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## Detection of Melanoma and Skin Diseases Based on the Fusion of Structural and Textural Features Using Convolutional Neural Network

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ABSTRACT: Melanoma is a type of cancer that mostly starts in pigment cells (melanocytes) in the skin. In order to improve the diagnostic performance of melanoma, dermoscopy technique was developed. Dermoscopy or dermatoscopy is a non-invasive skin imaging technique of acquiring a magnified and illuminated image of a region of skin for increased clarity of the spots on the skin. Dermatologists often recommend a regular examination of the skin to identify and eliminate the melanoma in its early stages. To facilitate this process, this project presents an embedded skin cancer classification on a Raspberry Pi. It enables the classification of lesion taken by a Raspberry Pi camera module. It is a dual stage approach which effectively combines Computer Vision on clinically evaluated histopathological attributes for accurate detection of melanoma and other skin diseases. The dual stage approach is based on the combination of two types of features namely Structural features and Textural features. In the first stage, the image of the skin lesion is captured by the Raspberry Pi which has a dedicated camera input port that can record high resolution images. This is subjected to various kinds of pre-processing stages such as color conversion, filtering, contrast enhancement and image quality assessment by deploying open CV using Python language. This stage is followed by structural and textural feature extraction by segmentation using convolution and pooling stages of the Convolutional Neural Network and thereafter classification is performed. Several skin lesion images of patients collected from the ISIC are trained which gives the probabilities of the type of skin cancer. Then actual image is tested by comparing it with the trained images. Hence accurate results are obtained to detect whether the skin disease is benign or malignant or any other type. The output is obtained on a GUI platform and a large number of results of patients can be stored on the server connected to an IP address so that it can be accessed anytime from anywhere by health care professionals, which is a special feature of Raspberry Pi. The ultimate goal of the project is to extend the trained models in a commercial hand-held mobile and sensor device such as Raspberry Pi and democratize the access to preventive Health care.

**KEYWORDS:** Image Processing, Melanoma Detection, Fusion of Structural and Textural features, Convolutional Neural Networks, Raspberry Pi, Open CV.

#### I. INTRODUCTION

Skin is the layer of usually soft, flexible outer tissue covering the body of a vertebrae animal, with three main functions: protection, regulation, and sensation. The skin interfaces with the environment and is the first line of defense from external factors. Melanoma is a type of cancer that mostly starts in pigment cells (melanocytes) in the skin. In order to improve the diagnostic performance of melanoma, dermoscopy technique was developed. Melanoma is the deadliest form of skin cancer. While curable with early detection, only highly trained specialists are capable of accurately recognizing the disease. As expertise is in limited supply, automated systems capable of identifying disease could save lives and reduce unnecessary biopsies. Skin cancer is one of the most common worldwide malignancy. It has been found that over the past three decades, the people diagnosed as skin cancer. Early detection of malignant lesions has great significance for helping the clinicians to improve the chances of survival. Because of the visual similarities of some lesion types, correct diagnosis is a challenging task for clinicians, and is largely dependent on the experience. The survival rate for people with melanoma depends upon when they start treatment. The cure rate is very high when melanoma is detected in early stages, when it can easily be removed surgically. The prognosis is less



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favourable if the melanoma has spread to other parts of the body. As of 2003 the overall five-year cure rate with Mohs' micrographic surgery was around 95 percent for recurrent basal cell carcinoma. Treatment is dependent on the specific type of cancer, location of the cancer, age of the person, and whether the cancer is primary or a recurrence.

#### **II. LITERATURE SURVEY**

For the purpose of Melanoma detection at its early stages, several authors proposed different methods. Abbas *et al.* [12] proposed a matched filtering with first derivative-of-Gaussian method for hair detection. This method shows accurate results, but the multitude of parameters complicates its implementation. Barata *et al.* [13] used a bank of directional filters an Partial Differential Equation (PDE)-based interpolation for hair detection and in painting, respectively. Then, the authors applied a bank of directional filters and connected component analysis to detect the lines of pigment network. Recently, Koehoorn *et al.* [14] proposed a new approach based on thresholding set decomposition and morphological analysis using gap-detection by multi-scale skeletons. They applied their method on more than 300 skin images and compared visually their results to the literature. They also compared the execution time of these methods.

Mirzaalian *et al.* [15] proposed an alternative approach to detect hair in dermoscopic images using the measurement of turbulence quaternion [16] and dual matched filters for hair detection and suppression. On a database of 40 dermoscopic images and 94 synthetic images, the results obtained are, for segmentation. the authors classified several methods of image segmentation explored in the literature into different categories such as histogram thresholding, clustering, edge based etc. They also compared the recent border detection methods (50 methods), and concluded that half (25/50) of them use smoothing filters, and those based on thresholding are inherently robust against noises. The authors noted that two methods, clustering (19/50) and thresholding (18/50), are the most popular segmentation methods. Previously, Celebi *et al.* [18] used the Otsu thresholding method for lesion localisation.

Carlos Estevao Bastos Sousa and Leonardo BG Nascimento proposed a software to decision support for the detection of skin cancer. This approach is proposed, as this type of skin cancer is the only one that can metastasize, that is, proliferate to other organs such as lungs, liver, etc. The proposed system is elaborated through the acquisition of a set of images with 17805 samples, extractors of attributes gray level co-occurrence matrix (GLCM), Local Binary Pattern (LBP) and Central Moments. For the training and sample classification process, the Single Layer Perceptron (SLP), Multilayer Perceptron (MLP) and Support Vector Machine (SVM) classifiers are used.

In 2017 IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies (AEECT), Hiam Alquran, Isam Abu Qasmieh, Ali Mohammad Alqudah proposed The Melanoma Skin Cancer Detection and Classification using Support Vector Machine. The proposed system described an efficient method for detection, features extraction, and classification of melanoma skin cancer using image processing technique applied on suspected melanoma lesion of dermoscopy images. The proposed method shows high accuracy in determining the type of skin lesion whether it is benign or malignant which will be very beneficial for diagnosis of melanoma skin cancer efficiently.

#### III. EXISTING SYSTEM

In the Existing system of Medical field, Diagnosing skin cancer usually begins with a visual examination. If a suspicious spot is found, your doctor will first examine the area, noting its size, shape, color and texture, as well as any bleeding or scaling. The doctor may also examine nearby lymph nodes to see whether they are enlarged. A dermatologist may use a special microscope or magnifying lens to examine the suspicious spot more closely, a process called dermatoscopy. The two most common types of tests used in diagnosing skin cancer are biopsies and imaging tests. There are several different biopsy methods, but an excisional biopsy in which the doctor removes the entire growth is often sufficient to treat the skin cancer. Most skin cancers especially basal cell carcinoma, the most common form of skin cancer remain local and do not spread to distant organs. Melanoma and Merkel cell carcinoma are more prone to spread. In those cases, one of several medical imaging procedures may be used to determine whether cancer cells have metastasized to internal organs and bones. Imaging procedures include CT scan, MRI and X-Ray. These methods are painless and non-invasive but might cause infections to the patients because of the instruments being used. Laser Scanner skin images of cancer patients are acquired from various hospitals. Using image processing techniques like pre-processing and feature extraction, area of interest is separated. Developing the algorithm, features like area, perimeter and eccentricity are extracted from all the images.



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from these features are compared with the normal values suggested by a physician. From the comparison result, cancer stage is detected. A graphical user interface is developed to scan all the images and display the features and cancer stage. By using the devices such as CT scan, MRI, and X-Ray, The patient might get exposed to radiation so in that case, dermoscopy would serve as an alternative. But in dermoscopy, the early stages of melanoma can't be identified so abruptly. To overcome these disadvantages, our proposed system which is a hand-held device for detection and storage of skin cancer results seems sophisticated.

#### IV. PROPOSED SYSTEM

#### A. INTRODUCTION:

The proposed system concept of this paper is the use of Raspberry Pi as the main controller for a portable medical image processing system. The three basic stages of image processing for skin cancer diagnosis at its early stage are image preprocessing, segmentation and classification. The skin lesion image is captured through a special Pi camera using a smart phone. The coding for the three stages are performed in Open CV using python and then dumped into the Raspberry Pi kit from which the classification results are obtained and stored permanently so that it can be accessed anytime from anywhere with the individual patient IP addresses as depicted in Fig 1 shown below. The Convolutional Neural Networks are used to extract the structural and textural features by deploying the convolution and pooling layers. The Main feature of CNN is the automated feature extraction which makes the proposed system more efficient. The classification is performed using SVM classifier.



Fig 1: Implementation of the proposed system on Raspberry Pi

After installing the Raspbian operating system and the Python programming language all required hardware components are connected and the power supply is turned on. The system will boot and operate based on the Raspbian Operating System. The system then works on the Python software and checks the network settings to update the Python software with commands in the terminal window. Camera settings are activated to take pictures and save them in a folder. Python code is run to check the image is skin cancer result. The Raspberry Pi is a single computer board with credit card size that can be used for many tasks that your computer does likes games, word processing, spreadsheets etc. Raspberry Pi can be used as a desktop computer the heart of a media center and other applications.

The software portion of this paper has two phases namely the training and the testing phases. The images of the skin lesion are initially trained by the general image processing stages and then a test image is given as input and then compared with the results of the trained images. The main aim of this paper is to detect whether the skin lesion of a patient is malignant or benign at the earlier stages and to extend the trained models in a commercial hand-held mobile and sensor device such as Raspberry Pi and democratize the access to preventive Health care.

In a nutshell, this paper proposes a smartphone(Fig 2) and IoT devices based skin cancer detection system that utilizes deep learning and low-cost camera to take the snapshots of suspected skin lesions and distinguish between malignant and benign melanoma skin images.



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Fig 2: Smart Phone and Iot based skin cancer Detection system

#### **B. BLOCK DIAGRAM:**

The block diagram of the proposed system is shown in Fig 3. The image of the skin lesion is given as input from a smart phone and is captured by a low cost embedded Pi camera. Then the image is subjected to various stages of processing for which coding is implemented in Python language using Open CV software. The features are extracted by Convolutional Neural networks and structural and textural feature fusion is performed.





#### C. IMAGE ACQUISITION USING THE RASPBERRY PI CAMERA AND PREPROCESSING:

Image Acquisition is the initial stage. The skin lesion images of several patients are obtained from the ISIC(International Skin Imaging Collaboration) which contains the largest publicly available collection of quality controlled dermoscopic images of skin lesions. A set of images are considered for training phase. The image is captured through a smartphone and given as input to the Raspberry Pi Camera. Fig 5 shows the Raspberry Pi camera module with cable. The camera consists of a small (25mm by 20mm by 9mm) circuit board, which connects to the Raspberry Pi's Camera Serial Interface (CSI) bus connector via a flexible ribbon cable. The camera's image sensor has a native resolution of five megapixels and has a fixed focus lens. The software for the camera supports full resolution still



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images up to 2592x1944 and video resolutions of 1080p30, 720p60 and 640x480p60/90. Installation involves connecting the ribbon cable to the CSI connector on the Raspberry Pi board.



Fig 5: Raspberry Pi camera module

After image acquisition, the image is subjected to preprocessing techniques such as RGB to gray scale conversion, image filtering using median filter, Contrast Enhancement using Adaptive Histogram Equalisation and then the image quality is assessed. All the above processes are coded in the Open Cv software using Python language.

### D. AUTOMATED STRUCTURAL AND TEXTURAL FEATURE EXTRACTION USING CONVOLUTIONAL NEURAL NETWORKS (CNN):

In this paper, the structural and textural features are extracted using a variant of deep learning models called Convolutional Neural Networks (CNN). A typical CNN comprises of Convolutional, Pooling and Fully Connected layers (Fig 6). The key building block of CNN is the convolutional layer. CNNs eliminate the need for manual feature extraction, one doesn't need to select the features required to classify the images. They are flexible and work well on image data and are more powerful than machine learning algorithms and are computationally efficient. It uses convolution of image and filters to generate invariant features which are passed on to the next layer. The features in the next layer are convoluted with different filters to generate more invariant and abstract features and the process continues till one gets final feature which is invariant to occlusions.



Fig 6: Convolutional Neural Network (Convolution and pooling layers)

Hence the structural and textural features are extracted and fusion is performed and then the severity of the skin cancer is predicted as to whether it is malignant or benign.

#### E. RASPBERRY PI 3 CONTROLLER:

Raspberry Pi board is the central module of the whole embedded image capturing and processing system. Its main parts include: main processing chip unit, memory, power supply HDMI Out i.e VGA display, Ethernet port, and USB ports. This main processing chip connects a camera and display. The Raspberry Pi design does not include a built in hard disk or solid state drive. It instead uses an SD card for booting and long term storage. This board is intended to run Linux Debian based operating systems. This Raspberry Pi module has a Samsung class 4 micro SD card preloaded with the Raspberry Pi. The camera module attaches to Raspberry Pi by a 15 pin Ribbon Cable, to the dedicated 15 pin MIPI Camera Serial Interface (CSI), which was designed especially for interfacing to cameras. The CSI bus is capable of extremely high data rates. After the connections are done, the coding for the image processing is implemented on Open CV software. Fig 7 shows the board diagram of Raspberry Pi 3 (Model B) and Fig 8 shows the Pin diagram.



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Fig 7: Raspberry Pi Board( Version 3, Model B)

A powerful feature of the Raspberry Pi is the row of GPIO (general-purpose input/output) pins along the top edge of the board. A 40-pin GPIO header is found on all current Raspberry Pi boards (unpopulated on Pi Zero and Pi Zero W). Prior to the Pi 1 Model B+ (2014), boards comprised a shorter 26-pin header.



Fig 8: Pin Diagram of Raspberry Pi 3

Thus, after the coding has been completed for all the stages, the connections are given to the Raspberry Pi kit and the result is viewed in the monitor. The results of the patients are permanently stored virtually so that its easily accessible anytime anywhere by both the doctors and the patients by using the appropriate IP addresses. So, this system serves as a handheld mobile database for patient case history.

#### V. EXPERIMENTAL RESULTS

#### A. HARDWARE SETUP:

The Hardware set up comprises of the Raspberry pi Version 3 Model B+ kit, HDMI Cable, Raspberry Pi Camera Module with cable (5Mp) and a Power cable for Power Supply. The Camera module is connected to the camera Port of the Raspberry Pi kit. The SD card inbuilt within the Pi kit stores the coding required for the Melanoma Detection.



Fig 9: Hardware Setup

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#### **B. CONFIGURING THE RASPBERRY PI KIT WITH THE SOFTWARE:**

Initially the power cable is connected to a general power supply and the HDMI cable to the respective port for connecting to the monitor. Then the Raspberry Pi is configured with the Open CV Terminal version via a remote app called VNC viewer. The VNC viewer is associated with an individual IP address of the host accompanied by a user name and password through which the remote process is initiated. After entering the credentials, the Terminal Version of the Open CV runs the commands for the coding. The commands for the coding file location are entered and then the coding is executed.



Fig 10 Configuring the Raspberry Pi Kit with the Software

#### C. IMAGE ACQUISITION AND MELANOMA DETECTION:

The Skin Lesion image collected from the ISIC dataset is captured through a smart phone and is given as input to the Raspberry Pi camera. The camera captures the image and the image is subjected to pre-processing, Feature extraction by the CNNS and then classified as Melanoma or any other skin disease as shown in Fig 11



Fig 11: Image Acquisition and Melanoma Detection

#### D. RESULTS AND OUTPUT OF MELANOMA DETECTION:

The detection of Melanoma and other skin diseases have been successfully implemented in a handheld device – Raspberry Pi. The Skin lesion image has been captured through a smart phone and given as input to a special camera accessible by the Raspberry Pi. The coding for various stages of the image processing has been implemented in Python Language using Terminal Open CV software.



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felanoma				1
1] [0.05323817 Melanoma				
L] [0.0552899 Melanoma 1]			0.10880375]]	
0.05228108 Melanoma		0.34385186	0.11642546]]	
[0.05316623 Melanoma	0.50896555	0.32565483	0.112 <b>7</b> 1338]]	
[0.04819278 Melanoma 1]	0.4290057		0.13107617]]	
[0.04414958 Melanoma 1]	0.5019975	0.38146636	0.07238659]]	
[0.05274739 Melanoma	0.54063433	0.30363768	0.10298054]]	

#### Fig 12 RESULT OF MELANOMA DETECTION

#### VI. CONCLUSION

The severity of skin cancer is increasing the death rates day by day so the detection at the early stages has become a necessity. Several techniques were developed for this purpose which proved fairly effective. An image improvement technique was developed for earlier illness detection and treatment stages; the time issue was taken in account to get the abnormality problems in target pictures. Image detection using raspberry pi is a form of signal processing where the input from the user images and the output from its skin cancer detected images or a set of characteristics or parameters associated with images. Digital image acquisition usually experiences undesired camera shake due to unstable camera movements. Low contrast images captured using the Raspberry Pi camera module can be scaled up first to identify specific image regions. The most important processing is the removal of noise as a result of noise disturbance during image acquisition on the camera. Due to its small size, which is about the size of a credit card and its lightweight, raspberry pi is very suitable for use as a portable medical image processing system. Besides that Raspberry Pi also consumes low power. Moreover the results of the patients can be stored permanently for viewing it at anytime. The implementation of Convolutional Neural Networks for feature extraction in this paper resulted in an automatic mode of feature extraction without the need for manual selection of features via coding We have built a portable medical image detection system using Raspberry Pi hardware and a special camera for Raspberry Pi and Python and Open CV software. Our system can classify the image of the skin whether they are normal or cancerous. The system can do classification automatically and quickly. Besides that, the system that we made is concise, lightweight and easy to carry everywhere.

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