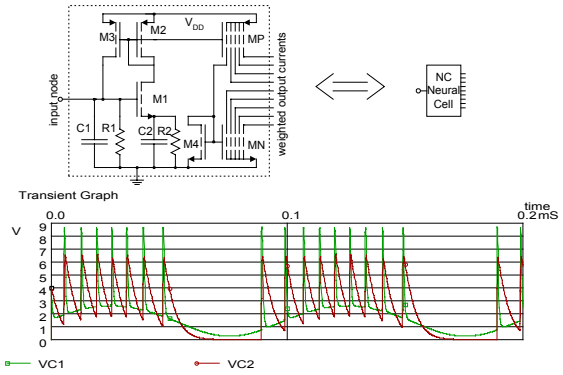
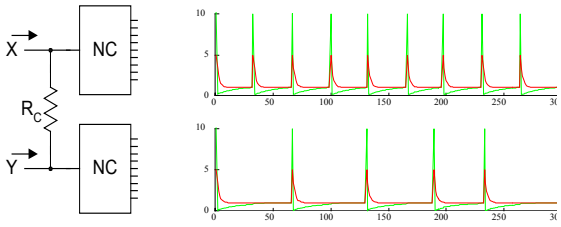
B. M. 'Dan' Wilamowski
University of Idaho

VLSI Analog Signal Processing

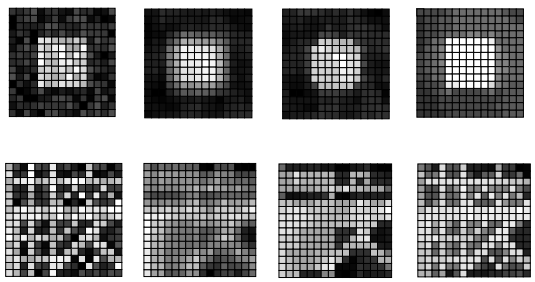
Pulse Coded Neural Networks



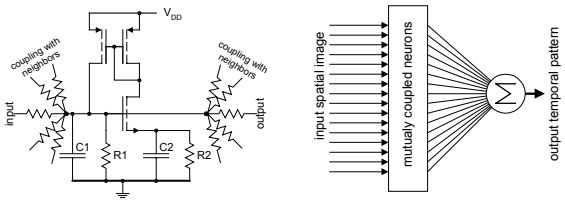
Pulse Coded Neural Networks 2



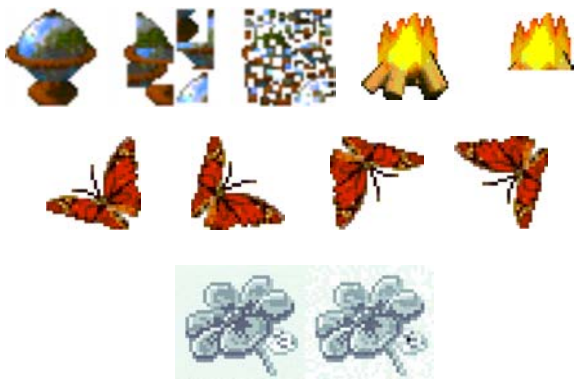
Pulse Coded Neural Networks 3



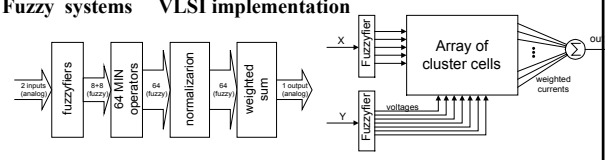
Pulse Coded Neural Networks 4



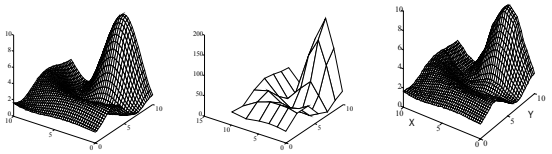
Pulse Coded Neural Networks 5



Fuzzy systems VLSI implementation

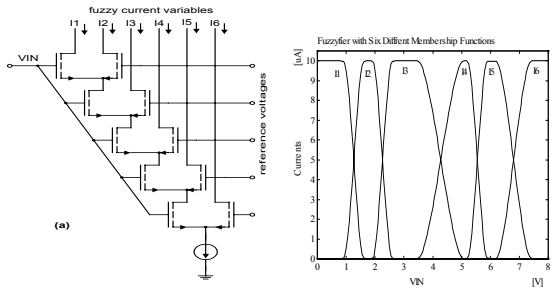


Block diagrams of the fuzzy VLSI chip



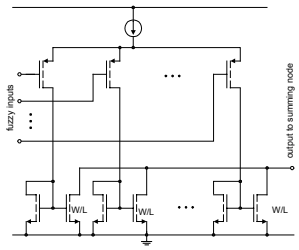
Control surfaces: (a) desired control surface, (b) information stored in defuzzifier as weights, and (c) measured control surface of VLSI chip

Fuzzy systems VLSI implementation 2

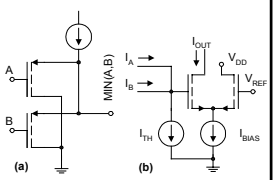


Fuzzifier (a) circuit diagram of fuzzifier, (b) example of the SPICE simulation

Fuzzy systems VLSI implementation 3

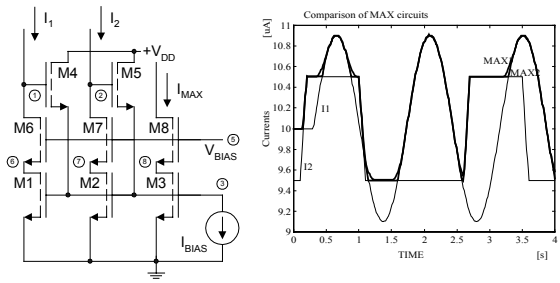


Defuzzifier using normalization and weighted sum



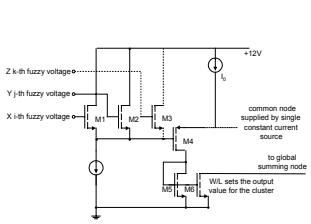
Selection circuits (a) MIN circuit in voltage mode (b) neuron circuit with threshold in the current mode

Fuzzy systems VLSI implementation 4

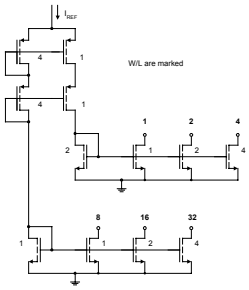


MAX operators (a) concept diagram and (b) simulation results for MAX1 and for the proposed MAX2.

Fuzzy systems VLSI implementation 5

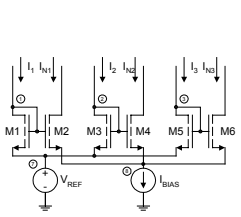


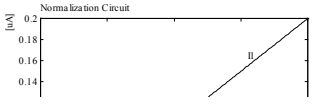
The cluster cell with rule selection (transistors M1-M4) and defuzzification (source I_0 and transistors M4-M6)



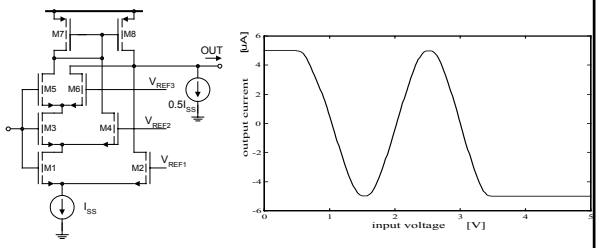
Six bit programmable current sources

Fuzzy systems VLSI implementation 6





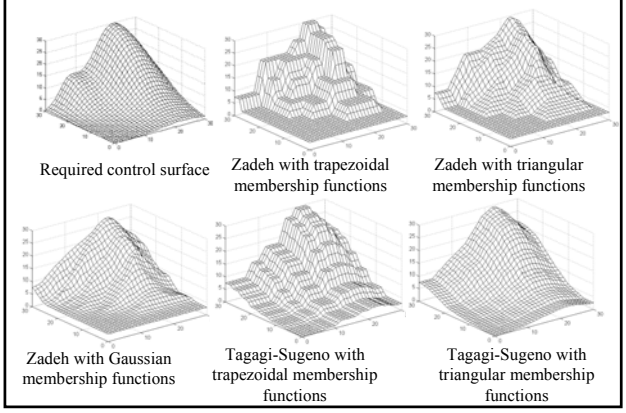
Normalization circuit (a) circuit diagram and (b) characteristics



(a) (b)

Circuit performing sin and cos operations (a) circuit diagram and (b) result of Spice simulation

Fuzzy systems - microprocessor implementation



Required control surface

Zadeh with trapezoidal membership functions

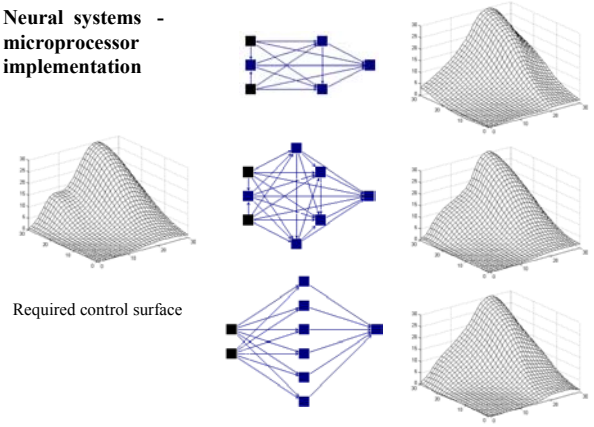
Zadeh with triangular membership functions

Zadeh with Gaussian membership functions

Tagagi-Sugeno with trapezoidal membership functions

Tagagi-Sugeno with triangular membership functions

Neural systems - microprocessor implementation



Required control surface

Comparison of various fuzzy and neural controllers

Type of controller	Error MSE
Zadeh with trapezoidal	0.945
Zadeh with triangular	0.671
Zadeh with Gaussian	0.585
Tagagi-Sugeno with trapezoidal	0.309
Tagagi-Sugeno with triangulal	0.219
Tagagi-Sugeno with Gaussian	0.306
Neural network with 3 neurons in cascade	0.00057
Neural network with 5 neurons in cascade	0.00009
Neural network with 6 neurons in one hidden layer	0.00030