CHAPTER II
LITERATURE SURVEY

2.1. IMAGE COMPRESSION TECHNIQUES USING NEURAL NETWORK

Jiang et al., [JIA99] presented a survey on image compressing by using neural networks. With the exception of the available techniques on image compression characterized by succession of JPEG, MPEG and H.26x principles, novel techniques such as neural networks and genetic algorithms are being recommended to investigate the potential of image coding. Potential applications of neural networks to vector quantization have now developed into well recognized, and further characteristics of neural network involvement in this field are stepping up to play considerable roles in supporting with those conventional technologies. Jiang et al., provided a broad survey on the growth of neural networks for image compression which includes three divisions: straight image compression by neural networks; neural network execution of existing approaches, and neural network based technology which offer enhancement when compared with conventional approaches.

Robert et al., [RDS95] developed a neural network technique for image compression. Neural network technique is well matched to the problem of image compression because of their extremely parallel and disseminated manner. The features of neural network are similar to certain features of this particular visual system, which permits to process visual information without any difficulty. For instance, multilayer perceptrons can be utilized as non-linear predictors in differential pulse-code modulation (DPCM). Such predictors have been revealed to enhance the predictive gain comparative to a linear predictor. An additional active area of study is in the application of Hebbian learning to the extraction of principal components, which are the source vectors for the best possible linear Karhunen-Lo`eve transform (KLT). These learning approaches are done repeatedly and have certain computational merits when compared with typical eigen decomposition approaches, and can be made to adjust to transformations in the input signal. An additional model called as self-organizing feature map (SOFM), has been widely used with a significant success in the design of codebooks for vector quantization (VQ). The resultant codebooks are less
susceptible to preliminary conditions than the typical LBG algorithm, and the topological ordering of the entries can be utilized to further increase coding effectiveness and reduce computational complexity.

Dwivedi et al., [ASA06] recommended a novel hybrid image compression approach: Wavelet-MFOCPN. This approach obtains the properties of localizing the global spatial and frequency correlation from wavelets and categorization and functional estimation operations from modified forward-only counter propagation neural network (MFOCPN) for image compression. In order to examine the effectiveness of this approach several benchmark test images are used. Experimental observations of this approach illustrated an improvement in the performance regarding the decoded picture quality and compression ratios, when evaluated against the available wavelet and neural network based image compression approaches.

J. Jiang [JIA95] presented a broad survey on the growth of neural network technique for image compression. Three major classifications had been focused. These comprises neural networks directly exploited for image compression, neural network implementation of conventional approaches and expansion of neural network dependent technology which facilitates further enhancements over the existing image compression algorithms. J. Jiang proposed several neural network approaches in image compression and coding. These comprise direct improvement of neural learning approaches and indirect applications of neural networks to enhance available image compression approaches. For direct learning technique, improvement of neural vector quantization considered to be the most capable approach which has revealed improvement over traditional algorithms. Since vector quantization was included in several image compression algorithms like JPEG, MPEG, and wavelets based variables etc, several useful applications have been commenced in commercial world.

Ivan Vilovic [IVA06] proposed that there are number of trials of using neural networks as signal processing tools for image compression. A direct solution method is used for image compression using the neural networks. An experience of using multilayer perceptron for image compression is presented. The multilayer perceptron is used for transform coding of the image. The network is trained for different number of hidden
neurons with direct impact to compress ratio is experimented with different images that have been segmented in the blocks of various sizes for compression process. Reconstructed image is compared with original image using signal to noise ratio and number of bits per pixel.

Image compression is one of the key image processing techniques in signal processing and communication systems. Compression of images leads to reduction of storage space and reduces transmission bandwidth and hence also the cost. Advances in VLSI technology are rapidly changing the technological needs of common man. One of the major technological domains that are directly related to mankind is image compression. Neural networks can be used for image compression. Neural network architectures have proven to be more reliable, robust, and programmable and offer better performance when compared with classical techniques. The main focus of Ramanaiah et al., [RAR10] is to development of new architectures for hardware implementation of neural network based image compression optimizing area, power and speed as specific to ASIC implementation, and comparison with FPGA. The proposed architecture design is realized on ASIC using Synopsys tools targeting 130nm TSMC library. The ASIC implementation for 16 input neuron with low power techniques adopted such as buffer insertion, clock gating and power gating limits dynamic power in the range 449µW to 713µW, cell leakage power to 18µW to 28µW, total cell area from 6319 Sq µm to 8662 Sq µm with maximum frequency ranging from 80MHz to 120MHz. ASIC physical design reports, the total power to be 20.2574µW, 97% better than the power during synthesis. In ASIC Physical Design a chip size of 14334.07Sq µm is achieved out of which the core area is 9945.07Sq µm, and it requires 8 metal layers for routing total wire length of 12592.2µm.

A new image compression algorithm based on an unsupervised competitive neural network to prevent the edge degradation is proposed. Dong-Chul Park et al., [DYW99] proposed unsupervised competitive neural network, called weighted centroid neural network (WCNN), utilizes the characteristics of image blocks from edge areas. The mean/residual VQ (M/R VQ) scheme is utilized in this proposed approach as the framework of the proposed algorithm. A novel measure for calculating edge strength is devised by using the residue of an image block data from the M/R scheme. The edge strength of an image block data is then utilized as a tool to allocate the proper code vectors in the proposed WCNN. The WCNN
successfully allocates more code vectors to the image block data from edge area while it allocates less code vectors to the image block data from shade or non-edge area when compared to conventional the neural network based VQ algorithm. As a result, a simple application of WCNN to image compression problem gives improved edge characteristics in reproduced images over conventional neural network based VQ algorithms.

Compression of data in any form is a large and active field as well as a big business. Image compression is a subset of this huge field of data compression, where we undertake the compression of image data specifically. Research of Dutta et al., [DCH09] aims at reducing the number of bits needed to represent an image. Inter-pixel relationship is highly non-linear and unpredictable in the absence of a prior knowledge of the image itself. Thus artificial neural networks have been used here for image compression by training the net using the image to be compressed. The ANN takes into account the psycho visual features, dependent mostly on the information contained in images. The algorithms, on application on the image data preserves most of the characteristics of the data while working in a lossy manner and maximize the compression performance. The results have been checked with and without the use of quantization, and without median filtering of the image. The ANN algorithm used here is mainly the back-propagation of multilayer perceptrons.

2.2. WAVELET BASED IMAGE COMPRESSION

Kalra et al., [ASP07] suggested a neural and interpolation approach for wavelet transforms based image compression. The features of providing spatial and frequency details in the transform domain through wavelet transform plays an important role in generating a significance map of coefficients that has to be coded in the case of image compression. The author also provided a wavelet based image compression approach, in which transmission of spatial locations of wavelet decomposed lower subbands coefficients is eradicated. The spatial position information of considerable coefficients of subbands of all levels can be determined by interpolation of higher level subbands to lower level at decoder side. Consecutively, saves the data related to the positional information of considerable coefficients, additionally providing a chance to improve the image quality at same compression level by incorporating additional wavelet coefficients. The experimental
observations reveal that the integration of interpolation and vector quantization (VQ) using neural networks provides better performance than baseline JPEG.

G. K. Wallace [WAL92] proposed the JPEG still picture compression standard. An integrated ISO/CCITT working group identified as JPEG (Joint Photographic Experts Group) has primarily developed the original compression standard for continuous-tone still images, both grayscale and color. JPEG’s standard intends to be very general, to assist an extensive range of applications for continuous-tone images. In order to use for several applications, the JPEG standard comprises of two essential compression techniques, each with different means of operation. A DCT (Discrete Cosine Transform)-based technique is used for ‘lossy’ compression and an analytical technique for ‘lossless’ compression. JPEG features an uncomplicated lossy technique recognized as the Baseline technique, a division of the additional DCT-based modes of operation. The Baseline technique has been the extensively utilized JPEG technique, and is adequate in its individual right for a huge amount of applications.

S.W. Hong et al., [HOB00] presented an edge preserving image compression technique depending on sub band coding and iterative constrained least square regularization. The main purpose is to integrate the technique of image restoration into the current lossy image compression approaches. The technique makes use of the edge information obtained from the source image as an earlier knowledge for the following reconstruction. Usually, the obtained edge information has an inadequate range of magnitudes and it can be lossily conveyed. Subband coding is one of the exceptional lossy image compression approaches which are integrated to compress the source image. Vector quantization which is a block based lossy compression approach is implemented to compromise the bit rate incurred by the additional edge information and the target bit rate. It is clearly observed from the experimental results that the approach could considerably enhance both the objective and subjective quality of the reconstructed image by protecting more edge details. Particularly, the technique integrated with SPIHT (Set Partitioning in Hierarchical Trees) performs better than the original SPIHT with the ‘Baboon’ continuous tone test image. Usually, the model may be applied to any lossy image compression systems.
Mitchell A. Golner et al., [MWV00] discussed the techniques that optimized image compression ratio by using the information about a signal’s properties and their uses. This additional information about the image is used to attain additional gains in image compression. The approaches developed in this work are on the ubiquitous JPEG Still Image Compression Standard [IS0941 for compression of continuous tone grayscale and color images. This approach is based on a region based variable quantization JPEG software codec that was developed tested and compared with other image compression techniques. The application, named JPEG Tool, has a Graphical User Interface (GUI) and runs under Microsoft Windows 95. The author briefly discussed the standard JPEG implementation and lays foundation for software extension to the standard. Region selection approaches that complement variable quantization techniques are projected in addition to a short discussion on the theory and implementation of variable quantization approaches. The approach comprises of a presentation of global criteria for image compression performance and particular results obtained with JPEG Tool. The research on a variable quantization approach has led to the development of linear and raised cosine interpolation. The use of a wide range of scaling factors has resulted in a greater difference in fidelity between blocks coded with highest and lowest fidelities. This is due to the use of interpolation in the variable quantization mask. The region selection can be executed manually or automatically based on predetermined necessities.

Clark N. Taylor et al., [CTS01] projected the ubiquitous wireless multimedia communication; the bottlenecks to communicating multimedia data over wireless channels must be addressed. Two most important bottlenecks that are to be considered are the bandwidth and energy consumption necessities for mobile multimedia communication. The author addressed the bandwidth and energy dissipation bottlenecks by adjusting image compression parameters to current communication conditions and constraints. The author mainly focused on the JPEG image compression technique and presented the results of unstable some image compression parameters on energy dissipation bandwidth needed and quality of image received. The author presented a technique for choosing the JPEG image compression parameters to decrease energy consumption while meeting latency, bandwidth, and quality of image constraints. By adapting the source coder of a multimedia able radio to present communication conditions and constraints, it is possible to overcome the bandwidth
and energy bottlenecks to wireless multimedia communication. The author have chosen two parameters of the JPEG image compression technique to vary and presented the results of modifying the parameters on quality of image, bandwidth needed, computation energy, and communication energy. This approach has also presented an approach which run time chooses the optimal JPEG parameters to lessen overall energy consumption, helping to facilitate wireless multimedia communication.

Deepti Gupta et al., [DGS03] described that wavelet transform and quantization methods have generated the algorithm competent of surpassing the existing image compression standards like the Joint Photographic Experts Group (JPEG Algorithm). The author proposed new wavelet packets techniques for image compression. It is clearly observed from the experiment results that the techniques perform better than the existing wavelet filters. Wavelet transform is modeling the signals by combining algorithm based on wavelet. The Advances in translations and dilations of a simple oscillatory function of finite duration called a wavelet. Wavelet transform is used for analysis of the image at different decomposition levels.

G. Y. Chen et al., [CBK04] shown that Wavelets have been effectively used in image compression. But, for the given image, the option of the wavelet is an important issue. The author presents to use optimal wavelet for image compression, given the number of most significant wavelet coefficients to be kept. Simulated Annealing identifies the optimal wavelet for the given image to be compressed. In Simulated Annealing, the author needed a cost function to minimize. This cost function is defined as the mean square error between the decompressed image and the original image. The experiments are conducted using the test images Lena MRI scan and Fingerprint. These images are available in WaueLab developed by Donoho etal. at Stanford University. The results reveal that this technique is better than the Daubechies 8 wavelet (08) or image compression. In certain scenarios, this technique gets nearly 0.6dB enhancement over D8 by using optimal wavelet. This shows that the choice of the wavelet makes a vital difference in image compression.

Sheng Liu et al., [SNL06] had worked in the field of radar image compression of Voyage Data Recorder (VDR). A sheet of radar image is stored in VDR after a certain period of time, so the compression approach for radar image may be considered as immobile image
compression. The image compression procedure comprises Discrete Wavelet Transform (DWT), quantization and entropy coding. Initially, DWT and its fast Mallat algorithm are presented. Then, the character of the image after DWT is examined. Set partitioning in Hierarchical Trees (SPIHT) coder comprises the function of quantization and entropy coding. Then, several wavelet functions are selected to compress the radar image and code for it with two coding techniques Embedded Zero tree wavelet (EZW) and SPIHT. The simulation results reveal that the SPIHT approach is more effective than EZW.

Kin Wah Ching Eugene et al., [KGO06] proposed an enhancement approach, so named the Two Pass Improved Encoding Scheme (TIES), for the application to image compression with the extension of the existing concept of Fractal Image Compression (FIC), which exploits on the self similarity within a given image to be compressed. The author initially explores the existing image compression technology depending on FIC, before proceeding to develop the concept behind the TIES algorithm. The author then developed an efficient encoding and decoding algorithm for the implementation of TIES through the consideration of the domain pool of an image, domain block transformation scaling and intensity variation, range block approximation using linear combinations, and ultimately the exploitation of an arithmetic compression approach to store the final data as close to source entropy as possible.

Image compression using Discrete Cosine Transform (DCT) is one of the simplest normally used compression techniques. The quality of compressed images is slightly condensed at higher compression ratios due to the lossy nature of DCT compression, thus, the need for finding an optimum DCT compression ratio. A perfect image compression system must provide quality compressed images with significant compression ratio, while maintaining minimum time cost. Neural networks carried out well in simulating non-linear relationships. Khashman et al., [KHD07] proposed that a neural network could be trained to differentiate an optimum ratio for DCT compression of an image upon presenting the image to the network. The neural network connects the image strength with its compression ratios in search for an optimum ratio. Experimental results revealed that a trained neural network can simulate such non-linear relationship and therefore can be effectively used to offer an intelligent optimum image compression system.
Discrete Wavelet Transform (DWT) has many constructive properties when applied to image compression. The multiresolutional decomposition is of complexity $O(n)$ and conserves the geometric image structure within each subband [EWG96]. A tree-structured coding approach can efficiently make use of the inherent correlation in the subband representation. An algorithm is proposed which integrates a fast tree-structured quantization approach and partial search vector quantization. The approach explained by the author is a novel quantization thresholding approach which makes use of the DWT to decompose an image into octave wide frequency bands, then quantizes the coefficients using a “look ahead” measurement of the image based on the low frequency sub-image inherent in the DWT. This technique then uses vector quantization to code the thresholded coefficients of the decomposed image. A partial search vector quantization algorithm is used to enhance the speed of the quantization by using a sorted table of the energy content of the code vector. Each subband has a connected codebook which is generated using the Pairwise Nearest Neighbor (PNN) algorithm to offer an initial codebook and then uses the Generalized Lloyd (GL) algorithm to attain a final codebook.

Mei Tian et al., [MSL05] discuss the possibility of Singular Value Decomposition in Image Compression applications. A mistake viewpoint that is about SVD based image compression scheme is demonstrated. This paper goes deep to study three schemes of SVD based image compression and prove the usage feasibility of SVD based image compression. In this paper the author investigate into using singular value decomposition as a method of image compression scheme. The application of SVD based image compression schemes has shown their effectiveness. Although this paper has drawn some progress, some limitations of his study are still in existence. These limitations could be solved by the future work. The percentage of the sum of the singular values should be flexible selected according to different images and adaptive to different sub block of the same image.

Erjun Zhao [EZD05] described that Fractal image compression is a new technique in image compression field based on Affine contractive transforms. Fractal image compression methods belong to different categories according to the different theories they are based on. All of those are discussed in this paper. In the end a conclusion is made to summarize the characters of fractal image compression.
Sheng Liu et al., [SNL06] had worked in the field of radar image compression of voyage data recorder (VDR). A sheet of radar image is storage in VDR after an interval of time, so the compression algorithm for radar image may be seen as immobile image compression. The image compression process includes Discrete Wavelet Transform (DWT), quantization and entropy coding. First, the DWT and its fast Mallat algorithm is presented. Then, the character of the image after DWT is analyzed. The Set partitioning in hierarchical trees (SPIHT) coder includes the function of quantization and entropy coding. The SPIHT coder is explained in his paper briefly. At last several wavelet functions in common use are chosen to compress the radar image and code for it with two coding algorithms embedded zero tree wavelet (EZW) and SPIHT. The simulation results show the SPIHT is more effective than EZW.

Chrysafis, C et.al, [CHO98] proposed a novel algorithm for wavelet based image compression with very low memory requirements. The wavelet transform is performed progressively and only require that a reduced number of lines from the original image be stored at any given time. The result of the wavelet transform is the similar as if we were operating on the whole image, the only difference being that the coefficients of different subbands are generated in an interleaved fashion. As soon as they become available, encoding the (interleaved) wavelet coefficients is begun. Each new coefficient in one of several classes is classified, each corresponding to a different probability model, with the models being adapted on the fly for each image. The authors’ scheme is fully backward adaptive and it relies only on coefficients that have already been transmitted. The authors’ experiments demonstrate that our coder is still very competitive with respect to similar state-of-the-art coders. It is noted that schemes based on zero trees or bit plane encoding basically require the whole image to be transformed (or else have to be implemented using tiling). The features of the algorithm create it well suited for a low memory mode coding within the emerging JPEG2000 standard.

Grgic el.al, [SKM99] describes about image compression using discrete wavelet transform (DWT) and represents images as a sum of wavelet functions (wavelets) on different resolution levels. The source for the wavelet transform can be composed of any function that satisfies requirements of multiresolution analysis. It means there exists a large
selection of wavelet families depending on the choice of wavelet function. The choice of wavelet family depends on the application. In image compression application this option depends on image content. The author provides fundamentals of wavelet based image compression. The options for wavelet image representations are tested.

Singh, P et.al, [SSA06] presents a new algorithm used for wavelet based image compression by exploiting zero tree concept in the wavelet decomposed image. The algorithm has a huge edge over previously developed wavelet based image compression algorithms in that it utilizes inter and intra band correlation simultaneously, something that previous algorithms failed to exploit. Besides the enhancement in coding efficiency, the algorithm also uses significantly lower memory for computation and coding thereby reducing the complexity of the algorithm. The outstanding feature of the algorithm is pass independent coding that makes it suitable for application to error protection schemes and makes it less vulnerable to data loss due to noisy communication channel. The algorithm codes all the color bands independently thus enabling disparity coding for the color information. The paper starts with the discussion of the concept original the algorithm and then sees the algorithm in a broader light. Comparisons contain made to SPIHT, the well known zero tree coder for wavelet based image compression in terms of coding efficiency, memory requirements and error resiliency.

Hacihaliloglu et.al, [HAK03] discussed on the wavelet based image compression for satellite communication. Synthetic aperture radar (SAR) and SPOT images are flattering increasingly important and abundant in a variety of remote sensing and tactical applications. Thus, there is a strong importance in developing data encoding and decoding algorithms that can obtain higher compression ratios while keeping image quality to an acceptable level. In this study aim to balance most of the well known compression techniques specifically discrete cosine transform and discrete wavelet transform. It investigates RADARSAT and SPOT images of dissimilar regions of different character. RADARSAT fine and standard beam type images of the different regions in Istanbul are used to test the performance of the compression algorithms. The regions, which have been investigated, were sea areas, forest areas, built environment-residential and industrial areas which define different patterns of urban land use. The studies showed that homogeneous areas like forest and sea give better
compression results compared to heterogeneous areas like industrial and environmental. The
second purpose of this study is to compare the two compression algorithms. The discrete
wavelet based algorithm give much better results compared to the discrete cosine transform
based algorithm. The results altered according to the quantization process and the transform-
coding algorithm.

Woods et.al, [DOW88] describes about the variations on BPN (backward propagation
network) and CPN (counter propagation networks) have been presented. The BPN variations
are slight quicker and the CPN variations are a little more accurate. The author suggests that
this variation should be tested on some other more difficult problems. To this end, a fault-
tolerant (in software) handwriting recognizer is creature developed using these BPN and
CPN variations, along with an adaptive resonance network. Preliminary results point to that
by using the author's equation with the BPN, a 20% decrease in learning time can be
obtained, which represents a reduction from 30 to 24 hours for learning the alphabet.

Soo-See Chai et.al, [SBG08] proposed a soil moisture retrieval technique using th
BPNN. The back propagation artificial neural network (ANN) is a well-known and widely
applied mathematical model for remote sensing applications for pattern recognition
approximation and mapping of non linear functions and time-series prediction. The back
propagation ANN algorithm is underpinned by a gradient descent algorithm that is used to
modify the network weights to maximize performance, using some criterion function. There
are a number of variations from general algorithm and it is necessary to explore these to find
the best method for any particular application. The application considered in this paper is the
determination of volumetric soil moisture content given airborne microwave measurements
of the H- and V-polarized brightness temperature obtained during the National Airborne
Field Experiment 2005 (NAFE’05). In this paper, a number of back propagation ANN
methods are investigated. A few produce the internationally acceptable accuracy of less than
or equal to 4%v/v of Root Mean Square Error (RMSE). However the standard deviation with
the 11 different variations of back propagation training algorithms (0.55) is significant
compared to the accuracy. Hence, there is a need for a full analysis of the back propagation
ANN and careful selection of the best back propagation ANN model to be used.
Christopher et al., [CHP01] describes characteristics of providing spatial and frequency information in the transform domain by wavelet transform plays a crucial role in forming a significance map of coefficients that needs to be coded in the case of image compression. In this paper presents a wavelet based image compression technique wherever transmission of spatial locations of wavelet decomposed lower sub bands coefficients is eliminated. The spatial position information of major coefficients of sub bands of each level can be found by interpolation of higher level sub bands to lower level at decoder side. This in turn, save the data consequent to positional information of considerable coefficients, further giving an opportunity to enhance image quality at same compression level by including additional wavelet coefficients. The simulation results prove that the combination of interpolation and vector quantization (VQ) using neural networks performs better than baseline JPEG.

Deepak et al., [DBT06] proposed a modified forward-only counter propagation neural network (MFO-CPN) for color image compression is proposed. It uses a number of higher-order distance measures for calculating winning node. It also incorporates nonlinear alterations of learning rates in both the layers. Results with these distance functions are compared. Proposed modifications direct to improvement in the image quality and faster convergence of network.

Saudagar et al., [SKS10] proposed a novel technique for image compression using the ANN. Image and video compression is one of the major components used in video-telephony, videoconferencing and multimedia-related applications where digital pixel information can comprise considerably large amounts of data. Management of such data can involve significant overhead in computational complexity and data processing. Compression allows efficient utilization of channel bandwidth and storage size. Typical access speeds for storage mediums are inversely proportional to capacity. Through data compression, such tasks can be optimized. One of the commonly used methods for image and video compression is JPEG (an image compression standard). Image and video compressors and decompressors (codecs) are implemented mainly in software as digital signal processors. Hardware-specific codecs can be integrated into digital systems fairly easily, requiring work only in the areas of interface and overall integration. Using an FPGA (Field Programmable...
Gate Array) to implement a codec combines the best of two worlds. The implementation of this work is carried out with JPEG algorithm with Artificial Neural Networks (ANN). The core compression design was created using the Verilog hardware description language. The supporting software was written in matlab, developed for a DSP and the PC. The implementation of this work was successful on achieving significant compression ratios. The sample images chosen showed different degrees of contrast and fine detail to show how the compression affected high frequency components within the images.

Improvements in speed occur primarily because the hardware is tailored to the compression algorithm rather than to handle a broad range of operations like a digital signal processor. For improving the ANN efficiency for image compression various works were suggested in past. Tang Xianghong et al., [TAL08] expounds the principle of BP neural network with applications to image compression and the neural network models. Then an image compressing algorithm base on better BP network is developed. Feed-forward networks using back propagation algorithm adopting the method of steepest descent for error minimization is popular and widely adopted and is directly applied to image compression. Image data compression by Vector Quantization (VQ) has received a lot of attention because of its simplicity and adaptability. VQ requires the input image to be processed as vectors or blocks of image pixels. The Finite state vector quantization (FSVQ) is recognized to give better performance than the memory less vector quantization (VQ). The author in presents a novel combining technique for image compression based on the Hierarchical Finite State Vector Quantization (HFSVQ).

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A new image compression technique is presented by Abidi et al., [AYC94] using hybrid neural networks that combine two different learning networks, the auto-Associative Multi-Layer Perceptron (AMLP) and the self-organizing feature map (SOFM). The neural networks simultaneously perform dimensionality reduction with the AMLP and categorization with the SOFM to compress image data. Two hybrid neural networks forming parallel and serial architectures are examined through theoretical analysis and computer simulation. The parallel structure network reduces the dimensionality of input pattern vectors by mapping them to different hidden layers of the AMLP selected by winner-take-all units of the SOFM. The serial structure network categorizes the input pattern vectors into several classes representing prototype vectors. Both the serial and parallel structures are combinations of the AMLP and SOFM networks. These hybrid neural networks achieve clear performance improvement with respect to decoded picture quality and compression ratios, compared to existing image compression techniques.

Setiono et al., [SEG94] presented an image compression technique using a feed-forward neural network. The neural network has three layers: one input layer, one hidden layer and one output layer. The inputs of the neural network are original image data, while the outputs are reconstructed image data which are close to the inputs. If the amount of data required to store the hidden unit values and the connection weights to the output layer of the neural network is less than the original data, compression is achieved. In our experiments, we achieved a compression ratio of about 10 with good reconstructed image quality. The neural
network construction algorithm we used has an attractive feature that each addition of a hidden unit to the network will always improve the image quality. Thus our compression scheme is flexible in the sense that the user can trade between image quality and compression ratio depending on the application requirements.

A hybrid fuzzy neural approach is proposed for the image compression by Mishra et al., [MIZ10]. The inputs to the network are the preprocessed data of original image, while the outputs are reconstructed image data, which are close to the inputs. This process is similar to a typical function approximation problem which involves determining or learning the input-output relations using numeric input-output data. A mutual subsethood based Fuzzy Neural Network is used for image compression application as a function approximator. If the amount of data required to store the hidden unit values and the connection weights to the output layer is less than the original data, compression is achieved. The network is trained for different number of quantization bits with direct impact to compression ratio. It is experimented with different images that have been segmented in the sub image blocks of equal sizes for compression process. The results encourage the possibility of using proposed fuzzy neural network for image compression.

It is difficult to get high compression ratio and good reconstructed image by conventional methods; Guo Hui et al., [GHW10] developed a new method of compression on medical image. It is to decompose and reconstruct the medical image by wavelet packet. Before the construction the image, use neural network in place of other coding method to code the coefficients in the wavelet packet domain. By using the Kohonen's neural network algorithm, not only for its vector quantization feature, but also for its topological property. This property allows an increase of about 80% for the compression rate. Compared to the JPEG standard, this compression scheme shows better performances (in terms of PSNR) for compression rates higher than 30. This method can get big compression ratio and perfect PSNR. Results show that the image can be compressed greatly and the original image can be recovered well. In addition, the approach can be realized easily by hardware.

A new image compression algorithm based on an unsupervised competitive neural network to prevent the edge degradation is proposed by Dong-Chul Park et al., [DCY99]. The proposed unsupervised competitive neural network, called weighted centroid neural
network (WCNN), utilizes the characteristics of image blocks from edge areas. The mean/residual VQ (M/R VQ) scheme is utilized in this proposed approach as the framework of the proposed algorithm. A novel measure for calculating edge strength is devised by using the residue of an image block data from the M/R scheme. The edge strength of an image block data is then utilized as a tool to allocate the proper code vectors in the proposed WCNN. The WCNN successfully allocates more code vectors to the image block data from edge area while it allocates less code vectors to the image block data from shade or non-edge area when compared to conventional the neural network based VQ algorithm. As a result, a simple application of WCNN to image compression problem gives improved edge characteristics in reproduced images over conventional neural network based VQ algorithms.

Li Huifang et al., [LIL10] combined the quantum neural networks and image compression using Quantum Gates as the basic unit of quantum computing neuron model, and establish a three layer Quantum Back Propagation Network model, then the model is used for realizing image compression and reconstruction. Since the initial weights of neural networks were slow convergence, we use Genetic Algorithm (GA) to optimize the neural network weights, and present a mechanism called clamping to improve the genetic algorithm. Finally, we combined the Genetic Algorithm with quantum neural networks to finish image compression. Through an experiment we can see the superiority of the improved algorithm.

Venetianter et al., [VER98] demonstrated how the cellular neural-network universal machine (CNNUM) architecture can be applied to image compression. We present a spatial subband image-compression method well suited to the local nature of the CNNUM. In case of lossless image compression, it outperforms the JPEG image-compression standard both in terms of compression efficiency and speed. It performs especially well with radiographical images (mammograms); therefore, it is suggested to use it as part of a cellular neural/nonlinear (CNN)-based mammogram-analysis system. This paper also gives a CNN-based method for the fast implementation of the moving pictures experts group (MPEG) and joint photographic experts group (JPEG) moving and still image-compression standards.

Vector Quantization (VQ) is a technique applicable to the compression of still and motion video images. The efficiency of the compression scheme depends on how well the statistical properties inherent in the image are extracted and used. Neural networks because
of their fast parallel search capabilities make good vector quantizes. A neural network used for VQ must be able to learn the local statistical properties of the image very quickly if it is to process video images efficiently in real time. However, quick learning is not a property normally found in neural networks developed to date. Worrell et al., [WOR92] described a self organizing neural network VQ architecture that has a fast autonomous learning algorithm suitable for use in real time image compression.

Image compression using stochastic artificial neural networks (SANNs) is studied by Liu et al., [LIU93]. The ideal is to store an image in a stable distribution of a stochastic neural network. Given an input image \( f \in F \), one can find a SANN \( t \in T \) such that the equilibrium distribution of this SANN is the given image \( f \). Therefore, the input image, \( f \), is encoded into a specification of a SANN, \( t \). This mapping from \( F \) (image space) to \( T \) (parameter space of SANN) defines the SANN transformation. It is shown that the compression ratio \( R \) of the SANN transformation is \( R = O(n/(K (\log n)^2)) \) where \( n \) is the number of pixels. To complete a SANN transformation, SANN equations must be solved. Two SANN equations are presented. The solution of SANN is briefly discussed.

Denk et al., [DEP93] presented a new image compression scheme which uses the wavelet transform and neural networks. Image compression is performed in three steps. First, the image is decomposed at different scales, using the wavelet transform, to obtain an orthogonal wavelet representation of the image. Second, the wavelet coefficients are divided into vectors, which are projected onto a subspace using a neural network. The number of coefficients required to represent the vector in the subspace is less than the number of coefficients required to represent the original vector, resulting in data compression. Finally, the coefficients which project the vectors of wavelet coefficients onto the subspace are quantized and entropy coded. The advantages of various quantization schemes are discussed. Using these techniques, a 32 to 1 compression at peak SNR of 29 dB was obtained.

A new kind of neural approach to image compression based on a self-adaptive size masking procedure is presented by Parodi et al., [PAP94]. The neural network (NN) generalization capability has been proved to be a key-element for their application to image compression. In order to improve this feature, an adaptive approach based on pattern classification by activity measure for training and validation is studied. Because of different
regions being characterized by different activity, a variable block-size technique has been adopted, in order to improve quality and compression. Different neural networks with different input masks and hidden number are trained on different activity patterns and used on different activity regions. The results have proved this approach to be able to remarkably improve the compression ratio and the global generalization capability of networks. Several tests on learned and unlearned pictures and comparisons with fixed size NNs and DCT-based (JPEG) approaches are reported.

A new multiresolution algorithm for image compression based on projection pursuit neural networks is presented by Safavian et al., [SRF97]. High quality low bit-rate image compression is achieved first by segmenting an image into regions of different sizes based on perceptual variation in each region and then constructing a distinct code for each block by using the orthogonal projection pursuit neural networks. This algorithm allows one to adaptively construct a better approximation for each block by optimally selecting the basis functions from a universal set. The convergence is guaranteed by orthogonalizing the selected bases at each iteration. The coefficients of the approximations are obtained by back-projection with convex combinations. Our experimental result shows that at rates below 0.5 bits/pixel, this algorithm shows excellent performance both in terms of peak S/N ratio and subjective image quality.

Veisi et al., [VEJ07] presented a complexity-based image compression method using neural networks. In this method, different multi-layer perceptron ANNs are used as compressor and de-compressor. Each image is divided into blocks, complexity of each block is computed using complexity measure methods and one network is selected for each block according to its complexity value. Three complexity measure methods, called entropy, activity and pattern-based are used to determine the level of complexity in image blocks and their ability are evaluated and compared together. Selection of a network for each image block is based on its complexity value or the Best-SNR criterion. Best-SNR chooses one of the trained networks such that it results best SNR in compressing a block of input image. In our evaluations, best results, with PSNR criterion, are obtained when overlapping of blocks is allowed and choosing the networks in compressor is based on the Best-SNR criterion. In this
case, the results demonstrate superiority of our method comparing with previous similar works and that of JPEG standard coding.

Selection of the best wavelet from various wavelet families for image compression is a challenging problem. There are many wavelets that can be used to transform an image in a wavelet-based codec. However, it is necessary to use only one wavelet to compress an image. The most appropriate wavelet will give a good compressed image; otherwise the wrong selection will produce a low quality image. Irijanti et al., [IYN08] applied artificial neural network (ANN) as a method to solve this problem instead of manual selection as in a conventional wavelet-based codec. The results show that the neural network based on image characteristics can be used as a solution to solve the problem. The input variables to the ANN are two image features, namely image gradient (IAM) and spatial frequency (SF) from three color components (red, green and blue) and the output the ANN is the wavelet type.

A lossy compression method for gray images is proposed by Watanabe et al., [WAM01] on the basis of a modular structured neural network. This modular structured neural network consists of multiple neural networks with different block sizes (the numbers of input units) for the region segmentation. By the region segmentation procedure, each neural network is assigned to each region such as the edge or the flat region. From simulation results it is shown that the proposed compression method gives better compression performance compared with the conventional compression method using a single neural network.

Data compression occurs naturally in the human brain. The brain detects features and the context to any input signal and associates with it a name and form. The use of artificial neural networks for compressing data has been used in the past with some degree of success. The difficulty with this technique is that even though it may achieve a high compression ratio, it provides only the `approximate' information and loses the `detail'. Kumar et al., [KUM98] a new concept has been developed-nested neural networks. These networks are built with a set of networks `nested' inside the larger network. This scheme has been implemented for data compression of images and the results are promising.
Huq et al., [HBR02] presented a modular approach of still image compression using dynamically constructive independent node neural networks (DCINNs). A new sub-image block classification technique using wavelet transform and LBG algorithm is proposed for partitioning images into different image clusters. Each module of neural network is trained on a particular image cluster. A modified dynamical construction algorithm is used for building such a network. The DCINN has the inherent capability of producing variable bit rates as it is composed of several independent subnetworks. This feature makes it suitable for transmission of image data over channels having time varying bandwidth characteristic. This architecture is also very robust to hidden node damage.

Rao et al., [RMN10] explored the application of artificial neural networks to image compression. An image compressing algorithm based on Back Propagation (BP) network is developed after image pre-processing. By implementing the proposed scheme the influence of different transfer functions and compression ratios within the scheme is investigated. It has been demonstrated through several experiments that peak-signal-to-noise ratio (PSNR) almost remains same for all compression ratios while mean square error (MSE) varies.

A three-layered neural network is described for transforming two-dimensional discrete signals into generalized nonorthogonal 2-D Gabor representations for image analysis, segmentation, and compression. These transforms are conjoint spatial/spectral representations, which provide a complete image description in terms of locally windowed 2-D spectral coordinates embedded within global 2-D spatial coordinates. Daugman et al., [DAU02] presented a neural network approach, based on interlaminar interactions involving two layers with fixed weights and one layer with adjustable weights, the network finds coefficients for complete conjoint 2-D Gabor transforms without restrictive conditions. In wavelet expansions based on a biologically inspired log-polar ensemble of dilations, rotations, and translations of a single underlying 2-D Gabor wavelet template, image compression is illustrated with ratios up to 20:1. Also demonstrated is image segmentation based on the clustering of coefficients in the complete 2-D Gabor transform.