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Survey on A 3D Reconstruction Technique for Computerized Dermoscopic Skin Lesion Classification

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***Abstract*:** Melanoma is a type of skin cancer. This paper gives an idea about different steps used in the "3D Reconstruction Technique For Computerized Dermoscopic Skin Lesion Classification". In which a non invasive computerized dermoscopy system used for the early detection of melanoma skin cancer. 3D image is reconstructed from the 2D dermoscopy image and it helps to get the relative depth of the lesion image. Using depth, system determines the stages of the cancer and gives analyses about the disease to the user.

Keywords: 3D reconstruction, non invasive computerized system, 2D dermoscopy image, Depth estimation

I. Introduction

A skin lesion is an abnormal growth or an area of skin that does not resemble the skin surrounding it. Skin lesions can be grouped in to two categories. Primary and secondary skin lesions .Primary skin lesions are variation in color and texture that may be present at birth or that may be acquired during a person's lifetime. Secondary lesions are the area unit those changes within the skin that result from primary skin lesions. The overwhelming majority of skin lesions don't seem to be cancerous. However doctors will determine whether particular lesions are cancerous or not based on the observations and the result of a biopsy. The early detection of skin cancer is a key to successful treatment. Skin cancers are broadly classified in to melanoma and non melanoma.

The world health organization reports a rapid increase of skin cancer cases. About two to three million cases of non-melanoma cancer and 132,000 melanoma cancers are reported annually worldwide. The early detection decreases the treatment cost. When considering various types of skin cancers and dependency skill level of dermatologist accurate diagnosis of melanoma is still a problem. The problem addressed during this is the way to analyze a given digital dermoscopic image for identification cancerous lesions particularly malignant melanoma.

Computerized system primarily constitutes of 5 components.(1)image acquisition (2)segmentation(3)feature extraction(4)feature selection(5)decision making. Considering the depth and 3D geometry of the skin lesion is critical to achieve the accurate diagnosis. A non invasive computerized dermoscopy system to aid diagnosis of skin lesions is proposed in this paper. Special emphasis is laid to aid diagnosis of in-situ melanoma. A Gradient vector flow model used for segmentation of the 2D dermoscopic skin lesion images. A depth map is derived from the 2D dermoscopic image for reconstruct the 3D image. The depth map construction is adopted and the depth map data is fit to the 2D surface to achieve 3D skin lesion reconstruction. The 3D skin lesion is represented as structure tensors. 2D skin lesion data color , texture and 2D shape features are and 3D shape features are extracted from the image . The 3D reconstructed skin lesion data is used to obtain the 3D shape features. The 3D shape features encompass the relative depth features estimated. After feature extraction and selection SVM classifier is used for classification.

II. Review

Identification of the skin lesion or region of interest in dermoscopic images is achieved through segmentation procedures. vogt, m.; ermert, helmut[32] proposed gradient vector flow method for segmentation, which has been successfully used in many applications. The initialization of GVF is automatic. A circle with a given radius placed on the image. A circle centre is given by the centre of the segmented region obtained by the active contour method.

Barata, C.; Ruela, M.; Francisco, M.; Mendonça, T.; Marques, J.S.[22] described Adaptive snake method, these are attracted by spurious edges which do not belong to the lesion boundary. These are appears in dermoscopic images due to artifacts such as hair, specular reflections or even from variations in the skin texture. First detects contour snakes in the image using robust estimation algorithm based on the EM algorithm. Detecting intensity transitions along a set of radial directions using correlation matching in the HSV color space and then edge linking by using simple continuity criteria.

Peruch, F.; Bogo, F.; Bonazza, M.; Cappelleri, V.-M.; Peserico, E [17] , Silveira, M.; Nascimento, J.C.; Marques, J.S.; Marcal, A.R.S.; Mendonca, T.; Yamauchi, S.; Maeda, J.; Rozeira, J [18] presented fuzzy based split and merge algorithm, aims at unsupervised perceptual segmentation of natural color images .First it extracts color feature and texture feature from an original image. Then split and merge technique is executed in 4 stages.

III. DIFFERENT METHODOLOGIES

In this paper different steps are used for detecting skin cancer. Mainly 4 steps are used.

A. Segmentation

The segmentation of skin lesions is an important process. Inaccurate segmentations will affect all downstream processes such as feature extraction, feature selection and the final diagnosis. Accurate segmentations are especially crucial for features that measure properties of the lesion border. Dermoscopic images generally consists of normal skin and skin lesion segments. Identification of the normal skin and skin lesion is critical to accurately extract features. The skin lesions can be identified using segmentation techniques. In which the system considers an adaptive snake (AS) method. These are attracted by spurious edges which do not belong to the lesion boundary. These are appears in dermoscopic images due to artifacts such as hair, specular reflections or even from variations in the skin texture. First detects contour snakes in the image using robust estimation algorithm based on the EM algorithm. First detecting intensity transitions along a set of radial directions using correlation matching in the HSV color space. Edge linking by using simple continuity criteria.

An active contour is essentially a curve made up of various energies. The curve deforms dynamically to mould to the shape of a targeted object. There are various methods for implementing an algorithm to achieve object outlining. The energies in the active contour can be divided into two categories. Internal and External energy functions which have the relationship. The Internal energy functions specialize in the intrinsic properties of the contour like snap and curvature, whereas the external energy functions are associated with the image properties like distinction and brightness.

Esnake = Einternal + Eexternal

These energy functions area unit then given varied weightings to manage the various properties of the contour that area unit crucial for an honest match of object define. These weightings have the effect of controlling the rate at which the contour minimizes and most importantly stop the contour from further shrinking once the outline of the object is tracked. This is known as the final approximation of the contour Energies contained in the contour, are minimized due to simulated forces acting upon it. When all the forces involved are at equilibrium, the contour has essentially reached its minimal state and the outcome of the curve is the final approximation of the object outline.

B. 3d lesion surface reconstruction

3D reconstruction is essential to estimate depth of the skin lesions. The computerized dermoscopy system adopts this technique to estimate the depth in dermoscopic images. Depth map obtained is fit to the underling 2D surface to enable 3D surface reconstruction. The 3D surface constructed is represented as structure tensors.

1) Depth map construction

Defocus estimation is an important process. Then the defocus is measured during a implicit or explicit deblurring process. We estimate the defocus blur at edge locations. An edge is re-blurred using a known Gaussian kernel method so the quantitative relation between the gradient magnitude of the step edge and its re- blurred version is calculated. The ratio is maximum at the edge location. Using the maximum value, we can compute the amount of the defocus blur at the edge location. The defocus blur estimation method described in previous step produces a sparse defocus map. In which ,we provided a way to propagate the defocus blur estimates from edge locations to the entire image and obtain a full depth map d(x). To achieve this, we want to seek a defocus map d(x) which is close to the sparse defocus map at each edge location. Here, apply the matting Laplacian to perform the defocus map interpolation.

2) Tensor structure representation of lesion surface

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Three dimensional legion surface S is represented as $S : A \subset D^3 \mapsto D^2$. Where D^3 is the three dimensional space in which A lies. A point A is represented as (X_A, Y_A, D (X_A, Y_A)) where D (X_A, Y_A), represents the depth map. The legion reconstruction is achieved as a gradient descent of the depth map based energy function. The 3D lesion reconstructed is considered as a structure tensor T defined as $T = \nabla D^{\rho} . \nabla D$.

Let ℓ represents a tangential space obtained from the depth map. The structure tensor obtained is used to compute 3D skin lesion features.

C. *Feature extraction & selection*

Feature extraction is the process of converting input data into set of features. Features are distinctive properties of input patterns that help in differentiating between the categories of input patterns. Feature plays a very important role in the area of image processing. Before getting features, various image preprocessing techniques like binarization, thresholding, resizing, normalization etc. are applied on the sampled image. Then various feature extraction methods are applied to the images that are useful for classification. Feature extraction techniques are helpful in various image processing applications e.g. character recognition. As features define the behaviour of an image, they show its place in terms of storage taken, efficiency in classification and obviously in time consumption also. Mainly color, 2D shape, 3D shape and texture features are extracted.

Color characteristics are often used by dermatologists to classify skin lesions. According to dermatologists melanoma skin lesions are characterized by variegated coloring. The variegated coloring induces high variance in the red, green and blue color space. Red, green and blue component data of the pixels in the segmented skin lesion is stored as vectors. The mean and variance of each channel is computed. To capture complex non-uniform color distributions within the skin lesion, mean ratios of the mean values is computed. Variations in color of the skin lesion with respect to the surrounding skin are also considered as color features.

To extract the texture features the segmented skin lesion image is converted to grey scale. Haralick-features are adopted to obtain the texture characteristics of the skin lesion. Considering applicability of the computerized dermoscopy system to classify even low quality skin lesion images, Haralick texture features is considered.. Texture features are computed using graytone spatial-dependence matrices .Shape, border and asymmetry features are considered as 2D shape features in the computerized dermoscopy system. A total of eleven 2D shape features are extracted from the segmented skin lesion images. The maximum, minimum and average or relative depth feature is extracted from the 3D skin lesion reconstructed. In addition seven Hu invariants and three affine moment invariants are adopted to characterize 3D shape features of the skin lesion.

1) *Feature Selection*

Feature selection, generally is identifying an optimized subset of features extracted that imparts highest discriminating power to the decision making mechanism adopted. In the computerized dermoscopy system color, texture, 2D shape, and 3D shape features of skin lesion images are extracted. Apart from imparting discriminating power, feature selection is adopted to study the impact of color features, texture features, 2D shape features, 3D shape feature and their combinations to classification of skin lesions.

D. *Classification*

Skin lesion classification is the final step of computerized dermoscopy system. In this, three different classes of classifiers i.e. SVM, AdaBoost and the recently developed bag-of features classifiers are adopted. The classifiers adopted are also referred to as decision making mechanisms. Classification broadly involves two phases namely training and testing.

In the training phase the classifiers learn from the training set S. Feature properties with respect to the classes are derived in the training phase. In the testing phase, classify test data R. Based on the feature properties observed in training, the decision making mechanisms T classifies a test image I_T represented by feature set F_T as the resultant class C_T . Skin lesion data is complex in nature and cannot be considered as a global model. In the BoF decision making mechanism, skin lesion data is considered as a combination of individual feature models rather than the complete feature set. The BoF classifier exhibits promising results when adopted for complex image analysis. Therefore, the BoF classifier was deemed applicable to solve our skin lesion classification problem. The capability to train a strong classifier from a combination of weak classifiers and appropriate feature selection capabilities exhibited by the

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AdaBoost algorithm motivated the authors to consider its inclusion in the system. SVM classifiers are robust, simple to implement and provide high degree of classification accuracy. A Gaussian radial basis function (RBF) kernel is considered in the computerized dermoscopy system. The RBF kernel assists in deriving complex relations between the skin lesion classes and complex nonlinear skin lesion data represented as a feature vector space. A linear kernel is a special case of the RBF kernel, hence the authors have considered to adopt a RBF kernel in the SVM classifier.

The below diagram gives the brief idea of the procedures used in the 3D Reconstruction Technique for Computerized Dermoscopic Skin Lesion Classification system. The main contributions of the study is summarized as follows

1. 3D reconstruction from 2D dermoscopic images using depth estimation.
2. 3D shape features considering the 3D lesion constructed.
3. Considering different algorithms for multiclass decision making.
4. Comprehensive skin lesion data considered in the study namely melanoma, in-situ melanoma, atypical nevus, common nevus, basal cell carcinoma, blue nevus, dermatofibroma, haemangioma, seborrhoeic keratosis and normal mole lesions.

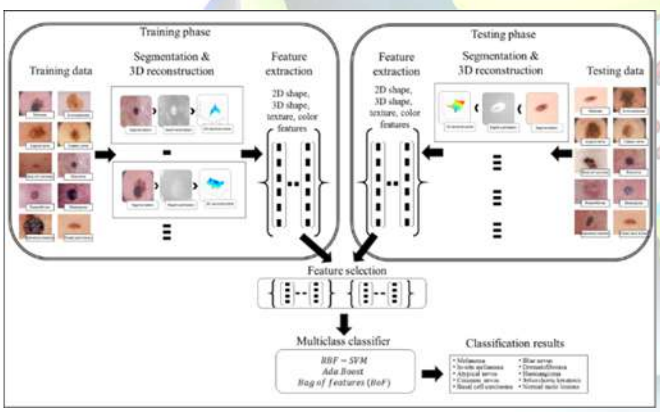

Fig 1.overview of the system

IV. Conclusion

Depth is an important factor to diagnose skin cancers. The 3D reconstruction method found the relative depth of the tumor. It increases the efficiency of the system. After preprocessing and segmentation, it made 3D reconstruction of the 2Dimage .The SVM classifiers are used for classification.

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