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Using Fuzzy Logic System (FLS) for Cotton Yarn Quality Assessment and Grading Classification Method

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Abstract: *This paper concerned on using of fuzzy logic system (FLS), for assessing and grading of cotton yarn surface quality based on the generated binary image pixel values of the yarn wound blackboard image. Fuzzy logic has toolbox in MATLAB and it is a good measuring frame to handle the problem of uncertainty, vague or unclear things in the image information. In this studying, FLS for cotton image classification is applied to identify homogeneous groups of data points and to select some parts from the other in a given dataset and assigning it to a class. By applying fuzzy rules and mathematical formulas, the calculated degree of membership of the input value (binary image white pixels of sample) used to decide the grade of yarn quality either good or bad, based on their relative similarities with the standard one. The yarn quality grading and classification can be accomplished by a process of grouping pixels into a set of classes based on their relative similarities with regard to certain properties.*

Key Words*: Pixels, Fuzzy logic system, Cotton yarn grading appearance, Membership function, Fuzzy rule, Tex.*

1. INTRODUCTION:

The term “Fuzzy Logic” has been developed in 1965 and it is based on the knowledge of "partial truth", which means truth values between "absolutely true" and "absolutely false". Fuzzy Logic offers a structure to model ambiguity, and the perception process of human decision. It is based on linguistic variables and through a set of fuzzy logic rules an inference system is built which is the basis of the fuzzy computation [1]. In MATLAB, Fuzzy logic has a toolbox which used to solve uncertainty or vague problems during image processing and classification. This fuzzy logic has a set and its elements have different degree of membership that the values always assigned between 1 and 0. A Fuzzy logic System (FLS) is to map an input space to an output space by using a fuzzy set. It tries to formalize the reasoning process of human language by means of fuzzy logic (by building fuzzy IF-THEN rules and by using linguistic variables such as adjectives and adverbs).

FLS for image classification is applied to identify homogeneous groups of data points and to select some parts from the other in a given dataset and assigning it to a class. The image classification can be accomplished as a process of grouping pixels into a set of classes based on their relative similarities with regard to certain properties.

This project mainly concerned on using of FLS image classification, for yarn surface quality assessing and grading based on the binary image pixel values of the yarn sample. Then by applying fuzzy rules and mathematical formulas of fuzzy membership function, the calculated degree of membership of the input value (binary image white pixels of sample) is used to decide the grade of yarn quality either its good or bad, based on their relative similarities with the standard one.

Evidently the cotton yarn sample image processing phase should be developed in GUI toolbox with the aim to get the most suitable features (pixel values) from the image to use as input value for yarn quality grading based on the fuzzification, fuzzy rules and defuzzification process. In MATLAB yarn image processing, from the generated binary image number of black and white pixel values, we take the white and applied in the formulated fuzzy rules and membership functions in FLS. Because the white pixel values indicates only the yarn surface in the yarn carrying blackboard and it is a combination of yarn cure (non-defect area) and surface defects. For this investigation, we received the prepared yarn sample image by email from Kombolcha Textile Industry which found in Ethiopian Country. In the figure below are the received yarn samples that we used for experiment in this investigation.

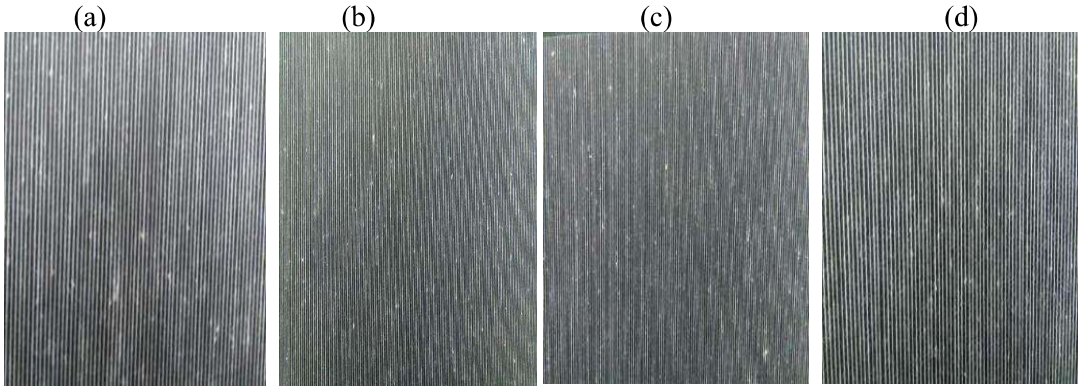

Figure 1.1 Cotton yarn samples for applying in this investigation (Tex); (a) 42, (b) 37, (c) 34, and (d) 29.4

Based on the ASTM standard (D-2255) method, totally there are six series of yarn count ranges in the world textile yarn manufacturing industry. Each series has a four graded standard photographs that the yarn manufacture uses it as a standard quality reference to compare and evaluate their product by visual observing. And according to the investigation of [5], they have been analysed and gave a fixed pixel number for each standard photographs.

This project deals by taking the standard ASTM yarn count series range of 50 to 25+ Tex, and its generated pixel values in MATLAB image processing to construct the membership function (MF) of the FLS, because the yarn sample for this experiment belongs in this count range and its parameters are listed in the table below.

Table 1: ASTM (D-2255) STANDARD IMAGE PIXEL VALUES OF SECOND SERIES YARN COUNT [5].

Series	Sample cotton yarn count	ASTM standard photograph values of 2nd series count	
		Image grade	Standard image white pixels
Second series	Range from 50 to 25+ Tex	A	323505
		B	376252
		C	415100
		D	468541

As shown in the above table, first grade image (grade A), has best yarn quality which means less thick, thin place and neps. While the last grade 'D', due to its higher number of thick places and neps, it's the worst in quality and has larger pixel number. As a result when we go to from grade A, to grade D, the number of white pixels becomes increase and black pixels are decrease, while from grade D, to grade A, the vice versa is true.

Generally, the white pixels of the binary image describes the quality of the yarn surface, because it is the combination of pure (core) yarn surface and different surface defects. That means the fewer pixels describes the higher yarn quality (less thick place and neps) and it has, while higher pixels describes low yarn quality (more thick place and neps).

2. REVIEW ON RELATED PAPERS :

According to the standard method of ASTM (D-2255-02), cotton yarn appearance standard were first adopted in 1938 and revised in1964, with series III being revised again in 1975. Traditionally the inspection is carried out directly by visual comparison of the wound yarn sample (blackboard wrappings of yarns) with the grade labelled photographic standards (grade A, B, C and D) and based on the assessment of regularity, freedom from imperfections, foreign matter, neppiness and lack of hairiness [2].

Researchers have developed an artificial intelligence and computer vision evaluation method for yarn quality testing and grade classification. In this investigation the quality classification was done through the integrated digital system which integrates the whole image processing algorithms. To classify the yarn quality and grade in artificial neural network, authors have been used eighteen yarn features and statistical results of USTER yarn evenness tester [3].

Authors have been used a statistical function of semivariogram method for evaluation of yarn surface unevenness. To accomplish their investigation, they used image processing algorithms in matlab software such as image acquiring, and grey scale image conversion. Then based on the standard yarn board (CSN8 0704), the fluctuation in the degree of greyness between the square field image has evaluated by semivariogram. The greyness degree were constructed from the standard yarn board by dividing the grey image into square field of selected size [4].