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AUTOMATED MILK PRESERVATION SYSTEM USING FUZZY LOGIC SYSTEM

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ABSTRACT

In this paper Automated Milk Preservation System has been discussed using fuzzy logic system. The basic idea of the research is to make theUltra-high temperature processing (UHT) Treated Milk Preservation systems automated by applying rule base of fuzzy logic. In this system three input variables were considered for three types of milk: Skim Milk, Full Cream Milk and Low Cream Milk. According to the required type of milk the nine output variables were designed to fulfill the requirements. The output variables: Valve opening time for skim milk, Valve opening time for low cream milk, Valve opening time for full cream milk, Processing time of skim milk, Processing time of low cream milk, Processing time of full cream milk, Heating/cooling time for skim milk, Heating/cooling time for low cream milk, and Heating/cooling time for full cream milk were considered. The system is developed using MATLAB Simulink R2011a. The results obtained from simulation were according to the design values.

Keywords Fuzzy Logic System, UHT Treated Systems, Skim Milk, Full Cream Milk, Low Cream Milk, Milk Preservation Systems.

INTRODUCTION

In food processing mostly milk is subjected to high temperature sterilizing techniques like Ultra-high temperature processing− that is often termed as ultra-heat treatment (UHT) – or ultra-pasteurization to destroy germs and spores in milk. During this processing technique, milk is sterilized at temperature 135°C (275°F) for almost 1–2 seconds (Anonymous, 2008). This thermal treatment commonly employed to preserve various products like fruit juices, soy milk, cream, yogurt, broths, wine, and stews but mostly exercised for milk preservation (Anonymous, 2008). UHT milk has gained prominent achievement in among Europeans on account of its preservative efficiency and it is considered that UHT milk is consumed by 7 out of 10 Europeans regularly across the continent (Solomon *et al.*, 2005).

Milk is thought as an intact food for neonates as it contains more than 200 ingredients including unique functional and nutritional components. Modern food technology revealed various methods to isolate the functional constituents and their application in various product formulations (Chatterjee and Acharya, 1992).

India produces 80 million tons milk per annum considered as largest milk producing country throughout the world. Out of which 55 percent is consumed as fluid milk rest 45 percent is sent for industrial processing. Most of the poor Indian people living in therural areas are involved in milk producing profession. Attributable to tropical climate of India proper storage conditions are required but in various part of the country there is lack of sufficient cold chain and refrigeration facilities in rural areas to achieve the high demand of urban areas. So, innovative scientific, efficient and cost effective approaches arerequired to overcome these problems as well as for flourishing of rural people (Sahoo, 2003).

Now a days, every system is getting automated and the world are trying to make the systems more and more accurate. So for the purpose of efficiency and accuracy we have applied fuzzy logic to make the milk preservation system an adaptively controlled system.

Fuzzy logic Systems are more efficient and accurate due to the variable environment. The input and output variables vary according to the situation. The values of output variables are achieved according to the variation in the input values using the rule base of fuzzy logic system. In other automated systems the values entered are fix where as in fuzzy logic systems the values entered vary due to which it gives much more accurate results then other automated systems and make them more close to real time systems because they work on real time scenarios.

In section II the basic structure of the system is discussed, the designed algorithm for the milk preservation system is described in section III, section IV representsthe experimental results of the system and in the last section the MATLAB simulation Graphs are discussed.

Basic Structure of the Milk Preservation System: The Basic Flow diagram of the Milk Preservation System is given in Fig 1.

Firstly, all the milk is collected in a large chamber. Then the total required quantity of all types of milk will be transferred to the boiler to kill the germs.

After then there will be 3 different valves which will open as per required quantity of skim milk, low cream milk and full cream milk respectively. Each quantity will go in to a different chamber where it will be processed. First of all the fat will get extracted then it will go through the preservation process by heating or cooling. And afterwards it will get preserved in different packing.

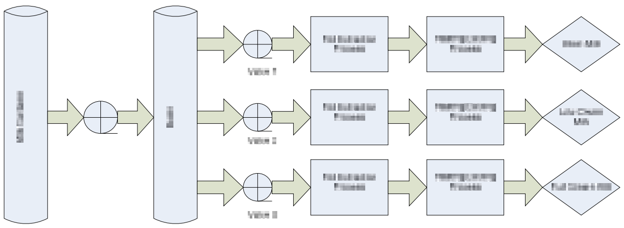

Fig 1: Flow Diagram of Milk Preservation System

Design Algorithm for Milk Preservation System: The design work includes 6 triangular shaped membership functions, range from 0 Liters to 100 Liters for the input variables: Volume Required for Skim Milk, Volume Required for Full cream Milk and Volume Required for Low Cream Milk. The membership Functions for Volume Required for Skim milk, Volume Required for Full Cream Milk and Volume Required for Low Cream Milk are 0-20Very Small, 0-40 Small, 20-60 Medium, 40-80 Above Medium, 60-100 High and 80-100 Very High.

The Membership functions for input and output variables are presented below in Table 1.

Table 1. The ranges of membership functions (MFs) for Input and Output Variables.

Membership Functions	Input Variable Range	Output Variable Range
Very Small	0-20	0-20
Small	0-40	0-40
Medium	20-60	20-60
Above Medium	40-80	40-80
High	60-100	60-100
Very Small	80-100	80-100

MFs for each input variable arepresented in Table 2.

Table 2. MFs for Input Variables.

Membership Function	Skim Milk (Liters)	Full Cream Milk (Liters)	Low Cream Milk (Liters)
Very Small	0-20	0-20	0-20
Small	0-40	0-40	0-40
Medium	20-60	20-60	20-60
Above Medium	40-80	40-80	40-80
High	60-100	60-100	60-100
Very High	80-100	80-100	80-100

Plot of membership functions (PMFs) for the Volume of Skim Milk is presented in Fig 2.

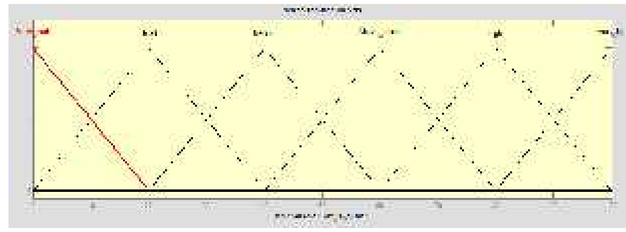

Fig 2: PMFs for input Fuzzy Variable Skim Milk Volume.

PMFs for the Volume of Low Cream Milk are presented in Fig3.

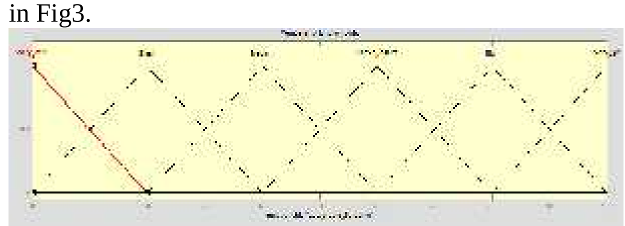

Fig 3: PMFs for input Fuzzy Variable Low Cream Milk Volume.

PMFs for the Volume of Full Cream Milk are presented in Fig4.

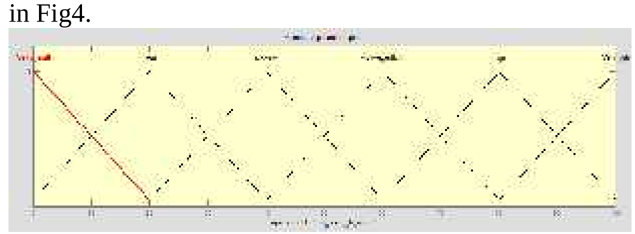

Fig 4: PMFs for input Fuzzy Variable Full Cream Milk Volume.

The MFs for each output variable are shown in Table 3.

Table 3. MFs for Output Variables.

MF	Valve opening time for Skim Milk	Valve opening time for Low Cream Milk	Valve opening time for Full Cream Milk	Process time of Skim Milk	Process time of Low Cream Milk
V.S	0-20	0-20	0-20	0-20	0-20
S	0-40	0-40	0-40	0-40	0-40
M	20-60	20-60	20-60	20-60	20-60
A. M	40-80	40-80	40-80	40-80	40-80
H	60-100	60-100	60-100	60-100	60-100
V.H	80-100	80-100	80-100	80-100	80-100

MF	Process time of Full Cream Milk	H/C time for Skim Milk	H/C time for Low Cream Milk	H/C time for Full Cream Milk
V.S	0-20	0-20	0-20	0-20
S	0-40	0-40	0-40	0-40
M	20-60	20-60	20-60	20-60
A.M	40-80	40-80	40-80	40-80
H	60-100	60-100	60-100	60-100
V.H	80-100	80-100	80-100	80-100

PMFs of Valve Opening Time of Skim Milk is shown in Fig 5.

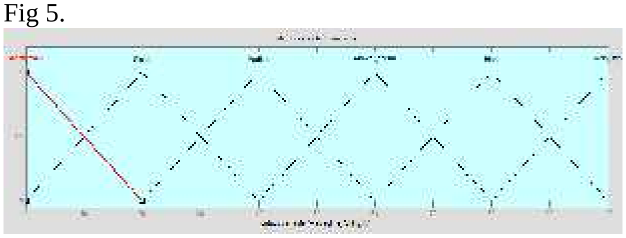

Fig 5: PMFs for output Fuzzy Variable Valve Opening Time of Skim Milk.

PMFs of Valve Opening Time of Low Cream Milk are shown in Fig 6.

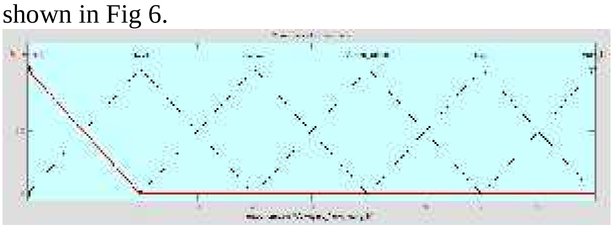

Fig 6: PMFs for output Fuzzy Variable Valve Opening Time of Low Cream Milk.

PMFs of Valve Opening Time of Full Cream Milk are shown in Fig 7.

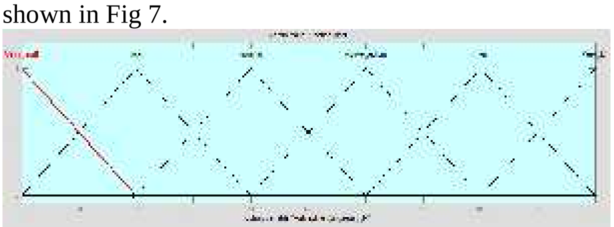

Fig7: PMFs for output Fuzzy Variable Valve Opening Time of Full Cream Milk.

PMFs of Processing Time of Skim Milk are shown in Fig 8.

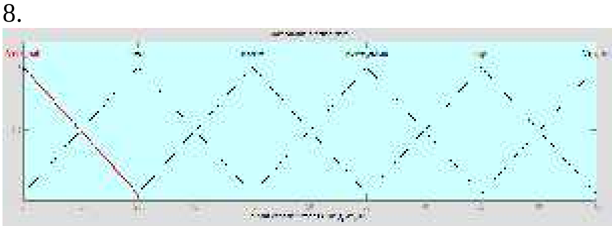

Fig8: PMFs for output Fuzzy Variable Processing Time of Skim Milk.

PMFs of Processing Time of Low Cream Milk are shown in Fig 9.

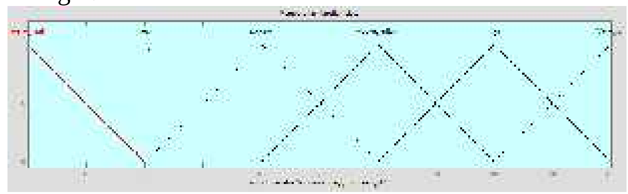

Fig 9: PMFs for output Fuzzy Variable Processing Time of Low Cream Milk.

PMFs of Processing Time of Full Cream Milk are shown in Fig 10.

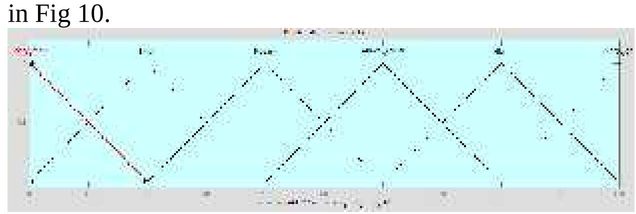

Fig 10: PMFs for output Fuzzy Variable Processing Time of Full Cream Milk.

PMFs of Heating/Cooling Time of Skim Milk are shown in Fig 11.

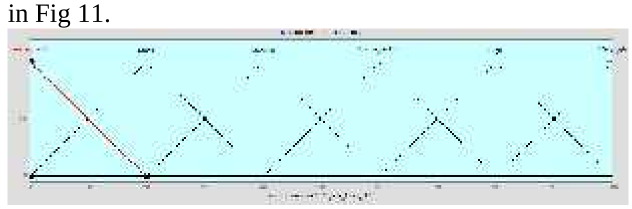

Fig 11: PMFs for output Fuzzy Variable Heating/Cooling Time of Skim Milk.

PMFs of Heating/Cooling Time of Low Cream Milk are shown in Fig 12.

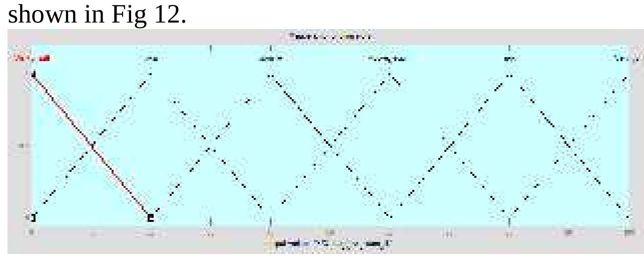

Fig 12: PMFs for output Fuzzy Variable Heating/Cooling Time of Low Cream Milk.

PMFs of Heating/Cooling Time of Full Cream Milk are shown in Fig 13.

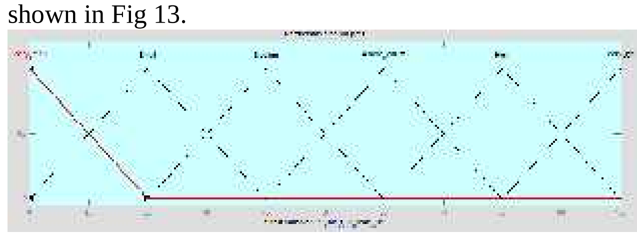

Fig 13: PMFs for output Fuzzy Variable Heating/Cooling Time of Full Cream Milk.

After declaring the membership functions the next step was to set the rules. The rules varied according to the input and output variables. For example if we need less quantity of any type of milk, the valve will open for less time, will operate for less processing time and requires less heating/cooling time.

The Rules are set, as if the Volume required is low then then Valve Opening Time Processing Time and Heating/Cooling time will also be low. Rest the detailed list of rules is given below.

1. If (Skim_Milk_Volume is Very_Small) and (Low_Cream_MIlk_Volume is Very_Small) and (Full_Cream_Milk_Volume is Very_Small) then (Valve_Time_of_Skim_Milk is Very_Small)(Valve_Time_of_Low_Cream_Milk is Very_Small)(Valve_Time_of_Full_Cream_Milk is Very_Small)(Process_Time_of_Skim_Milk is Very_Small)(Process_Time_of_Low_Cream_Milk is Very_Small)(Process_Time_of_Full_Cream_Milk is Very_Small)(H/C_Time_of_Skim_Milk is Very_Small)(H/C_Time_of_Low_Cream_Milk is Very_Small)(H/C_Time_of_Full_Cream_MIlk is Very_Small) (1)
2. If (Skim_Milk_Volume is Very_Small) and (Low_Cream_MIlk_Volume is Very_Small) and (Full_Cream_Milk_Volume is Small) then (Valve_Time_of_Skim_Milk is Very_Small)(Valve_Time_of_Low_Cream_Milk is Very_Small)(Valve_Time_of_Full_Cream_Milk is Small)(Process_Time_of_Skim_Milk is Very_Small)(Process_Time_of_Low_Cream_Milk is Very_Small)(Process_Time_of_Full_Cream_Milk is Small)(H/C_Time_of_Skim_Milk is Very_Small)(H/C_Time_of_Low_Cream_Milk is Very_Small)(H/C_Time_of_Full_Cream_MIlk is Small) (1)
3. If (Skim_Milk_Volume is Very_Small) and (Low_Cream_MIlk_Volume is Very_Small) and (Full_Cream_Milk_Volume is Medium) then (Valve_Time_of_Skim_Milk is Very_Small)(Valve_Time_of_Low_Cream_Milk is Very_Small)(Valve_Time_of_Full_Cream_Milk is Medium)(Process_Time_of_Skim_Milk is Very_Small)(Process_Time_of_Low_Cream_Milk is Very_Small)(Process_Time_of_Full_Cream_Milk is Medium)(H/C_Time_of_Skim_Milk is Very_Small)(H/C_Time_of_Low_Cream_Milk is Very_Small)(H/C_Time_of_Full_Cream_MIlk is Medium) (1)

And the list continues similarly as above. We have described 216 rules for this system of which the snapshot is given is the Fig 14.

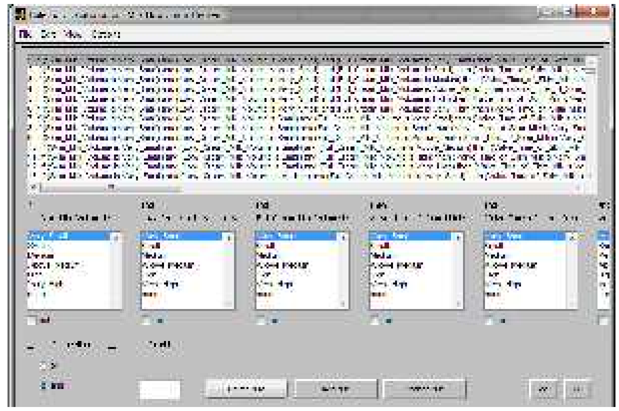

Fig14: Definition of rules in MATLAB Rule Editor.

RESULTS

Fig 15 shows the Rule Viewer in MATLAB. When the required volume of Skim Milk is 20 liters, Volume required of Low Cream Milk is 45 liters, and the required volume for Full Cream Milk is 76 liters.

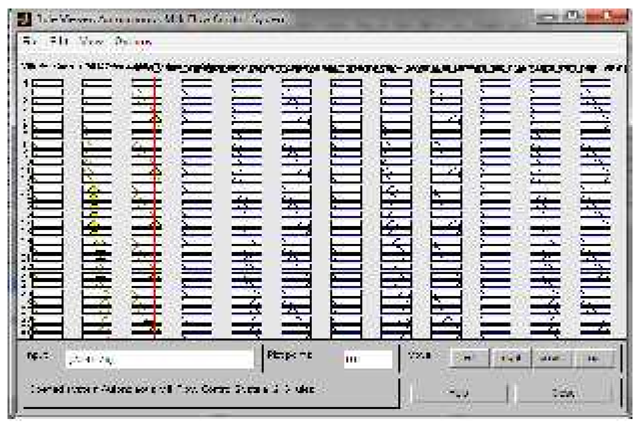

Fig 15: MATLAB Rule Viewer and Simulation Results of Automated Milk Preservation System.

Graph Discussion: The input variables are independent which is the volume required for Skim Milk, Low Cream Milk and Full Cream Milk whereas the output variables depend on the quantity required of each type of milk. For example if we require a less amount of each type of milk the valve will open for less time and it will also take less time to process and then after heating cooling it will be preserved. The input variables are directly proportional to the output variables so the graphs are linear as shown in the Fig 16, Fig 17, Fig 18 and Fig 19 below.

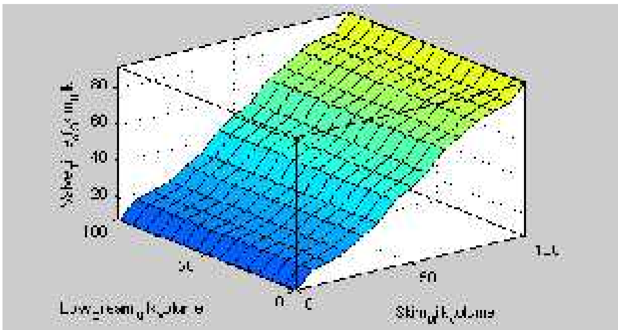

Fig 16: Plot between Required Skim Milk Volume and the Valve Opening Time.

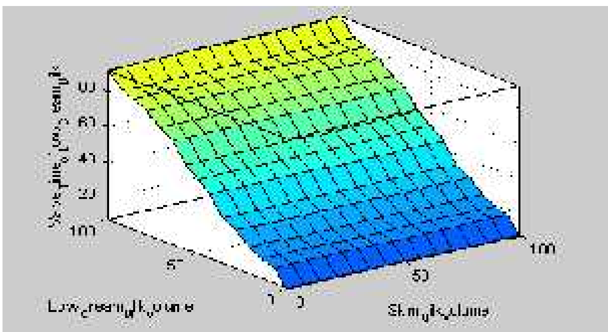

Fig 17: Plot between Required Low Cream Milk Volume and the Valve Opening Time.

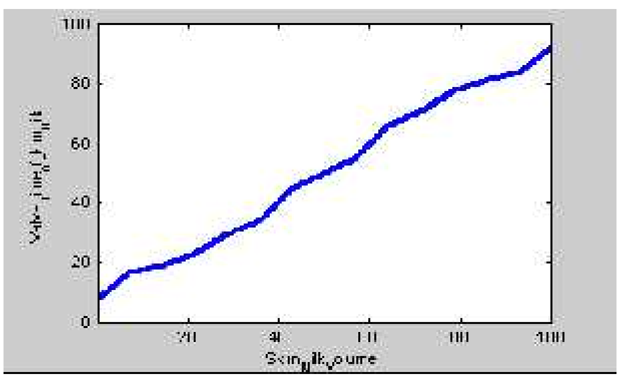

Fig 18: Plot between Required Skim Milk Volume and the Valve Opening Time.

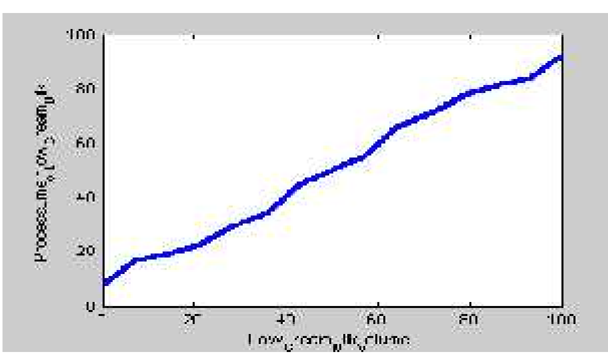

Fig 19: Plot between Required Low Cream Milk Volume and the Processing Time of Low Cream Milk.

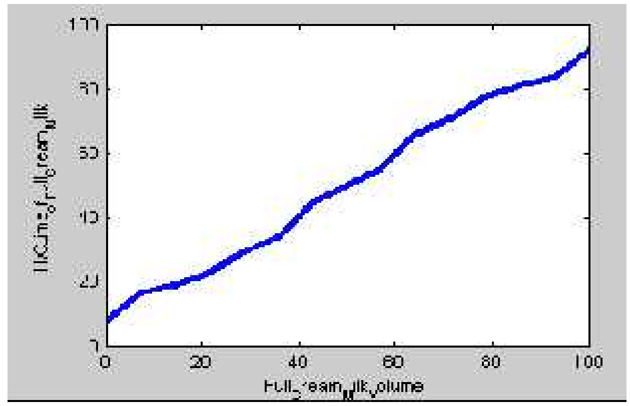

Fig 20: Plot between Required Full Cream Milk Volume and the H/C Time.

Conclusion and Future Work: The purposed automated milk preservation system simulated in MATLAB using fuzzy logic systems provides effective results which are very close to the real life results. The purposed design is very good in performance as compared to ususal Automated Milk Preservation Systems. This system is much more accurate and efficient compared to the other automated systems because it gives more accurate resut due to its variable environment based on the input and required output. In future this system can be made FPGA based to increase its profiency. Micro electronic based FPGA systems will help to adopt the requirement of low cost systems to implement it successfully.

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