Application of Multi layer (Perceptron) Artificial Neural Network in the Diagnosis System: A Systematic Review

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***Abstract* - Basic hardware comprehension of an artificial neural network (ANN), to a major scale depends on the proficient realization of a distinct neuron. For hardware execution of NNs, mostly FPGA-designed reconfigurable computing systems are favorable. FPGA comprehension of ANNs through a huge amount of neurons is mainly an exigent assignment. This work converses the reviews on various research articles of neural networks whose concerns focused in execution of more than one input neuron and multilayer with or without linearity property by using FPGA. An execution technique through reserve substitution is projected to adjust signed decimal facts. A detailed review of many research papers have been done for the proposed work.**

The proposed paper involves a Multi Layer Perceptron with a Back Propagation learning algorithm to identify a prototype for the diagnosis. In this paper, a brief introduction about artificial neural network used nowadays for diagnosis of disease is given.

Index Terms - Neural Network, FPGA, VHDL.

I. INTRODUCTION

In recent years machine learning methods have been broadly used in forecasting and prediction, especially in the field of medical diagnosis. Medical diagnosis is one of main problem in medical application. A large number of research groups are working world wide on the improvement of neural networks in medical diagnosis. Neural networks are used to enlarge the accuracy and neutrality of medical diagnosis. 'Neural networks' research and application have been studied for a half of hundred years.

Artificial neural networks (ANNs) are warning devices containing layers of computing nodes with extraordinary information processing characteristics. They are capable to sense non linearities that are not unequivocally originated as inputs, assemble them capable of learning and malleability. They acquire high parallelism, stoutness, simplification and noise lenience, which make them capable of clustering, function approximation, forecasting and association, and performing particularly parallel multi factorial analysis for modeling complex patterns, where there is little *a priori* knowledge [1]. Artificial neural models possessing such characteristics are desirable because: (a) nonlinearity allows better fit to the data, (b) noise-insensitivity leads to accurate prediction in the presence of uncertain data and measurement errors, (c) high parallelism implies fast processing and hardware failure-tolerance, (d) learning and adaptability permits the system to update and/or modify its internal structure in response to changing environment, and (e) generalization enables application of the model to unlearned data [2].

In the early 1940s, McCulloch and Pitts explored the competitive abilities of networks made up of theoretical mathematical models when applied to the operation of simple artificial neurons. When these early neurons were combined, it was possible to construct networks capable of computing any of the finite basic Boolean logical functions, including symbolic logic. The system comprised of an artificial neuron and input (stimuli) was referred to as "the Perceptron", which established a mapping between input activity and output signal. The next important milestone was the development of the first trainable network perceptron by Rosenblatt, 1959 and Widrow & Hoff, 1960, initially as a linear model having two layers of neurons or nodes (an input and an output layer) and a single layer of interconnections with variables (weights) that were adjustable during training. Some models increased their computational capabilities by adding additional optical filters and layers with fixed random weights, or other layers with unchanging weights. However, these single layers of trainable weights were limited to only solving linear problems. By 1974, Werbos expanded the network to have nonlinear capabilities, modeling with two layers of weights that were trainable in a general fashion, and that accomplished nonlinear discrimination and functional approximation. These original algorithms were named "back-error propagation, BP" and the networks called multilayer perceptrons (MLPs). In BP, the network error (i.e., difference between the predicted and true outcome) constitutes two steps: forward activation to produce a solution, and a backward propagation of the computed error to modify the weights (usually carried out through fitting the weights of the model by a certain function, such as squared error or maximum likelihood, using a gradient optimization method). Rumelhart and McClelland popularized ANNs in 1986, and a variety of ANN paradigms have been developed over the last 46 years. In fact, over 50 different ANN types exist. Some

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applications may be solved using different ANN types, whereas others may only be solved by a specific ANN type. Some networks are capable of solving perceptual problems, while others are more tailored for data modeling and functional approximation. Within cancer research alone, ANNs have been applied to image processing, outcome prediction, treatment-response forecasting, diagnosis and staging

Today, neural networks (NNs) area unit usually used in many fields and also back -propagation (BP) has been broadly accepted as flourishing knowledge rules to seek out the appropriate values of the weights for neural networks. Due to the advance architecture and ease of implementations, they're going to be applied during a very wide selection of medical fields. In lung disease like asthma, a person's airways turn into inflamed, thin and swell due to extra mucus, resulting difficult to breathe.

An exhaustive study on Artificial Neural Network (ANN) can be seen in "Neural and Adaptive Systems: Fundamentals through Simulations "by Principe, Euliano, and Lefebvre (2000). Paulo J. Lisboa and Azzam F.G. Taktak (2006) had done a systematic review on artificial neural networks in decision support in cancer. This paper informed on a systematic review that was performed to measure the benefit of artificial neural networks (ANNs) as decision making tools in the field of cancer. This paper reconsiders the clinical fields where neural network methods outline most significantly, the main algorithms featured, methodologies for model selection and the need for precise evaluation of results. This paper discusses the literature review of Multi Layer Neural Network with ANN based medical diagnosis, which is restricted to methods for selection of the amount of features and neurons, and evaluates relevant literature It is divided into five parts, including the introduction. Section 2 presents the background of Artificial Neural Network. Section 3 reviews Back Propagation learning algorithm. Section 4 provides a framework of genetic algorithms. Section 5 presents a brief literature review on ANN and considering the advantages and disadvantages. Finally, concluding remarks and future research scope is given in section 6.

The objective of this paper is to represent a literature review about the applicability of Artificial Neural Networks in medical field.

II. BACKGROUND: ARTIFICIAL NEURAL NETWORK

Artificial neural networks area unit extended within the basis of brain structure. Like the brain, ANNs will acknowledge patterns, handle facts and figures and be trained. They're ready by artificial neurons that employ the quint essence of genetic neurons.

• It acquires an amount of inputs (from distinctive knowledge or from output of former related to neurons). Every input approaches through an affiliation, that is named synapses and that features a weight. A nerve cell conjointly features a threshold worth. If the summation of the weights is beyond this worth, than the nerve cell is stirred up.

• The stimulation indication constructs the output of the nerve cell. This output is often the results of the matter or are often measured AN input for an additional nerve cell. To construct a synthetic neural network is needed to place conjointly variety of neurons. They're organized on layers. A network has AN input layer (which holds the values of outdoor capricious) And an output layer (the forecasts or the ultimate outcomes). Inputs and outputs communicate to sensory and motor nerves from physique. The network conjointly consist one hidden layer(s) of neurons, that performs an inside perform within the network. An Artificial Neural Network can be represented as an arithmetic linear interpretation of the individual neural design, reflective it's "learning" and "generalization" capabilities. Therefore, ANNs relates to the world of computer science and advance artificial intelligence.

Basically a neural network is formed by a systematic arrangement of "neurons" and again these arrangements are structured in the number of layers. All the neurons of a layer are related to the next layers of neurons with some weighted fashion. The number of the burden w_{ij} mere the force of the link among the i^{th} vegetative cell in every layer and also the jth vegetative cell in subsequent one. The formation of a neural network is created by an "input" layer, one or quite one "hidden" layer(s), and also the "output" layer. The final methodology of a particular three-layered neural network design is given in Fig. 1.

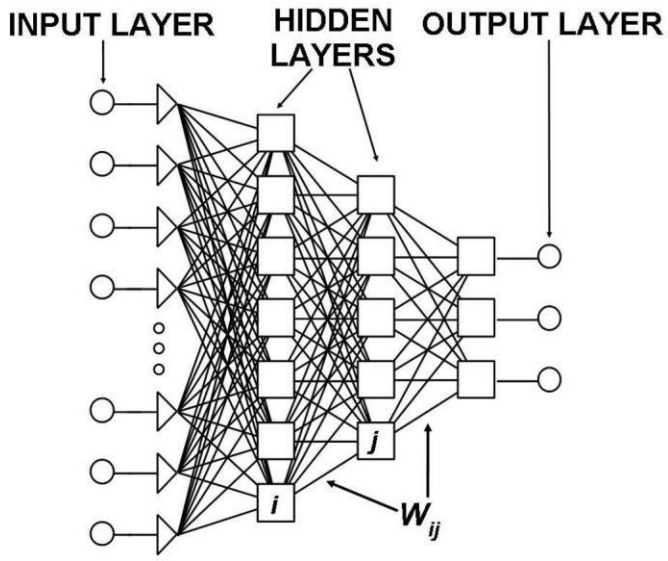

Fig 1. Conventional formation of Neural Network with 2- hidden layers

Here, the info area unit mathematically developed and also the result's settled to the neurons within the next layer. Eventually, the neurons within the final layer of network give the network's output. Mathematically it is observed that *j*-th neuron of a hidden layer observes the inward bound data (x_i) by following three calculations:

(i) Weighted estimation can be calculated and addition of a "bias" term (θ_j) according to Equation 1:

$$net_j = \sum_{i=1}^{m} (x_i * \text{Wij} + \emptyset_j) \quad j = 1,2,\ldots..,n \ldots\ldots\ldots(1)$$

(ii) Transformation of net_j via appropriate mathematical "transfer function"

(iii) Transferring the concluding results to neurons in the upcoming layer. For the activation of a neuron many transfer function can be used but sigmoid function is used the most frequently.

$$f(x) = \frac{1}{1+e^{x}} \ldots \quad \ldots\ldots\ldots (2)$$

III. Back Propagation Learning Algorithm

The back propagation algorithm was originally introduced in the 1970s, but its importance wasn't fully appreciated until a famous 1986 paper by David Rumelhart, Geoffrey Hinton, and Ronald Williams and it has become a popular training method for Multi Layer Perceptron. The essential training law of BP is based on the gradient straight method that regulates the weights to minimize Mean Square Error (MSE). The training process of BP can be started by multiplying the input vectors with the weights, as the biases and weights are summed in order to calculate the actual outputs. The required outputs have to be resolute and then compared with the actual outputs, progressing valuation and weight modification until the process approaches the desired MSE value. MSE is also identified as network error and represented mathematically as [22]:

$$E = \Sigma_K 1/2 \, (T_K - Y_K)^2$$

Where T_K is the desired output from the output layer, and Y_K is the actual output in the output layer. Although the recognition of BP as a training algorithm for MLP, it has disadvantages; it can get wedged with local minima during training [3-5] and can be slow, involving a high number of iterations while training

This paper describes several neural networks where back propagation works far faster than earlier approaches to learning, making it promising to use neural nets to solve problems which had previously been insoluble. Today, the back propagation algorithm is the workhorse of learning in neural networks. The Back propagation algorithm looks for the minimum value of the error function in weight space using a technique called the delta rule or gradient descent. The weights that minimize the error function are then considered to be a solution to the learning problem.

IV. Framework Of Genetic Algorithm

The genetic algorithm (GA) was introduced by John Holland in 1975. It is based on the idea of a Darwinian-type fitness for survival which is used to construct enhanced individuals for the desired problem, as dissimilar possible solutions compete and match with each other. It is basically a form of optimization that can be applied to composite utilities. GA has a resemblance with genetic materials in that individual requisites are symbolized by means of a linear string [6]. The basic idea of GA processes is demonstrated in Figure 2. GA initiates its process by formation of individual populations, which are known as chromosomes or genetic materials, then formulation and valuating each individual based on fitness, then levelling and selecting them according to their fitness. GA has two main operators, namely, crossover and transmutation, and they operate to imitate new generation of individuals (chromosomes) which are then sent to the first step of the process as the unfit individuals are replaced with the new and better ones [6].

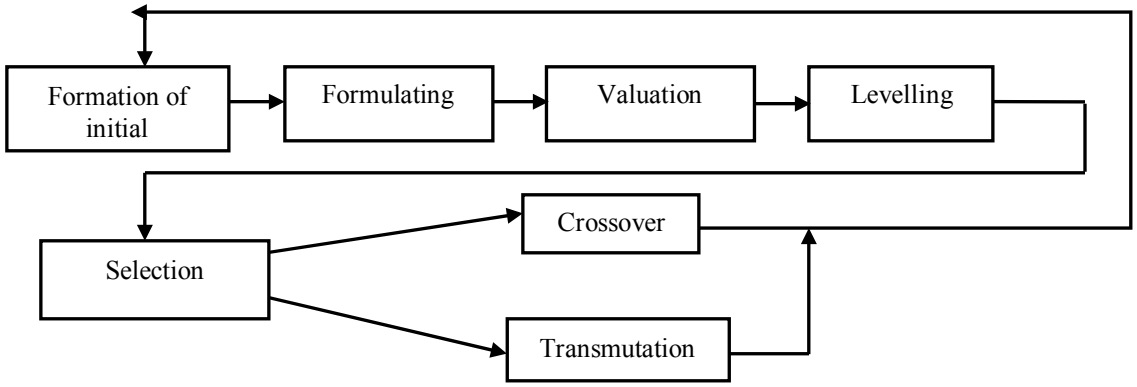

Fig 2. Processes and operations of Genetic Algorithm.

V. LITERATURE SURVEY

For the application of neural network in the various diagnosis system a systematic and deep literature survey is done which is as follows:

S.No.	Author's Namer	Year	Tools & Techniques	Description
1.	E. Chatzimichail, E. Paraskakis, and A. Rigas[7]	2013	MultiLayer Perceptron	In this paper, an advance machine intelligence methodology for the prediction of persistent respiratory disorder in youngsters is mentioned. By discrimination partial least sq. regression, nine out of forty eight extrapolative aspects related to the tenacious respiratory disorder are identified. Multilayer perceptron arrangements are found so as to urge the most effective estimate accuracy. In the results, it does delineate that the given system is ready to predict the asthma consequences with 99.77%.
2.	ParinyaNoisa, TaneliRaivio, and Wei [8]	2015		Human embryonic stem cells (hESCs) measures in vitro indeterminately while not trailing their capability to distinguish in numerous cell varieties upon exposure to acceptable signs. During this study, author segregate dhESCs to dop aminergic neurons via a transitional stage, neural root cells.
3.	KarthikKalyan, BinalJakhia, RamachandraDattatrayaLele,Mukund Joshi, and Abhay Chowdhary [9]	2014	using Multilayer Perceptron	The introductory study of this work shows an absolute study of assorted texture options extracted from ultrasonic images of the liver by using Multilayer Perceptron (MLP), to review the presence of sickness conditions. An echo texture pattern can be identified by analysing these images. Liver infection circumstances like fatty liver, cirrhosis, and abnormality square measure recognized for producing distinguishing echo patterns throughout America imaging; although these descriptions also are known to be visually difficult for deciphering them since of their imaging relic and spoil noise.
4.	Taimoor Khan and AsokDe,Hindawi [10]	2014	Field Programmable Gate Array(FPGA)	FPGA based neural network is demonstrated in this work. Different parameters of rectangular, triangular and circular antenna are analysed through FPGA based NN. This paper gives an idea to evolve a low price neural network based FPGA which is beneficial for the microwave applications.
5.	Yutaka Maeda, and Masatoshi Wakamura[11]	2005	Back Propagation	In this work, authors well thought-out associate FPGA realization of Hopfield neural network (HNN) with the encyclopaedic rule through prompt agitation. Neural networks (NNs) area unit extensively worn innumerable fields. At the same time, back-propagation (BP) is extensively enforced as a triumphant encyclopaedic rule to find the opposite ethics of the weights for NNs. As an example, the Hopfield neural network (HNN) could be a distinctive persistent neural network with proportioned absolutely interconnected weights. Persistent neural networks have attention-grabbing properties and might handle dynamic IP in contrast to standard feed forward neural networks. This paper shows, an algorithmic learning theme for recurrent neural networks mistreatment the synchronic perturbation technique.

6.	Hui Li, *Senior Member, IEEE*, Da Zhang, Simon Y. Foo [12]	2006	Feed Forward Neural Network	A reconfigurable hardware execution of feed forward NNs based on stochastic methodology is presented in this paper. The nonlinear sigmoid activation signal with minimum digital logic inputs is estimated by using stochastic computation theory.
7.	Indraneel Mukhopadhyay, Mohuya Chakraborty [13]	2014	Field Programmable Gate Array(FPGA)	In this research work, an advance technique is proposed for execution of Intrusion Detection and prevention system. This system is completely implemented on FPGA which can identify different networks outbreaks and prevent them from further transmission.
8.	Nasr A. BelacyAbdullah H. Altemani, Mostafa H. Abdelsalam1, Magdi A. El-Damarawi, Basem M. Elsawy, Noha A. Nasif, Eman A. El-Bassuoni1 [14]	2014		For the diagnosis of many respiratory syndrome, Lung function testing is a quite important. In this paper, it has been discovered that reference data is very small for Saudi adults.
9.	M. R. Mustafa,1 R. B. Rezaur,2 H. Rahardjo [15]	2015	Back Propagation	This paper shows the responses to rainfall application of ANN. It is not easy to measure the soil pore water pressure because it is tedious, time taking and expensive task. This article gives the relevance of artificial neural network (ANN) system for demonstrating soil pore-water pressure dissimilarities at several soil depths from the statistics of rainfall patterns.
10.	S. Himavathi, D. Anitha [16]	2007	Field Programmable Gate Array(FPGA)	Multilayer neural network with feed forward technique based FPGA is implemented in this article. Even though enhancements in FPGA bulks, the various multipliers in associate degree NN limit the scale of the network that may be enforced employing a single FPGA, therefore creating NN applications not feasible profitably.

VI. Conclusion

The ultimate aim of designing an efficient diagnosis system is to make best use of the classification accuracy and at the same time reduce the feature size. ANN can confidently be used to implement any diagnosis system because:-

(i) It has capability to handle a huge amount of facts and figures.

(ii) Condensed chance of ignorable pertinent data.

(iii) Diminution of identification time.

The outcome that has been obtained from above research articles shows that any medical diagnosis system based on ANN can attain quite high prediction accuracy. ANNs symbolize an influential tools and technique to facilitate and help physicians to complete diagnosis and many other tests.

References

[1] Leonardo Maria Reyneri *"Implementation Issues of Neuro-Fuzzy Hardware: Going Toward HW/SW Codesign"* IEEE TRANSACTIONS ON NEURAL NETWORKS, JANUARY 2003, VOL. 14, NO. 1, , pp(176-194)

[2] Cheol-Taek Kim and Ju-Jang Lee "*Training Two-Layered Feed forward Networks With Variable Projection Method"* IEEE Transactions on Neural Networks, Vol. 19, No. 2, February 2008.

[3] DING, S., SU, C. & YU, J. (2011) "*An optimizing BP neural network algorithm based on genetic algorithm*." Artificial intelligence review, 36.

[4] MCINEMEY, M. & DHAWAN, A. P. (1993) "*Use of Genetic Algorithms with Back Propagation in Training of Feed-Forward Neural Networks"*. International conference on neural networks. San Francisco, CA, IEEE.

[5] KITANO, H. (1990) "*Empirical studies on the speed of convergence of neural network training using genetic algorithm"m*. Machine Learning.

[6] ROOIJ, A. J. F. V., JAIN, L. C. & JOHNSON, R. P. (1996) "*Neural Network Training Using Genetic Algorithm"*, Singapore, World Scientific Publishing Co. Pte. Ltd.

[7] E. Chatzimichail, E. Paraskakis, and A. Rigas,**"***Predicting Asthma Outcome Using Partial Least Square Regression and Artificial Neural Networks"* Hindawi Publishing Corporation Advances in Artificial IntelligenceVolume 2013, Article ID 435321, 7 pages

[8] ParinyaNoisa, TaneliRaivio, and Wei Cui "*Neural Progenitor Cells Derived from Human Embryonic Stem Cells as an Origin of Dopaminergic Neurons"* Hindawi Publishing Corporation Stem Cells International Volume 2015, Article ID 647437, 10 pages

[9] KarthikKalyan, BinalJakhia, RamachandraDattatrayaLele,Mukund Joshi, and AbhayChowdhary , *Artificial Neural Network Application in the Diagnosis of Disease Conditions with Liver Ultrasound Images"* Hindawi Publishing Corporation Advances in Bioinformatics Volume 2014, Article ID 708279, 14 pages

[10] Taimoor Khan and Asok De, "*Hardware Neural Networks Modeling for Computing Different Performance Parameters of Rectangular, Circular, and Triangular Microstrip Antennas"* Hindawi Publishing Corporation Chinese Journal of Engineering Volume 2014, Article ID 924927, 11 pages

[11] Yutaka Maeda, Masatoshi *Wakamura "Simultaneous Perturbation Learning Rule for Recurrent Neural Networks and Its FPGA Implementation"*.IEEE TRANSACTIONS ON NEURAL NETWORKS, NOVEMBER 2005, VOL. 16, NO. 6.

[12] Hui Li, Da Zhang, and Simon Y. Foo "*A Stochastic Digital Implementation of a Neural Network Controller for Small Wind Turbine Systems"* IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 21, NO. 5, SEPTEMBER 2006

[13] IndraneelMukhopadhyay, MohuyaChakraborty*"Hardware Realization of Artificial Neural Network Based Intrusion Detection & Prevention System"* Journal of Information Security, 2014, 5, 154-165 Published Online October 2014 in SciRes.

[14] Nasr A. BelacyAbdullah H. Altemani, Mostafa H. Abdelsalam1, Magdi A. El-Damarawi, Basem M. Elsawy, Noha A. Nasif, Eman A. El-Bassuoni1 *"Reference Values for Lung Function Tests in Adult Saudi Population"*International Journal of Internal Medicine 2014, 3(3): 43-52 DOI: 10.5923/j.ijim.20140303.02

[15] M. R. Mustafa, R. B. Rezaur, H. Rahardjo,3 M. H. Isa, and A. Arif,"*Artificial Neural Network Modeling for Spatial and Temporal Variations of Pore-Water Pressure Responses to Rainfall"*Hindawi Publishing Corporation Advances in Meteorology Volume 2015, Article ID 273730, 12 pages

[16] [S. Himavathi, D. Anitha, and A. Muthuramalingam "*Feedforward Neural Network Implementation in FPGA Using Layer Multiplexing for Effective Resource Utilization"* IEEE Transactions on Neural Networks, vol. 18, no. 3, may 2007

[17] Cherin Joseph, Anu Gupta "*A Novel Hardware Efficient Digital Neural Network Architecture Implemented in 130nm Technology* "IEEE 978-1-4244-5586-7/10/2010

[18] Cheol-Taek Kim and Ju-Jang Lee "*Training Two-Layered FeedforwardNetworksWith Variable Projection Method*" IEEE TRANSACTIONS ON NEURAL NETWORKS, VOL. 19, NO. 2, FEBRUARY 2008

[19] W.Weishui, "*Implementing online natural gradient learning: Problems and solutions*," IEEE Trans. Neural Netw., vol. 17, no. 2, pp. 317–329, Mar. 2006.

[20] W. W. Tan and H. Huo, A Generic Neuro- *"Fuzzy Model-Based Approach for Detecting Faults in Induction Motors"*IEEE Trans. Industrial Electronics, Vol. 52, No. 5, Oct. 2005, pp. 1420-1427.

[21] M. S. Ballal, Z. J. Khan, H. M. Suryawanshi and R. L. Sonolikar, "*Adaptive Neural Fuzzy Inference System for the Detection of Inter- Turn Insulation and Bearing Wear Faults in Induction Motor*,"IEEE Trans. Industrial Electronics, Vol. 54, No. 1, Feb. 2007, pp. 250–258.

[22] R. H. Abiyev and O. Kaynak, *"Fuzzy Wavelet Neural Networks for Identification and Control of Dynamic Plants- A Novel Structure and a Comparative Study",*IEEE Trans. IndustrialElectronics, Vol. 55, No. 8, Aug. 2008, pp. 3133–3140.