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Automatic Melanoma Detection Using Local Binary Pattern and Support Vector Machine

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ABSTRACT: Melanoma is a skin cancer type that causes from the pigment containing melanocytes. Melanocytes are cells which produce melanin. They are located in the bottom layer of skin's epidermis, in the inner part of ear, bones, heart, and middle layer of eye and rarely occur in the mouth. In women melanocytes are commonly occur on the legs and in men they are found on the back. Melanoma is the most dangerous type of skin cancer. In this paper, a new system is proposed for the automatic detection of melanoma. The system uses enhanced image processing to segment the images without any manual process. Then comprehensive set of features are extracted from the segmented image using new and improved feature extraction techniques. Texture feature of a skin can be extracted using various methods of texture extraction algorithm. In this proposed system Local Binary Pattern (LBP) method is used for texture analysis. It has been found to be a powerful feature for texture feature extraction. It has been determined that when LBP is combined with the Histogram of oriented gradients (HOG) classifier and it improves the detection performance considerably on some datasets. Local Binary Pattern (LBP) is a very efficient texture operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number. Because of its power and computational simplicity feature LBP has become a popular algorithm in various environments. It can be a unified approach to the statistical and structural models of texture analysis applications. The features were fed automatically to a support vector machine classifier which achieved greater than 97% sensitivity and greater than 93% specificity. An SVM classifies data by finding the best hyperplane that separates all data points of one class from those of the other class. The trained system was tested with lesion images found online and it was able to achieve similar sensitivity.

KEYWORDS: Melanoma**,** Support Vector Machine, Local binary pattern

I. INTRODUCTION

Skin is the very sensitive and sensory part of the body that acts as the first layer of the defense against the environmental pollutions. Skin helps to regulate the human body temperature and it transmits the sensation of the touch to the brain. Skin cancer which is called as Melanoma is not common disease such as other skin cancers types. This is a very dangerous disease and anyone can get melanoma at any time. However, melanoma is curable disease but it should be found in the initial stages else it may causes the many deaths in the world. Skin cancer diagnosis is always done by doctors. By the research scientists say that globally doctors and researchers are diagnose about 160,000 new skin disease cases of melanoma by every year. But this is common among the non hispanic males and females. The most common body parts affected by the cancer in human beings are legs and back. There are various causes of skin cancer but 90% of the skin cancer cases are caused by the exposure of the Ultraviolet radiations from the sun. This exposure of the UV rays increases the risk of all three types of the skin cancer such as BCC (Basal Skin Cancer), SCC (Squamous Cell Cancer) and melanoma.

Normal skin:

The skin is the largest organ in your body. It is doing the vital roles to the human body , such as:

- Covering the internal organs and helping protect them from injury
- Serving as a barrier to germs such as bacteria.
- Preventing the loss of too much water and other fluids

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- Helping control body temperature
- Protecting the rest of the body from ultraviolet (UV) rays
- Helping the body make vitamin D

The skin has 3 layers: the epidermis, the dermis, and the subcutis.

Epidermis: This top layer of skin is very thin, averaging only about 1/100 of an inch thick. It protects the deeper layers of skin and the organs of the body from the environment. The main types of cells in the epidermis include:

Squamous cells: These are flat cells in the outer part of the epidermis that are constantly shed as new ones form.

Basal cells: These cells are in the lower part of the epidermis, called the *basal cell layer*. These cells constantly divide to form new cells to replace the squamous cells that wear off the skin's surface. As these cells move up in the epidermis, they get flatter, eventually becoming squamous cells.

Melanocytes: These are the cells that can become melanoma. They make a brown pigment called *melanin*, which gives the skin its tan or brown color. Melanin protects the deeper layers of the skin from some of the harmful effects of the sun. For most people, when skin is exposed to the sun, melanocytes make more of the pigment, causing the skin to tan or darken.
The epidermis is separated from the deeper layers of skin by the basement membrane. When a skin cancer becomes more advanced, it generally grows through this barrier and into the deeper layers.

Dermis: This middle layer of the skin is much thicker than the epidermis. It contains hair follicles, sweat glands, blood vessels, and nerves that are held in place by a protein called *collagen*, which gives the skin its elasticity and strength.

Subcutis: The deepest layer of the skin (the subcutis) and the lowest part of the dermis form a network of collagen and fat cells. The subcutis helps the body conserve heat and has a shock-absorbing effect that helps protect the body's organs from injury.

Melanoma skin cancers
Melanoma is a cancer that begins in the melanocytes. Other names for this cancer include *malignant melanoma* and *cutaneous melanoma*. Most melanoma cells still make melanin, so melanoma tumors are usually brown or black. But some melanomas do not make melanin and can appear pink, tan, or even white. Melanomas can develop anywhere on the skin, but they are more likely to start on the trunk (chest and back) in men and on the legs in women. The neck and face are other common sites. Having darkly pigmented skin lowers your risk of melanoma at these more common sites, but anyone can develop this cancer on the palms of the hands, soles of the feet, and under the nails. Melanomas in these areas account for more than half of all melanomas in African Americans but fewer than 1 in 10 melanomas in whites. Melanomas can also form in other parts of your body such as the eyes, mouth, genitals, and anal area, but these are much less common than melanoma of the skin. Melanoma is much less common than basal cell and squamous cell skin cancers, but it is far more dangerous. Like basal cell and squamous cell cancers, melanoma is almost always curable in its early stages. But it is much more likely than basal or squamous cell cancer to spread to other parts of the body if not caught early.

Causes of Melanoma
Melanoma occurs when something goes awry in the melanin-producing cells (melanocytes) that give color to your skin. Normally, skin cells develop in a controlled and orderly way healthy new cells push older cells toward your skin's surface, where they die and eventually fall off. But when some cells develop DNA damage, new cells may begin to grow out of control and can eventually form a mass of cancerous cells. Just what damages DNA in skin cells and how this leads to melanoma isn't clear. It's likely that a combination of factors, including environmental and genetic factors, causes melanoma. Still, doctors believe exposure to ultraviolet (UV) radiation from the sun and from tanning lamps and beds is the leading cause of melanoma. UV light doesn't cause all melanomas, especially those that occur in places on your body that don't receive exposure to sunlight. This indicates that other factors may contribute to your risk of melanoma.

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II. LITERATURE SURVEY

[1] Aimed the association of macroscopic CM disease descriptors, corresponding to imaging features, to low level biological information, corresponding to gene expression. Toward our purposes, an integrated dataset related to CM was used to derive a list of 32 genes highly related to CM disease status that comprise potential CM biomarkers. Statistics and a biologically inspired selection scheme that measures the impact of genes to imaging features were used to prioritize a total of 31 imaging features and select the most robust ones. Using suitable classification techniques, imaging features could discriminate with a moderate success malignant from benign CM samples. In this classification task, imaging features were outperformed by the genes subset selected here as the latter contained much denser information on the manifestation of CM. [2] Millimeter wave irradiation has been found to generate a dose-dependent heating of skin, providing an opportunity for destruction of heat sensitive cutaneous tumors including melanomas. *In vitro* irradiation of epidermal keratinocytes and melanoma cells revealed distinct susceptibility of melanoma cells to MMW hyperthermia with higher thermotolerance of keratinocytes. we compared the effect of MMW induced hyperthermia on human and murine keratinocytes and melanoma cells *in vitro*, and examined the effect of MMW on cutaneous melanoma in mice.We found a high susceptibility of human and murine melanoma cells toMMWhyperthermia *in vitro*, in addition to a selective tumor destruction of cutaneous melanoma *in vivo* in mice. Based on these results, we hypothesize thatMMW irradiation would be a useful treatment modality in cutaneous melanoma for humans.

[3] This paper presents a novel computer-aided diagnosis system for melanoma. The novelty lies in the optimized selection and integration of features derived from textural, borderbased, and geometrical properties of the melanoma lesion. The texture features are derived from using wavelet-decomposition, the border features are derived from constructing a boundary-series model of the lesion border and analyzing it in spatial and frequency domains, and the geometry features are derived from shape indexes. The optimized selection of features is achieved by using the gain-ratio method, which is shown to be computationally efficient for melanoma diagnosis application. Classification is done through the use of four classifiers; namely, support vector machine, random forest, logistic model tree, and hidden naive Bayes. [5] This paper described an automatic system for inspection of pigmented skin lesions and discriminating between malignant a benign lesions. The system includes a dedicated image processing system for feature extraction and classification, and patient-related data decision support machinery for calculating a personal risk factor. It has been shown that our algorithm is capable of recreating controlled lighting conditions and correcting for uneven illumination. Arobust segmentation algorithm has been developed. As a result, the features used for classification are scale and rotation invariant. Therefore, the distance at which the digital image was taken is of no significant importance as long as the size of the feature of interest can be resolved on an imaging device. [7] This paper develops a novel two-frequency approach for noninvasive evaluation of cancerous tissue with optimum depth and resolution. Frequencies of about 50 MHz are used in thickly sliced tissue to detect differences of the relative attenuation (C-scan mode scanning) with relatively limited resolution. Thus, suspect zones can be identified according to a quantitative criterion. These suspect zones are then selected for preparation of thin, transversal slices from within the original thick slices. Very-high-resolution (1-μm) visualization of cells is obtained at around 600 MHz on these transversal sections and adjacent sections are prepared for histological study in parallel. The technique's feasibility and potential are demonstrated on both normal and cancerous (melanoma) skin tissue. Isotropy of the specimens is experimentally verified to ensure that conditions were coherent for use of a 5-layer, angular spectrum model made to simulate longitudinal velocity, allowing estimation of longitudinal velocity from semi quantitative $V(z)$ data.

[11] The result of more than 96% correctly segmented lesion images (in a set of 4000 skin lesions) reflects a very reliable segmentation module for the special task of skin lesion segmentation. The impressive segmentation performance is achieved by fusion of several simple segmentation algorithms (thresholding, color clustering). The fusion concept allows for the further extension of the segmentation module by integration of other segmentation methods (texture analysis, other color segmentation algorithms).

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III. PROPOSED ALGORITHM

The proposed system describes about the common steps of the algorithms used in this study. Then it describes each step in detail. The proposed skin cancer type melanoma detection process consists of four main parts: They are image segmentation, feature extraction and SVM classification.

1. Image Segmentation:

The proposed image segmentation algorithm successfully segmented all images where the lesion was completely enclosed inside the image in the data set and this segmentation process identifies all partial lesion images and flagged segmentation failures. Images with poor contrast also able to detect the segmentation failure in the first pass and correct it and segment successfully in the second pass. The final result of lesion segmentation is a black and white mask where all pixels corresponding to the skin lesion are white. This mask can be applied on the original image to mask out all the non lesion skin areas from the image. This enables all feature extraction steps to only extract features and characteristics from the skin lesion, and not the surrounding skin.

2. Irregularity Measurement:

Two new methods to measure image irregularity are proposed. The first one Gaussian Smoothing Method that proceeds with smoothing the contour and comparing the perimeter of the smoothed contour to the perimeter of the original lesion. The second method to measure the irregularity is a lacunarity analysis of the image borders.

3. LBP operator application: In the second stage LBP are computed for each pixel, creating a fine scale textural description of the image.

4. Local feature extraction: Local features are created by computing histograms of LBP over local image regions.

5. SVM Classification: Each skin image in test set is classified by comparing it against the skin images in the training set. The training set consists of both normal and cancer skin images. The comparison is performed using the local features obtained in the previous step. The first two steps are shared by all the algorithms. SVMs have several advantages over the more classical classifiers such as decision trees and neural networks.

The support vector training mainly used for the optimization of a classification cost. Therefore, there is no risk of getting stuck at local minima as in the case of back propagation neural networks. Statistical and structural risk minimization is the principle used in SVM which minimizes the upper bound on the generalization error. Therefore, SVMs are less prone to over fitting when compared to algorithms such as back propagation neural networks that implement the empirical risk minimization principle. Other important advantage of SVM is that they provide a unified framework in which different learning machine architectures can be generated through an appropriate choice of kernel. The disadvantage of support vector machines is that the classification result is purely contradiction, and no probability of class membership is given.

a) Accuracy:

The accuracy of the classifier is the percentage of the test samples that are correctly classified by the classifier.

$$Accuracy = TP+TN / TP + FP + FN + TN \quad (1)$$

b) Sensitivity

It is also referred as true positive (TP) rate that is the propagation of positive samples that are correctly identified.

$$Sensitivity = TP / TP+FN \quad (2)$$

c) Specificity

It is the true negative (TN) rate that is the proportion of negative samples that are correctly identified.

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$$Specificity = TN / TN + FP \quad (3)$$

[TP – True Positive, TN – True Negative, FP – False Positive, FN -False Negative]

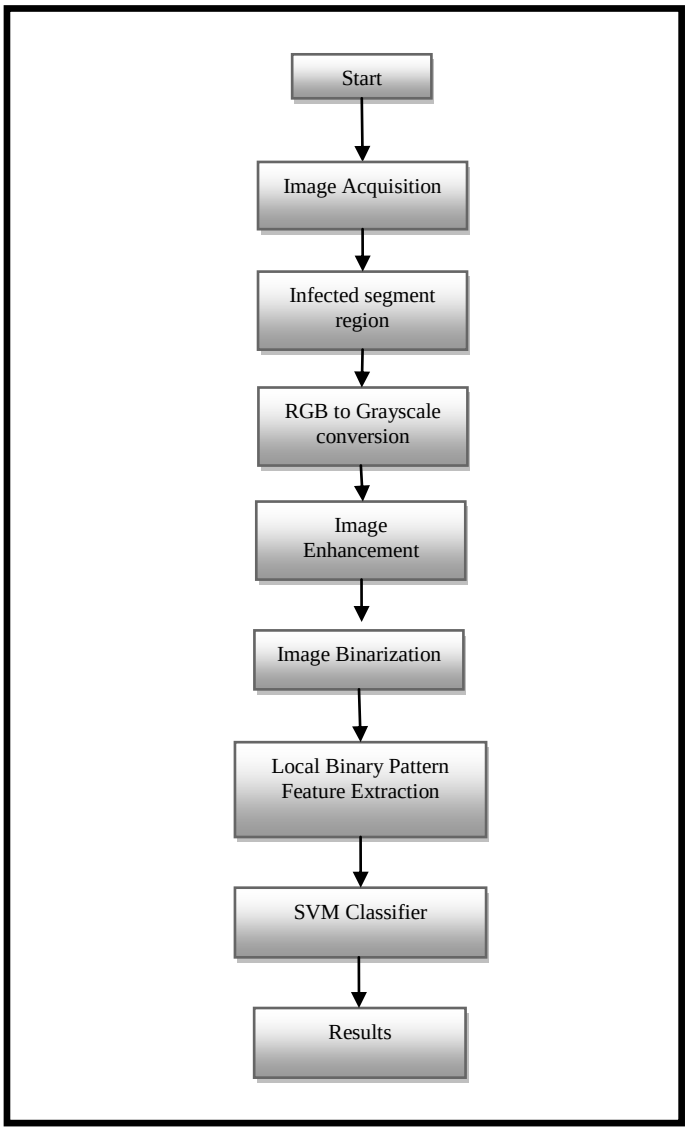

Fig: 1 Overall Flow Diagram of proposed system

IV. EXPERIMENTAL AND RESULTS

Database consists of 20 digital images, previously diagnosed, 10 of them are benign and 10 are melanoma. The mechanisms proposed i.e., SVM and Local Binary Pattern is performed for 4 test skin samples and experimented to test the accuracy, Specificity and Sensitivity.

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Parameters	SVM Classifier
TP	19
TN	18
FP	02
FN	01
Accuracy	93%
Specificity	95%
Sensitivity	90%

Table-1: Performance of the SVM Classifier**.**

Fig 2: Specificity Chart

The above chart describes the Specificity percentage of the proposed system for the test images.

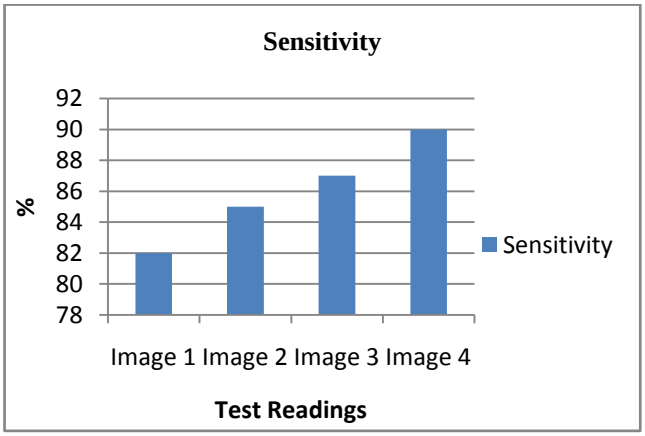

Fig 3: Sensitivity Chart

The above chart describes the Sensitivity percentage of the proposed system for the test images.

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V. CONCLUSION AND FUTURE WORK

The proposed work experimental results shows the improvement in identifying the Melanoma skin cancer at different stages using image processing techniques based on Local binary Pattern and SVM classifier. The prime concern of the proposed work is to extracting the skin image features i.e. area, perimeter and standard deviation of radii. This enables in analyzing the melanoma spot analysis and guides for the direction of spread of the cancer. This is the vital information where the skin expert may get vital information at fine accuracy. The features are normalized with respect to skin image size so that the features remain same if the image is varied in respect of it attributes. The main purpose is that the features should not vary for the same image at different orientation, size and location.

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