A CASE STUDY ON FOURIER TRANSFORMATION AND ITS APPLICATIONS ON FABRIC PRODUCTION

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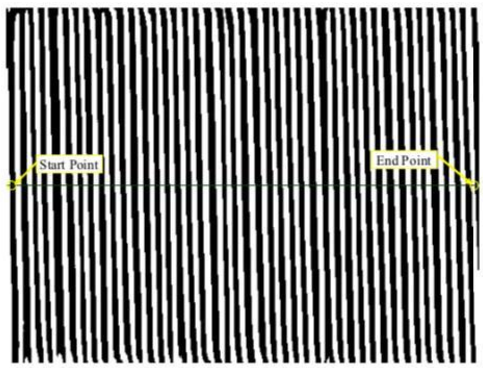
Abstract : "A case study on Fourier transform and its applications on fabric production" is a complete study on applications of Fourier transform concept which helps us to determine the density of a warp yarn which indeed helps us know well about the size of the needle to be used, amount of fabric available etc., we can also find the total weight of the fabric and error percentage values to determine the good quality of the fabric. Fourier Transform and its applications excels in its best in determining the standard of the fabric which associates with the defects detection and localization. The thread density of knitted fabric is one of the most significant parameters, interlacing is presently enumerated by blue-collar operations. The application problems are formulated using Fourier transformation concept.

I. INTRODUCTION

The warp and weft are the two distinct sets of yarns or threads which is used to produce the woven fabrics . By knowing the total number of yarn count and the length of the yarn we can determine the total weight of a fabric. It can be transformed into a frequency domain with a Fourier transform. A Fourier transform is carried out for the fabric image and then the thread density can be analyzed in the Fourier frequency domain. To explore the weight of the fabric it is very essential to have a complete knowledge about the length, count, quality of a yarn. In order to bate the inspection process costs and to enlarge the product's grade this procedure must be carried out. By finding the error percentage of a defect in a fabric we can determine the purity or quality of a fabric more accurately.

II. BASIC DEFINITIONS

Start and end point:



The black pixels in the above image represent the warp yarns while the white pixels show the interstices. The pixels in the standard line are traversed from left to right. The number of yarns along the standard line is then counted.

In image the start point is a black pixel which is chosen as the start pixel of the first yarn in the left, labelled as "Start Point" in the image. The white pixel belonging to the last interstice on the right is chosen as the end point, labelled as "End Point" in the image.

Density of warp yarn:

After obtaining the number of yarns, with the position of start point and end point, the density of warp yarns can be calculated with the magnification of the captured image. The calculation method is carried out as ,$D_{warp} = \frac{N}{(EP-SP+1)\times scale}$ where EP And SP are the endpoint and start point values respectively and the scale value completely varies according to the magnification state of the image in cm/pixel

Error percentage:

Measurement error is calculated to evaluate the inspection results of the automatic and manual methods. The error is calculated as , Error % $= \frac{|D_A - D_M|}{D_M} \times 100$ where, D_A is the automatic detection result, and D_M the manual detection result.

Comparing the automatic detection results to those of manual detection, it can be seen that the results are almost the same, with a maximum error of 0.98%.

III.KEY WORDS

Warp, weft, interlaced fabric density, weight of an apparel, Fourier transform, etc.,

IV.PROBLEMS

Problem 1:

Find the density of the warp yarn where the total number of warp yarns is 42, end point and the start point coordinates are given such as 506 and 4 respectively.

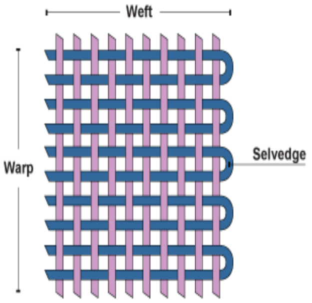
Given :

N=42 Threads (No. of Warps Yarns)

EP= 506 (Co-ordinate of the End point)

SP =4 (Co-ordinate of the Start point)

Scale – 0.002363 cm/pixel (Magnification value)



Formula :

$$D_{warp} = \frac{N}{(EP - SP + 1) \times \text{ scale}}$$

Solution:

$$D_{\text{ warp}} = \frac{42}{(506-4+1)\times 0.002363}$$

$$= \frac{42}{(503)\times 0.002363}$$

$$= \frac{42}{1.1885}$$

= 35.3 Threads / cm.

Problem 2:

Calculate the error% where the automatic detection and manual detection results are given as 41.3 and 41.5 respectively, thus determine the quality of the fabric using its value.

Given :

D_A =41.3 (Automatic detection result)

D_M =41.5 (Manual detection result)

Formula :

$$\text{Error \%} = \frac{|D_A - D_M|}{D_M} \times 100\%$$

Solution :

$$\text{Error \%} = \frac{|41.3-41.5|}{41.5} \times 100\%$$

$$= \frac{|-0.2|}{41.5} \times 100\%$$

$$=0.048 \times 100\%$$

$$=48\%$$

Since error percentage is so high it will affect the quality of the fabric.

Problem 3:

Calculate the weight of a fabric whose yarn length and count are 1200 and 30 respectively which is in 10 courses/min.

Given:

Course/min = 10 , Yarn length = 1200m , Yarn count = 30

Formula:

Fabric Weight = $\frac{\text{Course/ min}\times\text{Yarn length per course}}{\text{Yarn count}}$

Solution:

Fabric weight =$\frac{10\times1200}{30}$ =400

Therefore, Total weight of Fabric = 400 Kg.

4) Fourier Transform in amplitude spectrum of fabric

Amplitude spectrum can be calculated as :

M(u,v) :$\sqrt{R^2(u,v) + I^2(u,v)}$

Where R(u,v) ---------- Real Part

I (u,v) ----------- Imaginary Part

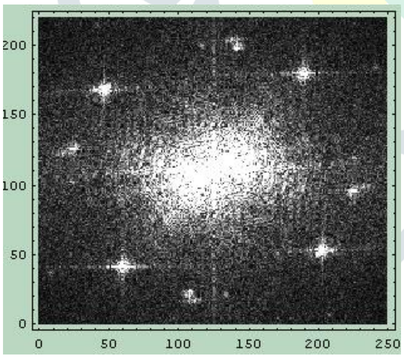
Log transform is adopted to transfer its value to be more understandable.

Strem (u,v) = $\log_2$ [M(u,v) + 1] After narrowing the numerical range, a linear transform is used to adjust the amplitude value into the range of (0, 255).

$$TM(u,v) = \text{floor}\left[\frac{Strem(u,v) - T_{min}}{T_{max} - T_{min}} \times 255 + 0.5\right]$$

TM (u,v) ---- amplitude spectrum after linear transform.

T_{max} - T_{min} ---- Max and Min value of Strem (u,v)



5)ERROR%

Calculate the error% where the automatic detection and manual detection results are given as 42.4 and 42.5 respectively.

Given :

D_A =42.4 (Automatic detection result)

D_M =42.5 (Manual detection result)

Formula :-

Error % $=\frac{|D_A - D_M|}{D_M} \times 100\%$

Solution :

Error % = |42.4 – 42.5 | x 100%

42.5

= |- 0.1|x 100%

42.5

= 0.0023 X 100% = 23%.

Since there isn’t much difference in its error % quality of fabric is still considered good.

V. RESULTS AND DISCUSSION

- With complete note on the start coordinate and the end coordinate values of a yarn we can determine the density of the longitudinal threads, i.e., warp yarns
- Even though there appears only a small change in the manual and automatic detection results, the error percentage value varies accordingly.
- We can clearly understand that the weight of a fabric will completely depend upon the total yarn length and its count.

VI. CONCLUSION

This application of Fourier transform in fabric production also indulged me in introducing the ways for a firm’s continuous improvement towards zero defects, zero wastage and zero breakdown. However there are various methods to identify imperfections in a fabric, choosing Fourier Transform concept is the wisest of all. An approach based on Fourier transform has been described to detect the structural flaws in fabric, determining the total density of a warp yarn, becoming a root cause to find measures for preventing the errors which puts down the quality of a fabric, etc., The experiment proved that this method would be a powerful tool in the application of Fourier transform analysis.

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