Use of Artificial Neural Network in Pattern Recognition

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Abstract

Among the various traditional approaches of pattern recognition the statistical approach has been most intensively studied and used in practice. More recently, the addition of artificial neural network techniques theory have been receiving significant attention. The design of a recognition system requires careful attention to the following issues: definition of pattern classes, sensing environment, pattern representation, feature extraction and selection, cluster analysis, classifier design and learning, selection of training and test samples, and performance evaluation. In spite of almost 50 years of research and development in this field, the general problem of recognizing complex patterns with arbitrary orientation, location, and scale remains unsolved. New and emerging applications, such as data mining, web searching, retrieval of multimedia data, face recognition, and cursive handwriting recognition, require robust and efficient pattern recognition techniques. The objective of this review paper is to summarize and compare some of the well-known methods used in various stages of a pattern recognition system using ANN and identify research topics and applications which are at the forefront of this exciting and challenging field.

Keywords: *Pattern Recognition, correlation, Neural Network.*

1. Introduction

Pattern recognition is the study of how machines can observe the environment, learn to distinguish patterns of interest from their background, and make sound and reasonable decisions about the categories of the patterns. In spite of almost 50 years of research, design of a general purpose machine pattern recognizer remains an elusive goal. The best pattern recognizers in most instances are humans, yet we do not understand how humans recognize patterns. Ross [1] emphasizes the work of Nobel Laureate Herbert Simon whose central finding was that pattern recognition is critical in most human decision making tasks: "The more relevant patterns at your disposal, the better your decisions will be. This is hopeful news to proponents of artificial intelligence, since computers can surely be taught to recognize patterns. Indeed, successful computer programs that help banks score credit applicants, help doctors diagnose disease and help pilots land airplanes depend in some way on pattern recognition... We need to pay much more explicit attention to teaching pattern recognition".

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Our goal here is to introduce pattern recognition using artificial neural network as the best possible way of utilizing available sensors, processors, and domain knowledge to make decisions automatically.

2. Pattern Recognition

Automatic (machine) recognition, description, classification, and grouping of patterns are important problems in a variety of engineering and scientific disciplines such as biology, psychology, medicine, marketing, computer vision, artificial intelligence, and remote sensing. A pattern could be a fingerprint image, a handwritten cursive word, a human face, or a speech signal. Given a pattern, its recognition/classification may consist of one of the following two tasks: 1) supervised classification (e.g., discriminant analysis) in which the input pattern is identified as a member of a predefined class, 2) unsupervised classification (e.g., clustering) in which the pattern is assigned to a hitherto unknown class. The recognition problem here is being posed as a classification or categorization task, where the classes are either defined by the system designer (in supervised classification) or are learned based on the similarity of patterns (in unsupervised classification).These applications include data mining (identifying a "pattern", e.g., correlation, or an outlier in millions of multidimensional patterns), document classification (efficiently searching text documents), financial forecasting, organization and retrieval of multimedia databases, and biometrics. The rapidly growing and available computing power, while enabling faster processing of huge data sets, has also facilitated the use of elaborate and diverse methods for data analysis and classification. At the same time, demands on automatic pattern recognition systems are rising enormously due to the availability of large databases and stringent performance requirements (speed, accuracy, and cost). The design of a pattern recognition system essentially involves the following three aspects: 1) data acquisition and preprocessing, 2) data representation, and 3) decision making. The problem domain dictates the choice of sensor(s), preprocessing technique, representation scheme, and the decision making model. It is generally agreed that a well-defined and sufficiently constrained recognition problem (small intraclass variations and large interclass variations) will lead to a compact pattern representation and a simple decision making strategy. Learning from a set of examples (training set) is an important and desired attribute of most pattern recognition systems. The four best known approaches for pattern recognition are: 1) template matching, 2) statistical classification, 3) syntactic or structural matching, and 4) neural networks.

3. Artificial Neural Networks

The main characteristics of neural networks are that they have the ability to learn complex nonlinear input-output relationships, use sequential training procedures, and adapt themselves to the data. The most commonly used family of neural networks for pattern classification tasks [2] is the feed-forward network, which includes multilayer perceptron and Radial-Basis Function (RBF) networks. Another popular network is the Self-Organizing Map (SOM), or Kohonen-Network [3], which is mainly used for data clustering and feature mapping. The learning process involves updating network architecture and connection weights so that a network can efficiently perform a specific classification/clustering task. The increasing popularity of neural network models to solve pattern recognition problems has been primarily due to their seemingly low dependence on domain-specific knowledge and due to the

availability of efficient learning algorithms for practitioners to use. Artificial neural networks (ANNs) provide a new suite of nonlinear algorithms for feature extraction (using hidden layers) and classification (e.g., multilayer perceptrons). In addition, existing feature extraction and classification algorithms can also be mapped on neural network architectures for efficient (hardware) implementation. An ANN is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons.

4. Works done

Interactive Voice Response (IVR) with pattern recognition based on Neural Networks was proposed by Syed Ayaz Ali Shah, Azzam ul Asar and S.F. Shaukat [4] for the first time in 2009. In this case, after entering the correct password the user is asked to input his voice sample which is used to verify his identity. The addition of voice pattern recognition in the authentication process can potentially further enhance the security level. The developed system is fully compliant with landline phone system. The results are promising based on false accept and false reject criteria offering quick response time. It can potentially play an effective role in the existing authentication techniques used for identity verification to access secured services through telephone or similar media. Over here speaker specific features are extracted using Mel Frequency Cepstral Coefficient (MFCC) while Multi Layer Perceptron (MLP) is used for feature matching. Our model is based on 8 kHz, 8 bit format using Pulse Code Modulation (PCM). At highest level, all speaker recognition systems contain two modules: Feature Extraction and Feature Matching. Similarly they operate in two modes: Training and Recognition/Testing modes. Both training and recognition modes include Feature Extraction and Feature Matching. In training mode speaker models are created for database. This is also called enrollment mode in which speakers are enrolled in the database. In this mode, useful features from speech signal are extracted and model is trained. The objective of the model is generalization of the speaker's voice beyond the training material so that any unknown speech signal can be classified as intended speaker or imposter. In recognition mode, system makes decision about the unknown speaker's identity claim. In this mode features are extracted from the speech signal of the unknown speaker using the same technique as in the training mode. And then the speaker model from the database is used to calculate the similarity score. Finally decision is made based on the similarity score. For speaker verification, the decision is either accepted or rejected for the identity claim. Two types of errors occur in speaker verification system- False Reject (FR) and False Accept (FA). When a true speaker is rejected by the speaker recognition system, it is called FR. Similarly FA occurs when imposter is recognized as a true speaker. Neural networks learn complex mappings between inputs and outputs and are particularly useful when the underlying statistics of the considered tasks are not well understood. Neural Networks being relatively new approach is investigated in this proposed solution. In this technique, a feed forward back propagation network is used for classification of speakers. The network is trained with the training sets extracted from the input speech by using MFCC technique of feature extraction. The model developed is a text-independent speaker verification system which can identify only a specific speaker based on his voice and rejects the claim of any other speaker.

Multilayer Perceptron (MLP) having four layers comprising of one input layer, two hidden layers and one output layer has been used. The input layer has nineteen (19) neurons (as there are nineteen feature vectors from MFCC processor) and uses linear transfer function. The output layer has one neuron (as binary decision is to be made) and uses linear transfer function. It is trained using back propagation algorithm. The network is trained by using a built in train function .This function trains the network on training data (Supervised Learning). The training algorithm used for this network is Gradient Descent (GD). In testing phase, 10% tolerance is present for the intended speaker i.e. if the output of the network is 10% less or greater than 10%, still the speaker is recognized as the intended speaker otherwise rejected. The test data consists of fifty (50) speech samples (other than those used for training the neural network) of the speaker for whom network is trained and 125 samples of imposter speech. The imposter speech data was collected from 13 persons (male). Out of 50 samples of the intended speaker 41 was recognized. So false reject is only 18%. Similarly for imposter data out of 125 trials only 17 were falsely accepted. Thus false accept is about 14%.

Currently, there are mainly two kinds of stock price pattern recognition algorithms: the algorithm based on rule-matching and the algorithm based on template-matching. However, both of the two algorithms highly require the participation of domain experts, as well as their lacks of the learning ability. To solve these problems, Xinyu Guo, Xun Liang & Xiang Li [5] proposed a stock price pattern recognition approach based upon the artificial neural network. The experiment shows that the neural network can effectively learn the characteristics of the patterns, and accurately recognize the patterns. As an approach for stock investment, technical analysis has been widely-scrutinized by research communities, and the technical pattern analysis is regarded as one of the most important technical analysis approaches. In the long-term stock analysis experience, stock analysts summarized many technical patterns beneficial for the investment decision-making, which can be classified into two categories: the continuation pattern and the reversal pattern. Continuation pattern indicates that the stock price is going to keep its current movement trend; while the reversal pattern indicates that the stock price will move to the opposite trend. In this paper, 18 typical technical patterns are chosen as the research target, including 10 continuation patterns and 8 reversal patterns. The technical pattern recognition algorithm can mainly be classified into two categories, one is the rule-based algorithm, and the other is template-based algorithm. In this work, an approach relying on neural network has been proposed, whereas the most noticeable difference lies in that the inputs of the network do not cover every time point in the series. On the contrary, a segmentation process is adopted in this work to first transform the original time series into a sequence of trend segments and corresponding features, with each of the features calculated in terms of the price at the last time point within the segment. Eventually, this sequence of features, instead of the whole time series, is designated as part of the inputs of the network, which not only reduce the calculation expense but also enable the alteration of time granularity for stock patterns by adjusting the length of the segments. Here, 18 kinds of typical technical patterns have been examined. A three-layer feed forward neural network is typically composed of one input layer, one output layer and one hidden layers. In the input layer, each neuron corresponds to a feature; while in the output layer, each neuron corresponds to a predefined pattern. The best situation is that once a certain sample is input into the network, the output will be a vector with all elements as zero only except the one corresponding to the pattern that the sample belongs to.

Nonetheless, due to the existence of classification errors and the fact that some testing samples don't belong to any of the 18 predefined patterns; some samples can not get exactly the expected output. 2029 samples out of 508 stocks from Stock Exchange were taken, which include 593 continuation patterns and 1436 reversal patterns, as training samples. At the mean time, 4937 samples as the testing samples out of 155 stocks were extracted from another Stock Exchange within the same time-interval. There are 54 continuation patterns, 270 reversal patterns and 4613 belong to neither of the two.

In order to improve the precision of electric power system short term load forecasting, a new load forecasting model was put forward in 2007 by Wenjin Dai, ping Wang [6]. This paper presents a short-term load forecasting method using pattern recognition which obtains input sets belong to multi-layered fed-forward neural network, and artificial neural network in which BP learning algorithm is used to train samples. Load forecasting has become one of the major areas of research in electrical engineering in recent years. The artificial neural network used in short-time load forecasting can grasp interior rule in factors and complete complex mathematic mapping. Therefore, it is worldwide applied effectively for power system short-term load forecasting. Short-term load forecasting has been useful in safe and economical planning operation of an electrical power system. It has been also used in start-up and shut-down schedules of generating units, overhaul planning and load management. One of the characteristics of electric power is that it can't be stockpiled, that is, the power energy is generated, transmitted, distributed and consumed at the same time. In normal working condition, system generating capacity should meet load requirement anytime. If the system generating capacity is not enough, essential measure should be taken such as adding generating units or importing some power from the neighboring network. On the other hand, if the system generating capacity is of surplus, essential measure should be taken too, such as shutting-down some generating units, or outputting some power to neighboring network. Load variation trend and feature forecasting are essential for power dispatch, layout and design department of power system. Artificial Neural Network and Expert System methods belong to quantitative forecasting methods. In this approach, the ANN traces previous load patterns and predicts a load pattern using recent load data. It also can use weather information for modeling. The ANN is able to perform non-linear modeling and adaptation. It does not need assumption of any functional relationship between load and weather variables in advance. The ability to outperform experiential qualitative forecasting methods especially during rapidly changing weather conditions and the short time required to their development, have made ANN based load forecasting models very attractive for on line implementation in energy control centers. Therefore, it is worldwide applied effectively for the power system short-term load forecasting. The Back propagation algorithm has been used in the experiment. The proposed method does not require heavy computational time and that the patterns considered for training the ANNs also have an impact on forecasting accuracy.

Shahrin Azuan Nazeer, Nazaruddin Omar, Khairol Faisal Jumari and Marzuki Khalid (2007) [7] used ANN approach in face recognition. They evaluated the performance of the system by applying two photometric normalization techniques: histogram equalization and homomorphic filtering, and comparing with Euclidean Distance, and Normalized Correlation classifiers. The system produced promising results for face verification and face recognition. Over here the face recognition system consists of face verification, and face recognition tasks. In verification task, the system knows a priori

the identity of the user, and has to verify this identity, that is, the system has to decide whether the a priori user is an impostor or not. In face recognition, the a priori identity is not known: the system has to decide which of the images stored in a database resembles the most to the image to recognize. The primary goal of this work was to present the performance evaluation carried out using artificial neural network for face verification and recognition. It composed of several modules which are Image Acquisition, Face Detection, Training, Recognition and Verification. In enrollment phase the image is acquired using a web camera and stored in a database. Next, the face image is detected and trained. During training, the face image is preprocessed using geometric and photometric normalization. The features of the face image are extracted using several feature extraction techniques. The features data is then stored together with the user identity in a database. In recognition/verification phase a user's face biometric data is once again acquired and the system uses this to either identify who the user is, or verify the claimed identity of the user. While identification involves comparing the acquired biometric information against templates corresponding to all users in the database, verification involves comparison with only those templates corresponding to claimed identity. Thus, identification and verification are two distinct problems having their own inherent complexities. The recognition/verification phase comprises of several modules which are image acquisition, face detection, and face recognition /verification. In image acquisition/face detection module face detection is used to detect face and to extract the pertinent information related to facial features. In this module, the background or the scenes unrelated to face will be eliminated. The system can detect a face in real-time. The face detection system is also robust against illumination variance and works well with different skin color and occlusions such as beards, moustache and with head cover. The face recognition module comprised of preprocessing, feature extraction, and classification sub-modules. The input to the face recognition/verification module is the face image, which is derived from two sources: from the camera and from the database. From these sources, each image is preprocessed to get the geometric and photometric normalized form of the face image. During feature extraction, the normalized image is represented as feature vectors. The result of the classification for the recognition purpose is determined by matching the client index with the client identity in the database. Multilayer Feed-forward Neural Networks (MFNNs) is an ideal means of tackling a whole range of difficult tasks in pattern recognition and regression because of its highly adaptable non-linear structure. Result of the experiment presented a face recognition system using artificial neural networks in the context of face verification and face recognition using photometric normalization for comparison. The classification techniques used here was Artificial Neural Network (NN), Euclidean Distance(ED) and Normalized Correlation (NC).The experimental results show that N.N. is superior to the Euclidean distance and normalized correlation decision rules using both PCA and LDA for overall performance for verification. However, for recognition, E.D. classifier gives the highest accuracy using the original face image.

In 2006, ANN method was used for Electrocardiogram (ECG) pattern recognition by Lin He, Wensheng Hou, Xiaolin Zhen and Chenglin Peng [8]. Four types of ECG patterns were chosen from the MIT-BIH database to be recognized, including normal sinus rhythm (N), premature ventricular contraction (PVC), and atrial premature beat (A) and left bundle branch block beat (L). ECG morphology and R-R interval features

were performed as the characteristic representation of the original ECG signals to be fed into the neural network models. Three types of artificial neural network models, SOM, BP and LVQ networks were separately trained and tested for ECG pattern recognition and the experimental results of the different models have been compared. The SOM network exhibited the best performance and reached an overall accuracy of 95.5%, and the BP and LVQ network reached 92.5% and 91.5%. A typical ECG waveform contains P wave, QRS complex and T wave in each heart beat. Recognizing an ECG pattern is essentially the process of extracting and classifying ECG feature parameters, which may be obtained either from the time domain or transform domain. The features being frequently used for ECG analysis in time domain include the wave shape, amplitude, duration, areas, and R-R intervals. The basic problem of automatic ECG analysis occurs from the non-linearity in ECG signals and the large variation in ECG morphologies of different patients. And in most cases, ECG signals are contaminated by background noises, such as electrode motion artifact and electromyogram-induced noise, which also add to the difficulty of automatic ECG pattern recognition. Compared with the traditional clustering methods, the artificial neural network models have good adaptive ability to environmental changes and new patterns, and the recognition speed of neural network is fast, owing to its parallel processing capability. Therefore, artificial neural network models for ECG pattern recognition have been used here. The performance of artificial neural network to recognize ECG patterns may be lowered by noise corrupted ECG signals. Even though the neural network has some degree of fault tolerance, it is desirable that clean ECG signals are provided. Three different neural network models, which are SOM, BP and LVQ networks, were employed to recognize the ECG patterns. The ECG records of 4 different types of patterns were obtained from 11 patients. 200 ECG segments were chosen for each of the pattern, which produces a dataset with a total number of 800 ECG records, each containing a QRS complex. The four types of patterns are respectively designated as N, A, L and V. The training strategy of the neural network was as follows, the whole dataset was divided into four groups of equal size with equal number of the 4 patterns in each group, and every neural network model is tested by a different data group, while the other three is used for training. The performance of the neural networks was evaluated by the recognition sensitivities, the overall recognition accuracy and the neurons number needed. The overall accuracy is defined as the ratio of the total number of beats recognized correctly to the total number of beats in the test phase. It is observed that the performance of the SOM network is relatively better than BP network; while the SOM network needs a longer time for training. The error of BP network was defined as the mean difference of the ideal output and the real output which was 0.0459 in the training phase and 0.1041 in the testing phase. While the error of SOM network and LVQ network was not considered.

A rain attenuation model based on artificial neural network was proposed by Hongwei Yang, Chen He, Wentao Song, Hongwen Zhu in 2000 [9]. Based on analyzing several of factors affecting rain attenuation, a rain attenuation model with artificial neural network was founded after training and verifying many different neural network topologies. The results had shown that applying the artificial neural network to predict rain attenuation of high frequency wave is a good approach and decreases the mean prediction error by 0.59dB and the root of mean square error by 0.69dB. The work in this paper shows that it's a new and effective way to predict rain attenuation with artificial neural network. To predict rain attenuation from known rain rate is therefore

essential for design reliability and validity of communication system. The prediction of rain attenuation is a very complex and difficult task. Generally, the prediction models can be either theoretical (also called deterministic), or empirical (also called statistic), or a combination of these two. The deterministic models are based on the principles of physics and therefore, can be applied in different conditions without affecting the accuracy but their implementation usually requires a great database of radio meteorology characteristics such as atmospheric pressure, atmospheric temperature and so on, which is nearly impossible to obtain. Due to that the implementation of the deterministic models is usually restricted to the special area where radio meteorology data can be available. In the empirical models, nearly all influences are taken into account regardless of whether or not they can be separately recognized. This is the main advantage of these models. However, the accuracy of these models depends on the accuracy of the measurements, similarities between the conditions where the rain attenuation is analyzed, the conditions where the measurements are carried out. Proper factors affecting rain attenuation are considered as inputs of neural network and enough data used for neural network are selected. After training and verifying many different neural network topologies, an applied rain attenuation model is finally founded. Under the consideration of the factors affecting rain attenuation, 8 inputs have been selected. One group of the inputs has been chosen to take into account the effects of radio parameters on the rain attenuation. These inputs include frequency (in GHz), elevation angle (in degree) and polarization angle (in degree). The second group of inputs contains latitude (in degree), longitude (in degree), altitude (in km) and height (in km) of the earth station, which are intended for taking into account the terrain effects on the attenuation due to rain. The last group of inputs is rainfall rate (in mm/hour) which is the main meteorological factor affecting rain attenuation. When defining the prediction error as the difference between the measured and the predicted attenuation value at the same condition, the prediction error distribution of the ANN model and a conventional model (such as CCIR model) has been computed. The ANN model obtained mean prediction error 1.39 dB, RMS error 2.01dB and maximum prediction error 4.7dB over the range of the validation set, more accurate than mean prediction 1.98dB, RMS error 2.7048 and maximum prediction error 7.4 dB of CIRR model. It is easy to see that the ANN model showed satisfactory, even very good accuracy with nearly 0.6 dB increasing in average.

In 1997, Nallasamy Mani and Bala Srinivasan [10] applied artificial neural network approach for optical character recognition (OCR). That was a simple pattern recognition system using artificial neural network to simulate character recognition. A simple feed-forward neural network model has been trained with different set of noisy data. The back-propagation method was used for learning in neural network. The range of applications includes postal code recognition, automatic data entry into large administrative systems, banking, automatic cartography and reading devices for blind. Here the image processing time was significantly reduced while maintaining efficiency and versatility at the same time. But the complete system which encompassed all the features of a practical OCR system was yet to be realized. The key factors involved in the implementation are: an optimal selection of features which categorically defines the details of the characters, the number of features and a low image processing time. The character from the scanned image has been normalized from 60 X 60 pixel into 32 X 32 .The horizontal and vertical vectors (Vh and Vv respectively) are added together to form the input vector of the neural network. Finally, an input vector that contains 64

(horizontal + vertical) unique features of the character is evaluated. Histogram techniques have been used here for automatic processing of lines, words and characters extraction in the sequence. The erosion and dilation operations make the object smaller and larger respectively. Erosion makes an object smaller by removing or eroding away the pixel on its edges. Dilation makes an object larger by adding pixel around its edges. Dilation technique is used for extracting a word from the original image (gray scale). Image dilation is applied to make the characters in a word thicker until they join together. The image erosion techniques have been used for extracting each character from a word. The pattern editor is very useful in creating the training data files. The advantage is to train the network with user defined character sets, numerals and even with other languages. Once the network is trained it would create: an associated weight of the particular training file. The experiment had shown the recognition rate as 70% for noisy data to up to 99%. The main demerit of this work was that the experiment failed for multiple font and size characters and hand written character recognition.

Young-Sang Han, Seong-Sik Min, Won-Ho Choi and Kyu-Bock Cho (1992) [11] implemented ANN for fault detection of induction motor (IM). It was a learning pattern recognition system which cans prognose and diagnoses faults as well as aging conditions of the IM. For the diagnosis, this system uses frequency spectrum analysis method based on vibration conditions of the rotating machine. In ANN**,** inputs are several vibration frequencies. Outputs of artificial neural networks provide the information on the fault condition of motor. The PDP model, namely multi-layer perceptron model with an error back propagation learning algorithm is used for this diagnostic system. As the induction motor (IM) has merits such as easy maintenance, robustness and low cost, IM is the most widely used motor in industry applications. For the reason, it becomes very important to diagnose operating conditions, and to detect the faults of the machine for the improvement of its security and the reliability of the whole system. Although a motor is carefully constructed, it has inherent possibilities of faults which result from stress involved in energy conversion. Hence, it becomes very important to diagnose (incipient) faults and to prolong the life assessment of the IM for the reliability of the system. Conventional researches have been only concentrated on estimating machine parameters that can indicate the conditions of the machine. In those approaches, one fatal drawback is that its accurate dynamics should be known. An ANN based incipient fault detector has two parts of artificial neural networks. One part is a disturbance and noise filter. The other part is a high order incipient fault detector. It detects faults of turn to turn isolation and bearing wear only. Vibration Frequency by faults of major faults of the IM are unbalanced rotor, air gap variation, and unbalanced magnetic attraction force of slot, defect of ball, inner and outer race of bearing. Then a fault occurred in the motor, the symptom of the fault is directly shown through vibration. Therefore, it is very reasonable to analyze problems by means of vibration. Thus, the frequency spectrum of vibration is employed as inputs and the outputs correspond to the information on the defect of IM. For pattern recognition, a multi-layer perceptron model was chosen. It optimizes connection weights by means of error back propagation learning method; the back propagation algorithm uses an objective function, which is defined as the summation of square errors between the desired outputs and the network outputs. It then employs a steepest-descent search algorithm to find the minimum of tie objective function. If a motor is in operation, the capability of an expert system for these kinds of problems is normally limited because the user must be a skilled person to reach such decision making in diagnostic system. On the other

hand, the proposed method can be easily utilized by a non-expert. Detection method of this paper will be appropriate for condition monitoring diagnostic problem concerning optimal maintainabi1ity and availability of existing machine, or assurance of production quality control of motors.

In 1989, P. M. Grant [12] applied the concept of linear matched filtering, which is widely applied for the detection of communications and radar signals. It then explored the similarities and differences between matched filters and one type of artificial neural network, the 'associative memory', which was widely applied to pattern recognition and recall applications. Subsequently, a more promising approach based on 'multilayer perceptrons' is investigated for the design of nonlinear filters and its application is examined for the filtering of distorted data from communications channels to equalize and reduce the distortion prior to a binary decision process. It was well recognized that the optimal filter for detecting a signal contaminated by white Gaussian noise is the matched filter. For a coded signal waveform the matched-filter function is achieved by correlating the received signal against a reference waveform to give the correlated output. This is achieved by multiplying together the two time series waveforms and performing the time integration. Two basic realizations of the receiver are possible: the active correlator and the linear matched filter. For a filtering or pattern recognition operation where the form of the input data is known in advance, linear matched filters or correlators are optimized signal detectors. In other situations, where time-varying or non-stationary signal or channel characteristics occur, it is appropriate to consider applying artificial neural-network approaches.

5. Conclusions

While investigating the works chronologically we have noticed that though there are some merits and demerits of each individual work the application of ANN in each pattern recognition case always performed better result than that of without implementing ANN. The accuracy level of forecasting on the basis of present data set (experience) was always better.

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