

Intelligent Yarn Parameterization and Quality Control System for Spinning Mills

Pavithra.S¹, Mohanarathinam.A²

P.G. Student, Department of Electronics and Communication Engineering, Akshaya College of Engineering and Technology, Coimbatore, Tamil Nadu, India¹

Assistant Professor, Department of Electronics and Communication Engineering, Akshaya College of Engineering and Technology, Coimbatore, Tamil Nadu, India²

ABSTRACT: Textile Industry is one of the major revenue generating industries in India. Defect rate minimization of a product plays a very important role in the improvement of yield and financial growth especially in the yarn manufacturing process. It is highly emphasized here because of the mass production in the manufacturing process whereby a minor defect leads to large financial and production loss. As the yarn is the most preliminary product in the textile industry, it takes the utmost importance in the industry. The estimation of the yarn quality may not be an easy task and so uses expensive high end testing instruments which are not affordable by small and medium scale yarn manufacturers. The preliminary factors considered in the yarn quality estimate are the yarn evenness based on the yarn diameter and the yarn hairiness. In this proposed work, the preliminary factors of yarn such as yarn evenness and yarn hairiness are estimated by processing the image of the yarn. The uniformity of the yarn along the axis and thickness profile of the yarn along the length is derived using the edge detection and feature extraction methods. The system efficiency is improved by classifying the yarn quality based on the estimated parameters through yarn parameterization. In addition to the above, the proposed system uses an effective filtering technique for edge detection and to extract the hairs.

KEYWORDS: Yarn quality, Yarn evenness, Yarn hairiness, edge detection, feature extraction, yarn parameterization.

I. INTRODUCTION

The Textile Industry in India traditionally, after agriculture, is the only industry that has generated huge employment of both skilled and unskilled labour. The textile industry continues to be the second largest employment generating sector in India. It offers direct employment to over 35 million people in the country. The share of textile exports was 11.04% during April-July 2010, as per the Ministry of textiles. The raw material may be natural or synthetic. The natural materials include the cotton fibres, bamboo fibres, etc. while the synthetic fibres include the polyesters, nylon, rayon, etc.,

The end product of the textile industry which comes across several processes is the apparel. The flow of the textile process and the products are shown in the fig 1 in this section. It is inferred from the flow that the yarn is the most preliminary product which comes under the spinning sector. Hence, the textile processors give utmost importance to the yarn quality. Also, it is predictive to test the yarn quality thoroughly weaving or knitting process, thereby ensuring better quality fabric.

A yarn is a generic term for a continuous strand of textile fibres, filaments or material in a form suitable for knitting, weaving or otherwise intertwining to form a textile fabric. There may be enormous types of yarn which are the spun yarn, zero twist yarn, filament yarn, etc based on the fibre packaging model around the axis.

There are several factors that affect the influence the yarn quality namely, the types of fibres, yarn twist, yarn count, blending ratio (migration effect), and technology of production, measurement condition (temperature, humidity and test

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

speed). In this paper, the yarn parameters are estimated through imaging methodology by the yarn images. Hence, this paper deals with the acquisition, processing, classification of the images and decision making based on the parameters.



Fig 1 Flow of Textile Process and its Products.

The work in this paper is divided in three stages: 1) Image Acquisition 2)Image processing 3) Classification of parameters and decision making. Image Acquisition part describes the method involved in capturing the image of the yarn. Image processing stage describes the flow of processing the acquired yarn image through several image processing tools. Classification stage explains the guideline parameters for decision making in order to predict the yarn faults at the manufacturing stage.

This paper is organized as follows. Section II explains the existing works related to the yarn image processing. The overall concept of this paper and the image acquisition part is explained in the Section III. The acquired image is processed using several image processing tools in MATLAB software which is explained in the Section IV. The classification and decision making part is explained in the Section V and the Section VI shows the experimental results. Finally, the Section VII has the conclusion of this paper.

II. RELATED WORK

The concept of yarn parameterisation was implemented using image processing method by Fabijanska.A [5]. This paper describes the image processing methods to extract the protruding hairs of the yarn. AninditaSengupta et al., has proposed a design for a cost effective yarn parameterisation setup for image acquisition [2]. Also, a thoughtful work has been proposed in this paper with respect to the preliminary steps of the object analysis with different backgrounds and illumination levels. The hairs of the yarn are extracted with efficient masking techniques and edge detection algorithms. Yuvaraj.D et al., proposed a simple imaging and processing of the yarn image when compare with the commercial testers [6]. This paper mainly concentrates on the acquisition of the yarn images effectively without missing of the hairs and is done by generating a 2kV high power voltage in order that the yarn hairs projects away from the yarn surface. Guha.A et al., with their efforts to measure the yarn hairiness developed a method to measure the true length of all the hairs under a microscope [7]. A min. A. E proposed a novel classification algorithm based on neural networks to classify the type of yarn based on the values of the yarn count, yarn twist applied, etc., [1]. The system also uses the genetic algorithm for classification.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

III. SYSTEM DESCRIPTION

This Section describes the overall description of the entire system of yarn parameterisation through image processing and classification. There are three stages being involved in this system namely image acquisition, image processing and classification of parameters with decision making. Fig 2 in this section represents the processes overall system. The yarn selected for testing may be of any packaging type and is fixed to a holder. The setup comprises of bobbin/cone stand, yarn guides, tension control and motor for driving yarn delivery. There exist two delivery rollers out of which one is positively driven and the other rotates in friction to that roller. The end of the yarn is moved through the delivery rollers rotated by the motor. The speed of the motor can be varied based on the supply voltage. A camera with 8 MP to 12 MP is used to acquire the yarn images. The blocks of remaining stages are shown in the fig 3 where the parameters acquired from the processed image are classified and the information can be accessed through mobile phones.

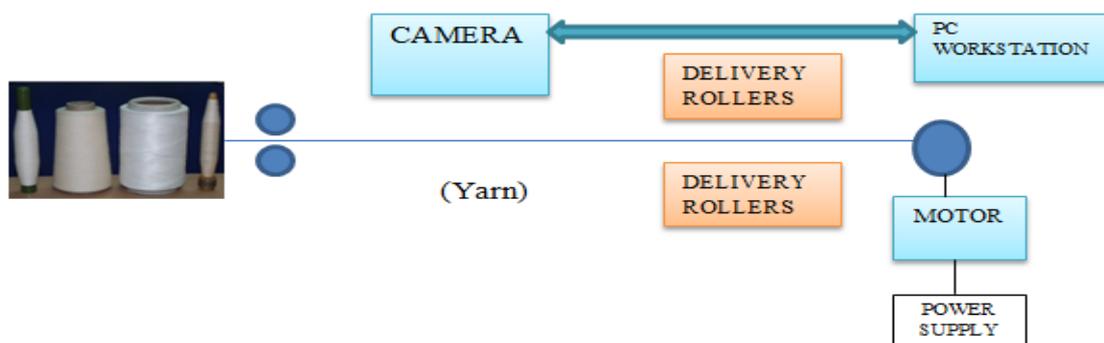


Fig 2 Yarn image Acquisition Setup

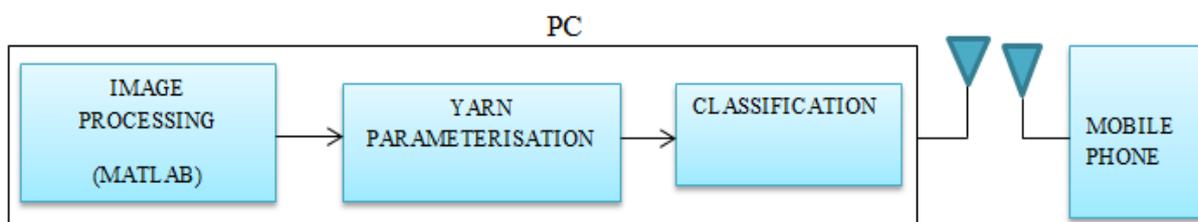


Fig 3 Processing & Classification end

IV. IMAGE PROCESSING

The yarn image is acquired by a digital camera as described in the Section III. The yarn is made to pass over a black chart of area 5x5 cm as the foreground of the image is white colour. The nominal standard for yarn parameters are units per meter. Since 1 meter of yarn cannot be wholly captured, the yarn is divided into 20 subsections of 5 cm. The images were acquired with 8 bit resolution and stored as monochromatic images of spatial resolution M X N equal to 480 X 640 pixels. Fig 4 shows the flow of image processing. In the analysis and pre-processing stage, the image is analysed for the position, presence of white pixels. Then, it is converted to binary image and threshold image is filtered. In this stage, particle filtering has few shortcomings which have been overcome by the bilateral filter. The edge detection is done through estimating the boundary through the length of the yarn. The difference between the positions of the two edges gives the diameter of the yarn. The calibration is done by repeating the same process for a known diameter of yarn and comparing with the unknown. This estimates the uniformity of the yarn along the axis and is parameterised as thin places (places which that have low diameter), thick places (places that have high diameter)

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

and neps (accumulation of fibres at a point) along the axis of the yarn. Fig 5 & Fig 6 of this section shows the faults that occur in the cross-section of the yarn with respect to uniformity and flow of yarn characterisation respectively.

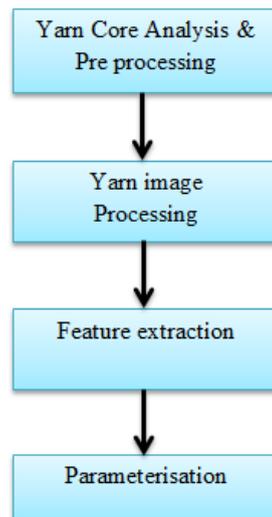


Fig 4 Flow of yarn image processing

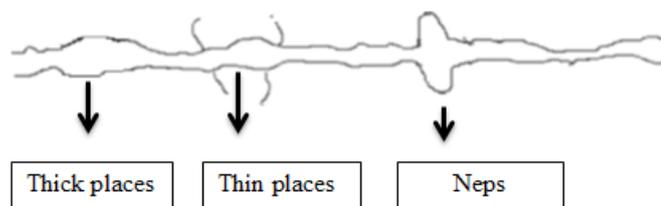


Fig 5 Yarn faults based on uniformity

The hairiness of the yarn is determined by the Hair Area Index (H_A) and Hair Length Index (H_L). They are given as follows:

- **Hair Area Index:** It is the unit less parameter defined as the ratio of summation of the total area of single fibers (S_f) and the total length of the core (S_c).

$$H.A.I = S_f/S_c$$

- **Hair Length Index:** It is the unit less quantity defined as the ratio between the total length of the released fibers (L_f) and the total length of the core (L_c).

The hairiness parameter is estimated by considering the pixel area away from the boundary. Firstly, the area of about 3mm and 6mm away from the two sides of the boundary are cropped. Then, the boundary is extracted by using the connected components functions and the boundary operator. The connected components function is the highly effective in extracting the hairs from the core yarn. The pixel area in the corresponding point is retrieved by filtering using a Gaussian filter and image sharpening. This gives the number of hairs and the area of the hairs in the input image area. The entire process is applied for 20 subsections of 1 meter (i.e., 5 cm) of the yarn.

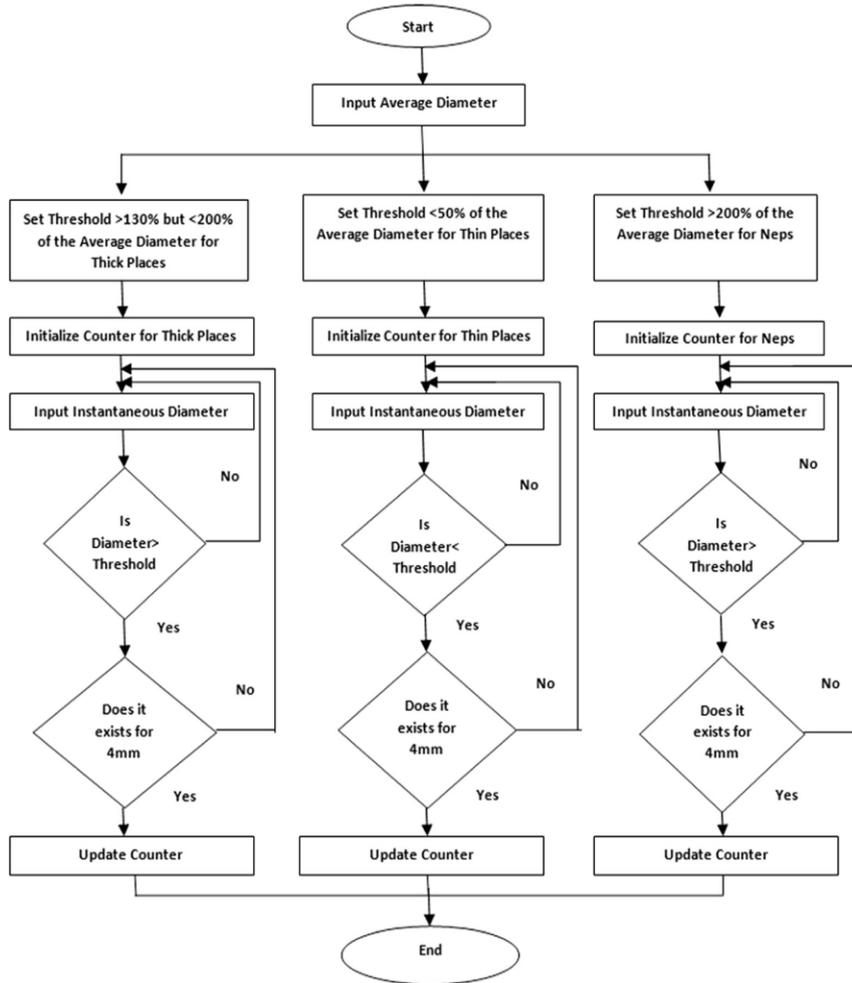


Fig 7 Flow of yarn parameterization

V. CLASSIFICATION AND DECISION MAKING

This section explains about the classification and decision making process with respect to process control. The estimated parameters such as the yarn diameter, uniformity parameters like neps, thin places, thick places, etc., hairiness index are the preliminary factors that influence the yarn quality. Apart from these factors, the other factors that influence the yarn quality are count variation, relative humidity maintained during the process, twist per inch (TPI) maintained during the process, etc.,

VI. EXPERIMENTAL RESULTS

The experimental results obtained for the estimated of the quality parameters are shown in this section. Fig 8(a) shows the input image. Fig 8(b) shows the edge preserved image of the binary scale and the fig 8 (c) shows the (thresholded image. Fig 8(d) shows the edge detected image while the fig 8(e) shows the extracted hairs from the yarn core.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

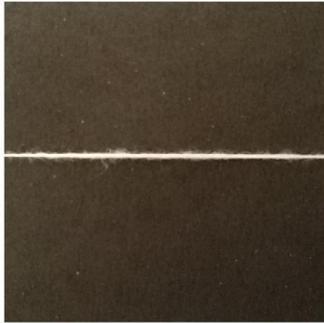


Fig 8(a) Input Image

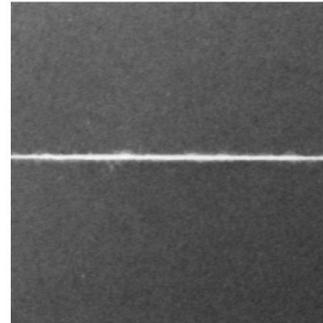


Fig 8(b) Edge Preserved Image in binary scale

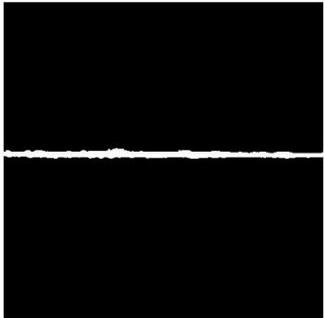


Fig 8(c) Thresholded Image

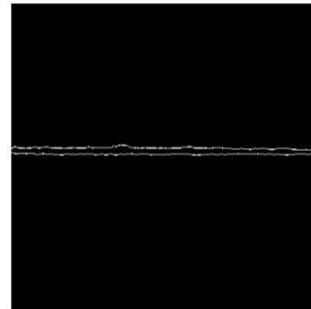


Fig 8(d) Edge Detected Image

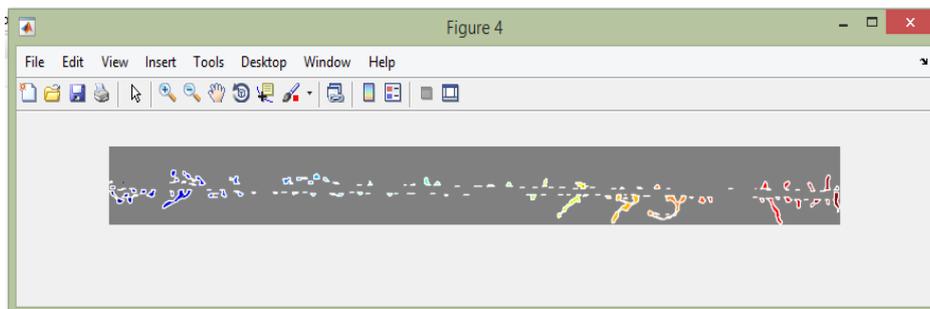


Fig 8(e) Extracted hairs from the yarn core

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

The following table 1 shows the estimated parameters for 40s count of plain cotton yarn and the estimated units are in terms of pixels and tabulated as follows.

Sample No	Length	Diameter	Yarn Evenness	H.A.I
1	687	13.220	Normal	4.7206
2	686	12.384	Normal	4.3410
3	686	12.879	Normal	3.909
4	687	13.429	Normal	4.1341
5	688	13.642	Normal	4.3213

Table 1 Experimental results for 40s count of yam

VII. CONCLUSION

We have implemented the intelligent textile yarn parameterization system and control system for spinning mills. Our system successfully estimates and classifies the yarn parameters with the normal values closer to the conventional testers. Our system overcomes the difficulties in filtering the yam core through the bilateral filter and the hairs are extracted more precisely through the connected components. Further, we propose to classify the yarn parameters and yam faults using the suitable classification algorithms, thus providing prior control decision for quality maintenance in future.

REFERENCES

- [1] A.E.Amin, "A novel classification model for cotton quality based on trained neural network using genetic algorithm", Elsevier, Knowledge-Based Systems, vol.39, pp. 124-132, 2013.
- [2] AninditaSengupta, Subashish Roy and SurajitSengupta, "Development of a low cost yam parameterization unit", Elsevier, Measurement, vol.59, pp.96-109, 2015.
- [3] Mandeep Kaur and Mandeep Shama. "Evaluation of Yam Quality in Fabric using Image Processing Techniques", International Journal of Applied Engineering and Technology, vol.4 (4), pp.54-60, 2014.
- [4] Neha Gupta, "Analysis of Defects in yam manufacturing process & its prevention in Textile Industry", International Journal of Engineering Inventions, vol.2 (7), pp.45-67, 2013.
- [5] A. Fabijanska, "Image Processing and analysis algorithms for yarn hairiness determination", Machine Vision and Applications, Springer, vol.23, pp.527-540, 2012.
- [6] D. Yuvaraj and R.C. Nayar, "A Simple Yam hairiness measurement setup using image processing techniques", Indian Journal of Fiber Text, Res.37, pp.331-336, 2012.
- [7] A. Guha, "Measurement of yam hairiness by digital image processing", Journal of Textile Inst., vol.101, pp.214-222, 2010.
- [8] Ruru Pan, Weldong Gao, Jihong Liu and Hongbo Wang, "Recognition the Parameters of Slub-yarn Based on Image Analysis", Journal of Engineered Fibers and Fabrics, vol.6(1), 2011.
- [9] Gabriela Krupincova, "Influence of yarn count, yam twist and yam technology production on yam hairiness", Faculty of Textile Engineering University of Liberec.
- [10] <http://textileamer.blogspot.in/2012/07/yam-faults-defects-of-yarn.html>.