

## **A NEURAL NETWORK IMPLEMENTATION OF HYPERBOLIC TANGENT FUNCTION USING APPROXIMATION METHOD**

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### **ABSTRACT**

*Neural network is mainly used in faster applications. Non linear activation function is one of the main building blocks in the neural networks. Hyperbolic and tangent sigmoid function used in neural network. The approximation is based on a mathematical analysis considering the maximum allowable error as design parameter. To derive the optimal finding of the number of input and output bits required for hardware implementation of the proposed Approximation scheme. In the proposed structure bit level mapping, multiplexer and barrel shifter structure is presented. In the bit level mapping sequential logic circuit is used instead of combinational logic circuit for faster convergence. A barrel shifter is a digital circuit that can shift a data word by a specified number of bits in one clock cycle. It can be implemented as a sequence of multiplexers. To design a 8 bit input 3bit output neural network such as a pulse coupled neural network. In this proposed scheme, power and delay can be reduced by the value of 2.1mw and 2ms respectively compared to the existing system. This neural network is mainly used in image processing applications which are satellite imaging and medical imaging. Hardware synthesis results show that proposed methods perform significantly faster, and use less area compared to other similar methods with the same amount of error.*

### **I.INTRODUCTION**

In analog and digital application, neural network is widely used. Neural network is nothing but it activated by itself. It is made of artificial neuron cells. It is modelled after analysing the human brain neurons working. Several cells works simultaneously to produce output. It is capable of learning themselves. It learning

and rectifying cells itself. In training method, it changes their name. Artificial neural network used in several methods. To determine the large inputs, which is unknown. Machine learning and pattern recognition is most useful application in artificial neural network. This can be learning and rectifying cells itself, which is used in satellite communication.

## II. CONCEPT OF HYPERBOLIC TANGENT FUNCTION

The hyperbolic tangent change between two consecutive inputs is proportional to the hyperbolic tangent derivative. Hyperbolic tangent is very faster response compared to sigmoid and threshold activation function. This tangent function is much better compared to other functions. In this structure bit level mapping is implemented by combinational circuit. Here multiplexer operates depends on the input range decoder. The main operation is done by using bit level mapping. Bit level mapping compare and reduce the number of input bits and it given to the multiplexer. The bits are approximated by the regions. The bit level mapping is purely combinational. These can be the main source of hyperbolic tangent function. The activation function is used to activate the neuron that is each cell in the brain. The activation function is implemented by using hyperbolic tangent activation function. The approximation error presents in all methods affects the neural network performance. Here error is not much reducable but area, power and delay is reduced. Approximation scheme is nothing but it approximate the output generated by the multiplexer. It has many methods to approximate the output.

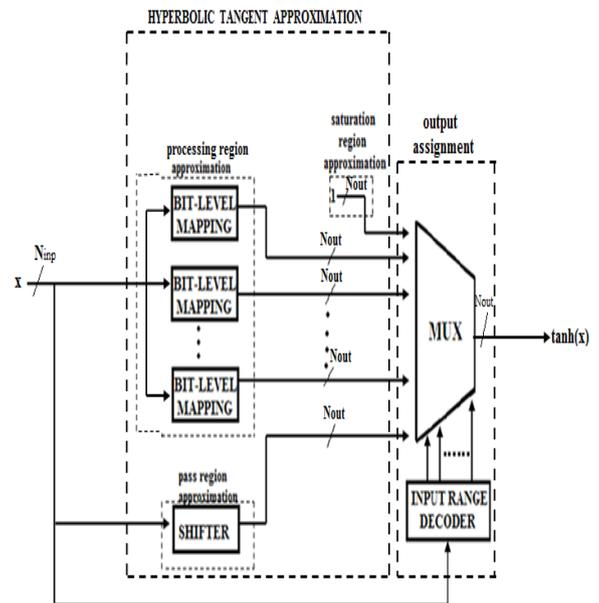


Fig. 1. Block diagram of existing structure.

The input range decoder is the selection line to the multiplexer. Here shifter is used to shift the input bits by one. The number of bit level mapping used is depends on the number of input bits used. This output can be approximated by three region that is saturation region, processing region and pass region.

Saturation region is always gives the output as '1'. No changes in the output level whatever the input it always produces the output as '1'. Pass region shifts the input bit by one using shifter. This output is given to the multiplexer. Processing region is the main block in this structure. It has the bit level mapping operation. Bit level mapping is one of the main operation in this circuit. It reduces the number of input bits given. It selects the bits and that

bits are given to the multiplexer block. These three regions are called as hyperbolic tangent approximation. The output error in the processing region is composed of two elements.

### III. BIT LEVEL MAPPING

The bit level mapping is main process in this structure. In bit level mapping, xor operation is used. Here input bits are compared with the default threshold values and it can be reduced. Then the selected number of outputs in the bit level mapping is given to the multiplexer block. This method approximates output based on a direct bit level mapping of input. This method is implemented by using combinational circuit. Here hybrid method is used. This method is the combination of linear approximation and bit level mapping. PWL and LUT are the another methods used in approximation scheme. But compared to bit level mapping, PWL and LUT uses more number of multiplier and adder circuits. So it increases the area, power and delay. By using hybrid method, the area, power and delay is reduced in this structure.

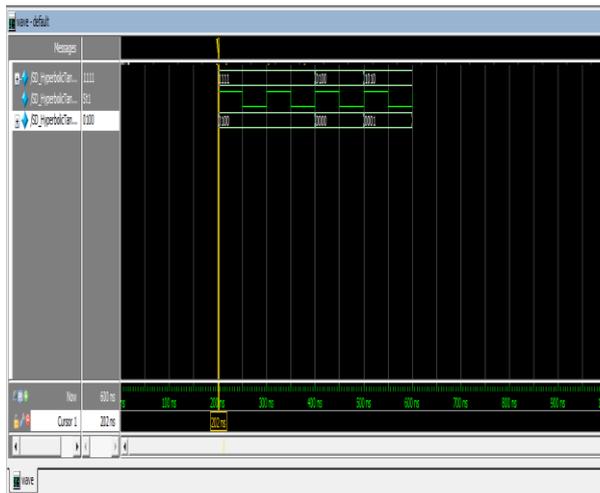
In this structure, which removes the need to store points and can be circuit. The circuit can be made to change state by

signals applied to one or more control inputs implemented using a purely combinational and will have one or two outputs. It is the basic storage element in sequential logic. The number of bit level mapping blocks required is equal to the number of ranges in the region. For each input range in the processing region,  $\log_2 N$  bits after None bit of input should be mapped to output bits using bit level mapping. The input and output of hyperbolic tangent function are represented as signed-magnitude notation. In the pass region, output is approximated by passing the input to the output, which means that a linear approximation is used in this region.

### V. APPROXIMATION SCHEMES

Approximation methods are used to solve the implementation problem. These methods are based on piecewise linear approximation (PWL), piecewise nonlinear approximation, lookup table (LUT), bit level mapping, and hybrid methods. Unlike other PWL approximation method is not based on input domain segmentation and exploits lattice algebra-based centered recursive interpolation (CRI) algorithm. In existing system, hybrid method is used, which is the combination of linear approximation and bit level mapping.

#### IV. OUTPUT OF EXISTING SYSTEM



In the above snapshot, binary values are given as the inputs and for that values are converted into decimal values. And the number of bits can be reduced that is the binary value 0110 is converted into decimal value of 6 and the output is 0001 and the decimal output is 1.

#### VI. COMPARISON OF INPUT AND OUTPUT BITS

Binary inputs	Decimal values	Binary outputs	Decimal values
0110	6	0001	1
0111	7	0001	1
1101	-3	1100	-4
1110	-2	1000	-8

#### VII. PROPOSED SCHEME

In this proposed scheme, the bit level mapping is implemented by using sequential circuit. This will reduce the area. Sequential circuit has inbuilt memory. So it does not need any extra memory to store the bits. Here barrel shifter is used instead of shifter, which

provides faster convergence. 8-3 network structure is designed by using pulse coupled neural network (PCNN), which is eight input patterns.

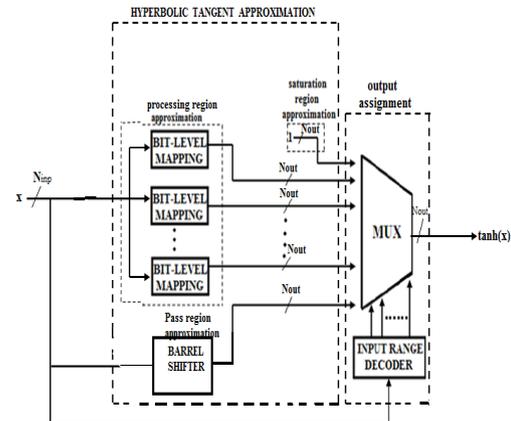
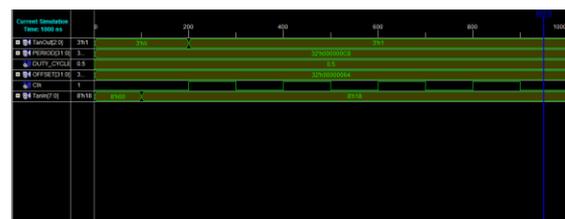


Fig . 2. Hyperbolic tangent approximation structure.

In existing structure six input patterns are used, here nine input patterns are used to implement 8-3 network structure. barrel shifter is used to shift a data word by a specified number of bits in a one clock cycle. It is implemented as a sequence of multipliers. The output of one mux is connected to the input of next mux in a way that depends on the shift distance.

#### VII. OUTPUT



In this snapshot, hexadecimal values are given. Here hexadecimal value 18 is given as the input and the output is 1. That is the

binary value of 18 is 00011000 which is 8 bit and the output produced is 3 bit value which is 001. So 8-3 structure is implemented that is 8 bit input and 3 bit output is obtained.

### VIII. EXPERIMENTAL ANALYSIS

In the above snapshot, A,B,C,D,E and F are inputs. A and B has default threshold values. Here, depending on the selection line, multiplexer will produces the output. Here decoder output is act as the selection line for multiplexer. If selection line 00, then the output is 00. If the selection line is 01, then the output is 01. If the selection line is 10, then the output is 10. if the selection line is 11, then the output is 11.

### VIII. ANALYSIS OF EXISTING AND PROPOSED STRUCTURE

Activation function	Area (um <sup>2</sup> )	Power (mw)	Delay (ms)
Existing approach	181124.80	35.6	11.81
Proposed approach	180250	33.9	9.76

### IX. CONCLUSION

The proposed approximation scheme provides faster convergence and reduction in area, power and delay. This can be achieved by using sequential circuit and barrel shifter. The proposed structure is used for implementing a 8-3 network, which is capable of recognizing eight different input pattern. Finally area, power

and delay can be reduced compared to existing structure.

In future, the post layout simulation will be used, which is used to provide efficient result. ASIC implementation also possible in this structure.

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