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An Efficient Technique Used to Generate Test Case on Embedded System Using Fuzzy Logic

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Abstract*— Logical generation of the test case process ensures that the test cases have been derived in a consistent and objective manner and which covers all the requirements of the system. Temperature monitoring and controlling of nuclear reactor system is used which is an embedded system in which simulation is done and fuzzy logic is used to generate the test cases. The goal of my paper is to make a more efficient technique that could find the least number of test cases of the output domain for the hardware so that we can analyse the accuracy. Fuzzy logic is best technique because it reduces the test cases of an output domain in few second and gives the correct result. As the test cases are reduced, it will increase the performance of the system and save the time, effort of the user.

Index Terms*— Test case, Embedded system, Fuzzy logic, Output domain.

I. INTRODUCTION

A system is a way of working or performing one or various tasks according to the program and set of rules. Example - A watch, which is a system and is used to display the time. Their parts are needle, battery, hardware with a beautifull dial, chassis and strap. An embedded system is a system which contains microcontroller and microprocessor that are hidden in the computer system. An embedded system is a system in which software is embedded in the hardware. It is also known as system on chip (SOC) as we can say the entire system is on the small chip. It is designed to perform dedicated function. It is a small part of a complete system which include hardware and the mechanical part. Each embedded system consists of custom and hardware buil around the central processing unit (CPU). The hardware contain memory chip in which the software is loaded. Embedded system is designed to perform dedicated task or action. The design engineer has made small size of an embedded system so that he can reduce its price and increase the reliability and performance. Embedded system plays a vital role in day to day life. We find it everywhere like when we use remote of television, timer in an washing machine, cell phone, fridge, MP3 player and many more devices which contain intelligence within it. Embedded system range has being started from the portable device such as the digital camera and the MP3 player and it reach to large stationary installation such as factory controls, traffic light or controlling the nuclear power plant. It embeds a real time operating system (RTOS) which control the software that is running on the hardware and it manages the access of resource according to the priorities of task within the system. [5]

A. Type of Embedded System

Embedded system is Classified into three types that are given below:-

- Small Scale Embedded System: These systems are designed with a single 8 bit and 16 bit microcontroller. These are the system which has small hardware and software complexities. They can be operated with the battery. Small scale embedded system software are to be fitted into the memory that it is available and keep the view to limit the power dissipation when the system is continuously in running state.
- Medium Scale Embedded System: These types of embedded systems are designed with a single or a few 16 bit or 32 bit microprocessor. This type of embedded system has hardware and software complexities.
- Sophisticated Scale Embedded System: This type of embedded system has the enormous software and the hardware complexities. They may need many IPs, scalar processors.

B. Characteristics of Embedded System

Some of the characteristics of an embedded system are as follows:

An embedded system may or may not have standalone features. Many of the embedded systems consist of small and computerised part in a large system that performs a dedicated task.

- It performs a dedicated function.
- It has complex user interface and other graphic interface.

The program that is written for the embedded system is stored in the read only memory (ROM). ROM is use to embed code and data in the system.

C. Fuzzy Logic

The application of fuzzy logic has significantly increased. It is being used in many devices such as camcorder, washing machine, microwave oven etc. The basic concept is that fuzzy logic plays an important role in many of the application is that fuzzy if- then rule or simply fuzzy rule. [1] [3]

D. Project on temperature monitoring and controlling of an nuclear reactor system

TMCNRS is an embedded system. In this temperature is controlled. Its hardware diagram is shown in figure1.

There are sensors which will sense the temperature and these are connected to temperature signals and output of this is connected to analog to digital convertor which will connect to microcontroller.

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Pumps, buzzer, LCD display are attached to the microcontroller which is an output device. Microcontroller is also connected to the interfece through which user will interact. Pumps are used to control the temperature of the system and buzzer is used which will tell that particular area is more risky. [4]

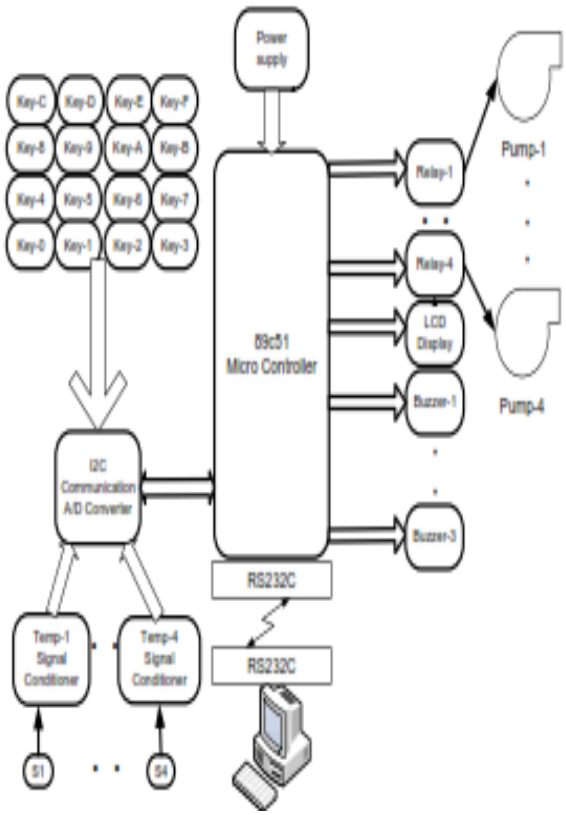

Figure1: Hardware diagram of TMCNRS [4]

E. Condition Required For Generating Test Cases In Tmcnrs

S.no	Condition for TMCNRS
Req. 1	If sensed Temperature 1 (input temperature 1) > then the Reference temperature 1 then Pump 1 will be ON else it will be OFF.
Req. 2	If sensed Temperature 2 > then the Reference Temperature 2 then pump 2 will be ON else it will be OFF.
Req.3	If ABS (Sensed temperature 1- Sensed temperature 2)> 2 then Buzzer 1 will be ON else it will be OFF.
Req.4	All these condition are also applied on Pump 2, Pump 3, Pump 4, Buzzer2, and Buzzer3.

Table 1: Conditions Required for the TMCNRS

Sensed Temperature1	Reference Temperature 1	State of Pump
28	30	Pump OFF
50	30	Pump ON

Table 2: States of Pumps

Sensed Temperature 1	Sensed Temperature 2	State of Buzzer
40	41	Buzzer OFF
50	32	Buzzer ON

Table 3: States of Buzzers

The reference temperature which is considered is 30, 32, 34, and 36. If sensed temperature 1 (= 50) > then Reference temperature 1 (=30) hence the Pump 1 will be ON else it will be OFF. Similar condition is applied on Pump 2, pump 3, pump 4 as shown in table 2.

If ABS (Sensed temperature1- Sensed temperature 2) >2 Buzzer 1 will be ON else OFF. ABS (Sensed temp 1(= 50) – (sensed temp 2 (= 32)) > 2 hence Buzzer 1 will be ON. Similar conditions are applied on the Buzzer 2, Buzzer 3 as shown in table 3.

II. PROPOSED SCHEME

In the proposed research, I have used the concept of fuzzy logic which helps us to make less combinations of output domain; it reduces number of the test case in output domain. It will take as many of the different input and give the single output. The possible output domain that comes is 14. As many input we give but the output will be among the 14 only.

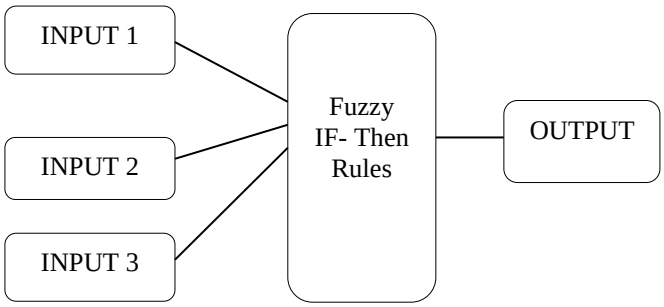

Figure 2: Interface of Fuzzy [2]

III. EXPERIMENTAL RESULTS

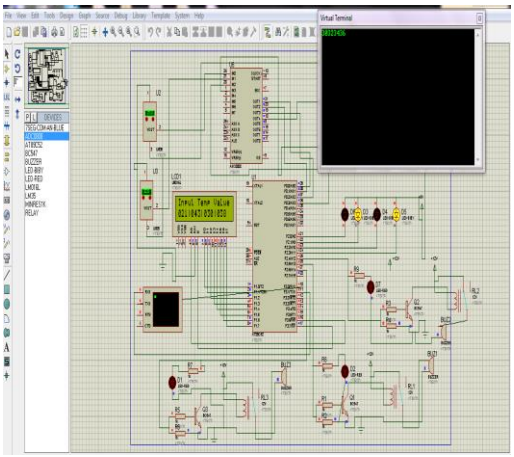

Figure 3: Checking the condition hardware

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In this input temp1= 21, input temp 2 = 43, input temp 3 =30 and input temp 4 =38. Reference temp1 = 30, reference temp 2 = 32 , reference temp 3 = 34 , reference temp 4 = 38.In this four input temperature and reference temperature are given according to that LED is ON. Condition is if input temperature increases from reference temperature according to that LED will be ON. In this input temperature of second and forth is greater than reference temperature such that second and forth LED is ON and other are OFF. Condition for buzzer is (input temp 1- input temp 2)>2 then buzzer 1 is ON and so on. Hence buzzer 1, buzzer 2, buzzer 3 is ON.

Figure 4: GUI interface of Temperature analysis

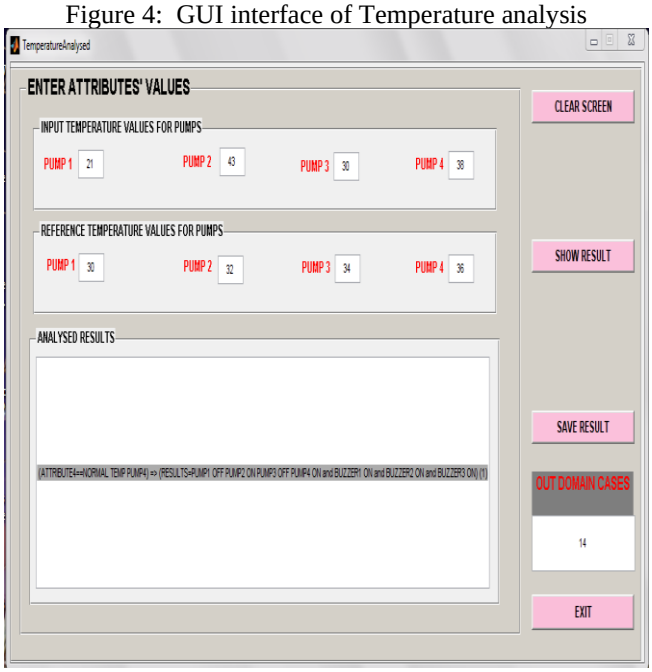

Figure 5: Checking the condition

(RESULTS=PUMP1 OFF PUMP2 ON PUMP3 OFF PUMP4 ON and BUZZER1 ON and BUZZER2 ON and BUZZER3 ON) (1). This is the number of test cases of an output domain.

In this input temp values and reference temp value are considered same as in figure 3. Here we are comparing this results with hardware result same value is applied according to that results are shown. In this if input temperature increases than reference temperature then the LED 2 and LED 4 is ON and other are OFF. Difference between Input temperature1 and input temperature 2 is greater than two so that the buzzer 1 is ON and so on.

IV. RESULTS AND CALCULATION

Type	Index	Member Function Name
Output	1	Pump1 ON
Output	1	Pump 2 ON
Output	1	Pump 3 ON
Output	1	Pump 4 ON
Output	1	Pump1OFF
Output	1	Pump 2 OFF
Output	1	Pump 3 OFF
Output	1	Pump 4 OFF
Output	1	Buzzer1 ON
Output	1	Buzzer 2 ON
Output	1	Buzzer 3 ON
Output	1	Buzzer 1 OFF
Output	1	Buzzer 2 OFF
Output	1	Buzzer 3 OFF

Table 4. Detail for the add member function output as type.

Hence the total number of output domain is 14.

S.No	Technique Used	Test Cases For 4 Pump and 3 Buzzer
1.	Exhaustive testing of input domain	96,059,601
2.	Exhaustive testing of output domain	128
3.	Pseudo-exhaustive testing of output domain	16
4.	Fuzzy logic for output domain	14

Table 5. Comparison of Pseudo-exhaustive testing with Fuzzy logic

V. CONCLUSION

The conclusion is that the numbers of test cases in output domain has been reduced with the fuzzy system. We can say that Matlab using Fuzzy logic is the best tool which helps us to reduce the test cases and give the correct result in few seconds. Fuzzy takes the input of different condition and its member function decide its range and it will show the correct results.

VI. FUTURE WORK

As I have used the technique of Fuzzy logic that have reduced the test cases. In future we can calculate the more cases that include fault in the motor or in other equipment. This can be accomplished by using neural network.

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AUTHOR PROFILE

Mannini Goyal is from Jalandhar, she has done her B.Tech and M.Tech in Computer Science from lovely professional University, her research area is system analysis and design.

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