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Melanoma Identification with Content based Image Classification using Bit Plane Features

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Abstract*: Augmented episodes of melanoma, a curable skin cancer variety of antagonistic nature, have stimulated the advancements in designing systems for computer aided diagnosis of the disease. Clinical diagnosis includes primary vetting of the symptoms followed by a biopsy and necessary medical examinations. However, computer based classification of the clinical images of dermoscopy have the potential to diminish the exertion of the dermatologist by offering a computer aided opinion independent of medical know-how. Assorted methods are proposed in recent times including the deep learning techniques for computer based melanoma recognition. But, most of the techniques have enhanced computational overhead which has added to the computational complexity of the entire system. In this work, the authors have attempted to design light-weight feature extraction techniques from high level bit planes of dermoscopic images by ignoring the noisy slices of bit planes for robust feature extraction. The proposed method of feature extraction is tested with three different classifiers for specificity and sensitivity outputs of the dermoscopic images. The results of classification have outclassed the performance of state-of-the-art feature extraction techniques.

***Keywords*: Medical Imaging; Classification; Melanoma; Dermoscopy; Bit Plane; uLBP; Binarization**

I. INTRODUCTION

The unrestrained expansion of cells named melanocytes results in a category of skin cancer popularly known as melanoma [1]. It causes premature deaths due to its insistent nature and uninhibited spread. It is recorded to be the most widespread category of skin cancer with an endurance rate of 5 years for delayed identification. The tumour formed due to incessant escalation of the melanocytes results in malignant form of cancer. However, it is observed that the cancer is curable in 99% of the cases if recognised before time with a 5 year interval for survival [2].

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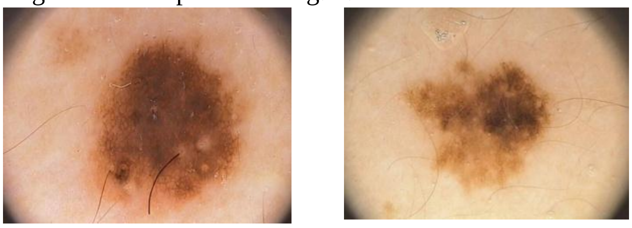
Thus, it is the need of the hour to devise precise schemes for early identification of melanoma to help the society fight against this deadly cause. Identification of skin lesions can be comfortably carried out with sophisticated imaging techniques in contemporary times. A non-invasive imaging technique for skin, readily referred as dermoscopy, is commonly used for preliminary inspection of skin disease by the dermatologist [3]. This imaging technique extends an improved observation of skin lesions by diminishing the interference of skin reflection and using elevated magnification aspect as in Fig. 1.



(a) (b)

Fig. 1. Example of dermoscopic image

However, getting clinical attention consumes considerable amount of time in most of the cases resulting in delayed care of the patient. This issue can be addressed by formation of an automated system capable of accountable melanoma detection without wasting time in traditional medical formalities. Recent literature has highlighted the importance of such a system with utmost significance.

This work has considered a public dataset offered by Dermatology Service of Hospital Pedro Hispano, Matosinhos, Portugal. The dataset is prepared with dermoscopic images taken under identical circumstances with a 20x magnification factor. The resolution of the images is 768*560 pixels and they are 8-bit RGB images [4].

Thus, the paper has the following objectives:

- Developing a technique for melanoma detection based on dermoscopic images
- Extracting smaller dimension and robust feature vector to facilitate malignancy identification with minimum delay and maximum accuracy
- Comparison of results to the state-of-the-art

The images are tested for content based image classification to identify the malignant and the benign cases separately. Feature extraction techniques resulting in small dimension feature vector are developed in this approach for faster convergence of classifiers with least computational overhead.

The results with the proposed techniques are compared to benchmarked technique and our method reveals superiority.

The organization of the paper is as follows. Introduction of the topic is followed by review of Related Work. Our approach is discussed in the subsequent section. Further, the outcomes are compared in Results and Discussions. Final section of the paper is the Conclusions of the research work.

II. RELATED WORK

Recent literature has covered assorted system configurations for recognition of melanoma. Diagnosis Systems imitating the workflow of dermatologists usually perceive and extract various dermoscopic arrangements [5] [6]. Nevertheless, majority of the systems have pursued stepwise approach of pattern recognition involving image segmentation, descriptor extraction and classification [7] [8]. Shape features are observed to be the most dominant type of descriptors extracted in the aforesaid techniques [9]. Combination of local and global features is also exploited in computer aided diagnosis [10]. Handcrafted feature extraction using wavelet decomposition on texture feature is combined to the geometric and boundary features of the lesions [11]. Feature fusion is carried out with Bag of Features in many of the researches of dermoscopic image classification [12]. The colour feature is also well utilized as a significant descriptor to identify the malignancy of the melanoma [13].

Deep learning based techniques have helped in dynamic feature learning procedure. Several ways of learning features in automated manner is adopted, namely, supervised, unsupervised and semi supervised learning [14] [15]. However, the techniques demand complex computations and high computational resources. The feature extraction may last for considerable amount of time, sometimes more than a month. Thus, the process often results in high computational overhead and late detection in case of emergency. Moreover, end to end classification with small datasets has every possibility of overfitting in classification results.

Different classifiers are effectively deployed to categorize melanoma images based on extracted features from dermoscopic images. Support Vector Machine (SVM) is applied on features extracted with histogram of oriented gradients (HOG) [16]. Extracted corner and geometric descriptors are used efficiently to train SVM [17]. A dual stage implementation of classification of melanoma images is carried out with random forest classifier [18].

This paper has carried out feature extraction of dermoscopic images to test the classification performances with three different classifiers, namely, Support Vector Machine (SVM), Random Forest (RF) and Logistic Model Tree (LMT). The results have shown high specificity and sensitivity and have surpassed the existing outcomes.

III. OUR APPROACH

We have considered PH^2 dataset for this work which consists of 200 images including images comprising of 80 common nevi, 80 atypical nevi and 40melanomas. However, in this work we have considered solution of a binary problem only by dividing the dataset images into two categories, namely, malignant and benign. Application of ground-truth segmentation mask is carried out on all the images to take out the smallest square area containing the lesion as in Fig. 2.

(a) Dermoscopic Image **(b) Ground Truth Segmentation Mask** **(c) Smallest square area after applying mask**

Fig. 2. Application of ground truth segmentation mask

Henceforth, the images are applied with bilinear interpolation of 256*256. Data augmentation is carried out with a rotation range of $[-180^o , 180^o]$ on all the images as in Fig.3. In this way, 12 varieties of each training image is created to form a training set of (12*200) = 2400 images.

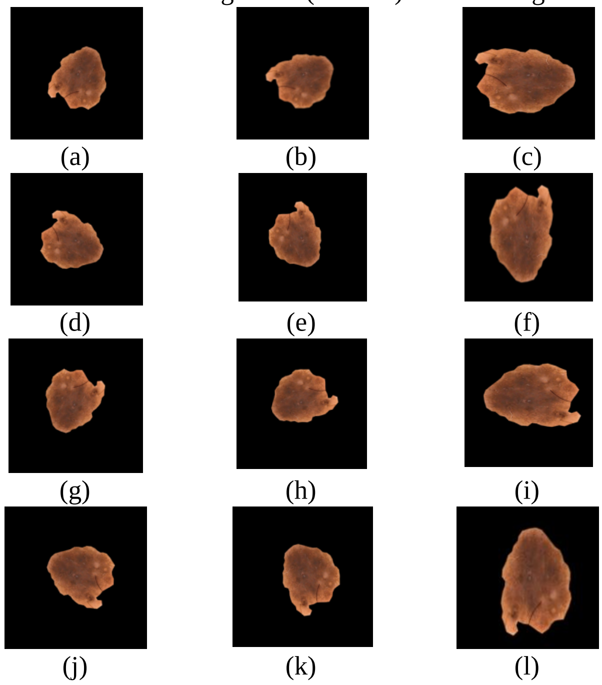


Fig. 3. Image data augmentation with rotation range of [-180o , 180o]

Dermoscopic images are digital images where the involvement of bit planes has an important character to comprehend the role of each bit in configuring the image. Each image in the PH^2 dataset are separated into eight different bit planes of binary matrices to divulge the significance of higher bit planes initiating from bit plane 5 to bit plane 8 as in Fig.4.

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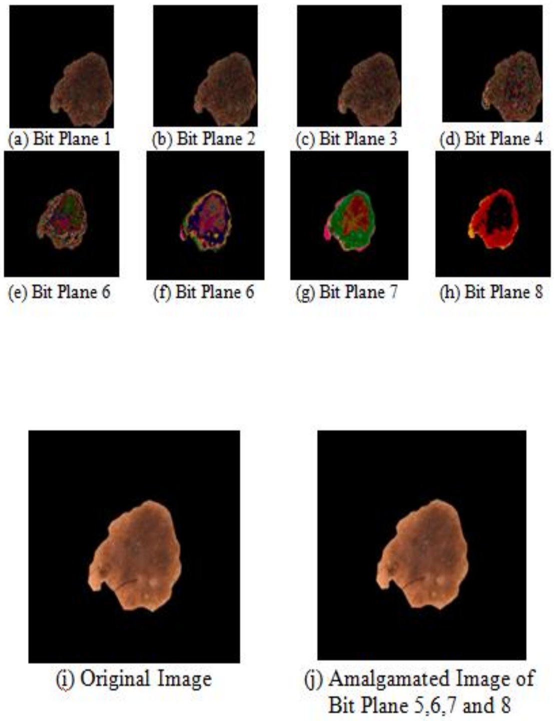

Fig. 4. Example of Bit Plane Slices of Dermoscopic Image and Image formation with High Level Bit Planes

The noisy lower bit planes are not considered and the images for feature extraction are prepared by combining bit plane 5 to bit plane 8. This is done to extract robust feature vectors from significant image bits resulting in higher classification accuracy.

Further, two popular feature extraction techniques are applied, namely, Sauvola's local threshold selection and uniform local binary pattern (*uLBP*) on the images formed by amalgamating the four higher bit planes.

Sauvola's local threshold selection has calculated the threshold locally for each image by sliding a rectangular window and binarizing the area covered by it. The threshold selection process is repeated for bit planes extracted from three basic colour components, namely, Red (R), Green (G) and Blue (B) of each image separately. The window is moved over the entire image. Finally, the grey values corresponding to *1's* and *0's* in the binarized image are identified to form two separate clusters. The mean of gray values for each of the clusters are considered as feature vectors for each colour component which forms two features. Thus, for three colour components the number of features sums upto *1*6* per image.

In case of *u*LBP feature extraction, each RGB-image is primarily converted to grey image before bit planes are extracted. Thereafter, the feature extraction technique is applied to form a feature size of *1*59* per image.

The extracted features are evaluated with three different classifiers, namely, Random Forest, LMT and SVM. The classification is carried out with 10 fold cross validation. The metrics for measurement of classification results are given by Specificity as Sensitivity as in equations (1) and (2).

$$Specificity = \frac{correctly..identified..benign..cases}{all..benign..cases} \quad (1)$$

$$Sensitivity = \frac{correctly..identified..malignant..cases}{all..malignant..cases} \quad (2)$$

IV. RESULTS AND DISCUSSIONS

The experimental setup comprises of a system with core *i5* processor and *Matlab 2015b*. A data mining tool named *Weka* is used to derive the confusion matrix for calculating specificity and sensitivity of the dermoscopic images.

The comparative results using three different classifiers, namely, Random Forest, LMT and SVM for two different feature extraction techniques are given in Fig.5.

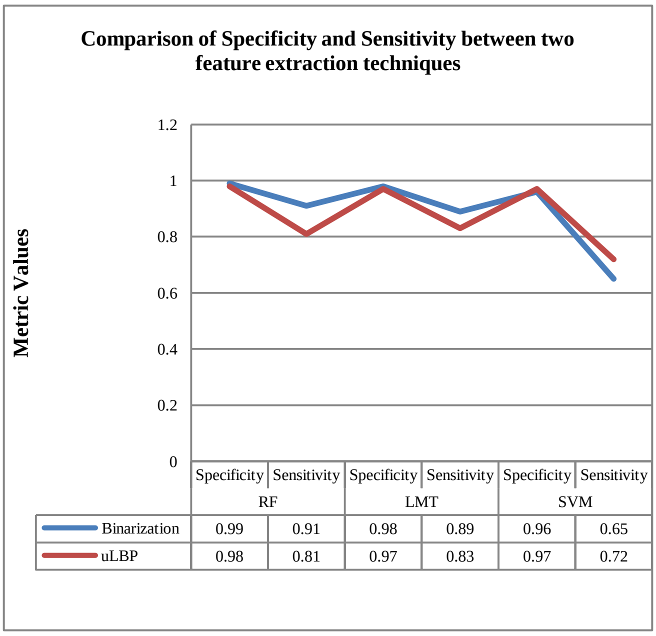

Fig. 5. Comparison of Classification Results for two feature extraction techniques

The results clearly revealed that the binarization technique has outclassed the performance of *u*LBP and has shown improved specificity and sensitivity.

Further, we have compared the results of our proposed technique to that of the state-of-the-art in Fig.6.

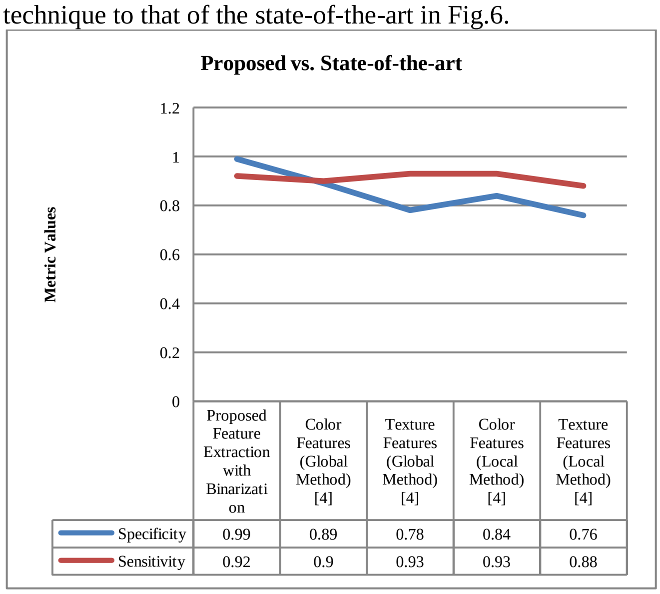

Fig. 6.Comparison of Classification Results of the proposed technique to state-of-the-art

The assessment in Fig. 5 has divulged higher specificity and sensitivity outcomes with the proposed technique compared to the benchmarked.

V. CONCLUSION

The crucial role of bit planes to facilitate robust feature extraction is highlighted in this paper. The benchmarked result in previous literature is evaluated by directly extracting feature vector from images, without dividing them into bit planes. Our approach of extracting feature vector from images created with combination of higher bit planes by discarding noisy lower bit planes has showcased improved performance in malignancy detection of melanoma.

Moreover, the extracted features in our technique are lightweight and can be easily used in real time application without worrying about computational overhead and time complexity. Thus, we have successfully extracted low dimension robust descriptors which have resulted in higher classification accuracy compared to state-of-the-art. The method discussed in this paper can be significantly instrumental in early detection of melanoma. This can reduce the mortality rate for this deadly disease and can contribute towards a sustainable society.

REFERENCES

1. 1. D. Schadendorf et al., Melanoma. Nature Reviews Disease Primers. 1, 2015, doi:10.1038/nrdp.2015.3.
2. 2. S. Sabbaghi, M. Aldeen, R. Garnavi, A deep bag-of-features model for the classification of melanomas in dermoscopy images. In: 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2016, doi: 10.1109/EMBC.2016.7590962
3. 3. M. E. Celebi et al., A methodological approach to the classification of dermoscopy images. Computerized Medical Imaging and Graphics. 31, 362–373, 2007
4. 4. C.Barata, M.Ruela, et al., Two Systems for the Detection of Melanomas in Dermoscopy Images using Texture and Color Features, IEEE Systems Journal, no. 99, pp. 1-15, 2013
5. 5. R. J. Friedman, D. S. Rigel, a W. Kopf, Early detection of malignant melanoma: the role of physician examination and self-examination of the skin. CA: a cancer journal for clinicians. 35, 130–151, 1985.
6. 6. M. E. Celebi, H. Iyatomi, G. Schaefer, W. V. Stoecker, Lesion border detection in dermoscopy images. Computerized medical imaging and graphics : the official journal of the Computerized Medical Imaging Society. 33, 148–153, 2009
7. 7. P. G. Cavalcanti, J. Scharcanski, Automated prescreening of pigmented skin lesions using standard cameras. Computerized Medical Imaging and Graphics. 35, 481–491, 2011
8. 8. I. Giotis et al., MED-NODE: A computer-assisted melanoma diagnosis system using non-dermoscopic images. Expert Systems with Applications. 42, 6578–6585, 2015
9. W. Hugo et al., Genomic and Transcriptomic Features of Response to Anti-PD-1 Therapy in Metastatic Melanoma. Cell. 165, 35–44. 2016
10. 10. C. Barata, M. E. Celebi, J. S. Marques, Melanoma detection algorithm based on feature fusion. Proceedings of the Annual International Conference of the IEEE Engineering in Medicine and Biology Society, EMBS. 2015–Novem, 2653–2656, 2015
11. 11.S. Ross-Howe, H. R. Tizhoosh. The Effects of Image Pre-and Post-Processing, Wavelet Decomposition, and Local Binary Patterns on U-Nets for Skin Lesion Segmentation. arXiv preprint arXiv:1805.05239, 2018
12. 12.S. Chakraborty, K. Mali, S. Banerjee, K. Roy, D. Saha, S. Chatterjee, S.Majumder, Bag-of-features based classification of dermoscopic images. In: 4th. International Conference on Opto-Electronics and Applied Optics (Optronix), pp. 1-6. IEEE, 2017
13. 13.C. Barata, M. E. Celebi, J. S. Marques, Improving dermoscopy image c lassification using color constancy. IEEE Journal of Biomedical and Health Informatics. 19, 1146–1152 (2015)
14. 14.A. Esteva et al., Dermatologist-level classification of skin cancer with deep neural networks. Nature. 542, 115–118, 2017
15. 15.Codella, Noel CF, Q-B. Nguyen, Sharath Pankanti, D. A. Gutman, Brian Helba, A. C. Halpern, and John R. Smith. Deep learning ensembles for melanoma recognition in dermoscopy images. IBM Journal of Research and Development 61, no. 4 , 5-1, 2017
16. S. Bakheet, An SVM Framework for Malignant Melanoma Detection Based on Optimized HOG Features. Computation. 5, 4, 2017
17. 17.A. Shereen, H. GholamHosseini, R. Sinha. SVM classifier on chip for melanoma detection. In: 39th Annual International Conference of Engineering in Medicine and Biology Society (EMBC), IEEE, pp. - 270-274, 2017.
18. 18. M. Silveira et al., Comparison of segmentation methods for melanoma diagnosis in dermoscopy images. IEEE Journal on Selected Topics in Signal Processing. 3, 35–45, 2009

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