Artificial Intelligence Augmented Skin Imaging using Computer Vision and Convolutional Neural Networks

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Abstract

The onset of Covid-19 has brought with it new challenges for dermatologists. One of them is the contactless diagnosis and treatment of skin cancer. Skin cancer is the abnormal growth of skin cells that is caused due to exposure to excess ultraviolet (UV) radiation from the sun. These rays damage DNA in the skin cells. There are three major types of skin cancer — basal cell carcinoma, squamous cell carcinoma and melanoma. Currently, confocal scanning laser microscopy and dermoscopy are used for the differential diagnosis of benign melanocytic lesions and melanoma. These specialized skin imaging tools allow dermatologists to manually study the pattern of skin lesions in order to identify the type of of skin cancer they are. Computer vision is a field of artificial intelligence which involves pattern recognition using neural networks.Hence, by harnessing the power of computer vision to automatically detect cancerous lesions, dermatologists can provide efficient medical care for skin cancer, quickly and without direct physical contact.

Aim: To use artificial intelligence to develop a smart skin imaging application that understands the skin's reaction to the sun by categorizing it into it's Fitzpatrick phototype with an accuracy of at least 75% and subsequently for the automatic, contactless diagnosis of skin cancer with an accuracy of at least 85% using low resolution images of skin lesions taken with a mobile device.

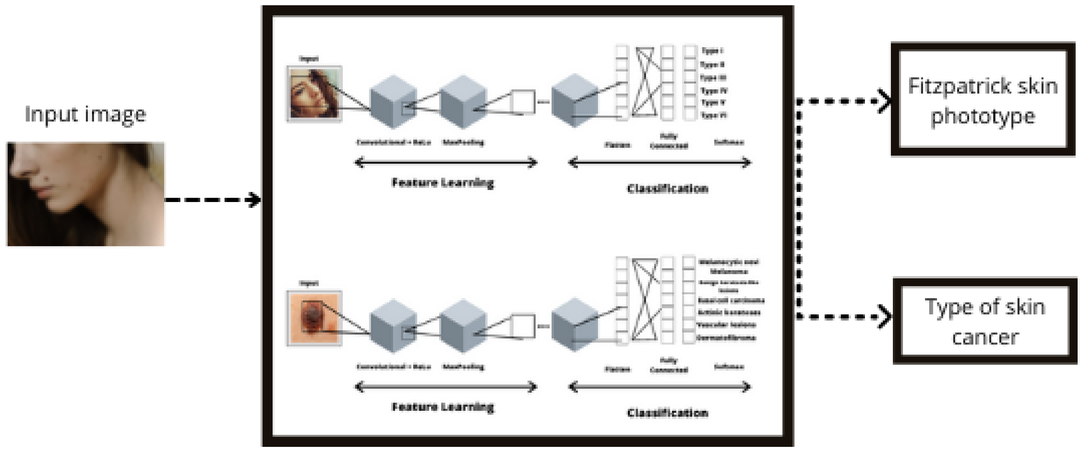
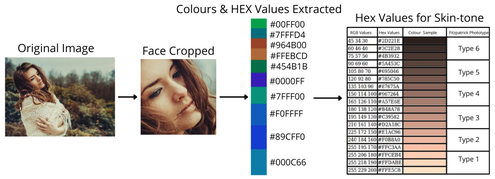


Figure 1: Proposed Methodolgy

Methodology

Figure 2: K-means Methodology



The color pixels were extracted and their hex values were compared to the skin-tone chart.

1 K-Means

2 Skin Segmentation

The threshold values were set according to the skin-tone chart and bounding boxes appear around the regions containing these values.

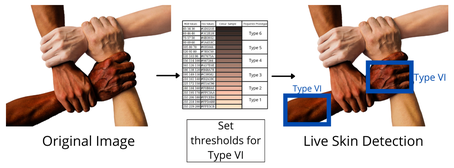
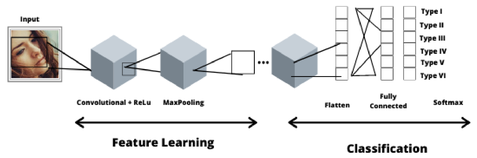


Figure 3: Skin Segmentation Example

Figure 4: Fitzpatrick Skin Phototype Classifier based on Ethnicities



Ethnicities were categorized into Fitzpatrick skin phototypes and used as the target variables for a convolutional neural network.

3 Fitzpatrick Skin-tone Classifier based on Ethnicity

4 Skin Cancer Classifier

Skin cancer types were used as target variables for a convolutional neural network.

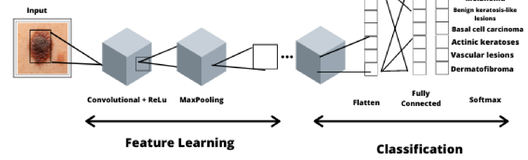


Figure 4: Skin Cancer Classifier

Results

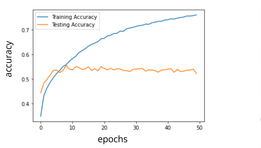


Figure 5: Fitzpatrick Skin Phototype Classifier Performance

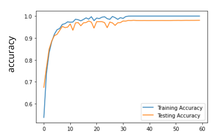


Figure 6: Skin Cancer Classifier Performance

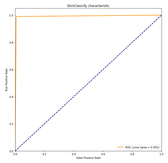


Figure 7: Skin Cancer Classifier ROC

In this study, we used three different methods to categorize skin phototypes into their Fitzpatrick skin phototypes. We used a k-means machine learning algorithm with 5 clusters, skin segmentation and a convolutional neural network. For the skin cancer detection feature of the software application, we used a convolutional neural network.

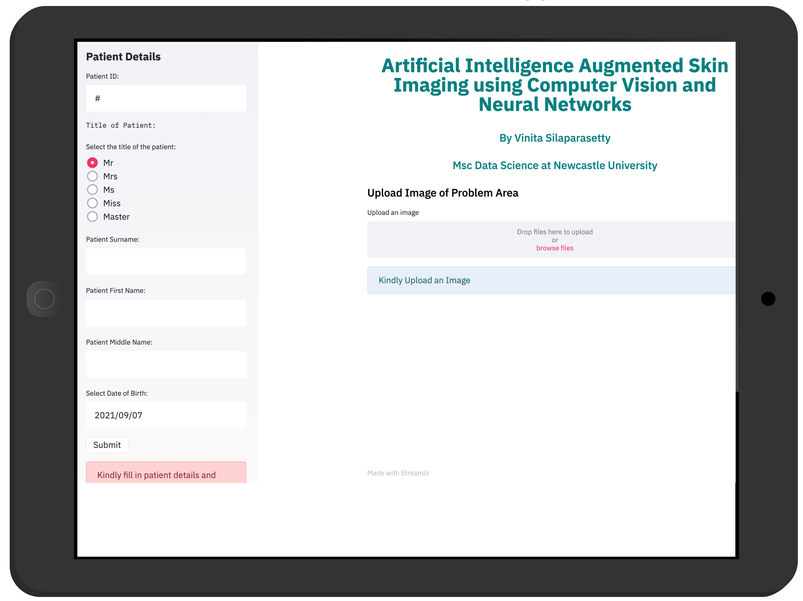
A standardized set of color values for different ethnic groups are required in order to get good results from the k-means model and the skin segmentation method.For the classifier based on ethnicity, we proved that it is possible, but more data pre-processing needs to be done in order to improve the model performance. We recommend extracting the pixel values from the images and using them to train the neural network.The skin categorization feature was not included in the final prototype as satisfactory results could not be achieved within the required time.
The skin cancer detection feature of this application exceeded expectations, by achieving 98\% test accuracy.

Conclusion

The data set included individual masks for each image. Perhaps if the masks had been applied, the performance could have achieved an accuracy over 98\%.
This prototype could benefit from additional features which we intend to add in the future:

- A progress tracking feature which allows the dermatologist to store information from the patient about their lesion over a period of time.
- A biological age detection feature. The biological age of skin has an impact on the vulnerability of a patient to skin cancer.
- A feature to monitor the amount of time the patient spends in the sun, particularly how much ultraviolet radiation the patient is exposed to .This would greatly help with reducing the risk of skin cancer.

Screenshot of Prototype



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