Defect detection of jute fabric using image processing

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ABSTRACT

Fabric inspection is important for maintaining the quality of jute fabric. Traditional inspection process for jute fabric defects is human visual inspection which is insufficient and costly. The quality of inspection process for jute fabrics is mainly performed manually. Mostly defects could be detected by the most highly trained inspectors. Manual defect detection is labour intensive, cumbersome, prone to errors and expensive. At present, the fabric defect detection in the jute industry is performed manually. In jute industry improved performance in the inspection of fabrics leads to good product quality and contributes to increased profitability and customer satisfaction. Hence the automatic fabric defect inspection is required to reduce the cost and time waste caused by defects. Automated defect detection is less labour intensive, more accurate, efficient and less costly. The detection of defects of moving jute fabric on inspection table can be identified using Image processing techniques. These image processing techniques are applied and for the input image of a defective fabric frame by frame, conversion into grey scale image, noise filtering, binary image conversion, thresholding are applied on each image of video and the output is obtained in real time. In real time, output will be display the marks on defect area, defect percentage and defect concentration graph of capture length of fabric on inspection table.

Keywords: Fabric inspection table, image processing fabric defect, machine vision, real time, image noise filtering, thresholding and defect percentage

Fabric defect detection is an important part of quality control in the jute industry. Nowadays in the jute industry are still used a human naked eyes to detect any kinds of defect on jute webs. The problems occurred when a human has their own limitations on different kind of perceptions in identifying a defect. Various techniques based on image processing are presented for the automatic quality control of jutes. In manual inspection, stress and fatigue happens to the worker due to inspection in case of higher and quicker productivity. However, the method has been both time consuming and has lower accuracy of detection. Detection of defect on finished fabrics and their classification based on their appearance plays a vital role in inspection of both hand-woven and machine woven fabrics. Generally the defect detection process is carried out by making use of the manual effort, during which some of fabric defects are

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very small and undistinguishable and can be identified only by monitoring the variation in the intensity falling on the fabric. Till date, most of the fabric industries in India carry out the process of defect detection by making use of a very skilled labour. An automated system that could detect defects and identify them based on their physical appearance would naturally enhance the product quality and result in improved productivity to meet both customer demands and reduce the costs associated with off-quality. Defect detection or inspection is a process identifying and locating defects. A fabric defect is a result of the manufacturing process. The jute industry is very concerned with quality. It is desirable to produce the highest quality goods in the shortest period of time possible. Quality inspection is an important aspect of industrial manufacturing. In jute industry, fabric defect detection plays an important role in the quality control. The quality of the fabric can be improved by decreasing defects in the fabrics. Generally, as any product in the market claims its quality, fabrics too have their own quality. The better the quality; on the customer perspective, the producer can expect more sales and on proprietor perspective, can fix a higher price. The manufacturer would always prefer to produce the highest quality goods within the shortest span of time. Till date, the process of identification, classification and correction of defects produced in a fabric; be it a handlooms or machine weaved, is done manually. Humans are prone to errors; and more over the process involves a huge amount of caution during the process. A statistic proves that even the highest fabric inspector is capable of identifying only up-to 30% of defects, whereas 70% remains unidentified, till it reaches the end-user. All these factors lead to a growing need for an automated fabric defect detection system which is the main objective.

Fabric Defects

Fabric texture refers to the feel of the fabric. It is rough, velvety, smooth, soft, silky, lustrous, etc. The different textures of the fabric depend upon the types of weaves used. Textures are given to all types of fabrics like Jute, cotton, silk, wool, leather, and also to linen. Jute fabric materials are used to prepare different categories and types of fabric products in the jute industry. In a fabric, defects can occur due to:

- ❖ Machine faults
- ❖ Color bleeding.
- ❖ Yarn problems
- ❖ Excessive stretching
- ❖ Hole
- ❖ Dirt spot
- ❖ Scratch
- ❖ Poor finishing
- ❖ Crack point
- ❖ Material defects (colors & cleanliness defect)
- ❖ Processing defects (constructions & colors defects)

Various techniques based on image processing are presented for the automatic quality control of jutes. General defects (shrinking, abrasion, etc.) are detected by using operations in the frequency domain. Local defects (broken threads, mispicks, double yarns, etc.) are detected using machine vision that imitates the visual coding in early human vision.

Different type of jute febric defects:

- ❖ Dye mark/Dye Spot
- ❖ Slack warp, faulty pattern card
- ❖ Holes
- ❖ Spirality (Over twisted yarn)
- ❖ Grease oil / dirty stains
- ❖ Mispick (Incorrect weft insertion)
- ❖ Slub (thickness of yarn)
- ❖ Bar (Variation in weft yarn)
- ❖ Wrong end (lack of control of warp tension)
- ❖ Slack end (insufficient warp tension)
- ❖ Slough-off weft (Weft yarn slips from pirn)

Manual Defect Detection

Inspection is the process of determining whether a product has deviated from a given set of specifications. In the jute industry, inspection is needed to assure the fabric quality before any shipments are sent to customers, because defects in fabrics can reduce the price of a product by 45% to 65%. Currently, the quality assurance of web processing is mainly carried out by manual inspection. However the manual inspection is subjected to 30% failure due to fatigue and inattentiveness. Indeed, only about 70% of defects can be detected by the most highly trained inspectors. In order to reduce the labor cost involved in the process of defect detection using automated fabric defect detection is more than economical along with the associated benefits. Efficient and robust defect detection algorithms on fabric textures are required to cater the needs of a fully automated fabric inspection system. A large number of fabric defects which are characterized by their vagueness and ambiguity and identifying them on a fabric is highly challenging. A number of algorithms have been developed to detect fabric defects.

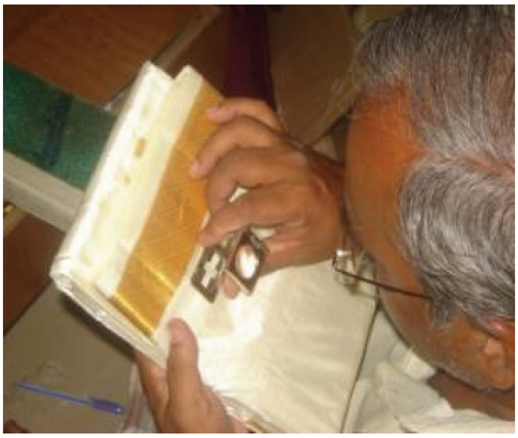


Fig. 1: Traditional Defect Detection mechanism

Fig. 2: Modern manual fabric inspection table.

Image Processing

Steps in image processing:

Image acquisition → Pre-processing → Feature extraction → Detection/segmentation → High-level processing → Decision making

Image acquisition — A digital image is produced by one or several image sensors, which, besides various types of light-sensitive cameras, include range sensors, tomography devices, radar, ultra-sonic cameras, etc.

Pre-processing — Before a computer vision method can be applied to image data in order to extract some specific piece of information, it is usually necessary to process the data in order to assure that it satisfies certain assumptions implied by the method. Examples are

- ❖ Re-sampling in order to assure that the image coordinate system is correct.
- ❖ Noise reduction in order to assure that sensor noise does not introduce false information.
- ❖ Contrast enhancement to assure that relevant information can be detected.
- ❖ Scale-space representation to enhance image structures at locally appropriate scales.

Feature extraction — Image features at various levels of complexity are extracted from the image data. Typical examples of such features are

- ❖ Lines, edges and ridges.
- ❖ Localized interest points such as corners, blobs or points.
- ❖ More complex features may be related to texture, shape or motion.

Detection/segmentation — At some point in the processing a decision is made about which image points or regions of the image are relevant for further processing. Examples are

- ❖ Selection of a specific set of interest points
- ❖ Segmentation of one or multiple image regions which contain a specific object of interest.

High-level processing — At this step the input is typically a small set of data, for example a set of points or an image region which is assumed to contain a specific object. The remaining processing deals with, for example:

- ❖ Verification that the data satisfy model-based and application specific assumptions.
- ❖ Estimation of application specific parameters, such as object pose or object size.
- ❖ Image recognition — classifying a detected object into different categories.
- ❖ Image registration — comparing and combining two different views of the same object.

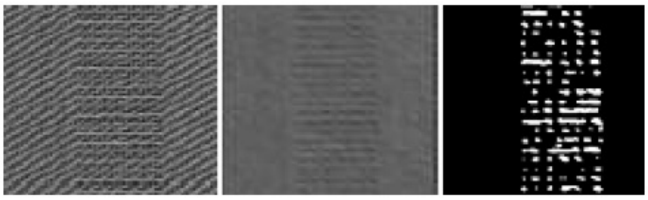
Decision making the final decision required for the application:

- ❖ Display the marks on defects area
- ❖ Calculate the total area of defects
- ❖ Defect intensity graph, defect point graph and defect percentage.

Limitations: Accurate identification of fabric defects was dependent on light source conditions.

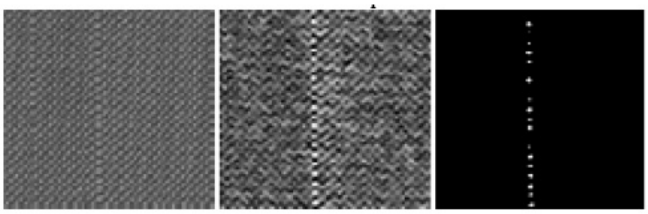
Image processing of different type of defective jute fabric

1. Harness breakdown



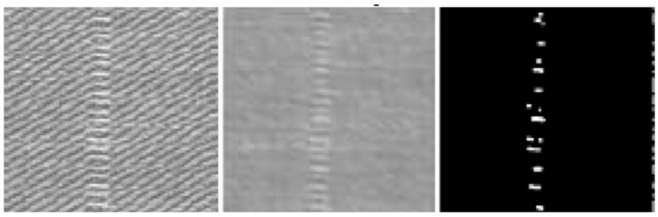
2. Warp blur

3. Mispick

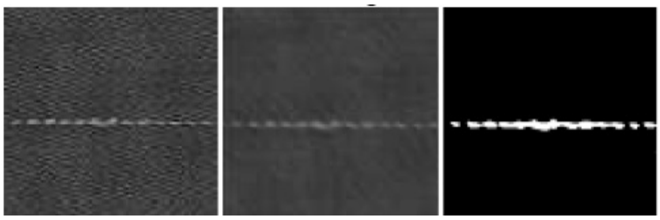


4. Warp float

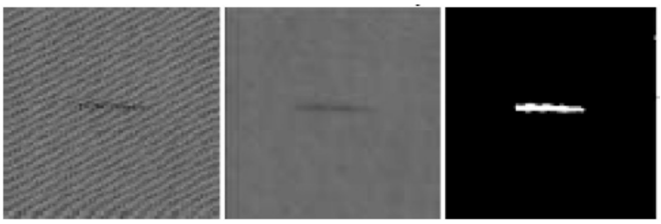
5. Mispick



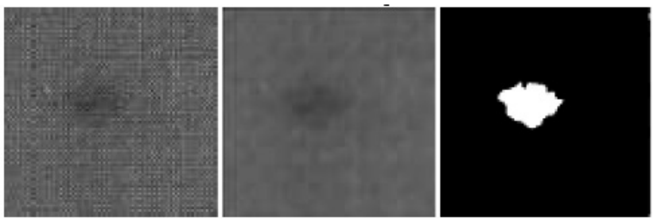
6. Foreign fiber



7. Color fly



8. Oil spot



9. Water damage

10. Knot

Fig. 3: Fabric image on different stage of image processing.

Methodology

This paper has discussed various aspects of fabric defects that can be identified using machine vision algorithms. These authors developed a machine vision algorithm for identifying various defects that occurs in jute fabric. The developed algorithm was in turn used to finding defects in real time jute fabrics and found to be efficient for detecting various defects present in the fabric. The following operations are carried out during image quality improvement:

1. Image Acquisition
2. RGB to Gray Color Conversion
3. Image Enhancement (Thresholding)
4. Defect Identification

Jute/fabric surface image is acquired by using the camera from top of the surface from a distance adjusted so as to get the best possible view of the surface. Below figures show the quality of the acquired fabric images. The jute images under test are of size 256×256 (64KB). For proper imaging, uniform lighting system is to be maintained to avoid any illusive defect by virtue of light reflection properties falling on surface. Originally, the images are acquired at RGB color scale. The images then are converted to gray scale.

Histogram equalization method is adopted to enhance the contrast of the fabric surface. Histogram Equalization algorithm works good in this case as the fabric texture. Below figures show the result after Histogram equalization algorithm for thresholding. Even good quality cameras are used with an adequate artificial illumination it is necessary to pre-process those images before applying image-processing methods. The different pre-processing techniques like contrast adjustment, intensity adjustment, histogram equalization, binarization and morphological operation is applied. In case of jute/fabric analysis using machine vision system, we are primarily concerned about the defect identification and which may be on account of uneven weaving from the normal weaving pattern or color difference (fading) or any other defect. Once the defect is identified, corrective action could be initiated. But, main emphasis is on getting alert as soon as the defect is identified.

We are taking an image of faulty fabric as an input to identify the fault in fabric. Then convert it to gray scale image. After converting it into gray scale image we filter it with the help of best suitable filter. This filtered image would be converted into binary image. And then histogram would be obtained to the faulty fabric image. At the last stage we obtain a grey threshold image as an output. Input of the Faulty Fabric Image: This phase is the initial phase of the system. Here the image is given as the input that is mainly taken by the various input cameras such as camera, CMOS (Complementary Metal Oxide Semiconductor) camera, or any basic Digital camera, etc. The acquired image must be converted into gray scale to eliminate the hue and saturation information while retaining the luminance. In this phase the color image that is given as the input is converted into the gray image. A grayscale image is an image in which the value of each pixel is a single sample, that is, it carries only intensity information. Images of this sort, also known as black-and-white, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest. In this phase the image that is given as the input is converted to the gray image. Digital images consist of many types of noise. Noise is the result of errors in the image acquisition process. This phase basically deals with the removal of external noise and disturbances in the image that is given. Image thresholding is a simple, effective, way of partitioning an image into a foreground and background. This image analysis technique is a type of image segmentation that isolates objects by converting grayscale images into binary images. Image thresholding is most effective in images with high levels of contrast.

Experiment and Results

Fabric inspection table

The fabric inspection table has been developed for online inspection of fabric using camera for defect analysis. The fabric passes through semi-transparent platform which can be adjusted by lower and upper light for uniform and clear visibility of fabric. It contains cloth roller, take off roller and other rollers for smooth and tight movement of fabric on platform. This roller movement is operated by motor which can be controlled by backward- forward switch, start-stop switch and speed control knob. It has sensor for display fabric length and fabric speed on platform. It has reset button to start counting the length of fabric. The panel box also contains upper light, lower light and both light switch buttons. It has horizontal camera stand which can move up and down vertically by adjustment wheel. Camera has been mounted on the camera stand above inspection table. Camera has been integrated to the inspection software using USB cable and capturing data online of moving fabric image. All camera adjustments like focus, brightness, contrast, etc. has been controlled from inspection software. Preparation of jute defective fabric and its capture of images on inspection platform using inspection software have been completed. Inspection software measures and analyses the fabric defects and expressed as no. of defects, defect map, point & intensity of defect graph at different position of fabric, % of defect, length captured, etc. The inspection table has been fabricated with following devices:

- ❖ Continuous and inching motion
- ❖ Forward and backward motion
- ❖ Speed changing devices
- ❖ Maximum possible width 46 inches.
- ❖ Top cover to eliminate overhead light interference
- ❖ Camera holding bracket with adjustable height
- ❖ Speed counter
- ❖ Continuous and inching motion
- ❖ Forward and backward motion
- ❖ Speed changing devices
- ❖ Maximum possible width 46 inches.
- ❖ Top cover to eliminate overhead light interference
- ❖ Camera holding bracket with adjustable height
- ❖ Speed counter
- ❖ Fabric length counter

Fig. 4: Inspection table

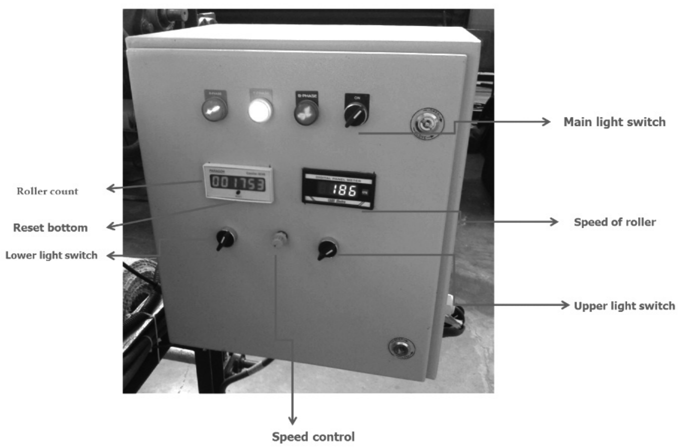


Fig. 5: Control panel of inspection table

Fig. 6: Jute Fabric image capture on inspection table

Fabric Inspection software

After completion of inspection table, software development work has been started. For development of standard software, different type of fabric video has been captured at different speed of fabric and different heights. Initial Image processing has been done on single image. Segmentation of all defect areas from whole image has been done in single image using image processing technique. Then calculate the total image area, total all defective areas and calculate the percentage of defective area. Indication mark has been display in all defective area at each centroid of defect area for clear view of fabric defects. There are two type of indication red and blue indicator. Red indicator show thick area and blue indicator show thin area of fabric. Image processing has been done in all frame of video for real time defect detect and calculate defect percentage. This software has display the real time image of fabric on inspection table. This software has start and stop button for capture the video and analysis. Before starting the capture the video, minimum defect size adjustment to be needed using scroll bar. On the basis of minimum defect size adjustment, software has been ignored the small defect size. After press the start button, software has been start the detect defect and calculate defect % of moving fabric on inspection table in real time. After press the stop button, captured length of fabric has been calculate on the basis of roller count which display on panel box. After press the graph button, software has been display defect concentration graph and defect point graph at the various lengths of fabric. Various trials have been done on different GSM fabric and different speed. Normal computer has been computing the defect detect and defect percentage on speed of fabric movement about four meters per minute.

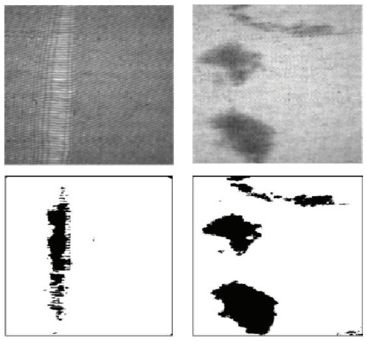


Fig. 7: Defect area segmentation using image processing

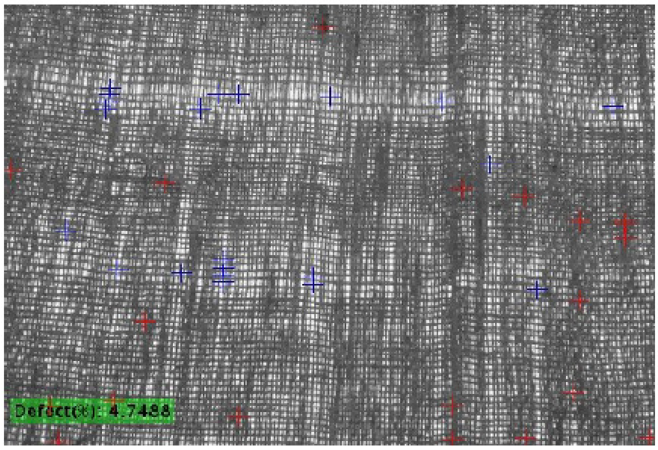


Fig. 8: Real time defect detect and total defect in percentage

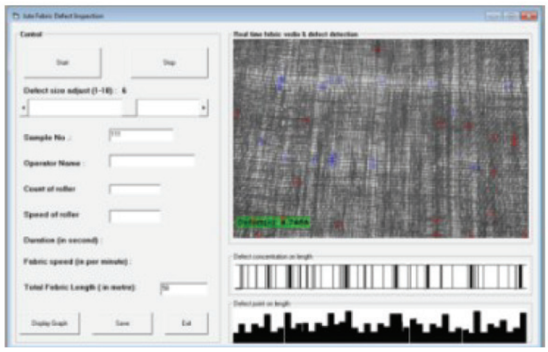


Fig. 9: Software for real time defect detect, defect % and display graph of moving fabric on inspection table

Conclusion

Jute febric industry need, automatic real time quality control in order to avoid end products defects in a quick and efficient manner. Manual control is inefficient; time consuming that leads to heavy material loss. On other hand automatic quality control is much more efficient, because it is real time and independent from manual efficiency. The detection of faulty fabrics plays an important role in the success of any company. Till now most of the inspection is done using human visual. This way is too much time consuming, cumbersome and prone to human errors. In past, many advances are made in developing automated and computerized systems to reduce cost and time whereas, increasing the efficiency of the process. Automatic inspection systems are designed to increase the accuracy, consistency and speed of the detection of defects in the manufacturing process of fabrics in order to reduce labour costs, improve product quality and increase manufacturing efficiency. It is easy to identify faults on fabric images and process by using this method. The manual jute quality control usually goes over the human eye inspection. Notoriously, human visual inspection is tedious, tiring and fatiguing task, involving observation, attention and experience to detect correctly the fault occurrence. The accuracy of human visual inspection declines with dull jobs and endless routines. Sometimes slow, expensive and erratic inspection is the result. Therefore, the automatic visual inspection protects both: the man and the quality. Here, it has been demonstrated that this system is capable of detecting fabrics' defects with more accuracy and efficiency.

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