that the above requirements are met.

The reason is that signal processing in the digital domain, with all of its complexity, gives us much greater flexibility. For instance; changing filter characteristics involves reprogramming a few numbers rather than pulling out and replacing resistors and capacitors.

Aliasing

We know that any band limited continuous time signal can be reconstructed with a specific number of samples. However, this process breaks down when the samples are spaced too far apart. An “alias” is a spurious signal that is obtained when the digital sampling of an analog signal occurs at too slow a rate. When a high frequency signal is sampled too slowly the high. Frequency signal will alias (look a whole lot like) low frequency activity upon analog reconstruction.



Signal detection

A signal detector is a device that alerts us when a desired signal appears. Radar and sonar operate by transmitting a signal and detecting its return after having being reflected by a distant target. The return signal is often extremely weak in amplitude, while interference and noise are strong. In order to be able to reliably detect the presence of the return signal we employ a signal detector whose output is maximized when a true reflection appears. Similar signal detectors are employed in telephony call progress processing, medical alert devices, and in numerous other applications. Envision a system with a single input that must sound an alarm when this input consists of some specified signal. It is important not to miss any events even when the signal is weak compared to the noise, but at the same time we don't want to encourage false alarms (reporting detection when the desired signal was not really there). In addition, we may need to know as accurately as possible precisely when the expected signal arrived.

The signal to be detected may be as simple as a sinusoid of given frequency, but is more often a rather complex, but known signal. It is evident that signal detection is closely related to signal comparison, the determination of how closely a signal resembles a reference signal. Signal comparison is also a critically important element in its own right, for example, in digital communications systems. In the simplest of such systems one of several basic signals is transmitted every T seconds and the receiver must determine which. This can be accomplished by building signal detectors for each of the basic signals and choosing the signal whose respective detector's output is the highest. A more complex example is speech recognition, where we may build detectors for a multitude of different basic sounds and convert the input audio into a string of best matches. Generalization of this technique to images produces a multitude of further applications, including optical character recognition. Signal detection and comparison are nontrivial problems due to the presence of noise. We know how to build filters that selectively enhance defined frequency components as compared to noise; but how do we build a system that selectively responds to a known but arbitrary reference signal? Our first inclination would be to subtract the input signal sn from the desired reference Rn, thus forming an error signal En = Rn - Sn. Were the error signal to be identically zero, this would imply that the input precisely matches the reference, thus triggering the signal detector or maximizing the output of the signal comparator. However, for an input signal contaminated by noise %a = Rn + Vn, we cannot expect the instantaneous error to be identically zero, but the lower the energy of the error signal the better the implied match. So, a system that computes the energy of the difference signal is a natural comparator.

CONCLUSION

Noise is the unwanted energy that interferes with the ability of the receiver to detect the wanted signal. It may enter the receiver through the antenna along with the desired signal or it may be generated within the receiver. In underwater sonar systems external acoustic noise is generated by waves and wind on the water surface, by biological agents (fish, prawns etc) and manmade sources such as engine noise. In radar and lidar sensors the external electromagnetic noise is generated by various natural mechanisms such as the sun and lightning amongst others. Manmade sources of electromagnetic noise are myriad; from car ignition systems and fluorescent lights through other broadcast signals "The observation interval contains either the noise alone, or a specified signal and the noise and can be represented as a unit dimensional variable."

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