Design and Development of Embedded System using FNN on FPGA

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Abstract— The design and implementation of ES and System on Chip is complex task, in which huge amount of work and time for verifying system requires to limit the time to market constraints .In this paper, designation takes place entirely within simulink, system generator, xilnix and fuzzy tools environments. This can give the expected performance, and can be manufacturable, taking into account that the only scope for fixing design flow is in the software stage. Fixing an error reported after building the chip, is a very expensive and long process, considering the time of design required for the development of the Embedded system. Here, implementation of fuzzy logic is done on Irrigation system..
Key words: FNN(Fuzzy Neural Network),System generator, xilinx and MATLAB,ES(Embedded system)

I. INTRODUCTION

Field Programmable Gate Array (FPGA) containing reconfigurable units are programmable logic devices formed by arrays of logic cells communicated through routing channels with I/O vias. The interconnection of cells in FPGA is responsible to perform circuits of variable complexity and size. FPGAs have an enormous potential for developing SoC because of its reconfiguration facility . As a matter of fact there are several development systems boards from different vendors such as Xilinx Platform.Now, using Xilinx and system generator the entire design can be build on simulink and results can verified on xilinx's testbench.

Fuzzy Neural network is used to make system artificial intelligence. It has ability to feed human logic and trained given system according to rules set.Now, the Human thinking ,reasoning and evolution according to the system environment is most challenging part .so it is very necessary to interface such ability in system.The appropriate solution is the use of Fuzzy neural network in ES. Since human logic has no limits and control.It is very difficult to build all human logic in system. Microcontroller has limit of memory size and numbers of logic designation can not be build on microcontroller or arm or any other processor. The only solution remains is FPGA in which number of logic are designed and verified using testbench created in simulation. Thus, logic are developed using fuzzy neural network and verified and implemented on FPGA. The ES used in this project is Plant Irrigation System. The FNN development of Irrigation system contains its linguistic variable definition of input and output, rules assumption, fuzzification and defuzzification. After the designing FNNs, the logic is build to develop ths system in FPGA environment using system generator and simulink to interface with Xilinx so that the reduction in size, area and speed is possible and verification of system developer parameter. In xilnx floorplan shows the logic build on FPGA and area with minimum speed. The testbench created will show required result.

II. PROPOSED TECHNIQUES

The aim of this paper is to control the valve of pump using fuzzy expert system. The rules are ruled and defined its membership function of input and output linguistics variable. The input for this system is humidity and temperature and output is pump status. Figure shows the proposed system block diagram.

FPGA using system generator is implemented via system generator on simulink. The concept of FNN is designed on simulink and model code generation is done to develop on FPGA

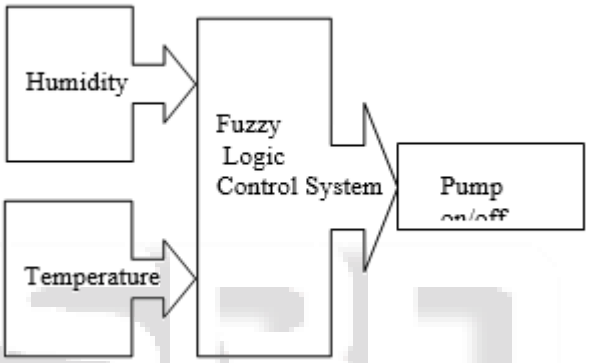


Fig. 1: System Block Diagram.

The Plant irrigation system using microcontroller is designed which shows humidity values on LCD and is used to control the complete system and for measuring the humidity value humidity sensor sy-hs-220 is used.. Humidity sensor is connected to the microcontroller in which the threshold voltage is defined.. In this system the threshold value is defined that is 60% if the humidity of soil exceeds this value then the water pump and sprinkler becomes active and whenever this value becomes goes down than the threshold then it becomes turns off. The system is shown in figure 3. Now, to make given system more efficient and with better performance, we are implementing on FPGA using FNN

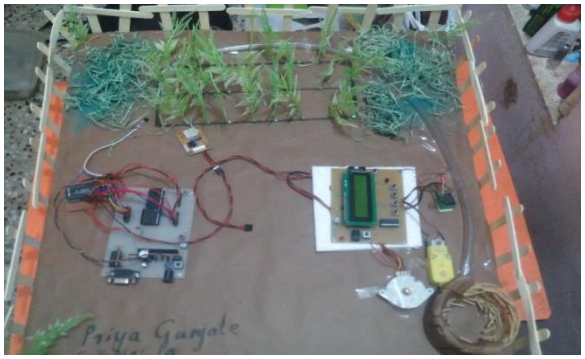


Fig. 2: Implemented Hardware for plant irrigation system

III. FNN (FUZZY NEURAL NETWORK) IN IRRIGATION SYSTEM.

The FNN is the combination of fuzzy and neural network. Here, ANFIS means adaptive Neuro Fuzzy inference system is designed and used. ANFIS adapots the weight based on system environment. Thus, the stystem becomes more intelligent and can predicts future logic. The structure of fuzzy system has logical inference flows from input variables output variables. The fuzzification of input variables is translated from analog values to desired one. Fuzzy inference rules are applied to the linguistics variables containing linguistics control rules. Output linguistics variable is went through linguistics rules. The defuzzification of output linguistics variable is translated into respective analog value.

No.	INPUT VARIABLE
1.	Humidity
2.	temperature
No.	OUTPUT VARIABLE
1	Pump on/off

Table 1: linustics variable

A. Input Variables:

The input variable's range and its type of fuzzy logic system methods used in system are shown in table

Linguistic Variable Name	Type	unit	min	max	default	Term name
Humidity	Trimf(Triangular membership function)	RH	0	100	0	Wet Medium dry
Temperature	Trimf(Triangular membership function.)	(0 C)	0	100	0	Large-neg Small-neg large

Table 2:

B. The Output Variable's Range And Its Type Of Fuzzy Logic System In System Are Shown Below:

No	Linguistic Variable Name	Type	min	max	Default	Term name
1	Pump-status	constant	0	1	0	1.Close 2.Little - open 3.Half-open 4.open

Table 3:

The development and design of FNN in simulink using system generator is done after ruling the system. Now, system-generator has ability to generate VHDL code directly and shows results.

IV. RESULTS

In this section results are outlined to authenticate the framework and to justify the objective. The design of ES using FNN on FPGA is shown in fig 3.Now, system design contained updation of weight with two input and output

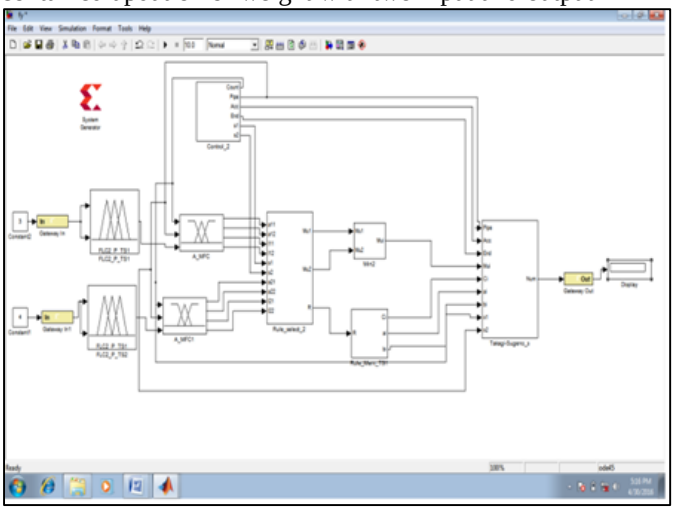
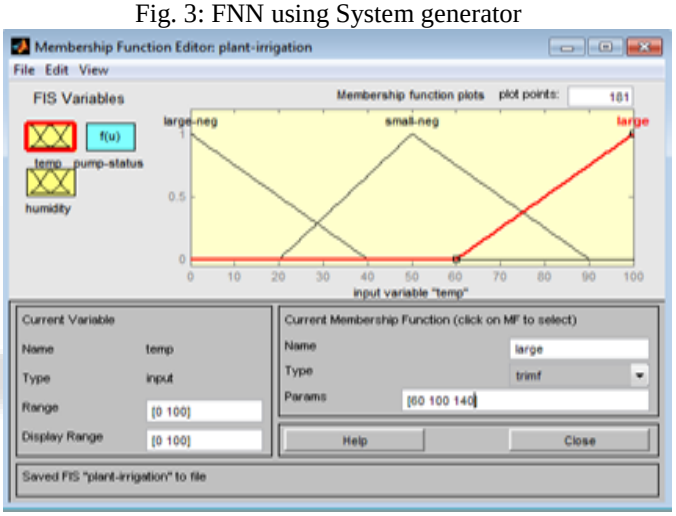


Fig. 3: FNN using System generator



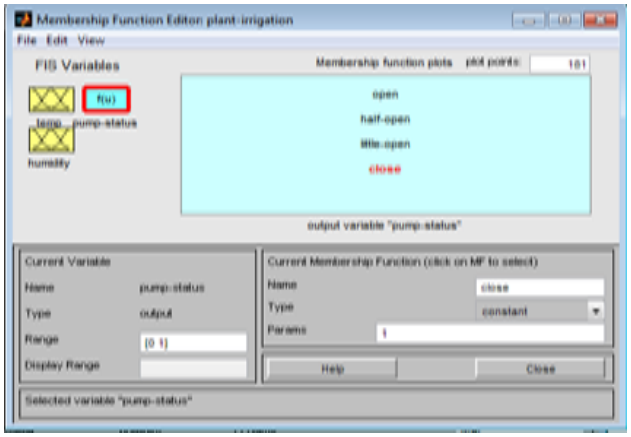


Fig. 4: Fuzzy rules and resulting graph

The whole working of fuzzy logic system is based on fuzzy rules. Fuzzy rules described the human logic and reasoning and also give all possible outcomes of the system. Fuzzy rules are ruled by 'If then'. If antecedent of system is trued to some degree of extent then consequent is also true with its degree of membership. All rules are created in rule editor. For example, If humidity is low and temperature is large then pump-status is open. The weight of rule is described its degree of support.

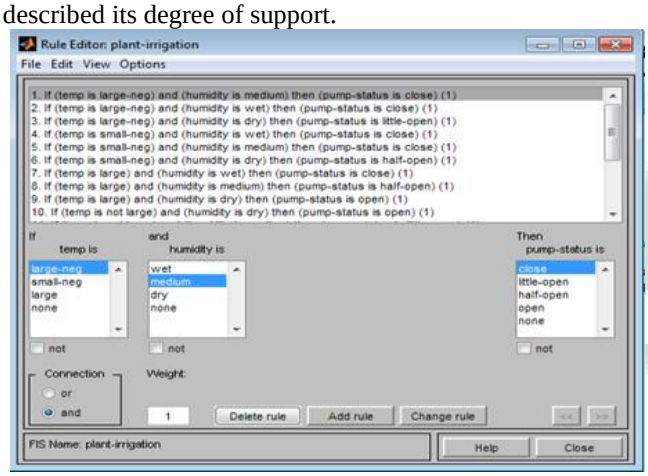


Fig. 5: Rule set window

Mean square value of training system shows the accuracy of training. The humidity values from soil are experimentally taken and given to system .The clustering of data is shown in fig.The graph is shown below

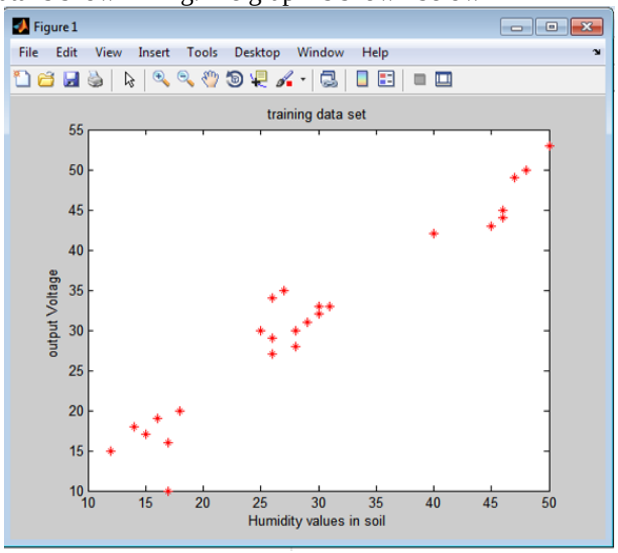


Fig. 6: Seven days training data sets of plant

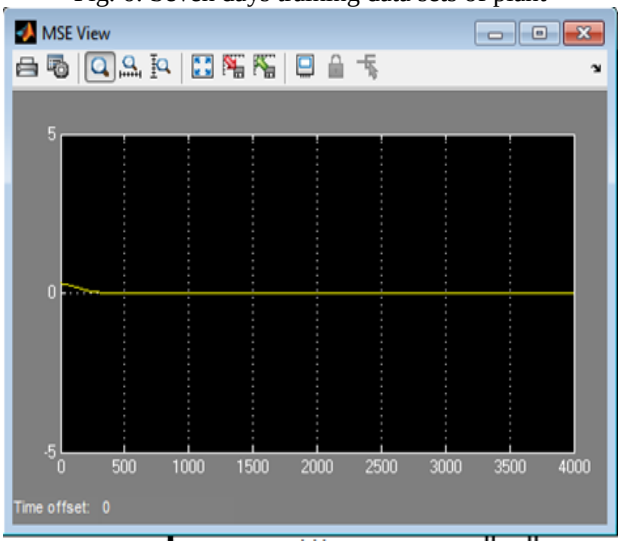


Fig. 7: Mean square value graph of training system

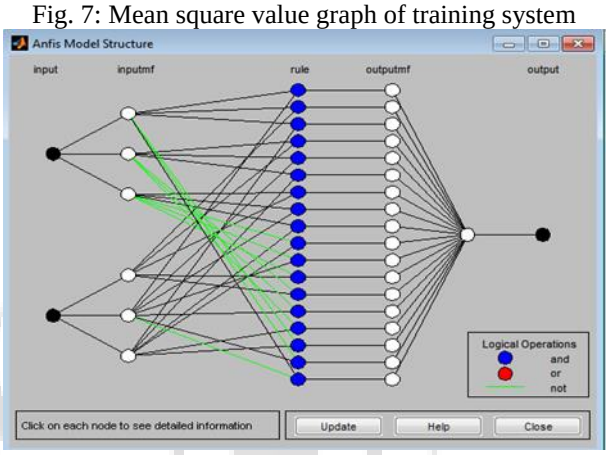


Fig. 8: Model structure for system

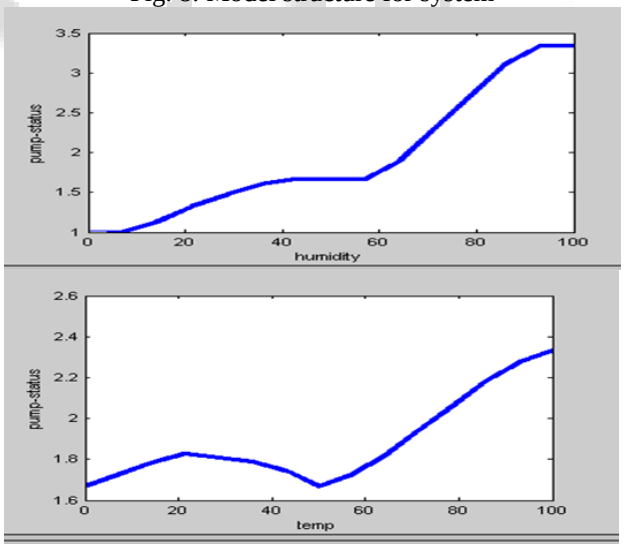


Fig. 9: flow graph of system

V. CONCLUSION

The development of irrigation system with appropriate definition of linguistics variable and membership function are designed .The fuzzy logic using ANFIS is done with good accuracy .In This paper ,the control mechanism of pump are proposed and interfaced with human logic .Error report is fixed with software tools and now the system is ready to build on Soc. The Complex task for designation is resolved using

system generator i.e. model based approach. With minimum area utilization & good speed, ES is developed. The perception of irrigation system is designed .the various results of system are shown.

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