

Automatic Differentiation of Melanoma and Clark-Nevus Skin Lesions

1. DESCRIPTION OF PURPOSE

Skin cancer is the most common form of cancer in the United States. Although, melanoma accounts for just 11 % of all types of skin cancer, it is responsible for most of the deaths, claiming more than 7910 lives annually. Melanoma is visually difficult for the clinician to differentiate from the benign Clark nevus lesion. The application of pattern recognition techniques to these lesions may be useful as an educational tool for teaching physicians to differentiate lesions as well as for contributing information about the essential optical characteristics for identifying them. The purpose of this study was to find the most effective pattern classification criteria and lesion-feature-detection algorithms for differentiating melanoma from Clark nevus lesions, using the Computer Vision and Image Processing Tools (CVIPtools) software package.

2. METHODS

Due to differences in lighting, skin color between individuals and the photographic and digitization processes, original-color images were normalized by converting them into relative-color images.

Image Database: A database of 60 color images of dermoscopic lesions was comprised of 20 melanoma, 20 melanoma *in situ* and 20 Clark nevus images.

Original-image preprocessing to remove artifacts: Dermoscopic-gel bubbles and camera flash were minimized using a second-order, Contra-Harmonic Filter (CHF) with mask size 5.

Border images created to generate relative-color images: Then “border-image” masks (BIs) were created by drawing borders around the lesions in the preprocessed color images. BIs were used to mask tumors out of the preprocessed images to generate skin-only images. They were also used to mask skin out of the preprocessed images to get tumor-only images.

Generation of relative-color images: For one original color image, the average RGB values of its skin-only image were subtracted from its tumor-only image to generating a relative-color image.

Segmentation: CVIPtools’ Principal-Color-Components Transform algorithm was used to segment the relative-color images into 4 principal homogeneous regions of color.

Morphological filtering: A circle with a 9-pixel diameter was used as a structuring element to pare projections and fill holes in the image objects, thereby “smoothing” their shape. Segmentation and morphological filtering reduced the number of objects in the lesions.

Feature extraction: A variety of feature vectors were created using combinations of the following features: area, thinness, perimeter and histogram features, including mean, standard deviation, energy, entropy; texture features included inertia and entropy. In some experiments, the lesion images, features were extracted from the two largest objects; in other experiments, features were extracted from the whole lesion which was treated as one object. One vector of feature values was generated for the lesion in each image.

Pattern Classification Algorithm Development: An image database of 60 lesion images was divided into sets of 30 images each. One 30-image set was divided into training and test sets of 15

images each. After training and testing with “the 15” and 15, if the classification results were consistent, the algorithm developed was executed on *the other* original training set of 30 images. If the consistency prevailed on the training set of 30, the algorithm was then executed on a training set of 50 images (30 original and 20 chosen from the test set of 30). A variety of combinations of feature measurements and pattern-classification schemes were applied to the 50. 415 pattern-classification algorithms were tested on this training set. Out of these schemes, the best four schemes were chosen and graded.

3. RESULTS FROM THE BEST OF FOUR ALGORITHM-LESION CLASSIFICATION SCHEMES

No. of Lesions in Training/Test Set	% Melanoma Identified	% Clark Nevus Identified	Average %
15/15	75	75	75
30/30	88	81	84
Swapping 30/30	93	61	77
50/10	100	60	80

4. SIGNIFICANCE OF WORK TO BE PRESENTED

Most of the previous research in this area has been performed using photographic images. In this research, we have used dermoscopic images. Melanoma is visually difficult for the clinician to differentiate from the benign Clark nevus lesion. This work may contribute significantly to the instruction of physicians needing to learn lesion differentiation, as well as to literature regarding important features for differentiation. The image processing algorithms developed, including preprocessing and postprocessing methods, will be useful in future research.

5. CONCLUSION

The table above shows the best experimental results. There was a reasonably good success rate in classifying melanoma (88%) and Clark Nevus (81%). Seven features including area, perimeter, histogram entropy, energy and standard deviation of contrast were extracted from the two largest objects in the Melanoma and the Clark-nevus lesion classes. The classification algorithm included Softmax scaling normalization, a vector inner-product metric and nearest-centroid pattern classification.



Fig 1. Original Image. Lesion w/
skin, camera flashes, gel bubbles and hair.

Fig 2. Effects of preprocessing.

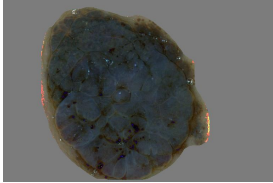


Fig 3. Relative Color Image.

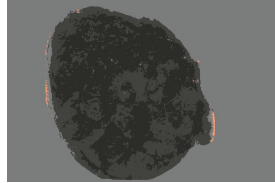


Fig 4. PCT-Segmented image

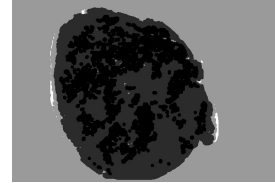


Fig 5. Morph.-filetered image

6. THIS WORK HAS NOT BEEN SUBMITTED FOR PUBLICATION ELSEWHERE.