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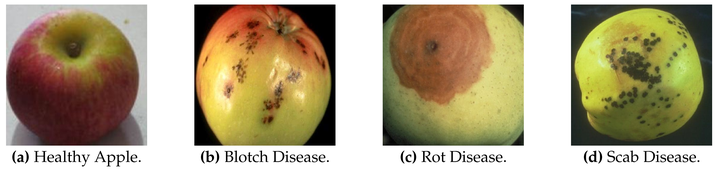
Detection and Analysis of Infected Food Items

Introduction

With the advances in computer vision, efforts are being made to automate tasks that now require human time and effort. One such domain is that of food quality inspection and food safety. In a developing nation like India where the population is humongous and there is a lack of systematic approach for food safety and nutritional aspects, it becomes increasingly important that proper food safety and storage measures be taken, since the losses to the stakeholders in such a scenario would be devastating, sometimes even fatal. Our effort in this direction is envisioned as an automated food monitoring system, which potentially would be placed in canteens, student messes and perhaps used by industries to make sure that they meet the quality standards.

Dataset Used

We used the dataset prepared by Dubey et al. for their paper. There are four classes of apples namely normal, blotched, scabbed and rotten. The distribution of images among different classes was almost uniform with 120 normal images, 104 apple blotch, 107 apple rot and 100 apple scab images, totalling to 431 images. There was variation in the images belonging to the same class, making the dataset suitable for application of learning techniques.



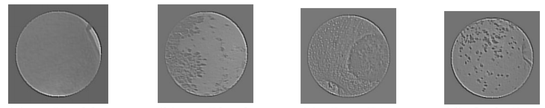
(a) Healthy Apple. **(b)** Blotch Disease. **(c)** Rot Disease. **(d)** Scab Disease.

Figure 1: Dataset Images

Proposed Approaches

Using Gabor Wavelets

The first approach is based on pixel-grid based representation of images. Gabor Wavelets are convoluted with the image, and the resultant images are summed up. The final image which is referred to as gabor image (Figure 2) is used to extract the Local Binary Pattern(LBP) and Haralick Features, which are then served as input to Support Vector Machine (SVM) and K-Nearest Neighbours (knn) machine learning models for classification.

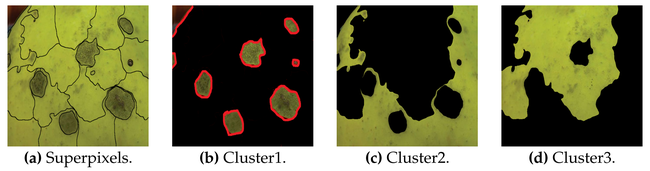


(a) Healthy Apple. **(b)** Blotch Disease. **(c)** Rot Disease. **(d)** Scab Disease.

Figure 2: Gabor Images computed from original Apple Images

Using Superpixels

Superpixels is an over-segmentation technique which divides the whole image into various bigger pixels making it easier to separate out the disease. After the superpixels have been extracted, a graph based approach is used where edges between various neighbouring superpixels are established on the basis of the color cues. Following segmentation, color features from HSV color space and LAB color space along with Support Vector Machines are used for classification.

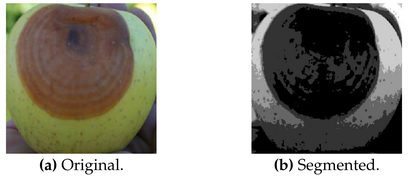


(a) Superpixels. **(b)** Cluster1. **(c)** Cluster2. **(d)** Cluster3.

Figure 3: Results of superpixel and the graph based approach

Multi-Thresholding using Optimization

The process of segmenting an image into more than 2 segments can be a very expensive process computationally. We propose an optimization approach to find the best thresholds. We have used a hybrid of Moth Flame Optimization and Gravitational Search Algorithm, due to its superior performance on the benchmark functions, and exploited the swarm nature of the algorithms to find the most optimal thresholds in the search domain. The fitness is calculated by the sum of intra-object variance. Lower the sum, more accurate is the segmentation result.



(a) Original. **(b)** Segmented.

Figure 4: Results of multi-thresholding using optimization

Feature Extracted

- Local Binary Pattern
- Gray Level Co-Occurrrence Matrix
- Haralick Features
- Color Space based features

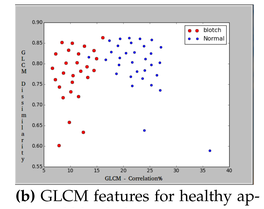
Results and Conclusion

The proposed segmentation algorithms provide results in such a form through which texture related features can be extracted effectively. The above mentioned features have been used for classification using Support Vector Machine and Knn giving around 80% for the 4 class problem and 96% for the 2 class problem (Disease or not diseased).

For K-nn (4 class problem)

original/ predicted	Normal	Rot	Scab	Blotch
Normal	16	0	0	0
Rot	1	7	3	4
Scab	0	1	14	1
Blotch	1	1	8	4

(a) Confusion Matrix



(b) GLCM features for healthy apple and blotch disease

Figure 5: Results

We would like to conclude by acknowledging that our proposed segmentation algorithms have proven effective for the apple dataset.

The proposed algorithms can be adapted to several other food items and finally a large scale food monitoring system for food storages can be made by extending and adapting ideas proposed by us.

References

[1] Shiv Ram Dubey et. al. *Adapted Apple for Fruit Disease Identification using Images*

[2] R. Achanta, A. Shaji, K. Smith, A. Lucchi, P. Fua, and S. Ssstrunk. *SLIC Superpixels*.

[3] S. Mirjalili, *Moth-flame optimization algorithm: A Novel Nature-Inspired Heuristic Paradigm*

[4] Rashedi E, Nezamabadi-pour H et al. (2009) *GSA: a gravitational search algorithm*