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A FUNDAMENTAL STUDY ON FABRIC FAULT DETECTION USING DIGITAL IMAGE PROCESSING

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Abstract

The main purpose of this paper is to identify the damaged cloth which may contain defective yarns, colour bleeding, and pores that may be mingled with the good cloth materials at areas such as textile fabric industries, garments, and weaving factories. Automated defect detection for fabrics based on filters is proposed to manage the problem of human visual inspection. The monitoring process is done by a web camera, to capture the details of the cloth. A pre-trained Gabor wavelet network is used to extract the important texture features in the textile fabric. In this defect detection, few specific filters are used to process each frames of the cloth which is being captured by the web camera.

Introduction

At present, the textile fabric quality inspection process is mainly carried out manually whose reliability is limited by human errors. It is found that only about 70% of fabric defects could be detected [2], by the most highly trained inspectors. Added to the limitation in the quality is the increased cost for man power and time taken for inspection. Therefore, an automated system for the inspection and evaluation of quality of the fabrics is desired. Plenty of approaches were already proposed to address this problem. These approaches can be categorized into three classes: statistical, spectral and model based. Considering the drawbacks of these various approaches, a new scheme is to be proposed with a reduced implementation cost. The process of developing a real time automated visual fabric inspection system in general consists of three steps, namely, image acquisition, image processing, and image analysis

On the other hand, success in any industry/organization is a combination of strong processing techniques or we can say that better processing of their raw data. To manage quality in Textile plants with new trends and technology is a new concept. Every industry is dependent on some sort of digital systems to operate their data. Nowadays, every single organization has one goal- Increase productivity for better profitability. However, this doesn't only depend on sales we acquire but also on the quality in less time we provide. Introducing various Data processing tool and Techniques can surely help these industries to produce extensive production with quality

PROPOSED WORK

Automated Fabric Inspection A fabric defect is any abnormality in the fabric that hinders its acceptability by the consumer. The textile processing does not eliminate variability incurred during different steps in textile manufacturing.

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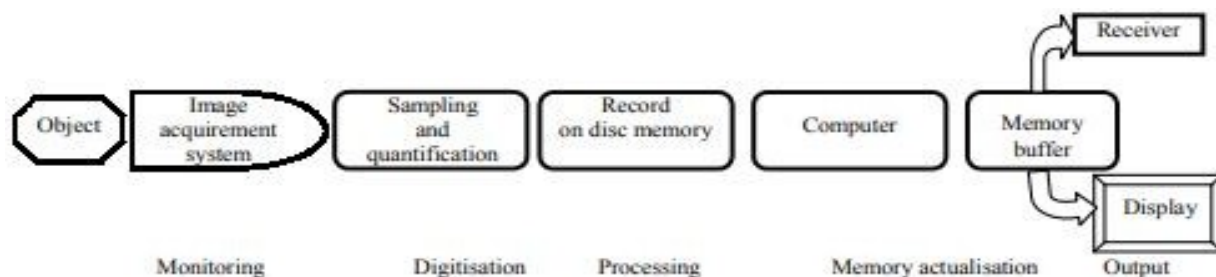
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As materials flow from one stage of processing to another, components of variability are added and the final product may involve a cumulative variability that is much higher than the variability of the input fibers and thus it cause a defect in the fabric. The main factors that lead to fabric defects are failure of opening and cleaning the machines that completely eliminate contaminants and trash particles, and it may leads to spinning, weaving and knitting related defects. So the fabric inspection has to identify all types of defects with minimum effort. The wavelet transform provides a solid and unified mathematical framework for the analysis and characterization of an image at different scales. It provides both time and frequency information, and can be successfully applied for textile defect detection. Fabric defect detection based on wavelet transform performs better with less computation than the traditional statistical texture analysis approaches in identifying defects. Fault detection positioning and classification of the faults occur in the weaving machine during weaving by using the principle of image processing, an automatic fabric evaluation system, which enables computerized defect detection – analysis of weaved fabrics. Wastage reduction through accurate and early stage detection of defects in fabrics is an important aspect of quality improvement. Automatic inspection systems are designed for increasing the precision, stability and speed with respect to Human Inspection Systems. Beside this, these automatic inspection systems provide high defect detection rates. Moreover, these systems also reduce labour costs, improve product quality and increase manufacturing efficiency consists the flow chart of an automated inspection system.

1. Image Acquisition A line scan camera uses linear array photo sensors systems, so linear array photo sensors systems provides a higher resolution and can inspect a larger portion of an inspected product. The system has to be used to synchronize the camera scan rate with the transport velocity of the product.



2. Pre-processing Pre-processing part is used to obtain useful information from captured fabric images by feature extraction techniques. Although fabric images are captured in high resolution, the images also include noises and other distortion.

Feature Extraction The aim of feature extraction is to obtain useful information from an image.

Fig -1: Automated fabric inspection system

In the case of fabric defect detection, defected and non-defected texture are characterized and analysed. Features are very importance to most fabric defect detection systems because they possess a close relationship to the detection accuracy of the fabric defect detection method.

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1) Detection /Classification: This part actually works like the fabric defect detector. In detection and classification section feature vectors are used to determine and classify the patterns to classes. In the detection of fabrics, since there are two classes considered: the normal fabric and the fabric defects.

2) Post-processing Fabric defect identification is complete in detecting and classification process. The faults may lead to give incorrect decisions that cause disposal of more fabric and extra cost may occur on the manufacturing process to reduce the risk, a post-processor is needed after the detection phase. The fabric defect could be simply defined as an abnormality in or on the fabric construction. The term construction here refers to both of yarn spacing (fabric density *i.e.* number of threads per unit length in both of warp and weft directions) and yarn interlacing (fabric structure). When there is any undesired abnormality inside the fabric construction during the manufacturing process, it results in a mechanical defect. As the woven fabric is a finished product of many accumulated manufacturing processes starting from the fibre, it can show various kinds of defects ascribed to the processes which follow one another till the realization of the fabric. Therefore, the source of the fabric defect has a vital importance to differentiate between and/or explain these defects.

Defects in Fibre

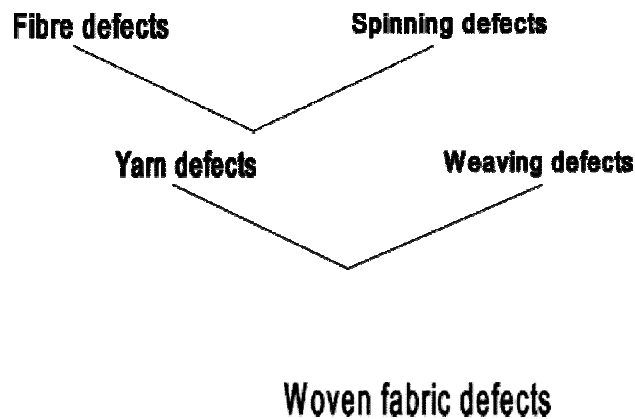


Figure 2: Flow chart of woven fabric defects based on its source

Figure 2 illustrates a flow chart of woven fabric defects based on their source. From this figure, it is understood that, the defective product found after each manufacturing process is the total sum of raw material defects and the defects attributed to the process itself.

Types and Reasons

As it is called woven, should any defect assigned to the weaving operation represent the first reason of woven fabric defects. Therefore, most defects in fabric occur while it is woven on

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the loom. Some of these fabric defects are visible, while others are not. However, some fabric defects may be rectified during weaving and after weaving while others are not. The following tables summarize the most common fabric defects, their reasons and degree of severity as well. The tables are constructed on the base of defect direction or the area where the defects are extended.

According to the mentioned base, the most common fabric defects are presented in the following three tables where tables (1), (2) and (3) present the most common fabric defects appearing in more or less extended areas, warp and weft directions. In addition, figures (3), (4), (5) and (6) illustrate the defects of each table respectively.

Table (1): The most common defects appear in more or less extended areas

Defect type	Definition	Reasons	Severity
Floats	A portion of a yarn in a fabric that extends or floats, unbound, over two or more adjacent ends or picks	It is caused by missing of interlacement of two series of threads	Major fabric defect
Weft curling	A twisted weft thread appears on the surface of the fabric	It is caused by inserting a highly twisted weft thread or when the weft thread is running too freely	Minor fabric defect
Slubs	A local uneven fabric thickness	It is caused by an extra piece of yarn that is woven into fabric. It can also be caused by thick places in the yarn or by fly waste being spun in yarn during the spinning process	Minor/Major fabric defect
Holes	fabric area free of both of warp and weft threads	a mechanical fault caused by a broken machine part	Major fabric defect
Oil stains	A fabric area contains oil spots	It is caused by too much oiling on loom parts or from other external sources	Minor/Major fabric defect
Stitching	A common fabric fault in which the ends and the picks are not interlaced according to the correct	As the main purpose of the loom is to interlace two sets of threads according to the correct order of the pattern, This defect	Major fabric defect

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	order of the pattern	is a result of any undesired motion of the main or auxiliary loom mechanisms such as: shedding, picking.... etc.	
Rust stains / Dirt	A fabric dirty area or when it contains stains	Stains are caused by lubricants and rust. Most of the stains can be traced back to poor maintenance and material handling	nor/Major fabric defect

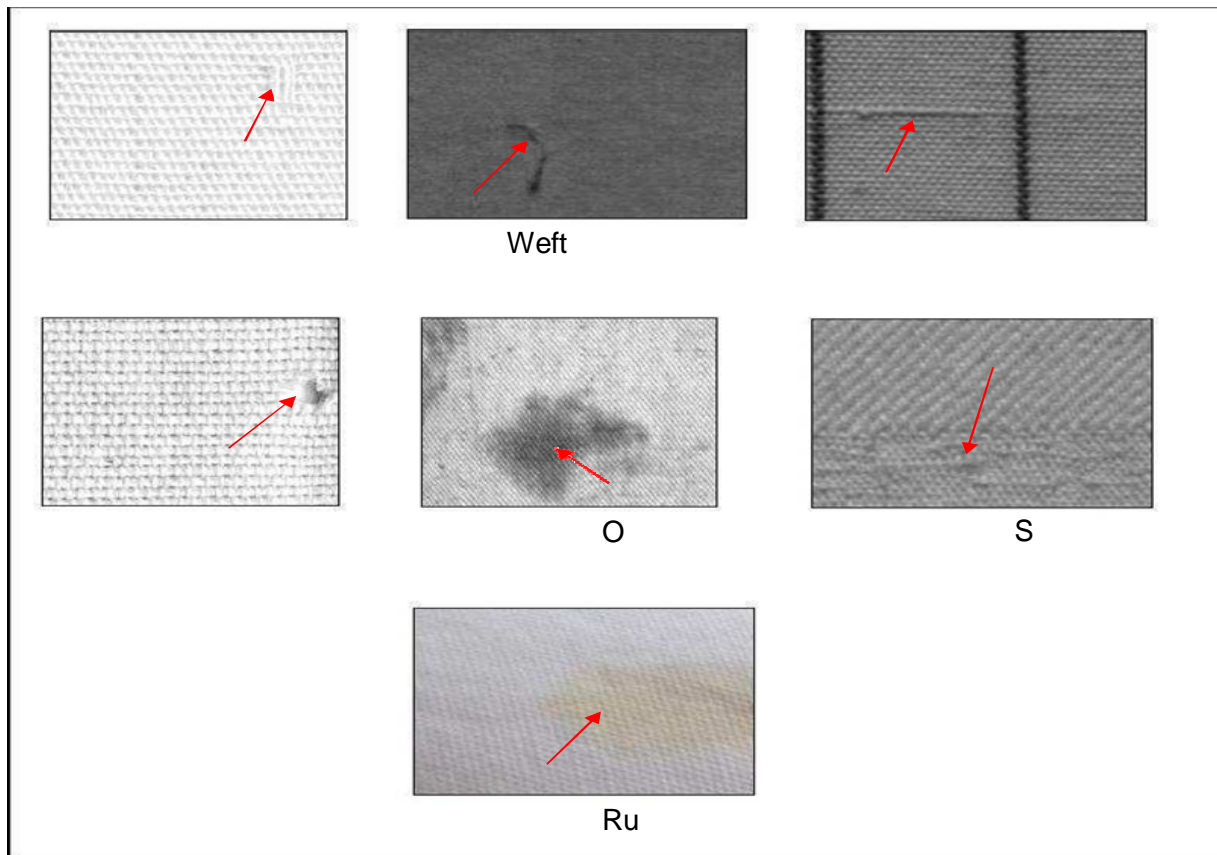


Figure 3: The defects of the first part of table (1)

Table (2): The most common defects appear in more or less extended areas

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Knots	A fabric place where two ends of yarn have been tied together and the tails of the knot are protruding from the surface	caused by tying spools of yarn ends together	Minor fabric defect
Smile marks / Pin holes	Marks or holes along fabric selvage	It is caused by the temples or pins which hold the fabric while it processes through tenter frame	Minor fabric defect
Snag	read segment or group of fibres pulled from its normal pattern	It is created due to the friction between the fabric and sharp or rough objects	Minor fabric defect
Tear	Damaged fabric portions differ from holes in that it has a random un even shape	It is created due to the friction between the fabric and sharp or rough objects	Major fabric defect
Gouts	A local uneven fabric thickness differs from slubs in that they are characterized by a lumpy appearance while slubs generally are symmetrical	It is caused by masses of accumulated short fibre (fly) being drawn undrafted into the filling yarn during the spinning process	Major fabric defect
Weft snarls	A short length of three fold weft yarn of which two folds are inter-twisted	It is caused due to insufficient twist setting which increasing the possibility of yarn severe rubbing between the shuttle and the box front plate	Minor fabric defect
Moiré	presence of wavy areas in a periodical sequence, where crushed and the uncrushed threads reflect light differently that affects the fabric appearance	It is caused due to a different compression of weft and/or of warp threads	Major fabric defect

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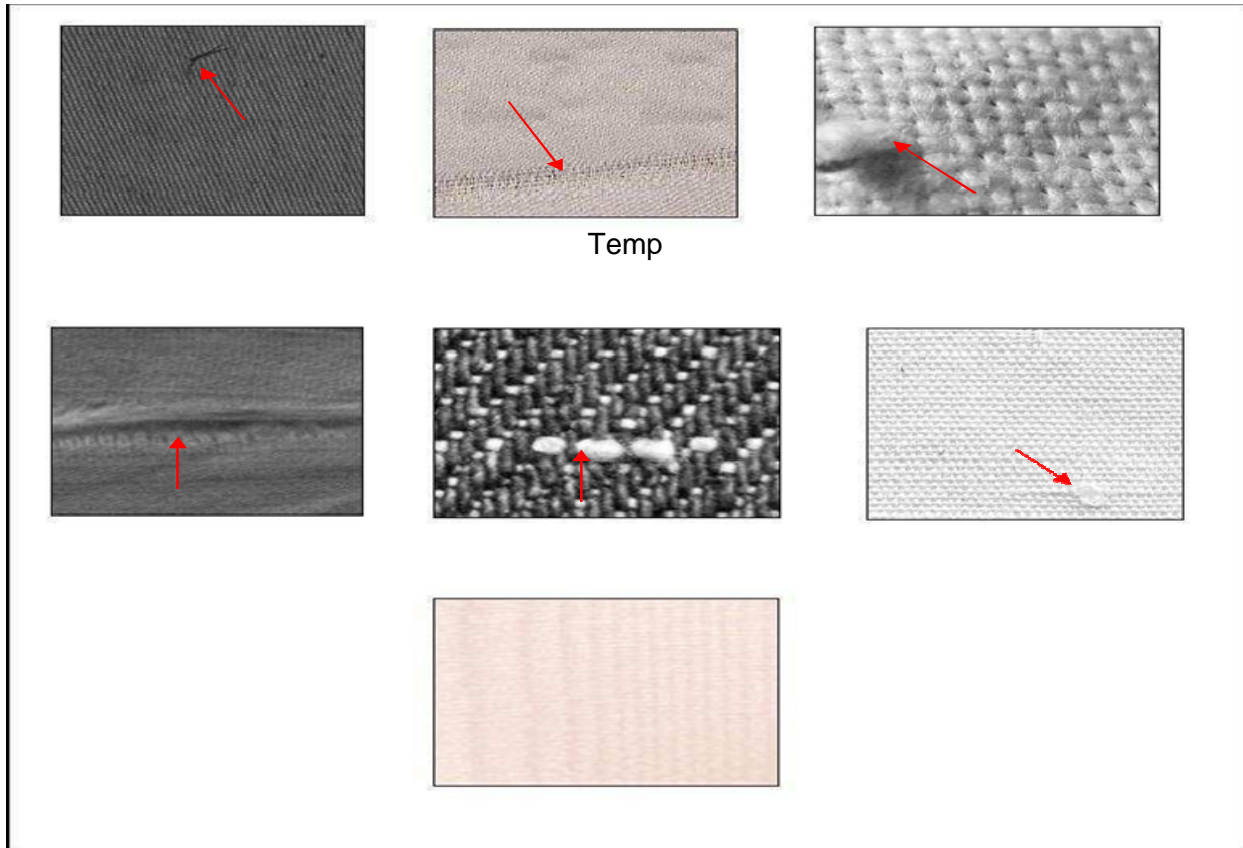


Figure 4: The defects of the second part of table (2)

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Table (3): The most common fabric defects appear in warp direction

Defect type	Definition	Reasons	Severity
Miss-end	Warp thread is absent in the fabric for a short or long distance	It is due to incorrect warping or by a broken warp thread that never replaced by another one	Major fabric defect
Warp stripes	One or more faulty threads giving rise to zones of different aspect	It is caused by scraping or rubbing between warp threads and some parts of production machines or due to In accurate reeding	Major fabric defect
Light/Slack warp thread	A warp thread or pieces of warp thread which are tighter or slacker than the other pieces/threads	It is caused due to the incorrect tension applied on warp threads	Major fabric defect
Double- ends	Two ends threaded in the same place of one	It is caused by incorrect warping or by a broken end wound on another and takes the behaviour of one thread	Major fabric defect
Coarse-end	A warp thread or pieces of warp thread which are coarser than the other pieces/threads	It is caused due to the presence of a warp thread that has different count (coarser thread) than the other warp threads	Major fabric defect
Smash	Any ends or warp threads are consequently broken	It is caused by a wrong timing of shedding, soft picking, insufficient checking of shuttle in the boxes, severe slough off, and damaged or broken Picking accessories	Major fabric defect
Open reed	It is conspicuous on fabrics that use different colored threads on warp and weft where, the warp threads is held apart, exposing the filling ones	It is caused due to the bent reed wires leaving a crack in the fabric	Major fabric defect

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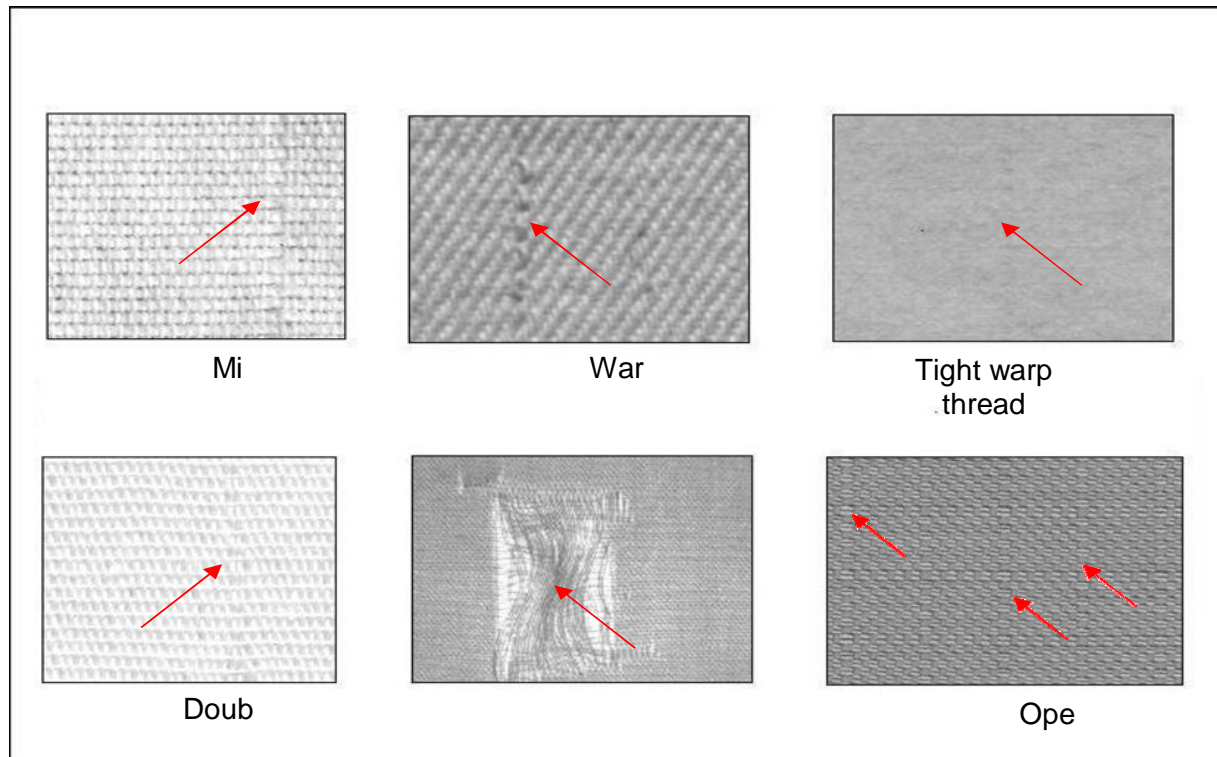


Figure 5: Some defects of table (3) Table (4): The most common fabric defects appear in weft direction

Defect type	Definition	Reasons	Severity
Miss-pick	A weft thread is absent in the fabric for a short or long distance	It is caused by incorrect picking or if the weaver restarted the loom after any stoppage without adapting the position for the new insertion	Minor/Major fabric defect
Irregular pick density	A jammed or opened area formed in the fabric due to uneven pick density (number of picks per inch)	It is a mechanical fault caused by an irregular beating up force	Major fabric defect
Double-picks	Two weft threads take the same place of one thread	It is caused by incorrect picking	Major fabric defect
Coarse-pick	A weft thread or pieces of weft thread which are coarser than the other pieces/threads	It is caused due to the presence of a weft thread that has different count (coarser thread) than the other weft threads	Major fabric defect
Starting mark (Weft bars)	A visual light/dark effect in weft direction	It is caused by a higher or lower weft density caused by the weaving machine	Major fabric defect

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ht/Slack weft thread	A weft thread or pieces of weft thread which are tighter or slacker than the other pieces/threads	It is caused due to the incorrect tension applied on weft threads	Major fabric defect
Skew / Bias	When the weft threads are not square or perpendicular with warp threads	It is caused due to the variation of the beating up force value after the insertion of weft threads	Minor fabric defect

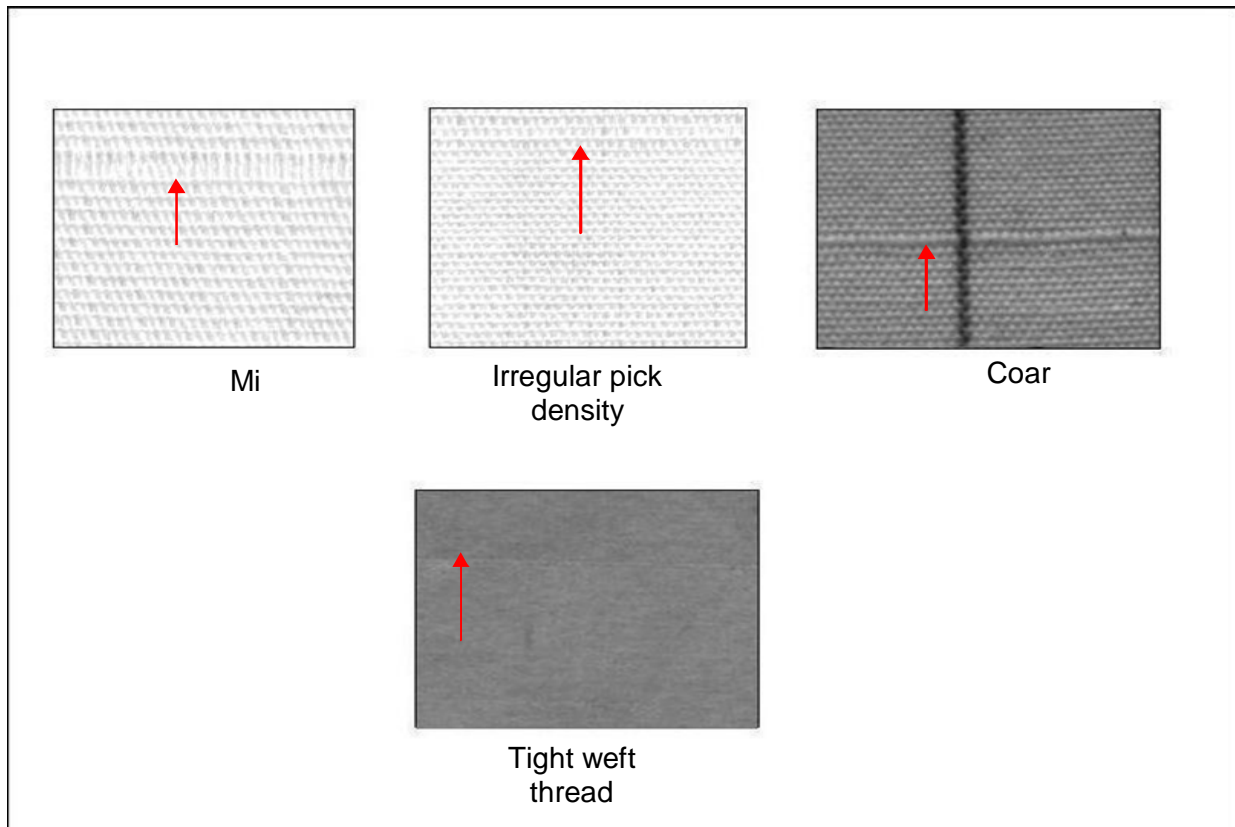


Figure 6: Some defects of table (4)

Because of the wide variety of defects as mentioned previously, it is too difficult to study all defect types, therefore, it is gainful to detect firstly the most famous fabric defects and then apply the procedure to detect all possible fabric defects. The chosen famous defects are: hole, oil stain, float, coarse-end, coarse-pick, double-end, double-pick, irregular weft density, miss-end, and miss-pick. These defects represent all possibilities regarding the

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expected defect type, size, direction *i.e.* warp direction, weft direction and/or both (as an area). In the same time, the defects are randomly distributed through all fabric images whereas the defects exist in the top, bottom, right or left side of the image.

Conclusion

Image processing in the Textile world has several advantages as compared to other technologies. It serves many processing methods to the initial image in order to get the best and accurate quality image. One more fact of image processing is images are in 2 dimensions even more but digital images are shown in multidimensional structures.

One of the greatest advantages of image processing in textile control is- the capacity of the administrator to post-process the picture. Post-preparing of the picture enables the administrator to control the pixel shades to revise picture thickness and complexity, and in addition, perform other handling techniques that could result in enhanced conclusion and less rehashed versions.

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