USE OFFUZZY LOGIC SYSTEM FOR COLOUR STRENGTH MEASUREMENT OF COLOURED FABRIC

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Abstract

The Colour strength measurement is a typical processing Textile coloration and is very critical especially in textile printing due to printed and unprinted portion. This paper presents a Fuzzy Logic Controller (FLC) system for textile Industry. This work describes a method for implementation of a rule-based fuzzy logic controller applied to a Colour strength measurement of printed fabric. The designed Fuzzy Logic Controller's performance is and compared with conventional CCM (Computer Colour matching). In textile quality printing is very important and it depends on parameters like K/S Ratio, Reflectance, L, a, b, c, H. For measurement of colour strength, samples of three colours red, blue and golden yellow with two thickeners for each are taken and the control architecture is developed which includes some rules. These rules show a good relationship between three inputs and an all outputs. The proposed system has been simulated in MATLAB/SIMULINK. The controller has then been tuned by trial and error method and simulations have been run using the tuned controller.

Keywords: Computer Colour matching (CCM), Fuzzy Logic Controller (FLC), K/S Ratio, Reflectance, MATLAB/SIMULINK

1. INTRODUCTION

Textile industry is most essential part of our society. In Textile industry Colour strength (K/S value) is most important parameter to test the quality measurement of a sample in terms of depth of the Colour printed fabric. The conventional method of Colour strength (K/S value) measurement is CCM (computer Colour matching). Here the printed samples were selected for study purpose. The Colour strength of printed fabric samples depends and is measured with variation in thickeners versus printing conditions such as fabric GSM (grams per square-meter), number of strokes and viscosity in printing process. K/S value, Reflectance, L, a, b, C, h parameters are related to the colour strength of printed fabric, also these parameters can be measured by using CCM (Computer colour matching) system.[1]-[4]. In this system the Colour strength is measured by using Kubelka-Munk theory and the Colour strength is defined as a function of fabric GSM (grams per square-meter), number of strokes and viscosity. The restrictions of Kubelka–Munk theory is the actual theory does not deal with all parameters of printed fabric, its response is affected by working conditions and it depends on mathematical model therefore its complexity increases as parameters increased.[5,6] Hence the conventional method shave difficulties like dependence on the accuracy of the mathematical model of the system. To minimize these difficulties of conventional CCM system, fuzzy control has been implemented which is mostly used for complex system where accurate mathematical models cannot give the satisfactory results. A fuzzy logic controller also makes good performance in terms of stability, precision, reliability and rapidity achievable. This work is based on the characteristics of CCM, its operation, description of Fuzzy Logic Controller, Functional block diagram of system ,design of FLC ,simulation model and simulation results are discussed.

2. INTRODUCTION OF COMPUTER COLOUR MATCHING (CCM) SYSTEM

The working procedure of CCMS which is used in dyeing lab to match the shade of the products. Generally buyer gives a fabric sample swatch or Panton number of a specific shade to the producer. Producer gives the fabric sample to lab dip development department to match the shade of the fabric. After getting the sample they analyze the colour of the sample manually. On the other hand they can take help from computer colour matching system. At first it needs to fit the sample to the spectrophotometer which analyzes the depth of the shade and it shows the results of the Colour depth. At the same time it needs to determine the Colour combination by which you want to dye the fabric. Then it will generate some dyeing recipe which is nearly same. After formulation of dyeing recipe it needs to dye the sample with stock solution. Then sample should dye according to the dyeing procedure.[6][9] After finishing the sample dyeing it needs to compare the dyed sample with the buyer sample. For this reason dyed sample are entered to the spectrophotometer to compare the sample with the buyer sample.

3. FUZZY LOGIC CONTROLLER (FLC) SYSTEM

Fuzzy logic is wonderful solution to non-linear systems because it is closer to the real world. Non-linearity is handled by rules, membership functions, and the inference process which results in improved performance, simpler implementation, and reduced design cost. With a fuzzy logic design some time consuming steps are eliminated. During the debugging and tuning cycle one can change system by simply modifying rules, instead of redesigning the controller. In addition, since fuzzy is rule based, One need not to be an expert in a high or low

level language which helps to focus more on application instead of programming.[10] Therefore Fuzzy Logic substantially reduces the overall development cycle.

4. VARIATONS IN PARAMETERS.

The variations in printing parameters are as follow----
GSM of the fabric----- 70,150,300
Viscosity(%) ----- 4%,5%,6%,7%
No. of strokes ----- 1,2,3,4
Colors used ------ G. yellow, Blue and Red (Reactive dye)
M/C used ------ Hand table printing.

5. BLOCK DIAGRAM OF FLC SYSTEM

Thickener, Colour, GSM, Viscosity and No. of Strokes are the input variables of fabric Samples. All these input values are crisp values and given to the FLC Controller block. The inference system then processes these fuzzy inputs using the fuzzy control rules and the database, which are defined by the programmer based on the chosen membership function and fuzzy rule table, to give an output fuzzy variable. The fuzzy output thus obtained is defuzzified by the defuzzifier to give a crisp value, which are given to multi-port block this block Choose between multiple block inputs. Total six parameters are selected in this system these are K/S ratio, Reflectance, a, b, C and H. these are displayed on Display block. FLC is developed in FIS editor. The FIS program thus generated is to be fed to the FLC before proceeding with the simulation.

5. DESIGN OF FUZZY LOGIC CONTROLLER

5.1. Membership Function Design

The designed input membership functions for Fuzzy Logic Controller are Thickener: Two types of thickeners (Sodium alginate) and Thickener 2 (Gum Indalca), Colour: Three types of colour are used namely Red, Blue and Golden Yellow. GSM: Three types of GSM values are as Low value GSM, Medium Value GSM and High Value GSM. Viscosity: Viscosity it is measured in percentage and classified as 4%, 5%, 6%, 7% for each GSM value. No of strokes: Four types of strokes are used 1,2,3,4 for each GSM Value. The Linguistics terms used for input membership functions are as follows GSM_ Low, GSM_ Medium, GSM_ High, Visc_ Low, Visc_ Medium, Visc_ Medium Low , Visc_ Medium high, Visc_ High, Stroke_ Low, Stroke_ Medium Low, Stroke_ Medium High, Stroke_ High. One If- Then Rules of the Rule Base used for the design of the Fuzzy Logic Controller is as follows: IF (GSM is GSM_Low) and (Viscosity is visc_low) and (Stroke is stroke_low) then (Colour Strength is ColourStrength_69_792)(Reflectance is Reflectance_8_354)(L is L_37_166)(a is a_-1_234)(b is b_-8_053)(C is C_8_147)(H is H_261_255)

5.2. FIS System

Today Fuzzy Inference System (FIS) is mostly used for automatic control modeling. Mamdani's fuzzy inference method is the most popular. There are five parts of the fuzzy inference process first is fuzzification of the input variables, second is application of the AND operator to the antecedent, Third is implication from the antecedent to the consequent, Fourth is aggregation of the consequents and fifth is defuzzification.[10,12]

6. SIMULINK MODEL OF SYSTEM AND SIMULATION RESULT

Fuzzy Logic Controller models for three colours means Blue Red and Golden Yellow and for thickener 1. These Fuzzy Logic Controller blocks contain a bus selector block which Select signals from incoming bus. The Mux block combines its inputs into a single vector output. An input can be a scalar or vector signal. All inputs must be of the same data type and numeric type. Output blocks in a subsystem represent outputs from the subsystem.

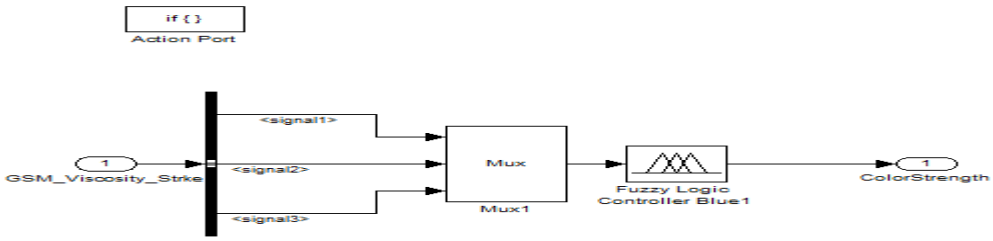

Fig.1: Fuzzy Logic Controller for Blue colour and Thickener 1

Some output parameter values for K/S Ratio,Reflectance, L, a, b, c and H for different Thickeners, colours, GSM Value,Viscosity and No. of Strokes are shown in Fig.2.

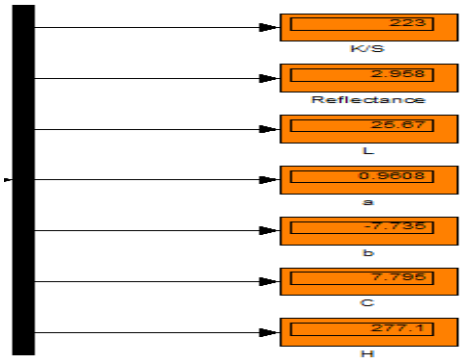

Fig.9: Output parameter values for input parameter Thickener 1, Colour Red, GSM 1, Viscosity 4%, No. of Strokes 3.

Thevalues of FLC are more accurate than the CCM system and time required displaying parameter values are also reduced to millisecond as CCM uses in seconds. As an example from several readings during our experimental work, some FLC readings for blue colour are given as a representative sample in tabular format in Table 1and Table 2.

Table 1: FLS System Readings of Thickener 2(Gum Indalca) and Blue colour.

Thickener 2(Gum Indalca) (Input)									
BLUE colour(Input)									
GSM In gram (Input)	**No. of strokes (Input)**	**Viscosity in percent (%) (Input)**	**(K/S ratio) (Output)**	**Reflectance (Output)**	**L (Output)**	**a (Output)**	**b (Output)**	**C (Output)**	**H (Output)**
127.328042	1	4%	158.2	3.668	25.67	0.4577	-11.32	11.33	272.4
	1	5%	198.2	3.25	25.56	1.372	-8.718	8.828	279
164.569190	1	4%	211.4	2.878	22.06	0.848	-9.81	9.848	275
	1	5%	252.2	2.622	22.06	1.254	-7.66	7.763	279.3

Table 2: FLS System Readings of Thickener 2(Gum Indalca) and Golden Yellow colour.

Thickener 2(Gum Indalka) (Input)
GOLDEN YELLOW colour(Input)

GSM In gram (Input)	No. of strokes (Input)	Viscosity in percent (%) (Input)	(K/S ratio) (Output)	Reflectance (Output)	L (Output)	a (Output)	b (Output)	C (Output)	H (Output)
127.328042	1	4%	29.2	11.5	65.5	26.37	40.88	48.65	57.15
	1	5%	30.45	11.15	67.63	33.05	44.8	55.67	53.56
164.569190	1	4%	33.42	10.38	63.08	24.34	40.03	46.85	58.68
	1	5%	38.61	9.399	64.98	32.77	43.34	54.34	52.88

7. CONCLUSION

The conventional colour strength measurement methods are linear and their construction is based on linear system theory. Hence they require complex calculations for evaluating each parameter. The Fuzzy Logic Control system is satisfactory, in relation to parameter variations while achieving the accurate results. It has ability to handle system nonlinearities. Fuzzy logic provides a certain level of artificial intelligence to the controllers since they try to reproduce the human thought process. This facility is not available in the conventional methods. From the work and results obtained one can use dyed or printed samples for recipe prediction in terms of K/S, etc .irrespective of GSM, no. of strokes, changes in viscosity.

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