Exploring Statistical GLCM Texture Features for Classifying Food Images

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I. Introduction

Image processing algorithms, which recognize foods from photographs, have been proposed as a method for patients to conveniently track foods they eat. However, food recognition is challenging because 1) the same type of food can differ in shape when prepared differently. 2) the wide variety of food leads to a large number of food categories.

Machine learning based food classification has been proposed but its accuracy depends on the types of visual features used. Most prior food classification work has utilized Scale Invariant Feature Transform (SIFT) features that are robust and widely used in object recognition. Chen *et al* [1] presented the Pittsburgh fast-food image dataset with 101 food categories and benchmarked it using SIFT features.

Gray Level Co-Occurrence Matrices (GLCM) are statistical texture features used in computer vision systems in the food industry, especially for detecting meat decay [2]. However, till now they have not been used as features for food recognition. In this work, we compare the accuracy of SIFT to GLCM features for recognition of 4 different categories of foods (apples, burgers, bread and prepared dishes).

II. Methodology

Our images are collected from the Pittsburgh Fast-food Image Dataset [1] and the Fruit Image Dataset. We extract features from each picture, and construct histograms that are then normalized as a 'bag of features'. A Support Vector Machine (SVM) classifier is used to recognize the food pictures. For each food category, 6 training images and 12 test images are used as the test set. Figure 1 shows our test set.

Bag of SIFT Features: For each image, the SIFT descriptor extracts a set of 128 keypoints of the image. Then a codebook is generated based on keypoints using K-means clustering. The dictionary size is 100. The 'Bag of SIFT Features' is later used by the SVM classifier as the training and test set.

GLCM Features: We explore 10 GLCM features: Angular Second Moment (ASM), Contrast, Variance, Correlation, Inverse Difference Moment (IDM), Entropy, Sum Entropy, Sum Variance, Cluster Shade, and Maximum Probability.

III. Results and Conclusion

Figure 2 shows the SIFT keypoints and histogram. Figure 3 shows the classification accuracy for SIFT and GLCM features. GLCM features perform better than SIFT overall, and for single-item or homogeneous foods (e.g. Apple) while SIFT performs well for complex dishes due to their widely diverse appearances because a wide variety of food types (spaghetti, sushi, etc) are lumped into this dishes category.

These results are promising and suggest that GLCM features may yield more accurate food classification. However, our dataset is small. In future work, we plan to evaluate SIFT and GLCM features on larger datasets.

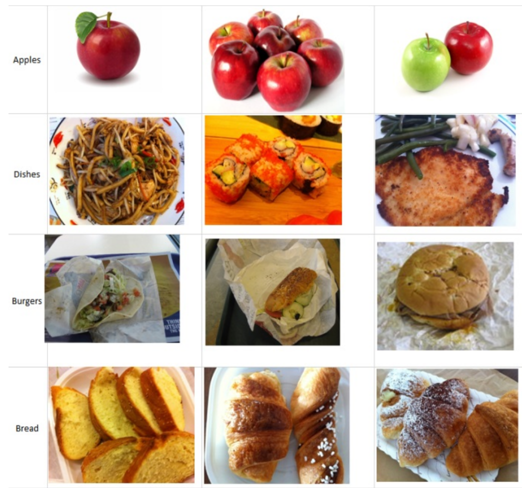

Figure 1. Test images of apples, dishes, burgers and bread

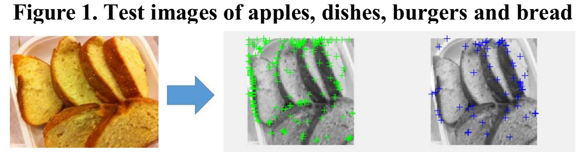

Figure 1 Food Recognition using Bag of SIFT features

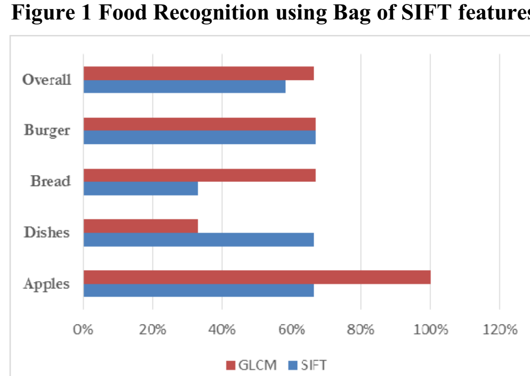

Figure 3. Overall classification accuracy and different Categories

References

[1] Mei Chen, et al. "PFID: Pittsburgh fast-food image dataset." In Proc Int'l Conf on Image Processing (ICIP).

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