Modified Skin Lesion Detection Mechanism Using Application of Fuzzy Support Vector Machine

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Abstract- **In this paper, effective approach for early detection of skin lesion using segmentation and classification is proposed. Skin images contains distortion in terms of unwanted hairs and noise initially, hence filtering is required in order to remove noise from the image. Segmentation is the next step used to extract lesion area. Segmentation yield parameters such as Geometric Mean, Standered Deviation, Kurtosis, Moments etc. Results of segmentation are compared against various well known measures and result obtained is commendable. Support vector machine and fuzzy neural technique is used for classification. Results show significant improvement over SVM+KNN. Accuracy is improved by 45%, F-Score is improved by 40%, Precision is improved by 45% and recall is also improved by 45%.**

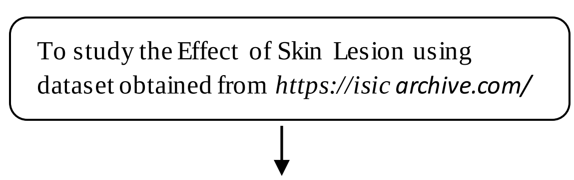
Index Terms- SkinLesion, Pre-processing, Segmentation, SVM, Fuzzy Filtering.

I. INTRODUCTION

Image processing is the need of the hour in detecting commonly occurring diseases. Detecting regions from the skin appearing different than usual is fascinating task and play critical role in human computer interaction suggested by [1]. Skin cancer is increasing by leaps and bounds and hence early detection of the same is necessary. One of the deadly skin cancer is melanoma which if detected at stage 4, survival rate is only 9-15% but if detected early at stage 2, survival rate is increased to 85-99% as suggested by [2]. Thus early detection of such cancers is essential for well being of living entities.

Various classification mechanisms for detection of skin lesions is described through this literature. Skin artifacts removal scheme given by [3]. Two steps involving distortion removal from radar signals and then performance is analysed by the use of artificial neural network strategies. Ad-hoc skin classifier is suggested by [4]. The proposed model is less dependent on changes in the skin colour, illumination conditions etc. [5] gives skin lesion detection from CMYK images. CMYK is not used most often but turned out be good choice in the detection of skin lesion as proved through experimental results. Melanoma early detection is handled by [6]. This work suggests two major components of a non-invasive skin lesion detection and prevention system which is fully automatic and used for the early detection and prevention of melanoma. The first component uses the equations to generate alerts preventing skin burn due to sunlight. The equation also calculates the time it takes to completely burn the image due to sun burn. The second component is fully automatic skin analysis module used to perform classification, feature extraction etc. [7]describes pixel wise skin colour detection based on neural network technique. The worth of the research is proved through experimental research. [8] Discussed multicentre wave waveguide for early detection of skin cancer. The device used is easy to fabricate and produces better result as compared to existing literature.

Detection of skin cancer is difficult as the confusing behaviour of distinct skin lesions. Demography image classification and segmentation is critical for the identification of skin lesion. Proposed work deals with the exploration of segmentation strategy combined with fuzzy filters to decide the membership and early detection of skin lesions. The key features are given through following diagram



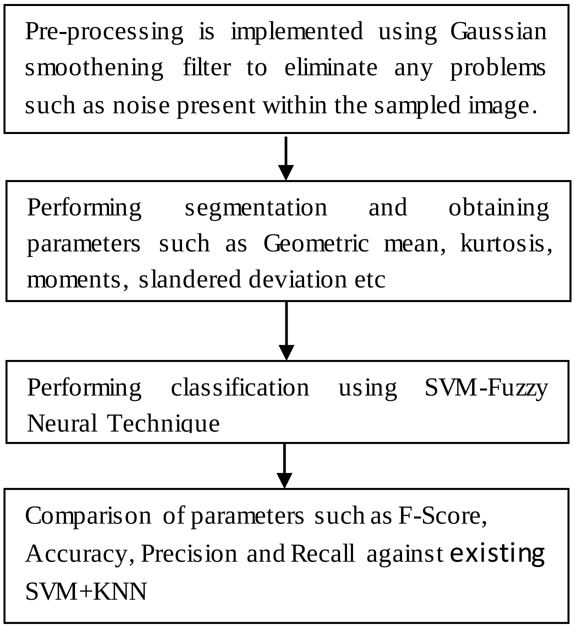


Figure 1: Flowchart of key features associated with Proposed Methodology

II. LITERATURE SURVEY

Effective techniques are required to detect skin cancers at early stage. Technology helps to detect cancer as early as possible so that cure is within the reach of humans. Segmentation and feature extraction is critical towards this aspect. This section discusses mechanisms that enhance performance of skin lesion detection process.

A. SUPPORT VECTOR MACHINE AND ANN(ARTIFICIAL NEURAL NETWORK)

Skin lesion detection is compulsory at early stage to avoid deadly effects within human body. Death rate is enhanced considerably if detection is at 4th stage. Recovery rate is greatly enhanced if it is detected at 2nd or early stage of lesion. Support vector machine is one of the effective images processing segmentation mechanism used to detect distinguished part from the original part. [9]proposed precise segmentation strategy. Precise segmentation of the infected area along with surrounding area is critical for accurate analysis and diagnosis of lesion. Improved ALDS based on probabilistic approach is followed. Neural network decision theory is used to detect the melanoma. The member ship function decide melanoma if obtain value is within the range specified for particular member function.[10]suggests SVM+ANN to detect hands and body movement but is quite capable to detect lesion also. SVM+ANN is given through following flowchart

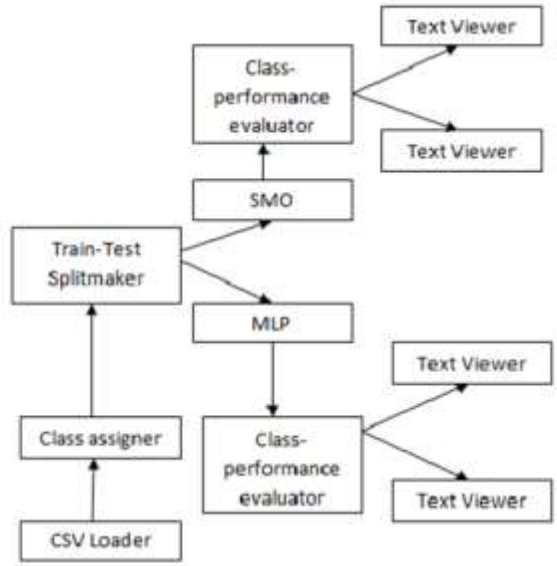


Figure 2: SVM+ANN Methodology

To minimize the energy consumption active contour is used. The energy function used is listed as under

$$E_{Total} = \int_0^1 E_{int}(V(s)) + E_{img}\big(V(s)\big) + E_{con}(V(s))$$

Equation 1:Total Energy Consumed

E_{total} is the total of energy consumed during segmentation. E_{int} ,E_{img} and E_{con} are the energy consumed during image initialization, image processing and conversion. V indicates the vector initialization during support vector machine operation. As proposed by [9],In the initial observation results were not consistent, hence similarity index was observed, using the following equation

$$SSIM = \frac{(2u_x u_y + c_1)(\sigma_{xy} + c_2)}{(u_x^2 + u_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)}$$

Equation 2:Similarity Index

U_x and U_y indicates the membership functions whose value lies between 0 and 1. After this step feature extraction and comparison is performed using SVM and ANN techniques. Obtained results suggest optimality of this technique.

B. SVM AND DEEP BELEIF NETWORK

Skin Lesion image detection process begins by first feature extraction and then feature selection process. For this purpose segmentation is required and classifiers are required to be trained. [11] Proposed SVM and Deep belief network for detection of skin lesion. A test vector x is considered for training purpose. Final classification through classification model is given through the following function

$$F_{final} = sign(w.(f_i(x)_{k*i})$$

Equation 3:Final Classification giving results in terms of parameter w.

The classifier includes deep learning architecture and exponential loss function used to enhance seperability. Deep belief network is constructed using greedy layer wise unsupervised learning algorithm and parameter space of W is constructed by the use of unsupervised learning approach along with exponential loss function for fine tuning the classifier. Accuracy of the classifier is up to 95% hence is efficient. Deep belief network is given as under

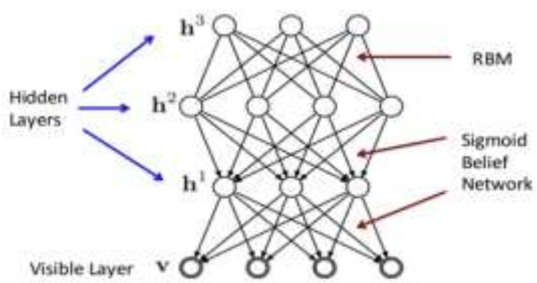


Figure 3: Deep Belief Network Working

C. SVM AND TEXTURE CLASSIFICATION

[12]give mechanism to classify demography image into melanoma and non melanoma images. Texture and colour features are extracted for analysing the same. [13], [14]GLCM is used to extract the texture features of an image. Colour histograms are effective mechanism proposed to extract the colour features in three colour spaces with primary colour collaboration including RGB, HSV and OPP. Classification is generated by the use of SVM(Support Vector Machine).[15] Proposes ship detection by the use of texture and SVM classification. Image is characterized into sub block to reduce the complexity of the image. Each block is processed separately and then collaborated together to form complete image. Supervised learning technique SVM is used for classification. From the mathematical point of view, feature extraction mechanism utilized following equation

$$for\ label\ pair(i,j)\ x = 1 - - - l$$

$$\min(y) = \frac{1}{2} w^t w + C \sum \delta$$

Equation 4:Feature Extraction function

W is known as weight factor, δ known as misclassification, C is known as regularization parameter.

Classification and accuracy can further be improved by the use of neural network techniques along with SVM(Support vector machine).

III. PROPOSED METHODOLOGY

Proposed methodology uses Gaussian smoothening to remove the hairy part out of the skin. [16]–[19]Gaussian smoothening commonly used for face detection but in the current situation, is implemented for removing artifacts in skin images. In other words noise handling mechanism is used to handle any noise present within the image. Gaussian noise handling mechanism provide filtered image which is presented to SVM. [20]describes problem with classification is that region is classified in class i only if ith decision function is positive. The value if not positive then it is not classified. This problem of unclassified region is resolved by the use of fuzzy filter mechanism. Hence fuzzy support vector machine is proposed to overcome this problem of misclassification. The detailed steps are described as under

A. PREPROCESSING

In the pre-processing phase image is filtered using the Gaussian noise removal to remove any artifacts present within the image. The transformation associated with the Gaussian filter is applied to every pixel present within the image. The transformation equation used is given as

$$G(x) = (1/\sqrt{2\pi\sigma^2})^{e^{-\frac{x^2}{2\sigma^2}}}$$

Equation 5:Feature Extraction using one dimensional coordinate system

G(x) is the Gaussian smoothening function, 'σ' is the slandered deviation and 'x' is the pixel position values.

This equation is implemented in one dimension. In two dimensions the equation is altered as

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-x^2+y^2/2\sigma^2}$$

Equation 6:Feature extraction function using two dimensional coordinate system

Where 'X' is the distance of pixel from horizontal axis and 'y' is the distance of pixel from vertical axis. 'σ' is the slandered deviation.

The image is resized to make critical portion of the image clearer. The clipped image is enhanced using histogram equalization mechanism. Histogram equivalence technique on coloured image is applied. The equation used is as follows

$$Hq(v) = round\left(\frac{cdf(v) - cdf_{min}}{(MxN) - 1}x(L - 1)\right.$$

Equation 7:Cuumulative Frequency Equation for coloured images

'Hq' is the histogram equalization function. Cdfmin is the minimum non zero value in cumulative frequency. MxN indicates number of pixel. To scale pixels in the original image having pixel L-1 and the equation is modified as

$$Hq(v) = round\left(\frac{cdf(v) - cdf_{min}}{(MxN) - 1}x(L - 2)\right.$$

Equation 8::Cuumulative Frequency Equation for coloured images with L-2 pixels

Scaling of pixels allow non zero values of the pixels to be preserved. The values of colours in terms of RGB is enhanced by increasing the intensity values as

RGB(R,G,B)=RGB(255,254,100)

The values of RGB are adjusted to desired levels to increase the intensity levels. This mechanism is followed to increase contrast levels. After the intensity is enhanced pre-processed image is presented to the next phase of fuzzy SVM.

B. FUZZY SVM(SUPPORT VECTOR MACHINE

[20], Fuzzy systems are rules based environment to correctly reach to the solution of the given problem including outlier detection or unnecessary regions. The rules are described by the use of If-Then technique.[20]this system is proposed to resolve unclassified region. Fuzzy membership functions are used to realize the classification results. Optimal hyper planes are defined to determine whether the obtained values of membership functions satisfy the hyper plane(D(x)) or not.

Satisfaction Criteria D(X)>1

One dimensional membership function $m_{i_j}(x, y)$ is defined for determining optimal separating hyper planes $D_j(x) = 0$ as follows

a) if values of diagonal are equal (i==j)

$$m_{i_j}(x) = \begin{cases} 1 \; for \; D_i(X) > 1 \\ D_i(x) \, for \; D_i(X) < 1 \end{cases}$$

3.2.2 if values of diagonal are not equal(i≠j)

$$m_{i_j}(x) = \begin{cases} 1 \; for \; D_i(X) < 1 \\ -D_i(x) \, for \; D_i(X) > 1 \end{cases}$$

Equation 8: Fuzzy Membership functions defination

The procedure of classification is listed as follows

3.2.3 if the pixel value x is such as $D_i(x)>0$ and is satisfied only for that class then it is fed into that class.

3.2.4 if $D_i(x) > 0$ and x lies between various classes then classify the data into the class with maximum $D_i(x)$

3.2.5 if $D_i(x) <_= 0$ and x lies between various classes then classify the data into the class with minimum $D_i(x)$

IV. FLOW OF PROPOSED WORK

The proposed system performs pre-processing and the support vector machine is applied to classify the data. The classification if not successful then misclassification is obtained in terms of accuracy and fuzzy technique is implemented in order to classify the data. The misclassification hence is considerably reduced. Figure 3 describes the proposed flow of the system. The proposed work is implemented through the work is listed below

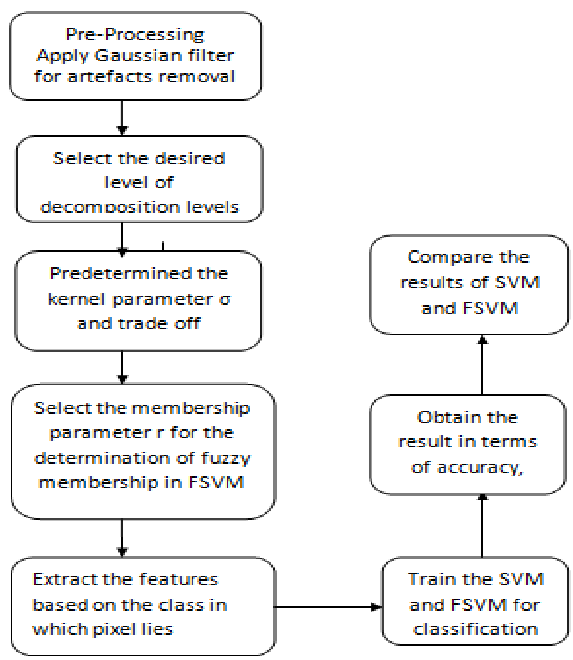


Figure 3: Flowchart showing the flow of operation

V. DATASET

The dataset is derived from the hospital and health care centers along with online source https://isic-archive.com/. The skin disease detection images are coloured and are of different sizes. Hence resizing of images is needed. Dataset description is given as under

ImageSet	Size(KB)	Type	Resizing needed
Skin1	200	Coloured	Yes
Skin2	22.9	Coloured	Yes
Skin3	8.24	Coloured	Yes
Skin4	35.9	Coloured	Yes
Skin5	35.9	Coloured	Yes
Skin6	5.06	Coloured	Yes
Skin7	20.0	Coloured	Yes
Skin8	6.11	Coloured	Yes

Table1:Dataset Description

Used images are under the category of melanoma cancer. These images are listed as under

Figure 1: Image set a)Skin1 b) Skin2 c) Skin3 d) Skin4

These training set features are populated into the worksheet and then feature extraction is performed.

Figure 2: Image Set a) Skin5 b) Skin6 c) Skin7 d)Skin8

Image resizing is needed as clear from different sizes of training et presented. The worth of research is proved by the use of literature survey conducted as under.

VI. PERFORMANCE EVALUATION

The performance is evaluated by suing the dataset derived from the hospital. The listed dataset used and results are obtained in terms of segmentation and histogram as

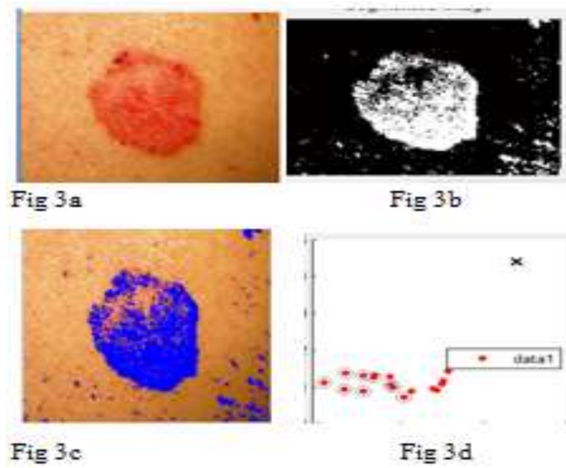


Figure 3: 3a indicates original image. 3b indicate segmented image. 3c re plotting of segmented image. 3d indicates Nearest neighbours of segmented image.

When results are plotted in terms of SVM and SVM+KNN, plots are obtained as

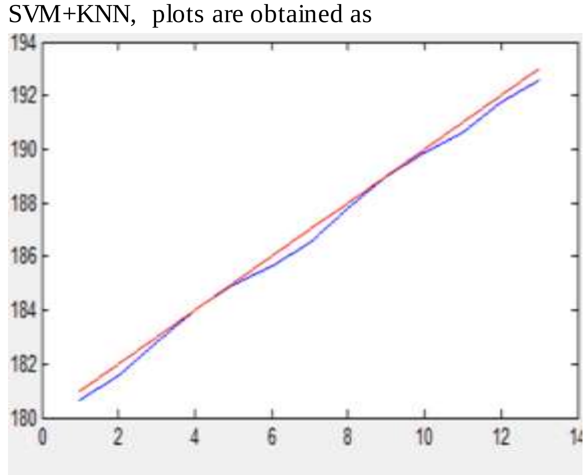


Figure 4: Red plot is for SVM+KNN and Blue plot is for SVM plot

Misclassification is reduced considerably when fuzzy SVM is used. The results are compared against the existing techniques SVM+KNN to prove the worth of the study. Plot in terms of accuracy is given as

Image Set	Attribute	SVM+KNN	Fuzzy SVM
Skin1	Accuracy	1.54321	2.9356
Skin1	F-Score	3.08637	5.0659
Skin1	Precision	1.54345	3.2569
Skin1	Recall	0.089172	0.1254

Table 2: Results in terms of various features using image Skin1

Plots in terms of various attributes on image set skin 1 is shown as follows

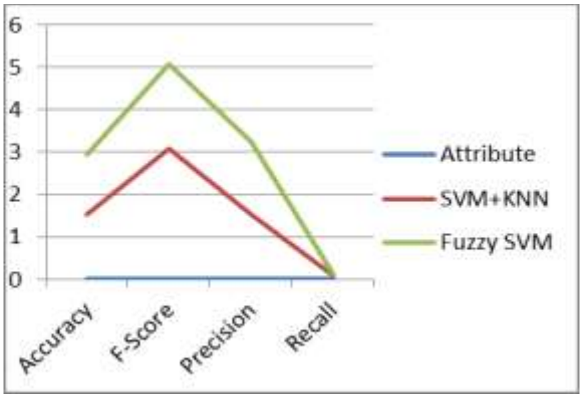


Figure 5: Plot in terms of Accuracy, F-Score, Precision and recall.

As the training image is altered the results shows variation. The results in tabular form is given as Under

Image Set	Attribute	SVM+KNN	Fuzzy SVM
Skin2	Accuracy	1.9875	3.4532
Skin2	F-Score	4.08637	5.9239
Skin2	Precision	1.8245	4.2324
Skin2	Recall	2	2.7665

Table 2: Results in terms of various features using image Skin2

The plots indicate graphical presentation for better understanding which shows better result for fuzzy SVM.

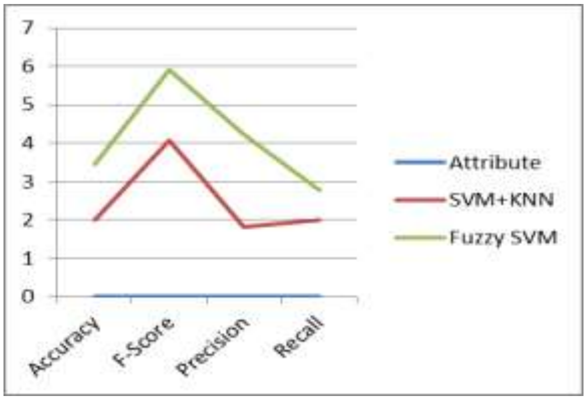


Figure 6: Comparison of results on skin 2 corresponding to accuracy, f score, precision and recall

Performance comparison indicates worth of the proposed system. Accuracy is considerably high in case of fuzzy svm rather than existing SVM+KNN.

VII. . CONCLUSION AND FUTURE SCOPE

Fuzzy SVM with Gaussian smoothening is used in order to enhance the accuracy and performance of the SVM segmentation to detect Skin Lesion. Early detection of such disease is critical for prevention and diagnosis which otherwise is not possible. To achieve accuracy in the inaccuracy inherent in formal labels associated with MRI image of skin , fuzzy concepts can be used for classification of samples for recovery, the SVM is a powerful method for data classification. The contribution of this literature is in terms of better accuracy, F-Score, precision and recall. Total of thirteen parameters are extracted from the proposed technique. These parameters are obtained as a result of feature extraction and selection. These attributes contributes to accuracy, F Score, Precision and recall. The rate at which result is obtained in case of complex image is slow. In the future overlapping pixel elimination mechanism can be used along with fuzzy svm to improve performance further.

REVIEW PAPER PUBLISHED

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