Textile Quality Analysis

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1. Introduction

Quality inspection in the textile industry is a laborious task performed manually by quality inspectors using a needle and a pick glass. Obtaining the thread density of the fabric is a time-consuming process even for seasoned inspectors and is prone to human error. To solve this problem, we aim to devise a robust CV based pipeline to automate this process and instantly infer the thread density and other quality metrics. The proposed solution will be deployed as a mobile app for widespread use in the textile industry.

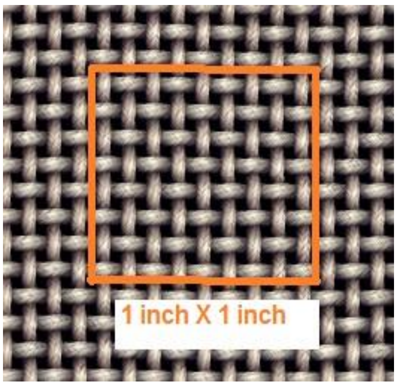
The value proposition of our solution is the automation of the fabric quality inspection task. Determining the thread density of the fabric is repetitive and laborious, and is time-consuming and prone to human error. Our solution seeks to instantly infer the quality metrics of the fabric directly from a smartphone camera. Thus, we provide a quick, accurate, and scalable solution to fabric quality inspection.

Based on our literature research, there is no existing solution which requires only the use of a smartphone camera to infer the thread count of a fabric.

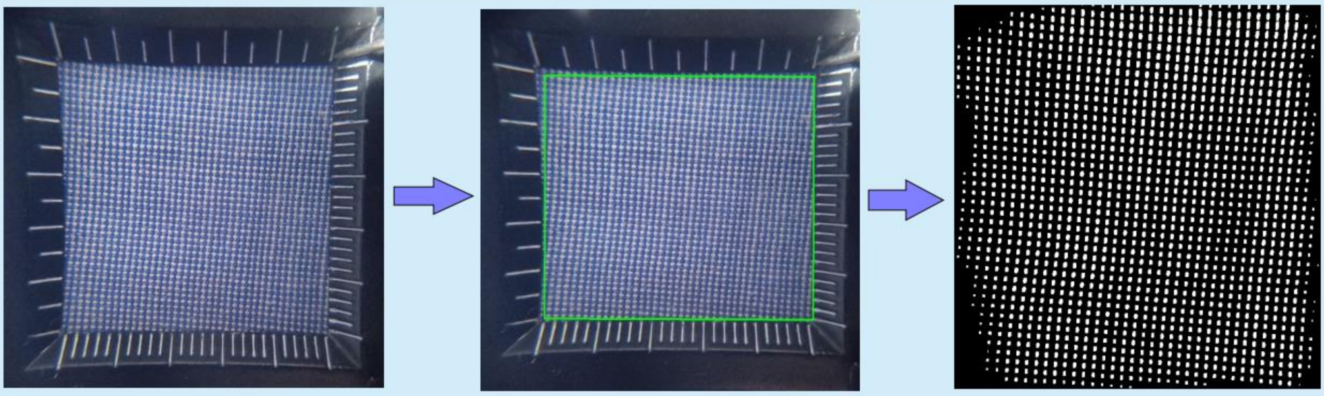
2. Task Overview

Warp and weft are the two basic components used in weaving to turn thread or yarn into fabric. The lengthwise or longitudinal warp yarns are held stationary in tension on a frame or loom while the transverse weft is drawn through and inserted over-and-under the warp.

A pick glass is a magnifying glass for comparing and counting yarns in fabrics. It is widely used in the textile industry with a magnification of 10X.



Fabric image under pick glass as input to our solution



Step 1:Input the fabric image under pick glass using a camera.

Step 2:Segment the fabric from the pick glass.

Step3: Obtain quality metrics from the processed map of the image.

Our solution divides the problem into three computer vision tasks, (1) Segmentation, (2) Pre-processing, and (3) Feature recognition. First, we segment the fabric from the input pick glass image. Next, we perform pre-processing on the image to account for the varied textures and lighting conditions. And finally, the feature recognition algorithm converts the image to a binary map from which the thread density and other metrics can be easily determined. All of these algorithms are carried out locally on the smartphone through an App.

3. Methodology

A. Image Segmentation

In this task, we separate and segment the fabric from the pick glass image. The following approaches were tested:

- Canny Edge Detector:
  We tried thresholding the image to obtain borders of the cloth material required and from this, get the contours to segment the image. But due to shadows and reflections, this caused improper outputs. To account for this adaptive thresholding was used which averaged out these lighting issues. From here to get the border canny edge detector was used but due to high noise, the output was not as desired. The cloth material has a lot of edges in itself causing a lot of noise along with edges in the frame.

- Hough Line Transform:

  This method was an attempt to get the four straight lines constituting the frame of the pick glass. But due to the irregularity of the output of canny edge detector the lines obtained could not be separated.

- Gabor Transform:

  As the cloth material and the frame has different texture, we tried to segment it accordingly using Gabor transform followed by k-means clustering. But the output was not accurate enough and could only identify some part of the texture as same. The edges didn't have good distinction.

- Filter:

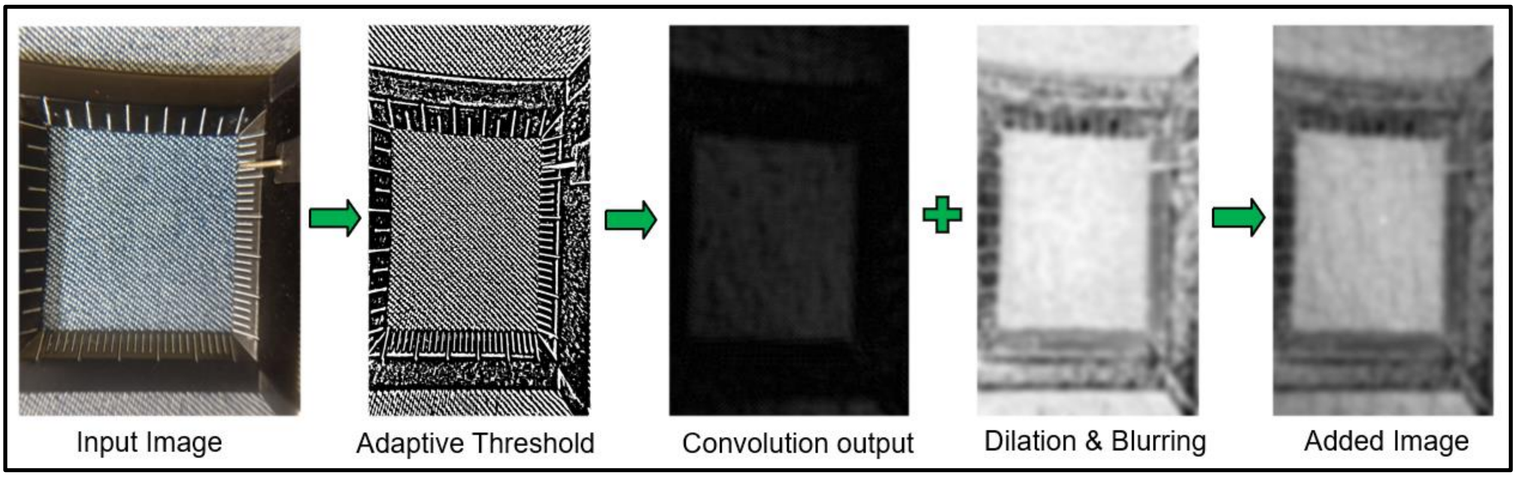
  As the cloth we are trying to analyze could be of different material and weave pattern we tried extracting its feature from the center of the picture which will always be having the cloth material. A filter is created by taking a small portion of the image from its center and assigned +1 and -1 values by thresholding it. This then convolved on an adaptive threshold of the image to get a map which shows where similar pattern exists. This could be thresholded and dilated to get a mask of the required portion. But the frames in some cases could cause interference due to it consisting of lines.

- Bilateral Filtering:

  The filter algorithm was trying to find the texture of the cloth material. To get better accuracy we considered finding the texture of the frame too. The bilateral filtering removes noise present on the frame as lines or reflections. The adaptive threshold of the cloth portion and the frame can be separated by differentiating them on the basis of smoothness. As the frame is far smoother than the cloth material. Blurring the result from, bilateral followed by adaptive threshold will give a mask of the cloth material.

- Final Working Algorithm:

  In the final algorithm the two masks made from the filter method and bilateral filtering method are combined and k-means is used to get the final mask. From this mask contours are extracted. These contours are smoothened using erosion and dilation. The contour is then converted into a rectangle contour using minrect function, which gives the minimum area rectangle required to enclose the contour. This contour is used as a mask to extract the required cloth portion from the image using get perspective function to a new image with only the cloth part.



B. Feature Recognition

Feature Recognition involves extracting the warp and weft of fabric using the output of segmentation algorithm. The following approaches were tested:

- Harris Corner Algorithm:

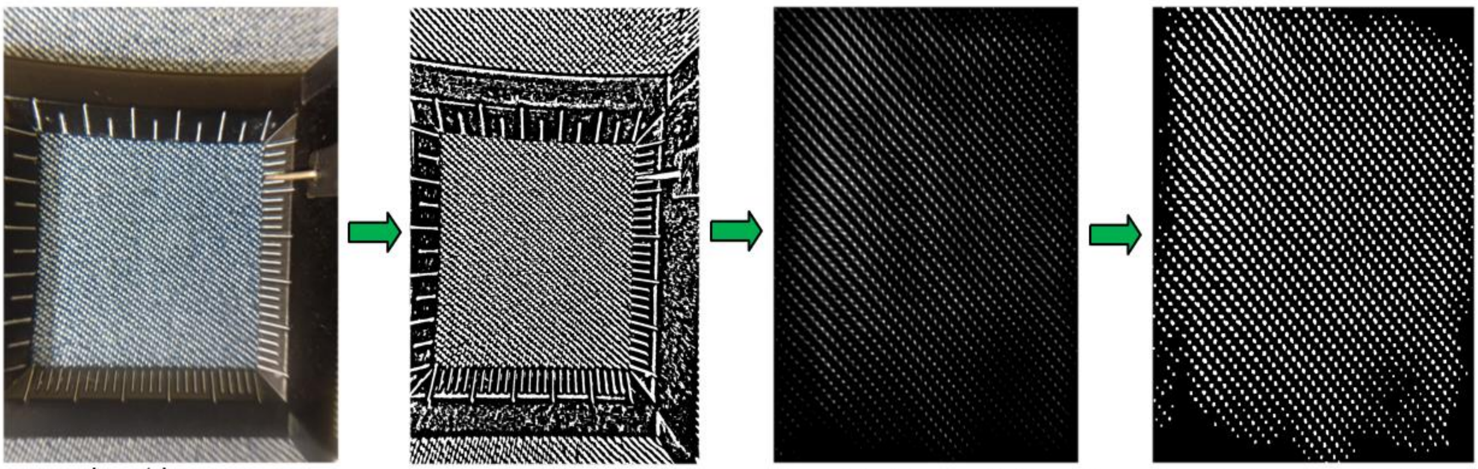
  Harris Corner algorithm traverses through an image and marks a point as a corner when the intensity drops or rises abruptly from all directions using spatial derivatives. This method failed for the FR because of the irregularity of the input unlike a chessboard image where there are clear boundaries and also counting the corners becomes troublesome as there might be two or more points marked as corners.

- Using contour detection:

  After applying Sobel Operator (Image Gradients) on both X, Y dimensions after which the fabric contains clear boundaries. But after we applied contour detection on this image, the result was highly deviated from the actual value due to the noise present the image after applying the gradient. Erosion followed by Dilation decreased noise by some amount but not in a desirable way.

- Hough Transform:
  Hough Transform takes the intensity of every pixel and plots them in Hough Space ((r, theta) space). Since, points in a line have the same theta, the brightness of dot in Hough space representing that particular is used to identify line in an image. Considering the fact that the diagonals should be excluded as they are longer than required lines, angle restriction of 0 and 90 degrees need to be maintained, which resulted in more than one line representing the same weft in the image.

- Final Algorithm:
  The input image is first adaptively thresholded. Next, a filter is obtained from the center of this image. This filter is correlated with the thresholded image. As the warp and weft count is to be determined by counting the periodic patterns row and column wise, the image is rotated. The rotated image is thresholded. The threshold is determined using the K-means algorithm. This gives a much simpler binary representation as output of the initial fabric image. From this ‘binary map’ it is much simpler to obtain the thread count and other metrics.



Input Image | Adaptive-Thresholded | Correlated image followed by Skewing | Thresholding and K-Means clustering

C. App Development

Since the final output of our problem statement is to be deployed in a mobile application, we have parallelly started designing it. The application, as of now, does the following; it accesses the device camera, allows the user to capture an image and the captured image is then displayed with an option to continue or retake the image. The captured image is then fed into the segmentation code.

The app will be designed in a way such that the user captures an image of the cloth through the pick glass and then the particulars of the textile, mainly warp and weft will be displayed to the user.

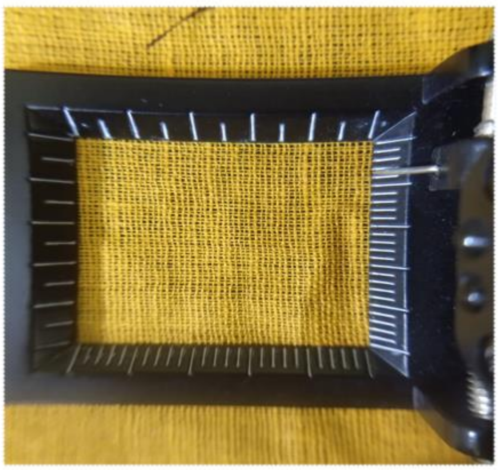
The application was designed using Android Studio.

4. Applications

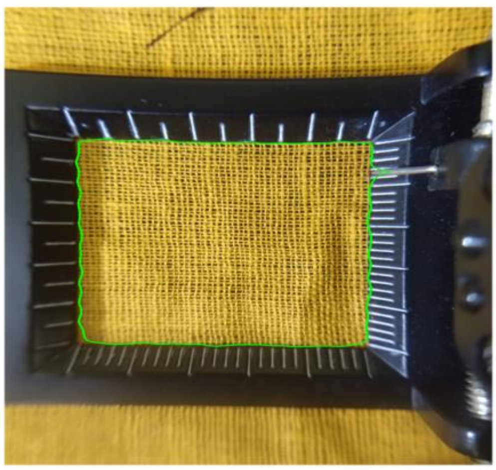
Our primary customers will be textile and apparel manufacturers. Also, our solution can be employed by textile and apparel importers for identifying quality defects and ensuring conformance to quality standards.

Our project idea was formulated based on the real-life need for quick and cheap fabric quality inspection. Our end deliverable is a mobile app that can instantly infer the quality metrics of a fabric. Hence, our solution is scalable and thus can be quickly deployed to the textile industry.

5. Working examples

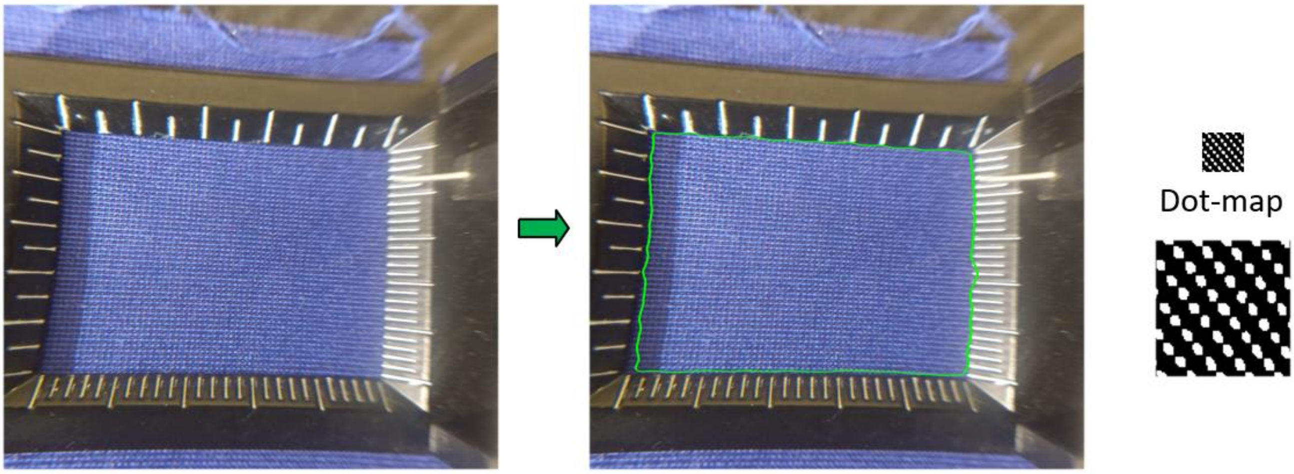


Input image

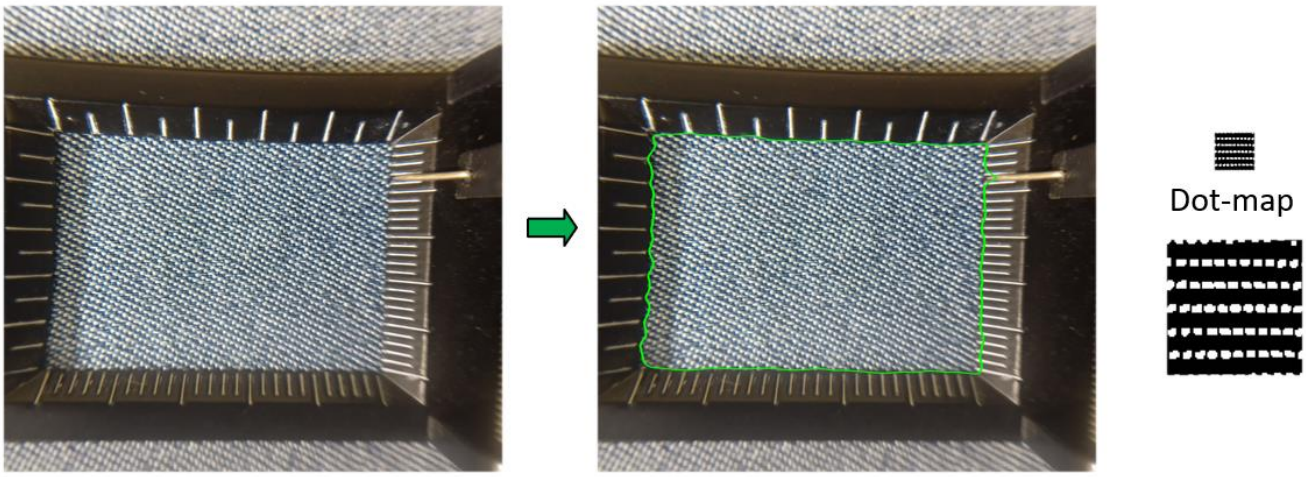


Segmentation Output

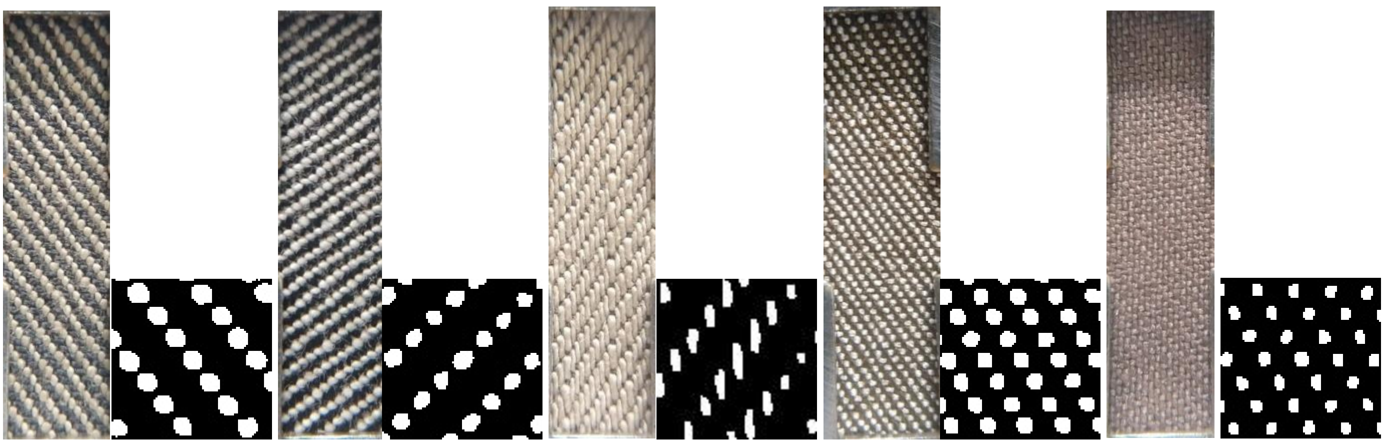
Dot-map



Input image　　Segmentation Output



Input image　　Segmentation Output



Appendix – Fabric Dataset & Code files

The below link contains a dataset of 60+ fabric images under a pick glass. As well as the final code files of segmentation and feature recognition.

Code files and Dataset