BUSITEMA UNIVERSITY
Pursuing Excellence

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DEPARTMENT OF GINNING AND TEXTILE ENGINEERING

TOPIC: ANALYSIS OF THE SURFACE ROUGHNESS OF WEFT KNITTED FARICS USING IMAGE PROCESSING

BY

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DECLARATION

I **AURIEN PAULINE BU/UG/2012/1813** declare that this report was developed by me and that it is my own original work and have never been presented to any institution in part or in full for any purpose.

DATE...21/05/2016............

SIGNATURE...........................

ABSTRACT

The main objective of the study was to design an off-line system that analyses the surface roughness of weft knitted fabric using Image processing. The results showed a good correlation between fabric roughness values measured by the two different methods. (Kawabata and image processing).

Surface roughness is an important factor during touching and handling of fabrics. The roughness of fabrics is important for garments which touch the human skin in a way that it influences the handle of fabric and plays an important role in end-use of fabrics, Fabric hand refers to the total sensation, experienced when a fabric is touched or manipulated in the fingers.

APPROVAL

This report that documents the final year project proposal was done under my supervision and guidance and hereby has my approval for submission for any academic purposes.

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I would like to express my sincere gratitude to my supervisor and course mates who supported me during the writing of this report.

Special thanks go to God for the life and good health He has offered me from birth.

DEDICATION

I dedicate this report to the guidance of my family's instructive love and support. May the lord bless you.

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LIST OF ACRONYMS

GSM Grams per Square Metre

SDLC System Development Life Cycle

FFT Fast Fourier Transform

SMD Surface Mean Deviation

SRNL Southern Range Nyanza Limited

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the study

Surface roughness is an important factor during touching and handling of fabrics. The roughness of fabrics is important for garments which touch the human skin in a way that it influences the handle of fabric and plays an important role in end-use of fabrics. Fabric hand refers to the total sensation, experienced when a fabric is touched or manipulated in the fingers.

Surface roughness is a measure of the texture of a surface. [3-4].

There are two reasons for surface roughness measurement. The first is to control manufacturing process and the second is to help ensure that the products perform well during end use. In case of textiles, the former is related to special finishing (pressing or ironing), but the latter is related to tactile comfort and handling of fabrics. [1-2]

Tactile comfort is important for garments which touch the human skin. A large number of different psychological and physiological responses of the human body along with fabric physical properties are incorporated to produce the subjective feeling of fabrics. Tactile feel is a multidimensional concept which consists of several characteristics including: compression, friction, bending, surface roughness, tensile, shear, and thermal behavior. Among these, surface roughness is a fundamental and effective factor.

Standard characteristics of a surface profile are based on the relative variability characterised by the variation coefficient (analogy with evaluation of yarns mass unevenness), or simply by the standard deviation. Standardised parameters describing the roughness of technical surfaces are given in the ISO 4287 standard [6]. For characterisation of the roughness of textiles surfaces, the mean absolute deviation (SMD) is usually used.

In general, there are subjective and objective techniques to evaluate surface roughness. Since 1955, researchers have attempted to measure surface characteristics of fabrics from a quantitative point of view. Previously, subjective assessments were used. Distinctive techniques have been proposed in this context since then which have their own advantages and disadvantages. The objective group also consists of contact and non-contact methods.

The first technique used to evaluate the surface roughness of fabrics is subjective methods. This means, evaluating the surface roughness by trained people as a measuring device. Commonly, in these methods, experts touch the fabrics with their fingers and then predict the surface roughness by using paired comparisons. The literature indicates that many investigators have studied the surface roughness of textiles by using this technique.

As a case in point, in 1956, Stockbridge *et al* [7] studied the surface roughness of woven and knitted fabrics subjectively. Four groups from low education, with little general alertness and little interest in the experiment till high education, were used. The groups were asked to evaluate surface roughness of fabrics by touching them with their fingers. Afterwards, they used the method of paired comparisons and determined the coefficients of consistency and unanimity among the subjects. The former was related to an individual's judgments, and the latter was related to the agreement within a group. Results showed that there was a significant agreement on the ranking of roughness between groups of subjects. Subjects also had wide variation in their ability to perform the discrimination required.

In 1988, the Multipurpose Fabric Tester was designed by Hearle and Amirbayat [14]. This instrument measures the surface properties (roughness and friction coefficient), drape coefficient, and bending stiffness of fabrics continuously and only with one sample.

In 1992, Ajayi [15] studied smoothness, friction and handle of woven, knitted and nonwoven fabrics surface state with high sensitivity. In fact, the measured parameter is the sensor strain energy, that is, the fabric roughness. A study on human touch revealed that the hand indicates skin strain energy, and so, the surface roughness. Considering the fact that the measured parameter in this apparatus is the sensor strain energy, the researchers claimed that this contact method is comparable with the hand evaluation system. Results showed that the peak height increases with the process intensity and decreases after sanding. This phenomenon is due to modification of fabric roughness.

In 1993, Pourdeyhimi and Sobus studied surface intensity and roughness (variation of surface intensity) in order to quantify changes in appearance of carpet surfaces due to mechanical wear. This research demonstrated the utilization of gray scale image analysis to evaluate the micro texture variation and roughness or relief. Results demonstrated that simple mechanical wear commonly entails a loss of relief and variation, but carpet structure had a significant effect on the observed trends.

In 1995, profilometric surface measuring systems were studied by Seifert *et al*. A contact method and a photic method (based on laser triangulation technique) which were the same in design and only different in sensor technology and a few technical details were used. In order to compare the measuring systems, three needle bonded fabrics were tested and surface profile and the roughness parameters were obtained. Results revealed that both systems had resolutions smaller than 1 μm in the test direction and so they were appropriate for high precision measurement. Due to dependency of the measuring precision to textile characteristics, special calibration of the measuring system for textiles was expected.

In 1997, Bueno *et al* [16] measured the surface roughness and investigated the effects of sanding and raising on the surface state of woven and knitted fabrics, macroscopically. The surface roughness was measured by the multidirectional roughness meter which was devised one year ago. The instrument provides information about the fabric state and the fundamental directions of fabric relief, which depend on the type of weave or knit. In fact, this technique specifies the surface state from a tribological point of view and can be applied for different finishing processes that modify the surface state, such as sanding, raising, calendaring or ironing. Similar to their previous research, the peak heights of the calculated auto spectrum changed with the process intensity and decreased after sanding or raising, due to modification of the fabric profile.

In 1999, Bueno, Durand and Renner studied emerizing and raising effects on woven and knitted fabrics by a non-contact method. In order to do so, an optical multidirectional roughness meter with the signal processing system in the frequency domain was developed which has three main parts: sample carrier, optical part and signal processing system in the frequency domain was developed.

In 2000, Bueno, Durand and Renner measured the surface roughness of fabrics by a non-contact method. The aim of researchers was the development of a non-contact method to investigate the surface state of fabrics. In order to do so, an optical multidirectional roughness meter designed in 1999 was used again but researchers tried to modify it. In the same year (2000), this group optically characterized the surface state of fabrics after sanding and raising processes. The surface roughness was measured by an optical multidirectional roughness meter developed in 2000. However, there is a difference between this device and the one used before. In the new one, the light beam projects to the sample surface and the beam splitter is in a completely parallel way.

In 2002, *Hu, Xin* and *Yan* classified polar fleece fabric appearance after abrasion by extended morphological fractal analysis. In this technique, the digital gray level image is treated as a three dimensional surface. Extended fractal analysis is capable of characterizing fabric textures where the roughness of these textures is not necessarily scale invariant. In other words, this method can be applied to physically describe surface roughness and texture regularity with the parameter mfv (multi scale fractal vector) and to classify the appearance grade with the Bayes classification method.

In 2003, Park *et al* evaluated the surface roughness of woven and knitted fabrics in a non-contact way. A measuring device based on the laser triangulation technique was devised which was composed of a laser displacement sensor with high accuracy and a linear motor. The sensor can measure the distance between itself and a sample surface (therefore the height of the object) with an accuracy of 1 μm.

In 2004, Vassiliadis and Provatidis [11] characterized the structure of woven and knitted fabrics by using surface roughness data obtained by KES. Perusals indicated that the surface roughness properties of fabrics provide knowledge on their structural characteristics. The data obtained from the KES system was signal-processed digitally owing to get the spectral characteristics of the surface roughness measurements. In fact, a novel analytical test was developed to maximize the usage of the data acquired from the KES system. It is claimed that the presented method has a non-destructive diameter and can be applied to woven or knitted fabrics.

In the year 2005, the back-scattering spectrum of textiles was studied experimentally by Moussa *et al* [18]. The influence of different parameters such as the surface roughness was demonstrated experimentally.

In 2005, another investigation was done by Fontaine *et al* [19] to characterize roughness-friction criteria for a tested surface. In order to do so, a patented device was developed which was capable of recognizing fine modifications on the surface state of textiles.

In 2007, Bertaux, Lewandowski, and Derler [8] studied the relationship between friction and tactile properties of woven and knitted fabrics. The friction coefficients of fabrics were measured by KES and textile friction analyzer (TFA). The tactile properties of the samples were appraised by two types of blind subjective sensory assessments. First, touch assessment by thumbs and the second was the prickle test. The former characterized the surface roughness and the latter characterized discomfort in terms of prickle throughout wearing. In addition, the surface roughness was measured by KES. The researcher tried to classify fabrics from the viewpoint of tactile properties and correlate fabric friction and subjectively perceived touch properties. This correlation was found just for knitted fabrics which ascribe to their surface structure. In order to understand whether or not other parameters could have affected the obtained correlation, fabric characteristics including bending, compression, basis weight, fabric thickness and hairiness were studied. They found that the related properties in the correlation between friction and the handle properties of fabrics using principal component analysis were bending, thickness and compressibility. On the other analogue signal conditioning, provides an output signal proportional to the target position.

In 2007, Militky and Mazal presented an image analysis technique to evaluate surface roughness of textiles. Researchers intended to devise a new system for measuring the surface roughness in a non-contact way. The RCM system was developed to measure roughness which uses the special arrangements of textile bend around sharp edges and laser lighting from the top. The result after image processing is so-called "slice" which is the roughness profile in the cross direction at a chosen position in the machine.

In recent times, some researchers have used blind subjective sensory assessments. This means the subjects have to cover their eyes because it is believed that vision can affect the assessment of texture. Moreover, there are some reports which compare subjective assessments to objective ones.

Weft-knitted fabric is made by looping together long lengths of yarn. It can be made by hand or machine. The yarn runs in rows across the fabric. If a stitch is dropped it will ladder down the length of the fabric. The fabric is stretchy and comfortable and is used for socks, T-shirts and jumpers.

1.2 PROBLEM STATEMENT

Because surface roughness plays a significant role in controlling the manufacturing process and improving the fabric quality during end use, it is therefore inevitable to measure it in order to satisfy end use of knitted fabric.

However, the available systems are quite expensive, time consuming like the Kawabata evaluation system, some give output data which is difficult to translate and not accessible to all textile engineers and not accessible to all textile engineers who would need to test for the surface roughness of weft knitted fabric. [10]

This project therefore aims at providing a cheap and yet a portable system for measuring the surface roughness of a weft knitted fabric.

1.3 OBJECTIVES OF THE PROJECT

1.3.1 Main Objective

To design an off-line system that analyzes the surface roughness of weft knitted fabric using Image processing.

1.3.2 Specific Objectives

1 To obtain the fabrics images and their specifications from southern range nyanza limited.

2 To apply various software modules that will be used for image processing and analysis of the weft knitted fabric.

3 To test the technique or software of the system.

1.4 JUSTIFICATION

Surface roughness of the fabric plays a significant role in the end use of the fabric. It is therefore very important for the knitter of weft knitted fabrics to be able to determine the mechanical properties of the fabric. However, these producers usually find it expensive to buy well established systems like the Kawambata evaluation systems. These systems are also too complicated for an average knitter to understand how it's operated.

This project therefore proposes a simple mobile application that will be used take photos of the fabric and ascertain the surface roughness. This mobile application will be cheap and easy to use.

1.5 SIGNIFICANCE

A mobile application is cheap and easy to operate. This means the system for measuring surface roughness will be portable since smart phones, lap tops and any other gadget are portable.

1.6 SCOPE OF STUDY

This project will be limited to collecting of weft knitted fabrics from NYTIL and determine their surface roughness using image processing. Digital image processing will be done using android operating system and MATLAB framework.

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