Systematic Analog Design Approach to a Simple Fuzzy Computer for Intelligent Computing

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ABSTRACT:
The aim of Science and Technology is to make Human life easier and sophisticated. In this regard an uncertain called Fuzzy Logic is introduced by LOTFI.A.ZADEH in 1965. Normally a new theory will survive when a society needs a new methodology. Today massive high level information has been constructed along with development of digital computer. The digital computer works on binary logic and in series processing with high computing speed. The result is numeric but inaccurate. But a man uses human logic in parallel processing with slow computing speed and gets accurate results by reasoning. Now society is waiting for interaction of man with machine systems which are more centered on human beings. It is possible to perform Fuzzy logic processing by using modified digital computer. However it is necessary to develop specialized hardware for fuzzy processing. The data handle, data structure, architecture and operations are completely different from digital systems. In this paper, we present an overview of the design of Fuzzy computer.

Keywords: *Fuzzification, DeFuzzification, Fuzzy Memory, Fuzzy Inference Engine, Fuzzy computer.*

INTRODUCTION: ***Why the intelligent society needs Fuzzy Logic instead of crisp logic?***

Because of more advantages and rugged processing the future society will use Fuzzy Logic in their computers.

- The Fuzzy logic having the ability to translate imprecise / vague knowledge of human Experts.
- Simple and easy to implement technology
- Software design and hardware implementation support results are easy to transfer from one system to another system.
- Smooth and robust behavior.
- Ability to understand unstable systems.

HARDWARE: The Fuzzy computer operates on 7 steps shown in fig.(1).

1. Choosing of inputs.
2. Measuring of inputs
3. Scaling of inputs.
4.Fuzzification.
5.Fuzzy processing.
6. Defuzzification.
7. Scaling of outputs.

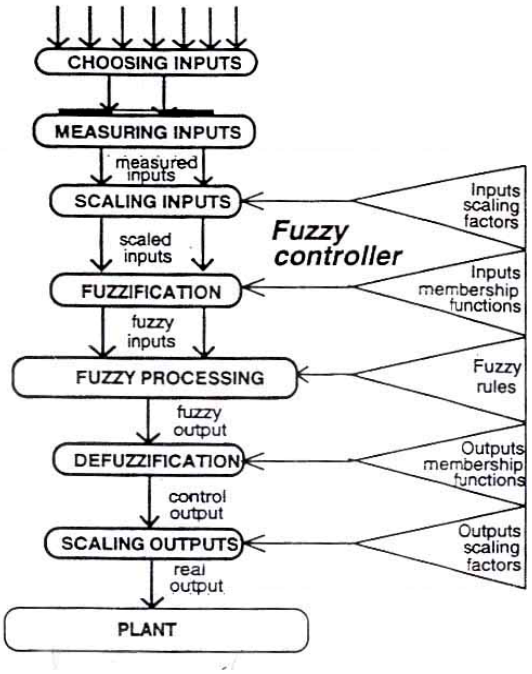

Fig.1) Flowdiagram of Fuzzy Computer

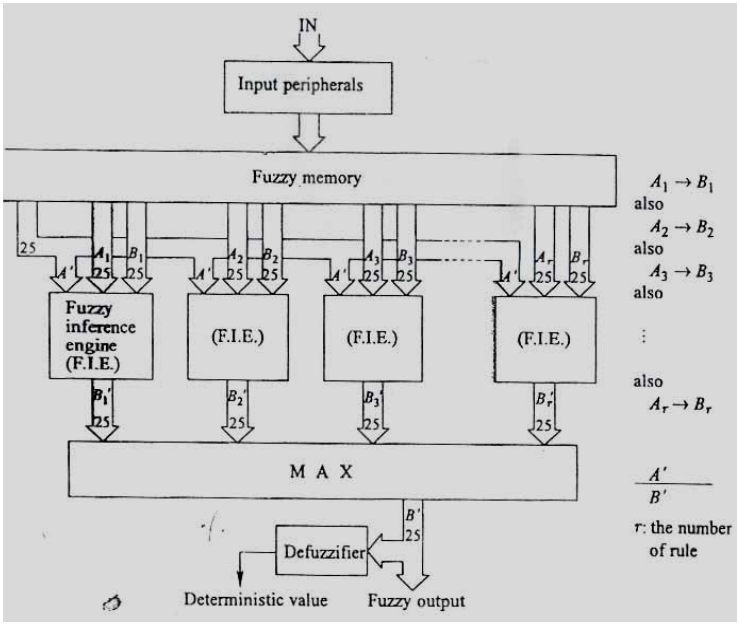

Fig.2) Architecture of a Fuzzy Computer

After knowing the real outputs of feeding to operate unstable system, in this paper I am thinking to concentrate mainly on Fuzzy rule processing and discussing with dedicated hardware.

AMBIGUOUS INFORMATION AND FUZZY INFERENCE:

Fuzzy reasoning derives new conclusion from inference rules stored in a knowledge base and given knowledge. What differs from normal inference is all of the variables in the propositions or Fuzzy variables i.e it is constructed of ambiguous linguistic variables.

This inference mechanism is used by if – then rules. For example if tomato is red then tomato is ripe. This ambiguous information is expressed in terms of a characteristic function called membership function. When we construct a hardware the design of basic circuits is extremely important, in order to carryout the inference, that means crisp sets are converted into Fuzzy sets. Then to do this conversion process, we require a membership function generator for generating Fuzzy logic sum, Fuzzy logic product, Fuzzy logic division. Now we would like to focus on built-blocks of Fuzzy computer shown in fig.(2) based on hardware approach.

Membership Function Generator:

The Membership Function Generator is a circuit that generates Fuzzy words that correspond to membership functions for given ambiguous words. The hardware approach
of Membership Function Generator is shown in the fig.(3).

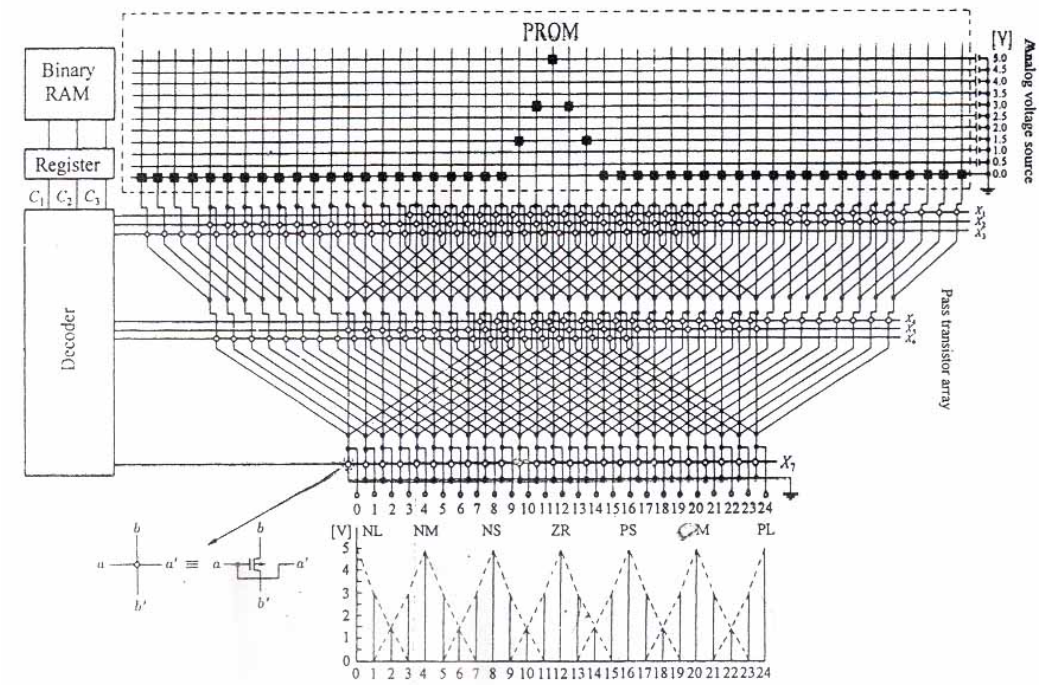

Fig.3) Fuzzy Membership function generator

The ambiguous words in the form of voltages distributed over M(M=25) signal lines. The Membership Function Generator is made up of 4 parts: PROM block, binary RAM, registers and decoders. The PROM block assigns the pattern of the membership function by using Transistor Array with 25 output terminals. The decoder block creates the signal from the Transistor Array to handle 7 pieces of ambiguous information on Negative big, Negative maximum, Negative small, Zero, Positive small, Positive maximum, Positive big are "Labels" attached to linguistic information. These labels can be stored in PROM. These labels are generated in the following way, shown in the table 1.

LABEL	C1	C2	C3
PL	1	1	1
PM	1	1	0
PS	1	0	1
ZR	1	0	0
NS	0	1	1
NM	0	1	0
NL	0	0	1
NG	0	0	0

Table 1) Fuzzy labels

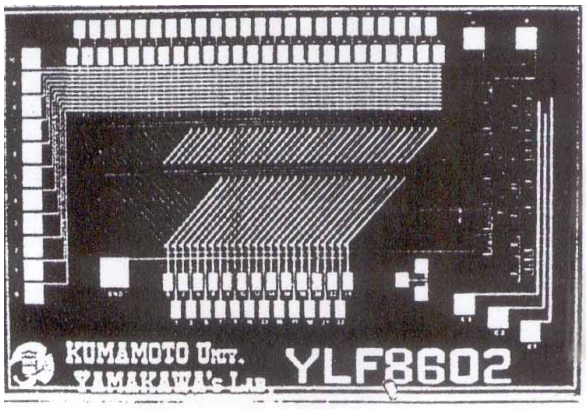

Fig.4) PMOS Membership function generator

The Membership Function Generator IC shown in fig.(4) is developed by Kumamoto University and Yamakawa's lab from Japan by using PMOS process with chip no. of YLF8602

Fuzzy Inference Engine:

Fuzzy Inference Engine is constructed from 288 BJTs were used on one Inference engine board with Inference speed of 100 ns. In Fuzzy Inference Engine, by using if – then rules and expert knowledge it can be concluded

Defuzzification:

The Fuzzy outputs are Defuzzified by clipping of membership functions by using various methods like "Centre of gravity Defuzzification" shown in fig.(5). Normally a Defuzzication uses a Centre of Gravity method to calculate the deterministic value with simple algorithm.
Deterministic value = Weighted sum(of output) / simple sum(of output).

The following circuit shows the conversion of Fuzzy word to deterministic value.

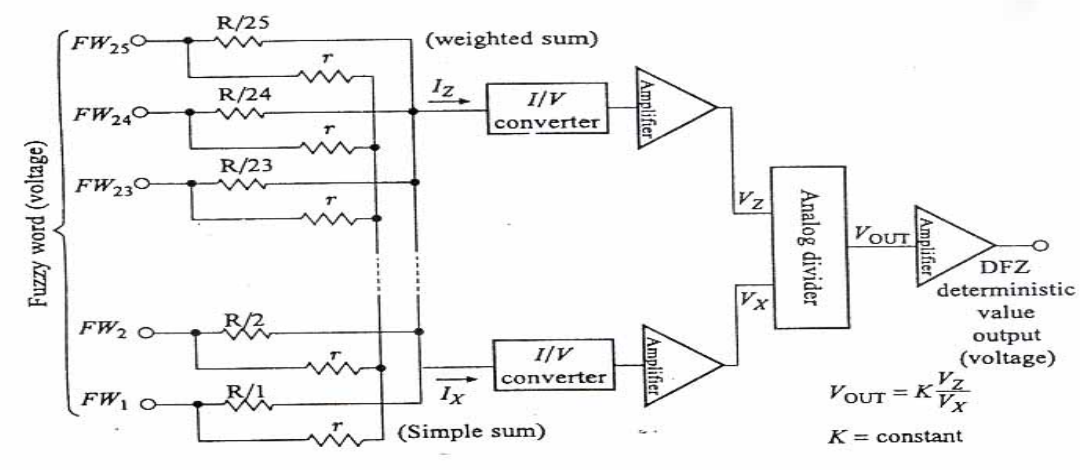

Fig.5)Defuzzifier by using center of gravity

Fuzzy Computer:

Now my aim is to construct fuzzy computer by using above all fuzzy building blocks. The fig.(6) shows the architecture of Fuzzy computer. The Fuzzy memory stores and reads out membership functions in units of 1 Fuzzy word. In Fuzzy Inference Engine a Fuzzy logic operation results a Fuzzy output. According to the need the fuzzy output is converted to deterministic value by a Defuzzifier with distributed voltage signal.

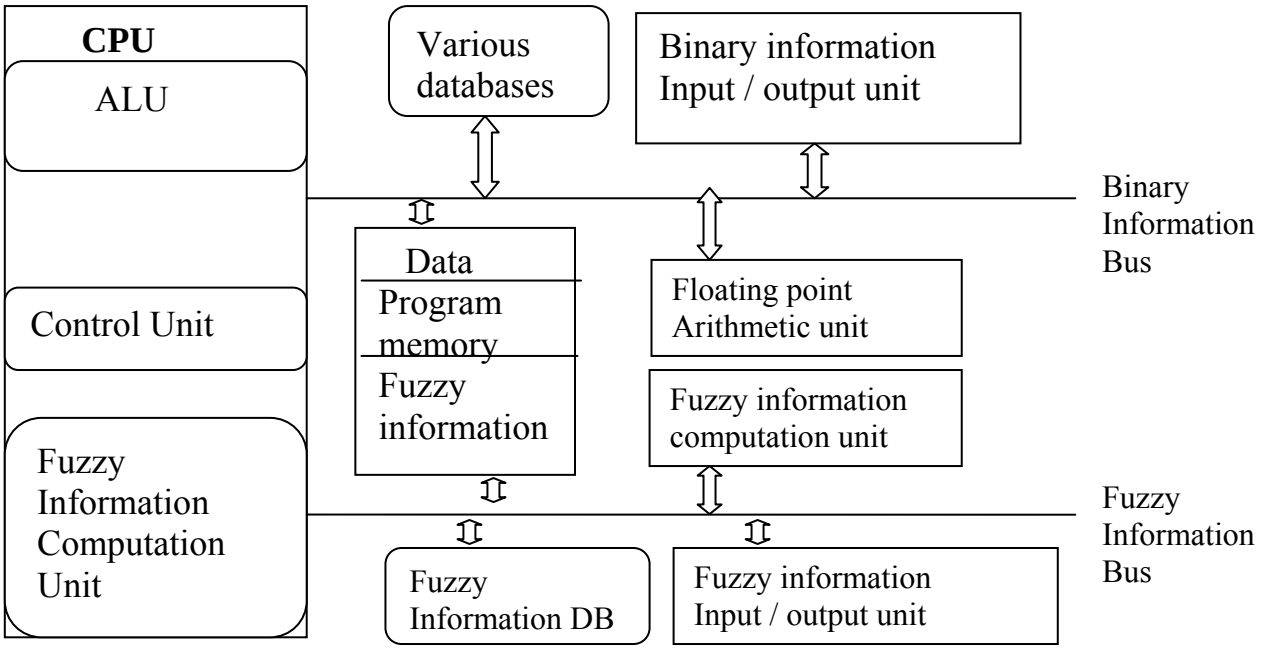

Fig. 6) Fuzzy information Processing Block Diagram

Conclusion:

In this paper, we discussed a specialized Fuzzy information processing hardware system by non-linear electronic circuits. The non-linear electronic circuits are well matched to the properties of Fuzzy information processing. The Fuzzy computer differs completely from the conventional digital computer in the information handling data structure, architecture, operation and properties. Therefore when we construct a system, we will use the best policy of keeping the excellence of conventional digital computer by filling it with sufficient Fuzzy operations. Analog and digital circuits having
their own merits and demerits . But the importance is to create a system with all these properties. Now a days, the current digital systems are not satisfactory for Fuzzy computers that are worthy of being called 6th generation computers. And I firmly believe that the creation of new systems that are more human oriented is indispensable.

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