Enhanced classification of malignant melanoma lesions via the integration of physiological features from dermatological photographs

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Outline

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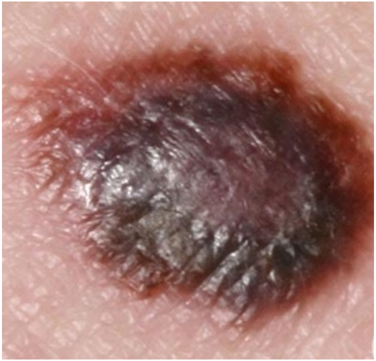
Contributions to State of Art

Results

Conclusion and Future Work

Dermatological Images



Skin Cancer Diagnosis using Dermatological images

ABCD(E) Visual assessment by dermatologist looking at the topologically visible features of the lesion before proceeding with biopsy.

- Asymmetry
- Border irregularity
- Colour variegation
- Diameter
- Evolution

Skin Cancer Diagnosis using Dermatological images

ABCD(E) The visual method suffers from[1]:

- Clinician subjectivity
- Low sensitivity

[1] G. Argenziano, H. P. Soyer, S. Chimenti, R. Talamini, R. Corona, F. Sera, M. Binder, L. Cerroni, G. De Rosa, G. Ferrara et al., Dermoscopy of pigmented skin lesions: results of a consensus meeting via the internet, Journal of the American Academy of Dermatology, vol. 48, no. 5, pp. 679-693, 2003.

Skin Cancer Diagnosis using Dermatological images

Automated diagnostic methods utilize extractable features from dermatological images

[2] P. G. Cavalcanti and J. Scharcanski, Automated prescreening of pigmented skin lesions using standard cameras, Computerized Medical Imaging and Graphics, vol. 35, no. 6, pp. 481-491, 2011.

[3] R. Amelard, A. Wong, and D. A. Clausi, Extracting high-level intuitive features (hlif) for classifying skin lesions using standard camera images, in Computer and Robot Vision (CRV), 2012 Ninth Conference on. IEEE, 2012, pp. 396-403.

[4] P. G. Cavalcanti, J. Scharcanski, and G. V. Baranoski, A two-stage approach for discriminating melanocytic skin lesions using standard cameras, Expert Systems with Applications, vol. 40, no. 10, pp. 4054-4064, 2013.

Skin Cancer Diagnosis using Dermatological images

Automated diagnostic methods utilize extractable features from dermatological images

LLF Low level image features $(S_L)^2$

- Numerous features extracted using existing image processing techniques

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Automated diagnostic methods utilize extractable features from dermatological images

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HLIF High level intuitive features (S_H)[3]

- Features extracted for the specific application of being compared against ABCD(E) criteria

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PF Physiological features (S_P)[4]

- Extracting physiological features from lesion colour in dermatological photographs

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Skin Cancer Diagnosis using Dermatological images

Hybrid Models of feature sets have been proposed to improve classification accuracy

- S_C Combining the LLF and PFs proposed by Cavalcanti *et al.*
- S_{LH} Combining LLFs and HLIFs

Contributions to State of Art

1. Propose a novel physiological feature set for skin cancer classification in addition to PFs proposed by Cavalcanti *et al.*
2. Present a hybrid feature set that combines LLFs, HLIFs and PFs for improved skin cancer detection performance

Physiological Features

Anatomical knowledge of cutaneous skin cancer

- Overgrowth of melanocytes
- Non-uniform distribution of eumelanin and pheomelanin
- Angiogenesis leading to increased uptake of oxygenated blood

Physiological Features

Anatomical knowledge of cancer motivates the extraction of five features:

- f_1 mean eumelanin concentration inside the lesion
- f_2 mean pheomelanin concentration inside the lesion
- f_3 variance of eumelanin concentration inside the lesion
- f_4 variance of pheomelanin concentration inside the lesion
- f_5 mean blood oxygen saturation inside the lesion

Physiological Feature Extraction

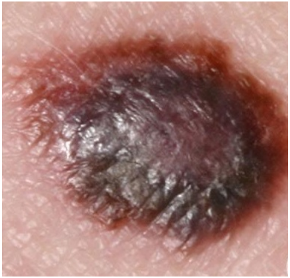
Generate an inverse nearest neighbour model; extension of Cavalcanti *et al.*

Step 1 Using a biophysically-based spectral model for simulating light-human skin interaction proposed by Krishnaswamy and Baranoski [5], varying eumelanin, pheomelanin and blood oxygen saturation levels to produced forward model

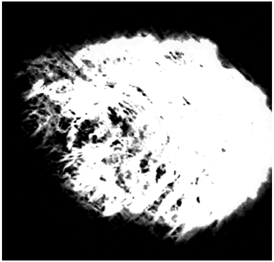
Step 2 Use a nearest neighbour approach for the inverse model to estimate eumelanin, pheomelanin and blood oxygen levels on a pixel-by-pixel basis

[5] A. Krishnaswamy and G. V. Baranoski, A biophysically-based spectral model of light interaction with human skin, in Computer Graphics Forum, vol. 23, no. 3. Wiley Online Library, 2004, pp. 331-340.

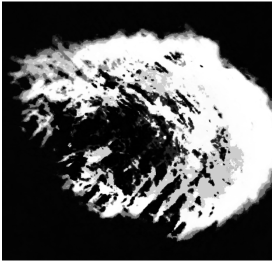
Concentration Maps



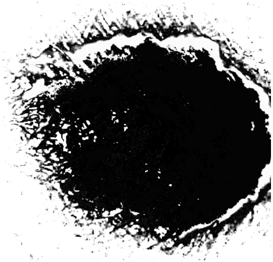
(a) Dermatological photograph



(b) Eumelanin map



(c) Pheomelanin map



(d) Blood oxygen sat. map

Experimental Setup

To determine the performance of the hybrid feature set with the novel physiological features:

- DermIS[6] and DermQuest[7] databases
  - 206 confirmed cases
  - 87 negative cases
- Illumination correction for skin cancer images applied [8]
- Randomly sampled: 90% for training and 10% for testing
- Bayesian classification scheme to assess separability of the classes
- Classes are modelled as conditional multivariate normal distributions
- Testing repeated 50 times

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[6] Dermatology Information System, http://www.dermis.net, 2012, Accessed: 08 Nov 2012.

[7] DermQuest, http://www.dermquest.com, 2012, Accessed: 08 Nov 2012.

[8] R. Amelard, J. Glaister, A. Wong, and D. A. Clausi, Melanoma decision support using lighting-corrected intuitive feature models, in Computer Vision Techniques for the Diagnosis of Skin Cancer, ser. Series in BioEngineering, J. Scharcanski and M. E. Celebi, Eds. Springer, 2013.

Classification Results

Table : Summary of classification results between Cavalcanti *et al.*(S_C) and S_{LP}.

Feature set	Sensitivity	Specificity	Precision	Accuracy
S_C	81.60	71.23	81.06	77.71
S_{LP}	**84.02**	**72.40**	**81.97**	**79.62**

Classification Results

Table : Summary of classification results from the different feature models.

Feature set	Sensitivity	Specificity	Precision	Accuracy
S_L	84.95	70.69	80.93	79.00
S_{LP}	85.96	75.47	83.62	81.76
S_{LH}	85.94	72.07	81.45	80.10
S_{LHP}	**87.73**	**76.34**	**84.38**	**83.05**

Conclusion and Future Work

We have demonstrated improved skin cancer classification performance with the inclusion of additional physiological features and combining LLFs, HLIFs and PFs into a hybrid feature set

Future work:

- Identifying feature contributions and either removing and/or adding additional features for improving classification performance
- Testing rigorously with more advanced classifiers to assess classification performance and prove significance

Funding and Questions

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Questions and correspondences can be sent to

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1 G. Argenziano, H. P. Soyer, S. Chimenti, R. Talamini, R. Corona, F. Sera, M. Binder, L. Cerroni, G. De Rosa, G. Ferrara et al., Dermoscopy of pigmented skin lesions: results of a consensus meeting via the internet, Journal of the American Academy of Dermatology, vol. 48, no. 5, pp. 679-693, 2003.

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