TEST Engineering & Management

May-June 2020
ISSN: 0193-4120 Page No. 3794-3799

Full Convolutional Networks for Skin Lesion Detection and Prediction of Melanoma Skin Cancer

[1]Ravi Dandu, [2]Jayakameshwaraiah M

[1, 2]Assistant Professor, School of Computer Science and Applications, REVA University, Bengaluru

Article Info
Volume 83
Page Number: 3794-3799
Publication Issue:
May-June 2020

Article History
Article Received:*19 November 2019*
Revised: *27 January 2020*
Accepted: *24 February 2020*
Publication: *12 May 2020*

Abstract

We present an algorithm to perform the task of detection of skin lesions and further processing to classify the segmented portion of skin lesions into different classes like Benign and Malignant. The proposed algorithm carries out the segmentation and detection of skin lesion by analyzing the boundaries of lesion regions having exhibited the properties of boundaries. The algorithm consists of different stages of operations like finding the boundaries of skin lesions by analyzing the pixel information gathered from images of a dataset. Further, the proposed algorithm finds the regions exhibiting the properties of boundary or edges of an object. The part one of the research is to determine the portion of regions with edges and boundaries along with convolution and subsampling. Part two of the proposed method is to determine the portion of image with up-sampling and classification by soft-max function. Thereby segmented portion of images are further subjected to tasks like features extraction and classification. The features are extracted from images by segmented portion are processed with different layers similar to VGG-16. The layers and blocks of 16 layers together contribute to the features extraction and features classification of images into different classes of skin lesions. The proposed Full Convolutional Neural networks have achieved an accuracy of 81.33% on a benchmark dataset with few contribution towards robustness. The proposed method has out-performed the results of other existing contemporary methods.

Index Terms**:** *Lesion Segmentation, Features Extraction, Features Classification, Prediction of Melanoma.*

1. Introduction

The research focuses mainly on prediction on skin cancer, as we are facing the problem of having an automated system, which does the task of analyzing and predicting the skin cancers in human beings, we are into the research arena of predicting the melanoma skin cancer by analyzing the medical images. The cancer is quite a dangerous problem in both male and females all over the world. Many research articles like [11], describes the ways of identifying the skin lesions. Especially the skin cancer is quite a big problem and challenging task for medical analysts, as the tissues of skin may very much closely be able to detect whether there is a skin disease or not at the early stages. If the skin cancer is predicted at the early stages by observing the sign of cancer tissue growing in skin, proper treatment shall be given and lives of those individuals may be saved. Thus, we have developed a new method of analyzing, understanding and predicting the skin cancer especially Melanoma Skin Cancer.

This automated system receives an input image and provides whether there is any problems with skins, if so suggests the proper treatment based on the type of skin cancer observed and predicted from processing an image. The Skin cancer is a big problem for doctors and physicians to predict at any early stages of it, as there would not be any kind of information in terms of color or texture based information clearly visible to bare eyes, we need a

May-June 2020
ISSN: 0193-4120 Page No. 3794-3799

system that investigates and analyzes the information of images pixel by pixel. Thereby the problem of skin cancer can be visualized and appropriate steps like treatment can be taken.

The full convolutional neural networks plays a vital role in analyzing and understanding the features of images that exhibits the problem of Skin cancer especially melanoma. The attributes like features are extracted with deep neural networks and features are subjected to the classification by soft-max, the problems of skin cancer shall be predicted with more degree of accuracy. The problem of skin cancer is detected and appropriate stages of skin cancer is predicted with deep convolutional neural networks, Further, the Convolutional neural network has certain processing layers like subsampling and convolution, where the resizing of images are done along with convolution thereby appropriate information shall be gathered from images. The research articles has presented [12] and[14] and other methods mentioned in [13]. The color of images represent some information supportive to signs of melanoma, but the texture combined with color together suggests sufficient information, while extracting the features of an images with high dimensional featured information.

2. Related Work

Segmentation of skin lesion by using bi-directional method [1] has suggested us to determine the region of lesions representing the characteristics of melanoma are detected with upper and lower axis, which has suggested to come with new method of identifying the regions of lesion more easily than other complex methods. Similarly, [5] has suggested us to enabled and inspired us to find a new way of diagnosing the skin cancer diseases with computer aided methods, the same task of diagnosis can be done with machine learning methods with different classifiers like SVM, Naïve Bayes and other existing classification methods. Some of the research article [4] have made a significant contribution towards identifying the skin lesion with less degree of accuracy. Thus, we have proposed a new method of detecting and segmenting the skin lesions from an image.

Further, research articles related to classification of skin lesions into different classes is made with few significant contributions in [2], [3] to enable the physicians to detect and analyze the feature areas of image exhibiting the characteristics of melanoma, but those methodologies have suggested the physicians to make manual use of regions, where exactly the melanoma skin cancer is present. Thus, we have developed a method which does the task of prediction of skin cancer with fully automated approach using deep learning.

3. Proposed Fully Convolutional Networks For Detection Of Lesion And Classification

The Full Convolutional Neural Networks consists of two (2) parts like Part 1 contains Convolution and Sub-sampling layers, Part 2 consists of Up sampling and Soft-max function for classification of extracted data into different classes based on features extracted from an image.

Part-I: Convolution and Sub-sampling

The process of subsampling is done to extract more finely detailed information from an image, as these sampling results in extraction of more information in the form of features vectors. Further, the feature collected from individual images are subjected to singular value decomposition during feature vector representation. Thus, SVD or Singular value decomposition pays a vital role in extracting features of different parameters in the form of vectors. Convolution is another important strategy used in neural networks to find an appropriate information from an image in the form of weights multiplied with features extracted to make a system more efficient. Thus, combination of convolution and subsampling together extracts sufficient information in the form of vectors. The main components of this part I consists of convolution done using '*', kernels, with features of every individual layers as per (1).

$$F_l^m = \varphi(w_l^m * F_{l-1}^m + B_l^m) \quad (1)$$

$$\varphi(x) = maximum(x, 0)\begin{cases} x, if\ x \geq 0 \\ 0, if\ x < 0 \end{cases} \quad (2)$$

Initially, the Given RGB image is converted into Hue, Saturation, and Value (HSV) format to make the system find the pixel values easily and characteristics of every individual pixels based on the nearest neighbors of central pixels of an image within a kernel of different subsampling sizes. We have adopted two techniques like augmentation and learning to detect and identify the features of images of medical data. We have trained our proposed system with the concept of VGG-16 network of data networks on a large image database.

Part-2: Up-sampling and Soft-max

The up-sampling together with soft-max function performs the task of training and classification of images into different classes, as there would be a layers specifically meant for sampling of features obtained from other upper or previous layers. Thus, we have a up-sampling with soft-max function that does the task of training along with classification. The purpose of using up-sampling is to enable the system gain enough information during training stage of every images of a dataset and later to classify the images into different classes.

Performance Evaluation

Some of the parameters considered for evaluation of performance metrics are sensitivity, specificity,

May-June 2020
ISSN: 0193-4120 Page No. 3794-3799

accuracy, precision and recall are few parameters considered for evaluation of performance of proposed method with respect to the other existing contemporary methods

$$Precision = \frac{TPR}{TPR + FPR} \quad (3)$$

$$Recall = \frac{TPR}{TPR + FNR} \quad (4)$$

$$Sensitivity = \frac{TPR}{TPR + FNR} \quad (5)$$

$$Specificity = \frac{TNR}{TNR + FPR} \quad (6)$$

$$Accuracy = \frac{TPR + TNR}{TPR + FPR + TNR + FNR} \quad (7)$$

It is clear from the above equation (3) and (4) that the precision and recall are essentially required to assess the degree of accuracy of segmentation of medical images based on the ground truth results provided by the physicians. The sensitivity and specificity parameters provided in (5) and (6) are sufficient enough to determine the accuracy of classification of medical images into different classes like Benign or Malignant.

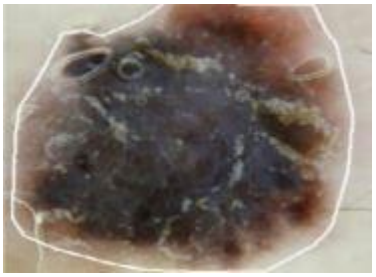
Figure 1: Images of a dataset exhibiting melanocytic lesions

4. Results

The detection of skin lesion is vital in analyzing and predicting the skin cancer, over segmentation may cause unpredicted results and under segmentation makes the system[8], [9], [10] with lack of accuracy. Thus, we need a system that is trained with sufficient information as such the details of images are extracted suitably and appropriate predictions are to be made with different classifiers with different classes like Benign or Malignant.

It is clear from the below Fig.1 that one of the images of a dataset is very clearly describing how well the proposed method has segmented the lesions and classification is made with it.

(a)



(b)

Figure 2: The detected lesion in the form of irregular shapes. (a) an image of a dataset exhibiting the characteristics of lesion and its is detected with proposed method. (b) indicates the detection of lesion with our proposed convolutional networks method.
The regi
on of skin lesion of black color is segmented and detected during the process of classification.

(a) (b) (c)

Figure 3: Proposed method with different stages like (a) input images fed to the system. (b) Representing the binarization of an input image. (c) Presents the detection of skin lesions with our proposed method.

The fig.3 shows the different stages of segmentation, which includes preprocessing, binarization and detection of melanoma skin cancer region with region of interest.

May-June 2020
ISSN: 0193-4120 Page No. 3794-3799

Table 1: Representation of erected methods vs. other contemporary methods in term of a metric sensitivity and specificity.

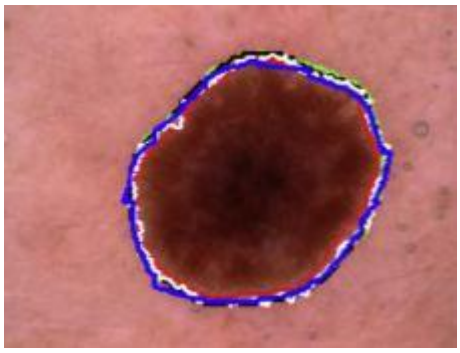
No	Methods	Sensitivity	Specificity
1	X. Li et.al [2]	78.94	81.32
2	N Tajbaksh [5]	79.31	84.67
3	Z Gu et.al [9]	80.15	85.63
4	W Shao et.al [21]	84.76	88.96
5	**Proposed FCN based Skin Lesion Detection and Prediction**	**90.15**	**89.68**

Detection of lesions of irregular shapes are predicted accurately with proposed full convolutional neural networks has led to the task of extracting the feature like ABCDE of skin. Thus, by extracting the ABCDE features in addition to various other vital features of it. A-Asymmetry, B-Border, C-Color, D-Diameter, and E-Evolving. The degree of accuracy shall be seen in[6] and [7].

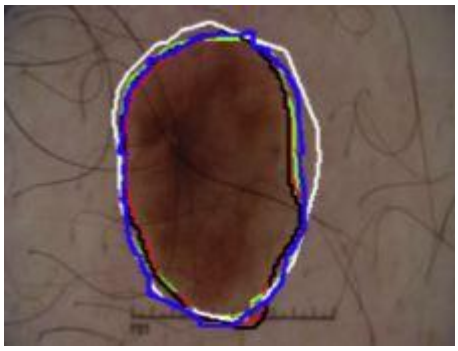
Table 2: Representation of erected methods vs. other contemporary methods in term of a metric Segmentation Accuracy with ground truth results

No	Methods	Accuracy
1	X. Li et.al [2]	80.16
2	N Tajbaksh [5]	83.47
3	Z Gu et.al [9]	88.91
4	W Shao et.al [21]	89.72
5	**Proposed FCN based Skin Lesion Detection and Prediction**	**90.67**

It is evident from the above table 1 and table 2 that the metric sensitivity vs. specificity is more essentially required for measuring the effectiveness of the erected method with respect to the contemporary methods. Further, Accuracy is another metric used to measure the efficiency of the emulated approach vs. other recent methods.



(a)



(b)

Figure 4: Detection of lesions with our proposed method with different parameters like Asymmetry, Boundary, Color, Diameter and Evolving are shown below.

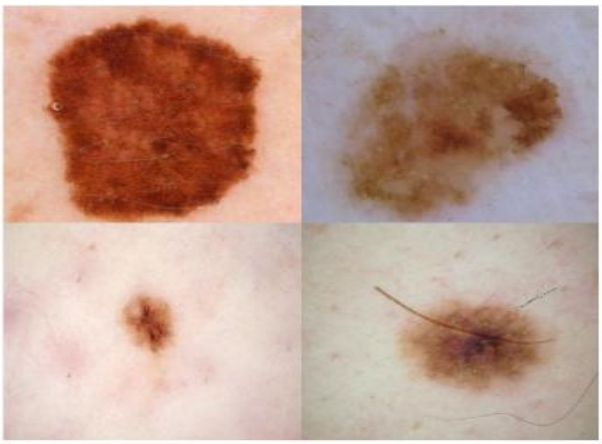


Figure 5: The result of processing of image of fig.1 on proposed method

5. Discussion

The proposed method shall be visualized in two phases, phase 1with segmentation or detection and phase 2 classification of skin lesion into different classes based on features collected from features extraction. The degree of accuracy of segmentation is determined by comparing the segmented portion of an

May-June 2020
ISSN: 0193-4120 Page No. 3794-3799

image with ground truth, where the ground truth is the actual area of lesion and segmented portion of skin lesion is the automated output of a system, thus, the system will be able to compare the degree of accuracy of segmentation with ground truth results provided by physicians. Phase 2 includes classification of results into different classes like Benign or Malignant, where Benign indicates there is no cancerous tissues found on skin region and Malignant represents that there is a sign of cancerous tissues in images. The classification of images into different classes is subjected to verification with actual information provided along with the dataset to measure the degree of accuracy.

6. Conclusion

The proposed research wok has focused on segmentation and classification of detected object into two (2) different classes like benign or malignant. The Benign indicates the detected portion of skin is not harmful, whereas the Malignant indicates that there is a risk of presence of melanoma skin cancer tissues. The proposed method not only focused on features like texture, it has also focused on various other features like Asymmetry, Boundary, Color, Diameter and Evolving are some of the features considered for prediction of skin lesion into two different classes. Thus, the proposed method has yielded a good accuracy of 81.33% over a bench mark images of a dataset.

References

[1] I. Z. Apostolakis, G. M. Karageorgos, P. Nauleau, S. D. Nandlall and E. E. Konofagou, "Adaptive Pulse Wave Imaging: Automated Spatial Vessel Wall Inhomogeneity Detection in Phantoms and in-Vivo," in *IEEE Transactions on Medical Imaging*, vol. 39, no. 1, pp. 259-269, Jan. 2020. doi: 10.1109/TMI.2019.2926141

[2] C. Qin, J. Schlemper, J. Caballero, A. N. Price, J. V. Hajnal and D. Rueckert, "Convolutional Recurrent Neural Networks for Dynamic MR Image Reconstruction," in *IEEE Transactions on Medical Imaging*, vol. 38, no. 1, pp. 280-290, Jan. 2019.

[3] M. Mardani*et al.*, "Deep Generative Adversarial Neural Networks for Compressive Sensing MRI," in *IEEE Transactions on Medical Imaging*, vol. 38, no. 1, pp. 167-179, Jan. 2019.

[4] Q. Yang *et al.*, "Low-Dose CT Image Denoising Using a Generative Adversarial Network With Wasserstein Distance and Perceptual Loss," in *IEEE Transactions on Medical Imaging*, vol. 37, no. 6, pp. 1348-1357, June 2018.

[5] X. Xu, F. Zhou, B. Liu, D. Fu and X. Bai, "Efficient Multiple Organ Localization in CT Image Using 3D Region Proposal Network," in *IEEE Transactions on Medical Imaging*, vol. 38, no. 8, pp. 1885-1898, Aug. 2019.

[6] M. Kim, J. H. Won, J. Youn and H. Park, "Joint-Connectivity-Based Sparse Canonical Correlation Analysis of Imaging Genetics for Detecting Biomarkers of Parkinson's Disease," in *IEEE Transactions on Medical Imaging*, vol. 39, no. 1, pp. 23-34, Jan. 2020.

[7] A. Bousse*et al.*, "PET Reconstruction With Non-Negativity Constraint in Projection Space: Optimization Through Hypo-Convergence," in *IEEE Transactions on Medical Imaging*, vol. 39, no. 1, pp. 75-86, Jan. 2020.

[8] P. Seeböck*et al.*, "Exploiting Epistemic Uncertainty of Anatomy Segmentation for Anomaly Detection in Retinal OCT," in *IEEE Transactions on Medical Imaging*, vol. 39, no. 1, pp. 87-98, Jan. 2020. doi: 10.1109/TMI.2019.2919951

[9] M. Abella, C. Martínez, M. Desco, J. J. Vaquero and J. A. Fessler, "Simplified Statistical Image Reconstruction for X-ray CT With Beam-Hardening Artifact Compensation," in *IEEE Transactions on Medical Imaging*, vol. 39, no. 1, pp. 111-118, Jan. 2020.

[10] L. Shi *et al.*, "Direct List Mode Parametric Reconstruction for Dynamic Cardiac SPECT," in *IEEE Transactions on Medical Imaging*, vol. 39, no. 1, pp. 119-128, Jan. 2020. doi: 10.1109/TMI.2019.2921969

[11] Babu K S, SukantaSabut, Ravi Kumar Y B,"Decision Trees for Segmentation and Assessment of Wound Healing Process of Diabetic Wound Healing Process," Skin ResearchandTechnology,vol.14,no.3,pp.347–353,2008.

[12] R. Schaffert, J. Wang, P. Fischer, A. Maier and A. Borsdorf, "Robust Multi-View 2-D/3-D Registration Using Point-To-Plane Correspondence Model," in *IEEE Transactions on Medical Imaging*, vol. 39, no. 1, pp. 161-174, Jan. 2020. doi: 10.1109/TMI.2019.2922931

[13] L. Guo, M. Li, P. Nguyen, F. Liu and S. Crozier, "Integral MR-EPT With the Calculation of Coil Current Distributions," in *IEEE Transactions on Medical Imaging*, vol. 39, no. 1, pp. 175-187, Jan. 2020. doi: 10.1109/TMI.2019.2922318

[14] A. Kumar, M. Fulham, D. Feng and J. Kim, "Co-Learning Feature Fusion Maps From PET-CT Images of Lung Cancer," in *IEEE Transactions on Medical Imaging*, vol. 39,

May-June 2020
ISSN: 0193-4120 Page No. 3794-3799

no. 1, pp. 204-217, Jan. 2020. doi: 10.1109/TMI.2019.2923601

Authors Profile

Ravi D, Assistant Professor, Holds MCA from VTU, Pursuing Ph.D.in REVA University, Bangalore. Having 12 years of academic experience. He published research papers in International journals and presented papers in various national and international conferences. His areas of interest include Data Science, Data Mining, Machine Learning and Wireless Sensor Networks.

Dr.M.Jayakameswaraiah, was awarded with Ph.D. in Computer Science from Sri Venkateswara University, Tirupati, Andhra Pradesh. He obtained M.C.A from Sri Venkateswara University, Tirupati. He has 10 years of experience in Teaching. His areas of research interest include Data Science, Data Mining, Internet of Things, Cloud Computing, Machine Learning, IoT and Wireless Sensor Networks. He has published 17 research papers in various international journals. He has presented research papers in various national and international conferences.