Study on Angles and Direction of Arrival of Radio Waves

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ABSTRACT

Image processing consists of a wide variety of techniques and mathematical tools to process an input image. An image is processed as soon as we start extracting data from it. The data of interest in object recognition systems are those related to the object under investigation. An image usually goes through some enhancement steps, in order to improve the extractability of interesting data and subside other data. Extensive research has been carried out in the area of image processing over the last 30 years. Image processing has a wide area of applications. Some of the important areas of application are business, medicine, military, and automation. Image processing has been defined as a wide variety of techniques that includes coding, filtering, enhancement, restoration registration, and analysis. In many applications, such as the recognition of three-dimensional objects, image processing and pattern recognition are not separate disciplines. Pattern recognition has been defined as a process of extracting features and classifying objects. In every three-dimensional (3-D) object recognition system there are units for image processing and there are others for pattern recognition.

Keywords : Pattern recognition, object recognition, Image processing **Introduction**

Introduction:

Array signal processing is used in several application areas such as radar, sonar, wireless communications, radio astronomy, seismology, acoustics, and medical imaging. Early contributions to this field have been made mostly in the context of wireless communications and radar systems in the first half of the 20th century. In the second half of the 20th century, the tremendous progress of digital processing hardware led to numerous new developments and applications. The present study is focused on coherent receive array processing. The sensors simultaneously measure a spatial field at different locations. The received data depends on the characteristics of the sources, the channels, the noise, and the measurement devices. It is processed to gain information about the sources. Typical objectives are to estimate the number of sources, the source direction of arrival, locations, velocities, etc. In other cases, the source waveforms or their powers are of primary interest. Due to the large number of applications involving different system models and signal processing objectives, array processing is a broad research field. The study would focus on direction of arrival estimation and beam forming, which are two closely related key aspects of array processing. Beam formers are spatial filters used to suppress interferers and noise while the desired signal is maintained. To maintain the desired signal, its spatial signature has to be known. Assuming far-field sources, the source spatial signatures can be estimated by estimating their direction of arrival. Therefore, beam formers are often applied after the source direction of arrival have been estimated.

Review Of Related Literature

Long distance transmission is possible with moderate power levels because of the existence of the ionosphere. However, while the ionosphere makes such transmission possible, it at the same time has characteristics which make difficult the measurement of signal direction of arrival and the extrapolation of such measurements for position fixing or propagation studies. The chief of these difficulties is that frequently there are in fact several possible ray paths between transmitter and receiver, and these paths do not lie exactly in the plane of the great circle passing through the transmitter and receiver locations. The former phenomenon complicates the direction-of-arrival measurement problem and the latter the problem of extrapolation of the direction-of-arrival measurements to the point of origin of the signal. The mechanisms giving rise to multiple paths through the ionosphere; i.e., the stratification of the region, magneto-ionic splitting, and irregularities of structure, are well known in principle, if not in details of behavior. As a consequence of the multiple signal rays arriving at a receiving point, the field in the neighborhood of the receiving antenna exhibits "interference" or "fringe" effects.

Digital Image Processing

Digital image processing is defined as the processing of two dimensional images by a digital computer. A digital image is represented by an array of regularly spaced and very small quantized samples of the image. Two processes that are related to any digital system are sampling and quantization. When a picture is digitized, it is represented by regularly spaced samples of this picture. These quantized samples are called pixels.

Image Analysis

Image analysis accepts a digital image as input and produces data or a report of some type. The produced data may be the features that represent the object or objects in the input image. To produce such features, different processes must be performed that include segmentation, boundary extraction, silhouette extraction, and feature extraction. The produced features may be quantitative measures, such as moment invariants, and Fourier descriptors, or even symbols, such as regular geometrical primitives.In image processing systems, quantization is preceded by another step called sampling. The gray level of each pixel in an image is measured, and a voltage signal that is proportional to the light intensity at each pixel is generated. It is clear that the voltage signal can have any value from the voltages that are generated by the sensing device.

Image Restoration

Image restoration refers to a group of techniques that are oriented toward modeling the degradation and applying the inverse process in order to recover the original image. Each component in the imaging system contributes to the degrading of the image. Image restoration techniques try to model the degradation effect of each component and then perform operations to undo the model, to restore the original image .

Object Recognition

Object recognition includes the process of determining the object's identity or location in space. The problem of object or target recognition starts with the sensing of data with the help of sensors, such as radio cameras and thermal sensors, and then interpreting these data in order to recognize an object or objects. We can divide the object-recognition problem into two categories: the modeling problem and the recognition problem.

Image Segmentation:

Image segmentation is the process of partitioning a digital image into disjoined, meaningful regions. The meaningful regions may represent objects in an image of three-dimensional scene, regions corresponding to industrial, residential, agricultural, or natural terrain in an aerial recognizance application, and so on.

Object Modeling

Modeling is the process of representing a real system in an abstract manner, in order to study its different features. It is widely used in all fields of engineering. In control engineering, for example, a mathematical model of a physical system is extracted to facilitate the study of its performance under different circumstances. In object recognition, a model is created for the object under investigation. This model is then compared to different models that are stored in a database. If this model matches one of the available models, say, the model of object A, then the investigated model is classified as object A. In an airplane recognition system, for example, the database contains models of different types of airplanes.

Wavelet Transforms

It is well known that in signal processing, the more compact your method of representing information the better. In 1822, Jean Joseph Fourier devised a very efficient way to represent the information content of a signal. His idea was to represent a signal as the sum of its frequencies. Transmitted power spectra, carrier frequencies, brain activity, NMR signals - all these global descriptions provide a lot of information in a compact manner. However, most of the power of this kind of representation vanishes when one tries to represent information that changes its nature during the course of signal recording. A good example of this kind of a signal is a musical score. A global analysis of a recording of a musical selection with a Fourier transform (*FT*) will indicate the specific notes played within the piece of music, but there is no way to recover the timing of the notes. The musical score, on the other hand, indicates each note that was played and the time it was played. Wavelets represent a signal in a way such that local frequency information is available for each position within the signal. Wavelets are able to analyze a signal based on the position-varying spectra. The multi-resolution pyramidal decomposition that results is also well matched to fractals and shows great potential for the removal of background noise, such as static in recordings, and for pattern recognition and texture segmentation. In the following section we discuss the conceptual understanding of how wavelets can be used in signal analysis.

Object Representation

The knowledge base has two segments. One segment contains the specific facts, that define the problem and the other segment contains the rules that operate on the facts during the problem-solving process. The knowledge in the knowledge base should be structured in a very powerful way to facilitate the searching process and to reduce the searching time. Three knowledge structures are common:

1. Relational Knowledge-Base Structure. This takes a form of a table.
2. Hierarchical Knowledge-Base Structure or Tree Structure. Each parent has one or more descendant, but each descendant has only one parent.
3. Network Structure. Each parent has one or more descendant and each descendant can have one or more parent.

The knowledge-base management unit accepts the extracted features of an object and then represents them in a way that is appropriate for symbolic processing. There are several ways to represent these features: first-order predicate calculus, frames, and semantic networks.

Neural Networks:

A ne:ural network consists of a number of nonlinear computational elements called neurons or nodes. The neurons are interconnected with adaptive elements known as weights and operate in parallel environment. The structure of neural networks is similar to simplified biological systems. Recently, neural networks have become a prime area of research because they possess the following characteristics:

- Highly parallel structure; hence a capability for fast computing
- Ability to learn and adapt to changing system parameters (e.g., inputs)
- High degree of tolerance to damage in the connections
- Ability to learn through parallel and distributed processing
- Nonparametric values, not dependent on as many assumptions regarding underlying distributions as traditional networks (e.g., classifier or optimizing circuits)

Neural networks have been used as associative content addressable memories and as classifiers. In an ACAM, the memory is associated not by an address, but rather by partially specified or many versions of the stored memory pattern. A classifier assigns an input sample to one of the predetermined classes. The use of neural networks has recently been proposed for creating dynamic associative memory, which utilizes supervised learning algorithms, by recording or learning to store the information as a stable memory state. The neural network minimizes the energy function formed by the mean square error constructed by the difference between the actual training signal and the signal estimated by the network.

Need of the Study:

The need for Direction-of-Arrival estimation arises in many engineering applications including wireless communications, radar, radio astronomy, and sonar, navigation, tracking of various objects, rescue and other emergency assistance devices. In its modern version, DOA estimation is usually studied as part of the more general field of array processing. Much of the work in this field, especially in earlier days, focused on radio direction finding – that is, estimating the direction of electromagnetic waves impinging on one or more antennas . Due to the increasing over usage of the low end of the spectrum, people started to explore the higher frequency band for these applications, where more spectrums is available. With higher frequencies, higher data rate and higher user density, multi path fading and cross interference become more serious issues, resulting in the degradation of bit error rate (BER). To combat these problems and to achieve higher communication capacity, smart antenna systems with adaptive beam forming capability have proven to be very effective in suppression of the interference and multi path signals .

Objective of the Study

The main objective of study is to present the performance analysis of directions of arrival estimation techniques, subspace and the non-subspace methods. Attempts would be made towards exploring the Eigne-analysis category of high resolution and super resolution algorithms, presentation of description, comparison and the performance and resolution analyses of these algorithms . Sensitivity to various perturbations and the effect of parameters related to the design of the sensor array itself such as the number of array elements and their spacing would also be investigated.

Research Methodology

The experimental methods to be used in this research study are described below:

There are three main characteristics for the measurement to assess the performance of radio compression algorithms. These are compression ratio, image quality and compression speed.

1. Compression ratio is the measurement of the capability of the storage or data reduction. A higher compression ratio means better data reduction can be achieved.
2. Image quality is a core measurement which aims to compare the decompressed data to the original data.
3. Compression speed refers to the computational effort required by the encoding and decoding processes.

These characteristics are usually used for judging the performance of the compression technique.The use of these characteristic measurements depends on the application and use of images for particular requirements. In addition, these characteristics are used to determine the suitability of the compression techniques for different applications.

In our method, the measured MVs are obtained by the conventional BMA. A new error function is defined and the statistics of the MV measurements are utilized to estimate the error variances during each iteration. Comparing with the other methods in literature, our method produces more accurate motion vectors (MVs) and better compensated images in terms of PSNR. Another benefit from the knowledge based adaptive approach is the fraction pixel accuracy of motion vectors can be achieved with no additional bits for MVs. We have then proposed a novel new scaled value criterion scheme to further improve the performance for block-based motion estimation. We have first reviewed the basic background knowledge about wave compression and wave coding system. Then the motion estimation and compensation techniques used in wave coding were discussed in details .We have then described a robust and efficient fast block matching method that is knowledge based adaptive search. Spatial and temporal correlations are utilized for choosing the candidate neighboring block for MV prediction. A more flexible search scheme has been proposed which adoptively adjusts the search pattern size according to the MVs of the neighboring blocks. Experimental results show that the developed algorithm requires less computation for ME than DS and ARPS with better overall PSNR performance. Thus, the proposed method appears to be an efficient and robust fast block-matching algorithm for motion estimation. We have given a brief review of the Matching Criteria (MC) algorithm which is a powerful tool for wave processing. We have then described a new scaled value criterion for applying with the Block matching Algorithm in motion estimation. The method is applied to the knowledge based adaptive three step search algorithm.

Conclusion:

The experimental results indicate that the proposed method in combination with the knowledge based adaptive algorithm proposed before, can effectively improve the ME performance in terms of the peak-signal-to-noise-ratio (PSNR) of the motion compensated images with smoother motion vector fields. In addition, since the proposed method can timely adjust the block partition according to the change of the complexity of the motion in the frame, it is more appropriate for waves containing frequent scene changes or scene cuts. Base on the results of the present study, we have shown that the knowledge based adaptive block motion estimation can efficiently improve the motion estimates with no extra bit rate requirement. Thus it is more appropriate for real applications.

In this paper the knowledge based adaptive block motion estimation is implemented in the 1-D or 2-D spatial domain to improve the motion estimation resulting from block-matching methods. It is also interesting to investigate applying this with object tracking to motion estimation. Although the computation will be increased, the performance is expected to be improved. Our research study also shows that the knowledge based adaptive block motion estimation can improve the motion estimation performance effectively. In our method, the adaptive block partition is carried out frame-wise. Future research is worth to be conducted for adaptive block partition which can be adjusted block-wise to improve filtering based motion estimation.

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