INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Automatic Stain Detection on Fabrics Using Image Processing

Murali Krishnan
P.G Scholar, (M.E Communication Systems)
Bannari Amman Institute of Technology, India
Dr. M. G. Sumithra
Professor, Department of Electronics and Communication
Bannari Amman Institute of Technology, India

Abstract:
Dry cleaners often find it time consuming and difficult in finding the invisible stains and fabric flaws. An automatic stain detector in fabrics has been proposed in this paper. The algorithm uses k-means clustering methods to identify the stains. The clustering approach for stain detection provides an apparatus that allows stain detection and analysis of flowed or damaged fabrics in a quick and efficient manner. Another objective of the proposal is to provide a detector that is easy to use, light weight, portable, convenient and durable. The algorithm is useful to personnel in the areas of textiles, dry cleaners, garment analysts, museum curators, manufacturers and retailers of clothing, textiles and upholstered furniture. Another objective of the algorithm is to provide a method for accurately identifying stains on various types of fabrics. Segmentation approaches in image processing can be used for this purpose. Clustering methods in segmentation is used in this algorithm to provide a faster and easier algorithm for detection of stains. The cluster centres are assigned in a random manner to further calculate the clusters and to classify the stains and the fabric.

Key words*: segmentation, clustering, k-means clustering, cluster centres, Region of interest (ROI)*

1. Introduction

Conventional dry cleaning [10] is risky to public health and the environment. Designers can help by minimizing the reliance on fabrics that need to be dry-cleaned by educating their customers about cleaning alternatives. On the surface, dry cleaning seems like a harmless and almost miraculous process. For consumers, the dry cleaner whisks away their beloved, and seemingly difficult to clean, one-of-a-kind pieces and delicate garments, and returns them perfectly pressed and in like-new condition. Even fashion houses rely heavily on the service for sample maintenance. When the cleaning process is scrutinized, however, it is found to pose risk to human health and our environment.

The conventional dry cleaning industry uses a chemical called perchloroethylene [11] [12] [13] or "PERC" to clean clothes. Known to cause a number of adverse health effects, high-level exposure to PERC can affect the central nervous system, kidney, and liver, and cause mood and behavioral changes, impairment of coordination, dizziness, headache, and fatigue. Chronic exposure to lower levels of the chemical can lead to cognitive and motor functioning impairment, headaches, vision impairment, and in more isolated cases, cardiac arrhythmia, liver damage, and kidney effects. PERC has also been demonstrated to have reproductive or developmental effects, and may cause several types of cancer.

The levels of PERC exposure in the dry-cleaning facility are also of concern. Workers handling PERC have been found to be at an increased risk of esophagus and bladder cancer, non-Hodgkin's lymphoma [14], spontaneous abortion, menstrual [15] and sperm disorders, and reduced fertility.

The automatic detection of textile stains has always been a hot spot. An automatic detection method is proposed based on image processing, which can solve the technical difficult problem of automatic detection technique efficiently. The procedure of the textile image processing has been researched, and the emphasis should be put on the image preprocessing and clustering. The experiments show that this detecting method of textile stains has a high detection rate relatively. The algorithm helps to reduce the usage of PERC and it reduces manual labor in laundries and dry cleaning centers.

2. Prior and Related Work

2.1. Segmentation

Segmentation is the classifications of an image into meaningful data for easy analysis of the image. Some of the existing methods for segmentation [16] are thresholding, region growing and clustering. Thresholding is the simplest method of image processing. From an RGB image converted to the corresponding gray level intensity image [1], we can partition the image by binary values, 1 and 0. The region above the threshold may be assigned 1 and that below the threshold may be assigned zero. This histogram approach cannot be relayed upon for effective classification of the image information as the binary approach of classification limits the representation of image segments and further reduces proper detection of the required area. Fig.1 shows segmented cloth image by thresholding [16] with less accuracy in the detection of stains. The region above threshold includes fabric areas with less stain and may lead to misinterpretation of the clean area of the fabric.

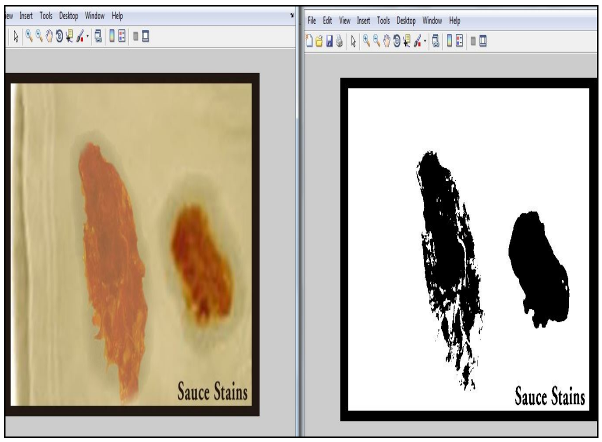


Figure 1: identifying sauce stains on fabric using thresholding

Region growing [16] is another approach which can be used to extract the stain alone. But the disadvantage of this approach is that it is a split and merge algorithm which focuses on selecting pixels with approximately similar intensity values and comparing the adjacent areas to fill them with average intensity which lacks clarity for the required image information.

2.2. Clustering Methods

Segmentation approaches based on clustering has many advantages over other approaches as it provides an efficient classification of image information and can be implemented in many fields of human interest such as aviation, military and medical fields. The implementation of segmentation on textile industry has aroused the interest of many scholars for it paves an easy to implement and effective method for detecting stains and it is harmless due to low consumption of PERC.
The various clustering approaches existing are c-means, fuzzy C-means, expectation maximisation algorithm and K-means clustering [1-5].

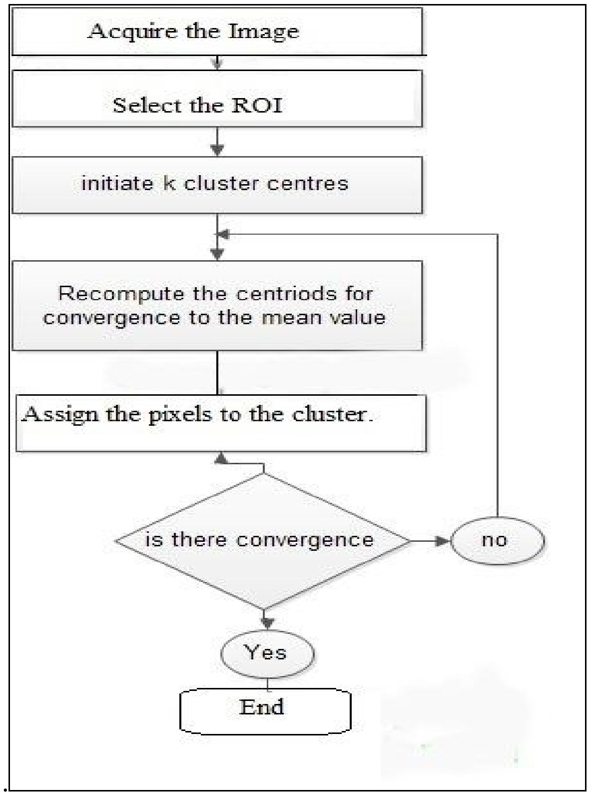
3. Proposed Method

3.1. Description of Algorithm

The algorithm is very similar to Forgy's algorithm [13]. Besides the data, input to the algorithm consists of k, the number of clusters to be developed. Forgy's algorithm is iterative, but k-means algorithm makes only two passes through the data set.
Flow chart.1 K-means clustering flow chart

- Begin with k cluster centres, each consisting of one of the first k samples. For each of the remaining n-k samples, find the centroid nearest it. Put the sample in the cluster identified with this nearest centroid. After each sample is assigned, recompute the centroid of the altered cluster.
- Go through the data a second time. For each sample, find the centroid nearest it. Put the sample in the cluster identified with this nearest centroid. (During this step, do not recompute any centroid)

Addition of certain features in the existing k means algorithm improves the detection of the interested region effectively with minimum chance of faulty clustering. The first step in k-means clustering is the initialisation of cluster centres. Common methods for initialisation include randomly chosen starts or using hierarchical clustering to obtain k initial centres [1], [2], [5]. The initialisation steps can be explained as follows.



- Convert n×p image matrix X to n×(p-1) matrix Z, where each row Z_i of Z is the polar representation of the corresponding row element of S^p in X.
- For each column Z, find the pair of neighbouring points with the largest angular distance between them and rotate Z such that these neighbours have the largest linear distance between them.
- One dimensional matrix for k-means is initialised with greatest value integer obtained from $(K\ (P-2)^{1/(p-2)}$ equi-spaced quantities [3],[4].

3.2. Applying Masking to K-Means Algorithm

For a given k and initial cluster centres $\{\mu_k;\ k=1\ldots k\}$, the general strategy is to position the datasets into k clusters, then to iterate the cluster mean directions until convergence [9]. The exact algorithm can be explained as follows.

1.Given k initialising cluster mean directions $\mu_1, \mu 2, \ldots \mu_k$, find the two closest mean directions for each observation X_i ; i= 1,2…n.

2. Classify the groups by C_{1i} and C2i respectively. Assign the update equation

$V_k^- = (n_k - 1)^2 - n_k^2 \|X_k\|^2 - 1$ and (1)

$V_k^+ = (n_k + 1)^2 - n_k^2 \|X_k\|^2 - 1$ (2)

All clusters are in the live image set at this stage.

The live set is updated to find optimum convergence [2].

Optimum transfer stage: For each X_i, i= 1, 2…n, we calculate the maximum reduction in the objective function. By replacing the live function ζ_i with another class, maximum reduction can be obtained as

$$W_i = (n_{ki}+1)(V_k^{+} - 2n_{ki}X_k^{-1}X_i) - (n_{çi}-1)(V_{çi}^{-} + 2n_{çi}X_{çi}^{-1}X_i) \quad (3)$$

If Wi > 0, then the only quantity to be updated is $C_{2i} = K_i$.

Quick transfer stage includes swapping and the objective function and the change in the objective function can be calculated as

$$Obj_k = \sum_{k=1}^{k} n_k \left(1 - \|X_k\|\right) \quad (4)$$

Providing a quick way of obtaining final value.

The exact extraction of the stained areas of the fabric can be detected by masking the clustered sample containing the specific cloth region and then subtracting it from the acquired image. The modified algorithm developed using k-means clustering can be discussed with the experimental results obtained from a stained fabric.

4. Experimental Results and Discussion

- MATLAB Implementation Results

The proposed scheme can be explained briefly with the results obtained after segmentation as follows. The overall flow of the program can be summarised with the following steps.

- Step1: Acquiring the image.
- Step2: Storing the ROI as the base image to be clustered for further operations.
- Step3: Cluster to extract useful cloth area from the ROI
- Step 4: Storing the fabric image obtained after applying the cluster field and using it as reference image.
- Step 5: Subtracting the reference image from the base image.

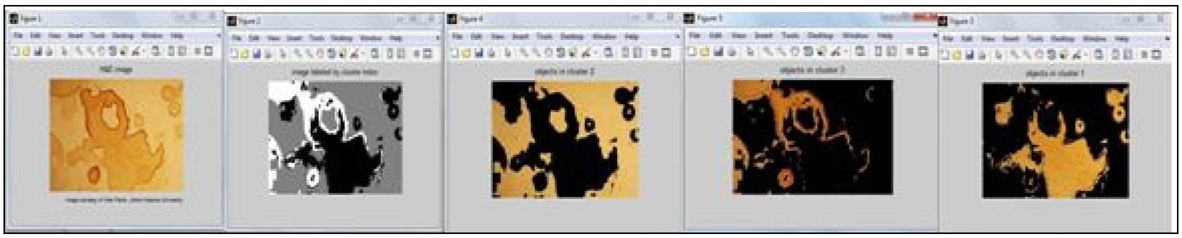


Figure 2: A. Acquired coffee stain image. B. grayscale intensity mapping. C. Cluster 1 containing region of interest. D. Template for stained area. E. Final cluster containing the stain alone.

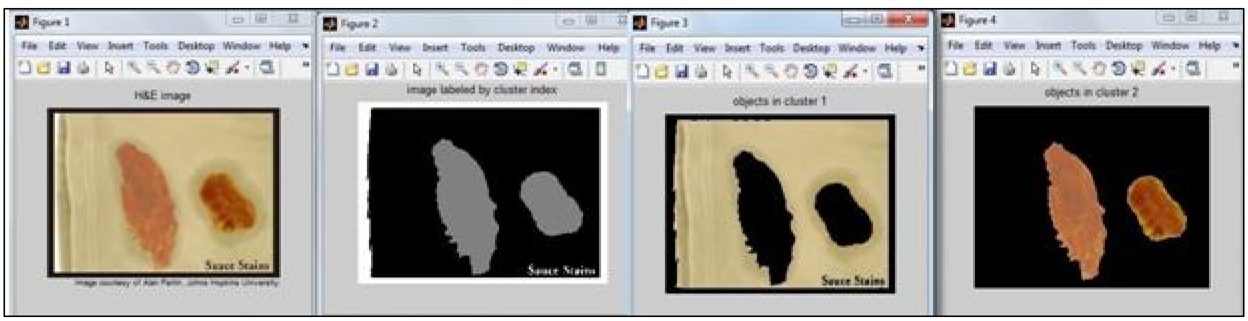


Figure 3: A. Acquired image having tomato sauce stain. B. greyscale intensity mapping. C. Cluster 1 containing region of interest. D. Final cluster containing the stain formed by mapping the image to the cluster.

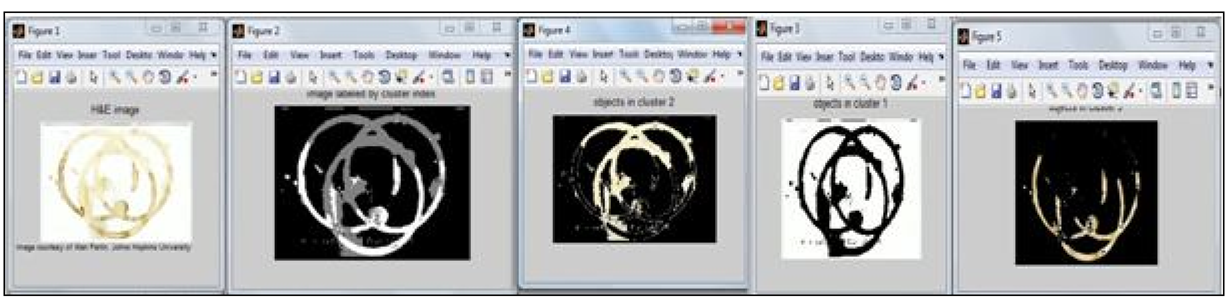


Figure 4: A .Acquired stain image. B. greyscale intensity mapping. C. Cluster 1 containing region of interest. D. Template for stained area. E. Final cluster containing the stain alone.

5. Conclusion

Segmentation based on clustering algorithms are widely used in many areas of human interest such as medical field, military applications, MRI scanning, industries etc. The proposed algorithm can be implemented in dry cleaning and washing machines to use the dosage of the solvent based on intensities of stain by simply observing the corresponding histogram on Matlab kernel. The quantity of the corresponding solvent can thus be minimised and thus the adverse effects of these solvents can be reduced. An optical imaging apparatus can be used to scan the entire fabric in textiles to detect the stains using the proposed algorithm. Further as the run time of the program is less the algorithm can be utilised effectively in large scale textile industries to find damages in clothes without manual labour. Computer image processing technology currently used in many areas of the textile industry. On the one hand be used in textile technology and textile testing instrument development. Image information processing technology in the textile testing a wide range of applications, including: the determination of fiber fineness, yarn evenness, hairiness, defect, test cloth. Therefore, in-depth, systematic study of image processing technology to detect areas in textile applications, will promote a large number of textile equipment replacement; the other hand, the fabric used in the simulation CAD system, the use of simulation technology to develop new fabrics products. China Textile Academy of fabric simulation CAD system developed is a method of using simulation software products and develops textile fabrics. Currently on the market for fabric simulation CAD system, its technology has reached world advanced level; some areas also led the international level, such as the double layer of fabric table for the simulation, terry fabric surface modelling methods. In fact the image information processing technology in the textile industry has great potential in application. For example, in existing fabric simulation based on the CAD system, combined with textile detection technology, can achieve physical test from the yarn to the final fabric simulation, not only to assess the quality of yarn, to provide the basis for the direct production, and can be predicted with the yarn woven into the fabric appearance quality.

6. References

1. Constrained K-means Clustering with Background Knowledge Proceedings of the Eighteenth International Conference on Machine Learning, 2001, p. 577{584. Kiri Wagsta, Seth Rogers's rogers@rtna.daimlerchrysler.com Stefan Schroed.
2. An Efficient k-Means Clustering Algorithm: Analysis and Implementation Member, IEEE. Tapas Kanungo, SeniorMember, IEEE, David M. Mount, Member, IEEE,Nathan S. Netanyahu, Member, IEEE, Christine D. Piatko, Ruth Silverman, and Angela Y. Wu, Senior
3. Spectral Relaxation for k-means Clustering. Hongyuan Zha & Xiaofeng He. Chris Ding & Horst Simon, Ming GU
4. Determination of Number of Clusters in K-Means Clustering and Application in Colour Image Segmentation Siddheswar Ray and Rose H. Turi School of Computer Science and Software Engineering Monash University, Wellington Road, Clayton, Victoria, 3168, Australia.
5. Constrained K-means Clustering.P.S.Bradley, K.P.Bennet,A.Demiriz.MSR-TR-2000 65
6. K. Fukunaga, Introduction to Statistical Pattern Recognition, 2ndedition. New York: Academic, 1990.
7. D. Comaniciu and P. Meer, "Mean shift: a robust approach toward feature space analysis," IEEE Trans. Pattern Anal. Mach. Intell., vol. 24, no. 5, pp. 603–619, May 2002.
8. B. Georgescu, I. Shimshoni, and P. Meer, "Mean shift based clustering in high dimensions: a texture classification example," in Proc. 9th Int.Conf. Computer Vision, Nice, France, 2003, pp. 456–463.
9. Pattern Recognition and image analysis., Earl Gose ,Richard Johnsonbaugh, Steve Jost ,Prentice- Hall , India. Pg-210-219
10. http://www.nrdc.org/living/stuff/files/CBD-DryCleaning-FS.pdf
11. http://www.epa.gov/chemfact/f_perchl.txt
12. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Tetrachloroethylene (Update). U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1997.
13. U.S. Environmental Protection Agency. Integrated Risk Information System (IRIS) on Tetrachloroethylene. National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 2012.
14. "non-Hodgkin lymphomas " at Dorland's Medical Dictionary
15. American College of Obstetricians and Gynecologists (ACOG) Committee on Adolescent Health Care. (2006). ACOG Committee Opinion No. 349. Menstruation in girls and adolescents: Using the menstrual cycle as a vital sign. Obstetrics & Gynecology, 108, 1323-1328
16. Linda G. Shapiro and George C. Stockman (2001): "Computer Vision", pp 279-325, New Jersey, Prentice-Hall