FUZZY LOGIC BASED MODEL FOR ENERGY CONSUMPTION IN COGNITIVE RADIO

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Abstract.
A cognitive radio is a system that automatically changes its parameters like reception and transmission. FLS (Fuzzy Logic System) can maintain the quality of service (QoS) of each network while the effective spectrum utilization is improved under a fluctuation traffic environment when the available spectrum is limited. Now a days, the energy problem becomes more and more important. Most of the devices in cognitive radio networks are mobile devices, so they are not able to get power provided all the time when they are in the network. The power of the devices can be run out if it cannot get charged in time. Because of this reason, we need to improve the energy efficiency so that the devices can work for longer time with the same energy consumption. In this paper we proposed a Fuzzy logic based model for energy consumption in cognitive radio.

Keywords: CR, FLS, energy consumption, throughput, delay.

INTRODUCTION

Now a day's cognitive radio is currently considered as one of the most promising solutions to the aforementioned scarcity problem by enabling a highly dynamic, device-centric spectrum access in future wireless communication system[1], [2], [3]. The Cognitive radio technology is getting a significant attention, with the approach to solve the issue of scarcity of available radio spectrum, [3]-[5].
Energy consumption is main important parameter for cognitive radio system. Minimization of power consumption is very important because cognitive radio system is wireless and having only a battery as power source.Energy consumption parameters can be defined in terms of minimum propagation delay and maximize throughput.

PARAMETER EFFECTING ENERGY CONSUMPTION

Delay

Dealy can be defined as the time taken for the signal to travel from the sender to the receiver. It can be calculated as the ratio of link length and the propagation speed over the medium. Delay = d / s; where d is the distance travelled and s is the propagation.

Throughput

Throughput can be defined as the total rate at which something can be produced. Thus, maximizing the throughput deals with the data throughput rate of the system. It improves the energy consumption of system.

MODELLING USING FUZZY LOGIC

Fuzzy logic controller is an approach between mathematical control model and human decision making control/ approach [4]. The system structure identifies the fuzzy logic inference flow from the input variables to the output variables. The fuzzification in the input interfaces translates analog inputs into fuzzy values. The fuzzy inference takes place in rule blocks which contain the linguistic control rules. The output of these rule blocks is linguistic variables. The defuzzification in the output interfaces translates them into analog variables. The following figure shows the whole structure of this fuzzy system including input interfaces, rule blocks and output interfaces. The connecting lines symbolize the data flow.

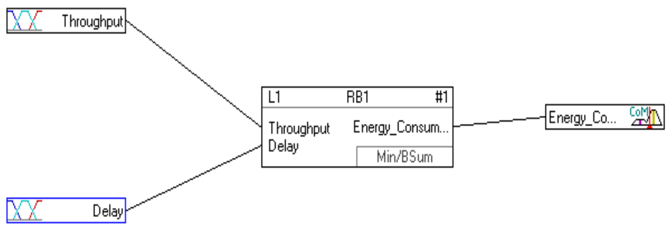

Figure 1: Structure of the Fuzzy Logic System

To design a fuzzy system input and output parameters are required. These parameters are given below.

Table1: Variables of Group "Inputs"

S. No	Variable Name	Type	Unit	Min	Max	Default	Term Names
1	Delay		Micro sec	1240000	1580000	1410000	Small medium large
2	Throughput		bps	10000	50000	30000	Low medium high

Input Variable "Delay"

In first input parameter Delay it consists of three membership functions. These membership functions are small, medium, and large as shown in figure 2.

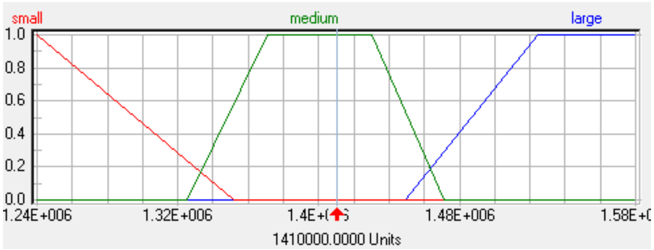

Figure2: MBF of "Delay"

Input Variable "Throughput"

In secound input parameter Throughput it consists of three membership functions. These membership functions are low, medium, and high as shown in figure 3.

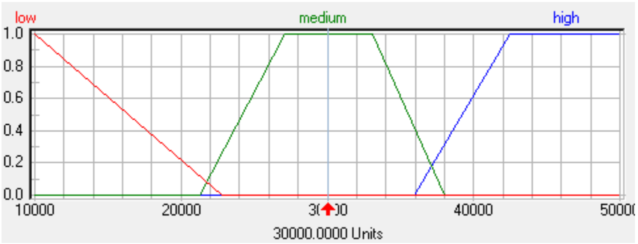

Figure3: MBF of "Throughput"

Output

Variables of Group "Outputs" is given in table2.

Table 2: Variables of Group "Outputs"

S. No	Variable Name	Type	Unit	Min	Max	Default	Term Names
3	Energy_Consumptn		mJ	420	600	510	very_low low medium high very_high

2.1 Output Variable "Energy_Consumptn"

In the output parameter Energy Consumption it consists of five membership functions. These membership functions are very low, low, medium, high and very high as shown in figure 4.

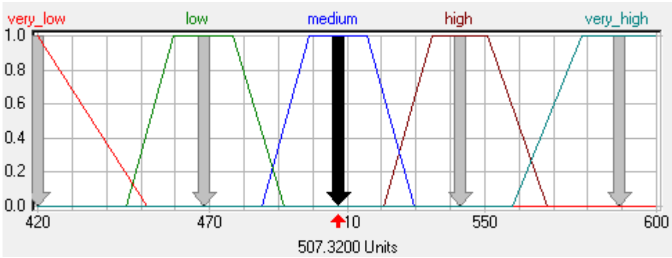

Figure 4: MBF of "Energy_Consumptn"

RULE BLOCK

The rule blocks contain the control strategy of a fuzzy logic system. Each rule block confines all rules for the same context. A context is defined by the same input and output variables of the rules.

The rules' 'if' part describes the situation, for which the rules are designed. The 'then' part describes the response of the fuzzy system in this situation. The degree of support (DoS) is used to weigh each rule according to its importance.

Parameter

Aggregation:	MINMAX
Parameter:	0.00
Result Aggregation:	BSUM
Number of Inputs:	2
Number of Outputs:	1
Number of Rules:	9

Table 3: Rules of the Rule Block "RB1"

IF		THEN	
Throughput	**Delay**	**DoS**	**Energy_Consumptn**
Low	Small	1.00	Medium
Low	Medium	1.00	Low
Low	Large	1.00	very_low
Medium	Small	1.00	High
Medium	Medium	1.00	Medium
Medium	Large	1.00	Low
High	Small	1.00	very_high
High	Medium	1.00	High
High	Large	1.00	Medium

SIMULATION AND RESULTS

In this section, we present simulation results of our proposed work based on Fuzzy Logic System. Simulation results are given here in the form of 3D graphs. In the proposed work, the energy consumption is inversely proportional to the delay. As the delay decreases, energy consumption increases. Energy consumption is directly proportional to the overall throughput of the system. So, maximization of the throughput gives increase in the energy consumption.

Graph in figure 5 is showing input parameters throughput and delay on X axis and Y axis respectively. Output parameter, energy consumption is taken on Z axis. It can be seen clearly that when throughput increases the energy consumption also increase whereas when delay increases the energy consumption decreases.

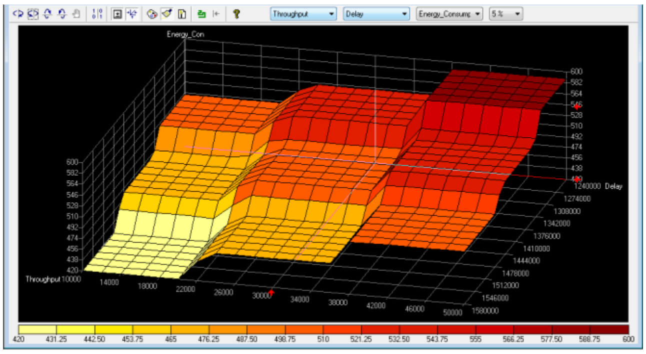

Figure5: Surface curve for input parameter “Throughput”, “Delay” and output parameter “Energy_Consumptn”.

From the observation table 4 it is clearly shown that the energy consumption is inversely proportional to the delay.

Table4: Observation table for model 2

Input			Output
S. No	**Propagation Delay**	**Throughput**	**Energy Consumption**
1	1465000	14880	439.99
2	1440000	19880	468.17
3	1465000	29880	484.41
4	1410000	30000	507.32
5	1340000	30000	516.00
6	1460000	40000	530.60
7	1455000	49880	537.06
9	1265000	45000	589.05

As the delay decreases, energy consumption increases. Increase in the throughput of the system, increases the energy consumption.

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