Final Project Proposal

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Dataset

[The Fabric Dataset]

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Description

The dataset consists of images of the following classes of fabric samples: acrylic, artificial_fur, artificial_leather, blended, chenille, corduroy, cotton, crepe, denim, felt, fleece, fur, leather, linen, lut, nylon, polyester, satin, silk, suede, terrycloth, utilities, velvet, viscose, wool. Each fabric sample was imaged under four different lighting conditions using a photometric stereo sensor to allow for material classification beyond textural classification [1]. The non-rigid material nature of various fabrics presents an interesting problem: how to classify different fabric types, especially when fabrics may be moving or changing shape. This scenario is especially true in the event the fabric is being imaged on a conveyor belt in the context of producing or recycling textiles. The imaging methods of the dataset under different lighting qualities create opportunities to use reflectance alongside textural identification methods.

The original size of the dataset is ~8000 images (~2000 samples each imaged under 4 lighting conditions). The number of fabric samples x 4 different images taken under different lighting conditions for each category of fabric in the original dataset is as follows:

- Velvet - 44 images
- Wool - 360 images
- Fleece - 132 images
- Felt - 16 images
- Artificial_leather - 12 images
- Viscose - 148 images
- Polyester - 904 images
- Cotton - 2352 images
- Chenille - 52 images
- Unclassified - 492 images
- Blended - 1644 images
- Lut - 16 images
- Corduroy - 96 images

- Suede - 20 images
- Silk - 200 images
- Utilities - 8 images
- Satin - 96 images
- Denim - 648 images
- Artificial_fur - 4 images
- Acrylic - 48 images
- Leather - 64 images
- Terrycloth - 120 images
- Crepe - 104 images
- Linen - 76 images
- Nylon - 228 images

Due to the limited number of samples associated with certain fabric types and the samples per category requirements associated with this project, our team had to examine ways to increase the sample sets and eliminate particular categories. We decided to resample each image into 4 sub-images of resolution 200x200 px, representing quadrants of the original image and eliminate those categories which did not contain enough samples to meet assignment requirements. As such, we were left with the following categories and their associated image counts after resampling:

- Wool - 1440 images
- Polyester - 3616 images
- Cotton - 9408 images
- Blended - 6576 images
- Denim - 2592 images

The remaining dataset of 23,600 images presents us with challenges related to the size and distribution of samples per fabric type. Depending on the performance of our classifier, we might also bring in a sixth category from the original dataset, which is labeled “unclassified” and contains 1,968 images. This category might reduce the error of the classifier for sorting less common instances of the named classes or those with features that cross the class boundaries. We will also need to investigate best practices for how to split the data into train and test groups as the data is not evenly distributed between classes through data augmentation of the underrepresented groups or more heavily weighting the underrepresented groups.

Research Question

Can we correctly classify textile materials (wool, polyester, cotton, blended, denim) using reflectance and microgeometry?

Example Images

Figure 1: Wool_22 images 1 - 4

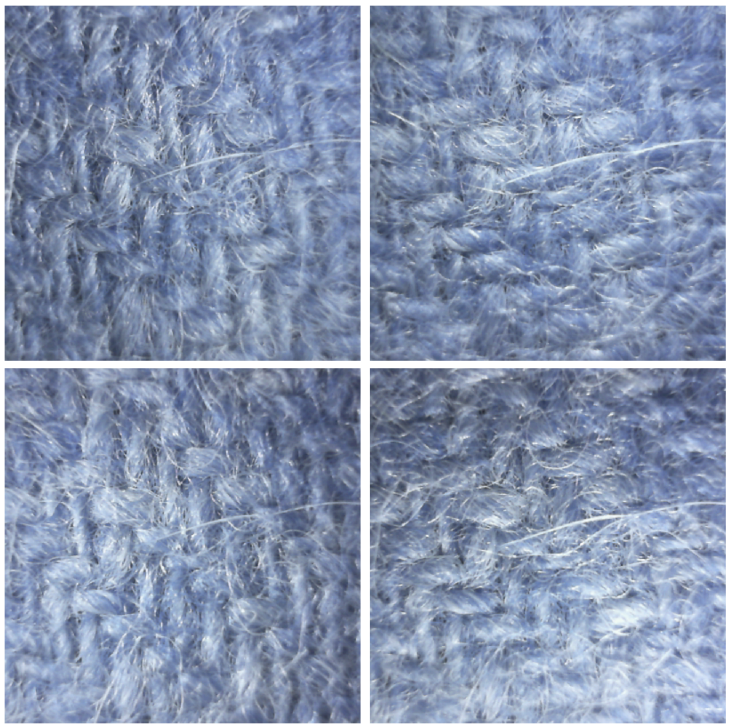


Figure 2: Wool_22 image 1 divided into 4 subimages

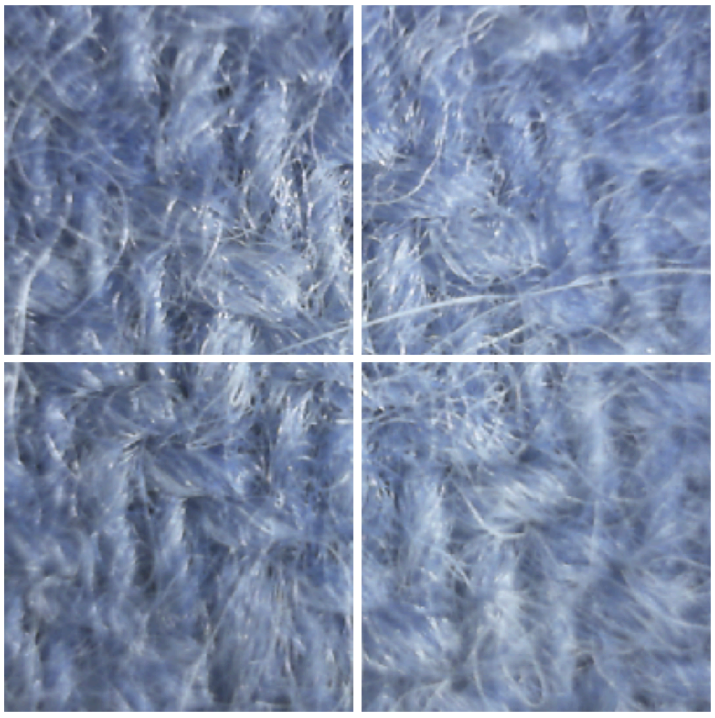


Figure 3: Denim_1 images 1-4

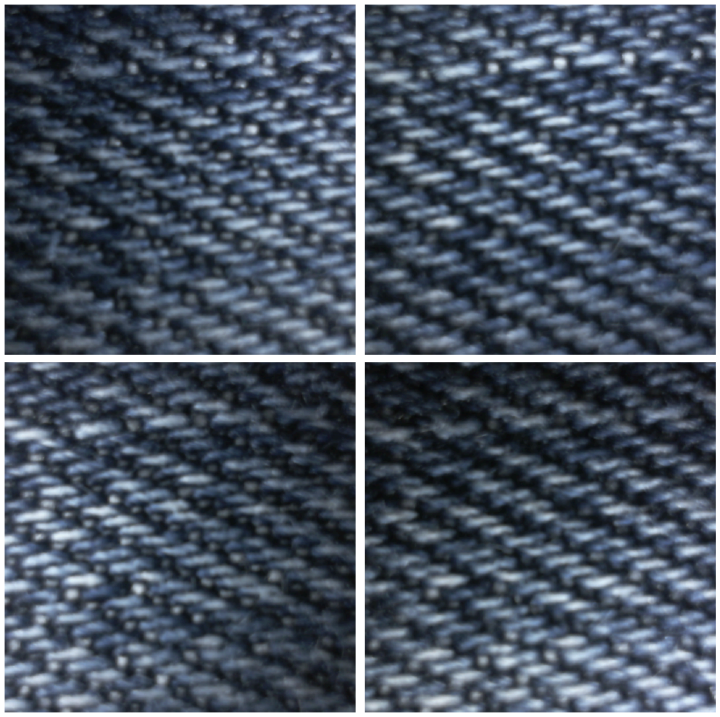
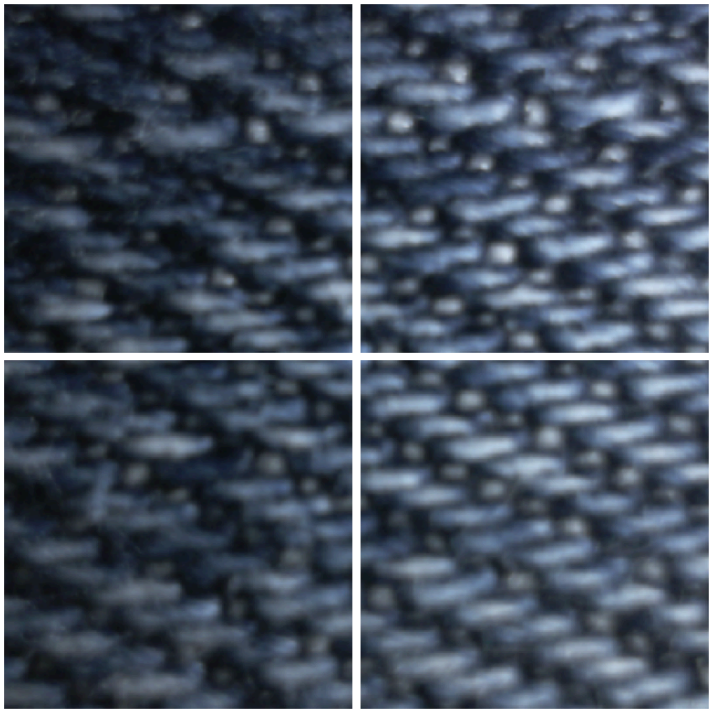


Figure 4: Denim_1 image 1 divided into 4 subimages



Methodology

We will first pre-process images, re-classifying them in more broad groups, adding Gaussian blur or other filters that we think important, to later create features using texture features, edge detection and gradient features, shape descriptors, frequency domain features, and statistical measures. Example methods for each feature area we hope to explore are listed in the table below:

Feature Area	Features [2,3,4,5]
Texture Features (characterizing surface structure and microgeometry)	• Albedo & Normal Maps • Gray-Level Co-occurrence Matrix (GLCM) • Local Binary Patterns (LBP) • Gabor Filters • Haralick Features
Edge Detection and Gradient Features (highlighting transitions in microgeometry and patterns common in machine-woven textiles)	• Sobel, Scharr, and Prewitt Operators • Canny Edge Detector • Laplacian of Gaussian (LoG)
Shape Descriptors	• Hough Transform • Contour Properties • Hu Moments • Fourier Descriptors
Frequency Domain Features (in an effort to identify structures and patterns not easily visible in the spatial domain)	• Fast Fourier Transform (FFT) • Wavelet Transforms
Statistical Measures (capturing distribution and variation in pixel values possibly correlated with microgeometry)	• Histogram-based Features • Entropy

References

[1] Kampouris, C., Zafeiriou, S., Ghosh, A., Malassiotis, S. (2016). Fine-Grained Material Classification Using Micro-geometry and Reflectance. In: Leibe, B., Matas, J., Sebe, N., Welling, M. (eds) Computer Vision – ECCV 2016. ECCV 2016. Lecture Notes in Computer Science(), vol 9909. Springer, Cham.

[2] Öztürk, Ş., & Akdemir, B. (07 2015). Comparison of Edge Detection Algorithms for Texture Analysis on Glass Production. Procedia - Social and Behavioral Sciences, 195, 2675–2682. doi:10.1016/j.sbspro.2015.06.477

[3] Li F, Yuan L, Zhang K, Li W. A defect detection method for unpatterned fabric based on multidirectional binary patterns and the gray-level co-occurrence matrix. Textile Research Journal. 2020;90(7-8):776-796.

[4] N. Mohanty, A. Lee-St. John, R. Manmatha, T.M. Rath, Chapter 10 - Shape-Based Image Classification and Retrieval, Editor(s): C.R. Rao, Venu Govindaraju, Handbook of Statistics, Elsevier, Volume 31, 2013.

[5] V.F. Leavers. Shape Detection in Computer Vision Using the Hough Transform (1992) DOI:10.1007/978-1-4471-1940-1 Library of Congress Data available