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Brief Description of Artificial Neuron

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Abstract: ***This paper represents the literature survey on artificial neural network. Artificial neural network is classified as one of the most dynamic research. Artificial neural network is developed with the aim of studying and simulating the behaviour of biological neuron. It is nothing but interconnection of artificial neurons. It is represented as simplified model of human brain. Hence it solves problem like a human brain. It is a data modeling tool that captures and represent input and output. It is also an adaptive system that changes its structure according to desire output. This can be used in different applications like robotics, security military and many more.***

Keywords: Artificial neural network (ANN), Neuron, Artificial Neuron

1. Introduction

Artificial neural network (ANN) is a mathematical model which represents the working of biological neuron. The purpose of development of ANN is the desire to replicate the behaviour of biological neuron. Now a days ANN is used in wide range of applications such as robotics, aerospace, military, speech recognition, telecommunications and many more. ANN is the interconnection of artificial neurons. The architecture of ANN is divided into three layers: input layer, hidden layer and output layer. Input layer takes information from other neuron or stimuli from external environment. Hidden layer is the processing layer where the processing of the information is done. Output layer after processing of the information passes it to other neuron or external environment. Artificial neuron is the processing element of the ANN. It consists of three parts: dendrites, synapses and axon. Dendrites receive information, synapses processes the information and axon transmits the processed information. Hence dendrites, synapses and axon is termed as input layer, hidden layer and output layer of ANN. One of the most important feature of neuron is its learning capacity which makes it useful for various applications. Artificial neural network has parallel structure. Hence the processing speed of ANN is more and is also less fault tolerant. This paper represents the brief summary of ANN. Section 2 defines the brief survey on literature and section 3 defines the summary.

2. Literature Review

Andrej krenker[1] presented the basics as a stepping stone in the area of artificial neural network. An artificial neural network is described as a mathematical model that simulate the structure and functions of biological neuron. Here biological neuron is presented as the basic building block of artificial neural network. This model consists of three parts: multiplication, summation and activation. Biological neuron consists of dendrites, soma, axon and artificial neuron consists of inputs, weights, bias, sum, transfer function and output. In biological neuron the input comes from dendrites, processes by soma and passes it on through axon. Similarly in artificial neural network the information comes into the body from input, each input is multiplied by weight, weighted inputs and bias are summed, passes through the activation function and at the end processed information passes from output. When two or more artificial neurons are combined, it forms an artificial neural network. The way of interconnection of artificial neuron is called topology, architecture or graph of artificial neural network. The two basic type of topologies are feed-forward topology and recurrent topology. In feed-forward topology the information flows only in one direction from input to output. In recurrent topology the information can flow in forward direction as well as in backward direction. Hopfield artificial neural network, Elman and Jordan artificial neural networks and long short term memory are various types of recurrent artificial neural networks. One of the most important feature of biological neuron is learning. Learning of artificial neuron can be done by three learning paradigms: supervised learning, unsupervised learning and reinforcement learning. In supervised learning pairs of input and desired output is provided that are represented in data vectors. Unsupervised learning is based on a given data and cost function is to be minimized. In reinforcement learning data is not given but generated from environment. An application of artificial neural network "using bi-directional artificial neural network for ICT fraud detection" is also provided.

Praveen kumar [2] has modeled the biological neuron in VHDL and showed the behaviour as how spikes is transmitted from dendrites to axon. This can be used to model artificial neuron which can be used in various fields like artificial intelligence, robotics, electronics and many more in future. The biological neuron is explained here as it has three parts: dendrites, soma and axon. The soma is the central part of the biological neuron. The inputs or information from various dendrites are received by soma. If the sum of these inputs exceeds a certain threshold then spikes are fired. These spikes travelled to other neuron through axon. The spikes are nothing but short electrical signals. The contact between axon of first neuron and dendrites of other neuron is called synapse. When neuron is fired, it generates action potential which is transmitted to other neuron, which contains action potential of other neurons and ultimately reaches the target neuron. Non linear addition is performed in soma of neuron which is considered as weight in artificial neuron. The input with more weight are considered as more important than the input with lower weight. The implementation is performed in VHDL. Here three dendrites are taken. The soma has basically two

functions to sum and compare, and to generate action potential. This is done in artificial neuron by using potential generator, addition and comparison. Here a global neuron system is also shown in which "clk" input is taken which is used to synchronize counter of timer and inhibit blocks. With the aim of simulating the main program, a test bench is provided. A test bench is nothing but a virtual environment which is used to verify a model or design.

Esraa zeki mohammed[3] has presented a hardware implementation of artificial neural network on field programmable gateway array(FPGA) to realize a feed-forward multilayer artificial neural network using Very High Speed Integrated Circuit(VHSIC) Hardware Descriptive Language (HDL). Artificial neural network are mostly implemented on software as it is beneficial because without knowing the internal working the designer can concentrate on application of neural network. Also the execution time of software based ANN is more as compare to hardware based ANN. Artificial neural network can be implemented in both analogue and digital circuits. The analogue implementation of ANN may spoil the non linear characteristics of complementary metal oxide semiconductor (CMOS). Digital implementation of ANN uses field programmable gateway array (FPGA) device because of its miniaturization of component manufacturing technology. Since ANN is based on parallel computation hence microprocessor and digital signal processors (DSP's) cannot be used. ANN is mostly used for target application. ANN is composed of artificial neurons. The structure of artificial neurons consists of inputs, which are multiplied by their corresponding weights, these are then added and if this sum crosses a threshold value then neuron is fired. The neuron is fired or not is checked by activation function, it is basically used to approximate any signal. Sigmoid function is used here as activation function. It is very expensive to directly implement sigmoid function. Hence two practical approach to directly approximate sigmoid function is: piecewise linear approximation and by using lookup table. Multiplier is used for multiplication and accumulator is used to accumulate the result of addition in register. In neural network neurons is organized into three layers: input layer, hidden layer, and output layer.

Saravanan K [4] presented the classification of artificial neural network. The training of artificial neuron is done by back propagation algorithm. Basically artificial neural network teaches rather than programming computational system to execute a task. While using any artificial neural network, the most important part is the selection of learning, training and transfer function for a data set. Here the maximum likelihood method was compared with back propagation neural network and it was found that the back propagation was more accurate than maximum likelihood method.

Amit Goyal [5] represented the algorithm for back propagation network. Here implementation of back propagation algorithm as well as formulation of individual modules of back propagation algorithm is done. A novel neuron circuit is designed which generates sigmoid function as well as its derivative. Neural network is represented as a data modeling tool that captures and represents the corresponding input and output. The artificial neural network is designed with the wish to implement a system that can perform tasks that human brain can do. An artificial neural network is a system which is made up of interconnected neurons. A neuron is a mathematical or computational model that performs information processing. ANN is a system which changes its structure as neuron learns. Also its output is degraded to a level of destruction of input. Here sigmoid function as well as its derivative is proposed. Also an error generator unit is presented which generates error signal. The back propagation algorithm is a mathematical tool and its execution involves iterative process. There are certain problems like exclusive OR which neural network cannot solve. The suggested solution of this problem is: By selecting the recoding scheme for inputs; Perceptron learning rule(by guessing the acceptable input); Back propagation learning rule (weight sets).

Sahil Abrol [6] presented the hardware implementation of artificial neural network on field programmable gateway array (FPGA). Neural network implemented on software are easy to implement while hardware are difficult to implement and consumes more time but performance of hardware implementation is better than software implementation. Since large number of artificial neurons cannot be used in FPGA realization of ANN therefore the design of neuron is used as micro neurons here. As ANN design is used to solve targeted problems hence it is worthless to implement in ASIC or VLSI. ANN can be implemented in both analogue or digital but analogue implementation are inaccurate computations and are less flexible. Here single layer perceptron is implemented. Perceptron is nothing but a neural network. The aim is to reduce the error signal which is defined as the difference between the desired output or actual output. Here it is shown that higher the learning rate lower is the number of iterations required.

Samiel Moukhlis[7] presented a method for classification of handwritten signatures using artificial neural network. The implementation is done on FPGA using VHDL. FPGA is a low cost powerful software development tool which provides true parallel implementations. The most important feature of artificial neural network is that it depends on its structure, learning mechanism and activation function. The classification of handwritten signature consists of three steps: Extraction of characteristics of handwritten signature using MATLAB; calculation of weights of ANN; hardware implementation. The design proposed here consists of multilayer perceptron two layers. Here the weights are calculated using software (MATLAB) and they are directly implemented in hardware (FPGA).

Dhirajkumar S. Jinde[8] presented a classification of data sets of IRIS using artificial neural network. Here feed forward multilayer neural network is used. Two input neurons, six hidden neurons and two output neurons are taken. The input taken are sepal length, sepal width, petal length and petal width and outputs are iris setosa, iris vergicolour and iris verginica. Here calculation of weight and training of ANN is done in MATLAB. VHDL coding is written based on these weights. The proposed design consists

of counter, ram generator neural network and comparator. Counter is used for providing inputs, ram generator is used for pattern generation, neural network consists of combinational circuits i.e. adders and multiplier.

3. Summary

The survey on Artificial Neural Network results that it is one of the best model to use in various applications. The leaning capacity of neurons makes it flexible i.e. we can increase or decrease the number of neurons as well as layers. Also its parallel computation and fast response time makes it advantageous than others.

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