An Efficient Method for Detection of Dysfunctionality in Heart through Iris Using Hybrid Method

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ABSTRACT

Multiple organs in human body make up human organ system among which heart plays an important role for correct functioning of human body. Usually heart disease is recognized when the situation is severe or when the person is attacked by heart attack. The cost to cure the disease at this stage is high. Hence, it is important to implement a system for early stage detection of heart abnormality with low cost. This paper proposes a hybrid deep learning model using convolution neural network and support vector machine for detection of heart Dysfunctionality through iris. Considering the performance of the proposed model which is evaluated using different evaluation metrics such as precision, recall, f-score & accuracy, it is found that the accuracy of the proposed hybrid model is outperforming than exiting.

Keywords: Iridology, Convolution Neural Network, Support Vector Machine, Localization, Segmentation, ROI (Region of Interest)

1. INTRODUCTION

The heart which pumps blood to various organs in the body is situated in the middle compartment of mediastinum located in chest. Its improper functionality may cause death. As stated by WHO [11], Cardiovascular disease is the principal cause of death in people aged 75 and above. The critical condition of the heart is known only when the person is attacked by a mild or severe heart attack. Even for the doctors it is difficult to recognize cardiovascular disease at the early stage. In this scenario, an alternative study called iridology[13] which studies the iris of human eye indicating each organ in the body can be used for early stage detection of abnormalities in human body. Non-experts or health practitioners uses this study for identification of abnormalities in body including deposition of toxins, basic genetics and other weaknesses. The observations observed by the practitioners are mapped to iris chart which is fractionated into zones which corresponds to a particular part in human body. Radiology devices such as ultra tomography, CT scans etc., are used as standard medical tools to check person's health condition which are invasive methods. Through these traditional methods the cost for checking of health condition of a person is high. Hence, an alternative method has to be developed which is non-invasive and costs low. Therefore, computerized iridology is a low cost and non-invasive method which can detect 70-80% of abnormalities of different organs in human body. In this paper, we are proposing an automated methodology based on convolution neural network and support vector machine for classification of heart abnormality in human using iridology.

This paper is further organized as follows section II talks about related work, section III presents methodology, section IV discusses environmental setup, section V deals with evaluation metrics, section VI discusses about the conclusion and future work.

2. RELATED WORK

A few studies that were proposed in study in iris using iridology, Aisyah Kumala Dewi et al [1] experimented using Principal Component Analysis (PCA) for feature extraction process and then used the Backpropagation Neural Network method to classify whether there is a disturbance in stomach or not using iris and obtained an accuracy of 87.5%.David Habsara et al [2] conferred a process for prediction of diseases in heart, lung, spleen and liver using image processing techniques such as Canny Edge Detection, Gaussian Filtering, Colour Normalization and weigh values of textual feature analysis is used for artificial neural network for classification and yielded good results than state-of-art methods.R. G. Alam Nusantara et al [3] suggested a method which uses histogram equalization for image contrast improvement and features extracted from GLCM matrix are used as input for back-propagation neural network algorithm for liver disorder detection and achieved an accuracy of 91.42%.Mahmud DwiSulistiyo et al [4] proposed a method using Linear Discriminant Analysis (LDA) for feature extraction and Cascade Correlation Neural Network for classifying whether the image shows symptoms of Dyspepsia or not and obtained an accuracy of 95.45%.PutudodyLesmana et al [5] experimented by using adaptive learning parameters in place of fixed learning parameters to train a backpropagation algorithm in neighbourhood-based network structure for detection of condition of pancreas organ and achieved an accuracy of 83.3%.DyanCeniAdelina et al [6] described a process for pancreatic damage identification in relation to diabetic indication which uses image processing and gray level co-occurrence matrix for feature extraction and classified the images using artificial neural networks which obtained an accuracy of 81.35%.EntinMartiana K et al [7] illustrated a process for autocropping of iris image using a series of image processing techniques such as histogram analysis, median filtering, binarization and cumulative distribution etc., using 40 images and successfully cropped 40% of the images.Nor'aini A.J. et al [8] demonstrated a process using principal component analysis and support vector machine with radial basis kernel and classified both vegina and pelvis with an accuracy of 75%. Lintang Indah Permatasari et al [9] experimented with principal component analysis and support vector machine for identification of heart disorder from iris and obtained an accuracy of 80%. Atul Bansal et al [10] developed two different methodologies using Wavelets and Gabor filters and used SVM classifier to classify obstructive lung diseases with an accuracy of 89% and 88%.

As per the literature, there were many methods which were proposed based on traditional and advanced machine learning techniques as an alternative method for detection of dysfunctionalities in heart and other organs of the body. This paper focuses on deep learning based convolutional neural network architecture combined with support vector machine for detection of heart abnormality in human body through iris of human.

3. METHODOLOGY:

The heart is vital organ in our body, which pumps blood through the vessels of the circulatory system. If it has abnormalities, it can cause death. Detecting the early stage of abnormalities is a bit difficult for the doctors. So, the disease is usually recognized when the situation is severe and it is dangerous for the patients as it leads to a late healing process. There are several invasive methods for checking the health condition of a person such as blood tests, CT scan and ultrasonography, etc., which are used as standard medical tools and costs high. Hence, this paper proposes an efficient and reusable methodology which doesn’t cause any effect to humans with low cost for the detection of heart abnormality through iris.

The architecture of the proposed system is highlighted in Fig-1. Initially the dataset is partitioned into 80% training and 20 testing data.

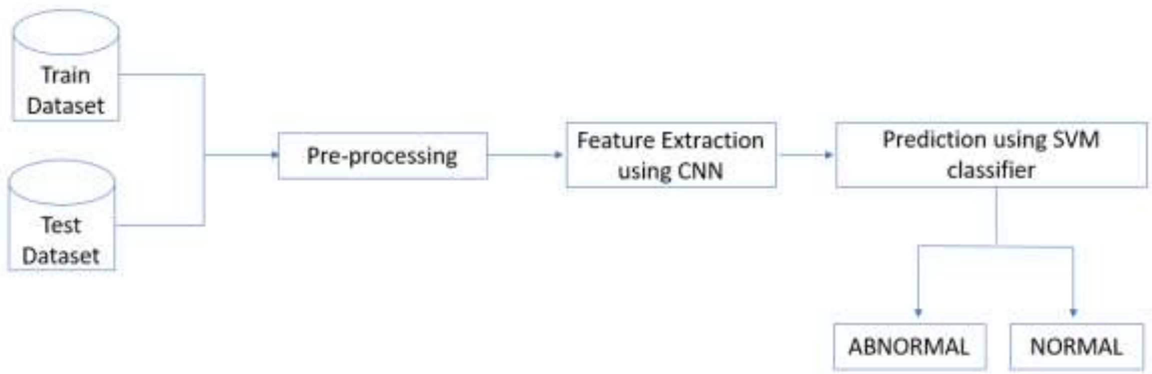


Fig-1. System Architecture

Pre-processing techniques such as image size conversion into 256 x 256 followed by augmentation of data with zoom range 0.2, width shift range 0.2 and height shift range 0.2 along with these the following pre-processing techniques are also considered.

A. LOCALIZATION OF IRIS

Localization of iris is the process of finding the boundaries of inner sclera and outer iris for detecting the iris outer boundary. Daugman [12] proposed a circular edge detection operator for non-concentric circle, as the pupil, iris and sclera are non-concentric circles, the circular edge detection can be used to detect the outer boundary of iris and inner boundary of sclera using,

$$\max(r, x_0, y_0) \left| G_\sigma(r) * \frac{\partial}{\partial r} \oint_{r, x_0, y_0} \frac{I(x,y)}{2\pi r} ds \right|$$

The localized iris using circular edge detection is as shown in Fig-2.

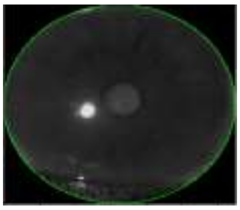


Fig-2. Localized Iris

B. SEGMENTATION OF IRIS

Segmentation of iris is the process of pixel by pixel classification of iris from pupil. The circle Hough Transform is a feature extraction method used in image processing for circles detection in faulty images, as the iris and pupil are non-concentric circles the CHT method can be used for segmenting iris from pupil using,

$$x^2_{c} + y^2_{c} - r^2 = 0$$

Where x_c and y_c are center coordinates and r is the radius which can define any circle, with these centre and radius values, the iris region is segmented which is shown in Fig-3.

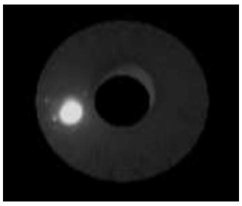


Fig-3. Segmented Iris

C. ROI – EXTRACTION

ROI – Extraction is the process of extracting region of interest viz., heart region from the segmented iris as shown in Fig-4. The heart region is located at clockwise direction between 2:00 to 3:00.

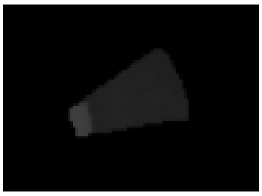


Fig-4. Extracted ROI

D. HISTOGRAM EQUALIZATION OF ROI

Histogram Equalization is an image processing technique that is used to enhance intensity of image. This can be accomplished by spreading the frequent intensities, i.e. extending the image intensity range. This results in increase of global contrast of an image which makes the areas in the image with lower local contrast region to attain a higher contrast. The Extracted ROI is intensified with histogram equalization for accurate identification of features using,

$p(\gamma_j)=n_j/n$, j=0, 1, 2, 3, 4 ……, L-1 (n = total no. of pixels in image)

$S_k=T(\gamma_k)=\sum_{j=0}^{k} P(\gamma_j)$, k = 0, 1, 2, ……, L-1 (Cumulative probability Distribution)

$S_k \Leftarrow (L-1)*S_l$

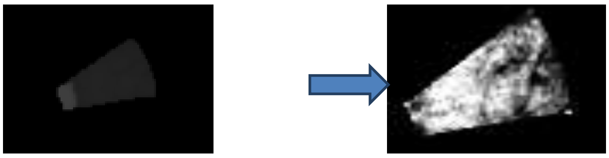


Fig-5. ROI Transformation from Low Contrast to High contrast

The proposed neural network model for feature extraction is highlighted in Fig-6. The CNN model is made up of 5 hidden layers with (120, 240, 512) units having (3x3, 5x5, 5x5) kernel sizes with pooling size 2x2 each, 1 fully connected layer having 256 units and last layer consists of SVM for output classification. ReLU activation function is used in all the layers except for the last layer where SoftMax activation function is used.

$$\text{ReLU: } f\left(h_\theta(x)\right) = h_\theta(x)^+ = Max\left(0, h_\theta(x)\right)$$

$$\text{SoftMax: } f(y_i) = \frac{e^{y_i}}{\sum_j e^{y_j}}$$

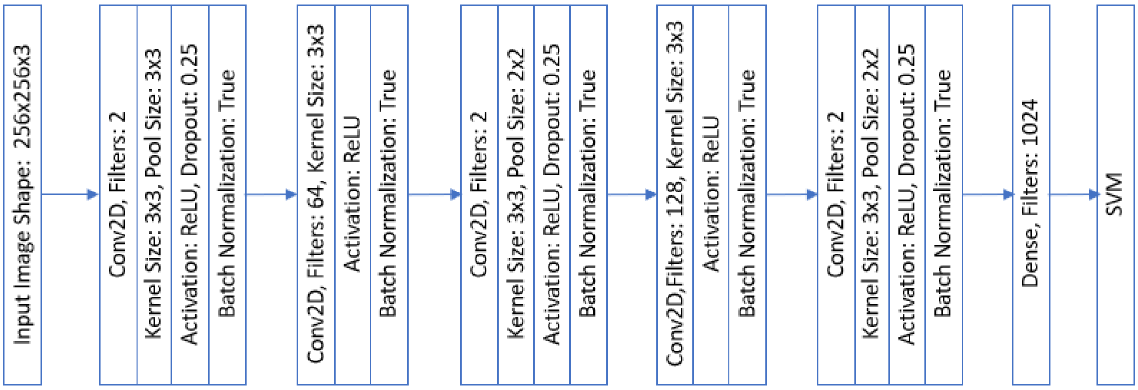


Fig-6. Neural Network Model

The model is trained by passing the training data where the features from images are extracted on passing through several layers and the images are classified by support vector machine from the extracted features. The trained model is used to predict the unseen from testing dataset.

4. ENVIRONMENTAL SETUP

The complete experimentation was carried out on a system configured with Windows 10 Operating System (64-bit) with Intel® Core™ i5-8250 CPU @ 2.20 GHz Processor, 8.00 GB Ram and 1 TB HDD installed with Anaconda, Python platform with supporting packages of Tensorflow and Keras.

The entire experiment was performed on a dataset collected from a hospital in Andhra Pradesh, which contains slitlamp images for 2 classes namely NORMAL and ABNORMAL with 40 images. Table-1 describes the dataset distribution among training and testing sets.

Table-1. Description of dataset distribution

Descripti	**ABNORM**	**NORM**
Training	20	10
Testing S	4	6

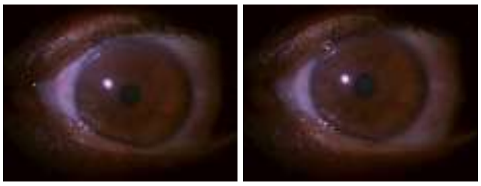


Fig-7.Slitlamp images of heart normal patient

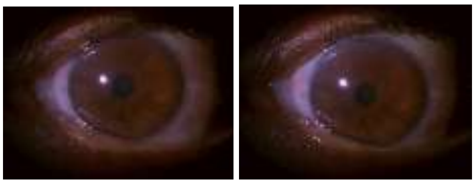


Fig-8.Slitlamp images of heart abnormality patient

5. EVALUATION METRICS AND RESULTS

The evaluation of the proposed method is based on several evaluation metrics such as Precision, Recall, F-Score and Accuracy, which are defines as follows,

$$Precision = TP / (FP + TP)$$

$$Recall = TP / (FN + TP)$$

$$F1\text{-}Score = (2 * Recall * Precision) / (Recall + Precision)$$

$$Accuracy = (TP + TN) / (TP + FP + FN + TN)$$

$$MSE = TP + (FP + TP)$$

$$RMSE = \sqrt{} (TP / (TP + FP))$$

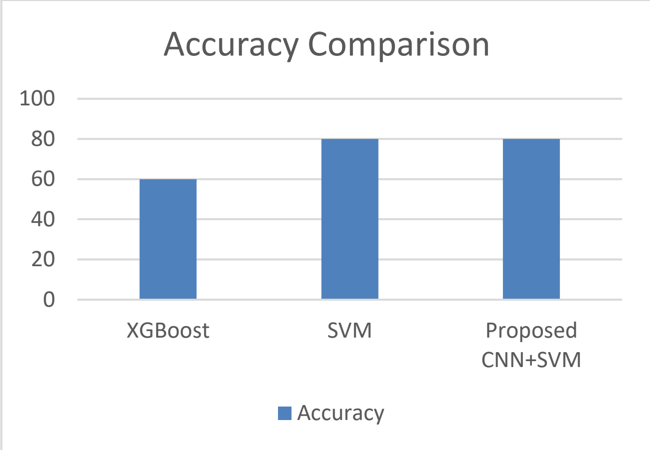
Where TP = Total no. of images correctly classified as abnormality, FP = Total no. of images incorrectly classified as abnormality, TN = Total no. of images correctly classified as normal, FN = Total no. of images incorrectly classified as normal.

The proposed model is compared for its performance evaluation with SVM and XGBoost tested with the same dataset used for the proposed CNN+SVM model, the inferred results are:

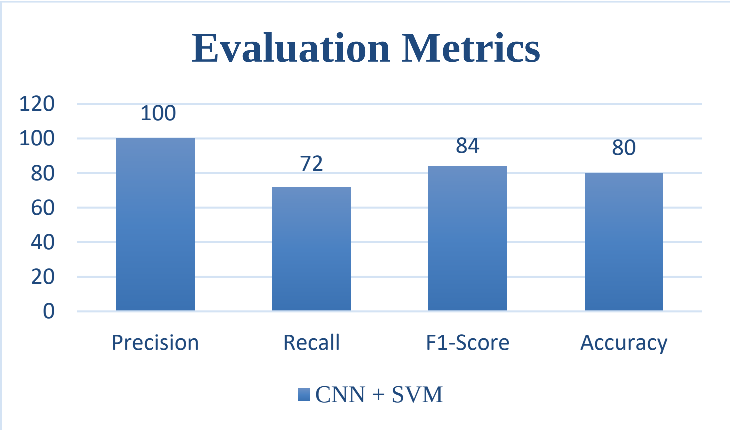
Table-2. Accuracy comparison for different networks

NETWORK	EPOCHS	ACCURAC
XGBoost	100	60
SVM	100	80
Proposed CNN+SV	100	82

From Table-2, it can be inferred that the proposed CNN + SVM model accuracy is same compared with SVM models performance, but the advantage of the proposed hybrid model is that the feature extraction process is done automatically with the CNN and then classified with SVM classifier which were hand engineered in SVM and XGBoost.



Graph-1. Shows accuracy comparison for different networks



Graph-2. Shows evaluation metrics of proposed CNN model

6. CONCLUSION AND FUTURE WORK

In this paper, a hybrid model using convolution neural network and support vector machine is presented to establish a relationship between iris of human eye and the detection of heart abnormality (Normal/Abnormal). The proposed identifies the abnormality in heart in an early stage with minimum cost. The results stated that using the hybrid CNN and SVM model the process of feature extraction is made automatic which was hand engineered in traditional and machine learning models and the proposed hybrid model obtained an accuracy of 80%. The data available on this methodology of detecting diseases is minimum and different deep learning architectures can be considered for feature extraction and classification processes which are considered as the future tasks in development of the proposed hybrid convolution neural network and support vector machine.

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