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Breast Cancer Classification and Detection using Deep Learning Algorithm

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Abstract:
This paper depicts CNN technology to detect the breast cancer. The process involves testing image, pre-processing, feature selection, feature extraction and dividing into separate classes. Feature learning is done by convolution and pooling process. By using CNN classifier normal and abnormal images can be obtained. Whereas in existing method SVM classifier is used to detect breast cancer by undergoing image enhancement, segmentation, feature extraction and directing them to SVM classifier.

***Keywords*:** Breast cancer, feature selection, feature extraction, Discrete wavelet transform, grey level coordinate matrix, calculation of selected features.

1. Introduction

When healthy cells in the breast change and grow out of control which results in the formation of mass or sheet of cells called tumor which results in cancer. According to Y. Ireaneus Anna Dr.S. Thamarai Selvi breast cancer is most common malignancy in women Breast masses and tumors appear in form of dense regions in mammogram. In the paper published by M Veta, JPW Plim, and MA Viergever, it determines the process of digital slide images adoption which is analogous to the digitization of radiological images.

According to Filipczuk, TFevens, Krzyzak, and R Monczak, breast cancer is the major cause of death in human. The early stages diagnosis and treatment is used to prevent the diseases from spreading so that the death rates among the women can be reduced. Initial detection through regular check-ups plays a preventive way in diagnosing breast cancer using ultrasound imaging and mammography. A tumor can be harmful or harmless. A cancerous tumour is malignant, that can grow and spread to all other parts of the body. Breast cancer spreads when there is a growth of cancer and their spreading into other parts of the body.

According to Filipczuk, Fevens, Krzyzak, and R Monczak development in imaging technique increases large data sets of available medical processes. This problem is solved by weakly supervised learning by demanding only labels for large groups and making performance similar.

According to Li and KN Plataniot is, they focus on the qualification of histo pathological patterns as a basic feature of breast carcinoma. They aim to reduce the breast cancer morbidity rate. According to Abdullah-Al Nahid**,** Mohamad Ali Mehrabi and Yinan Kong that cancer is caused by unwanted growth of cells which causes serious threat to humans. The people who suffer from various cancer diseases is showed by statistics. According to Angel-cruz-roa, the first step is the detection of tumor cells in the histologic section when diagnosing the breast cancer. The necessary prerequisite for tumor staging is delineation from background uninvolved tissue. It will be critical for the pathologist to manually identify the presence of breast cancer and treatment response. They spread from original site to other tissues the process like detection and delineation is a time consuming and tedious process.

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According to S Roberttson, H Azizepour, K Smith, and J Harteman, it is a malignant and heterogeneous disease. Types of breast cancer like Invasive and non-invasive breast cancer depends on their amount of spreading around the tissues. According to Hindu sign, karan sanwal and satyarth praveen, it is the development of malignant tumor in female breasts except curing them in the early stage no other prevention is there for the cancer. According to sharma, karbanda and kaushal mammographic image is used to detect and analyse the breast cancer. Its segmentation is used in detection of cancer regions and further analysis. When cancer cell travel through the blood or lymph vessels breast cancer spreads by growing into nearby tissues.

According to Fabíola Procaci Ken, Gustavo Antônio dSouza, Luiz Claudio Thuler; Gabriela Martins; Vivianne Aguilera Rolim de Freitas; Ellyete de Oliveira Canella. In Brazil women die mainly due to breast cancer called neoplasm. The mortality rate can be decreased only when breast cancer is detected earlier by screening method. In US because of mammographic findings the PPV of biopsies is performed that ranges between 15% to 40%. According to S.M. Astley, the abnormal growth of cancerous cells in mammary glands causes breast cancer.

The lymph nodes called axillary lymph nodes are found in armpit which is often checked for cancer. According to Maria

Rizzi, Matteo D'Aloia, Beniamino Castagnolo, For patient survival nationwide screening programs is spreaded for detecting the breast cancer earlier. So the breast cancer mortality can be reduced. Mammography is the diagnostic method that is currently available for showing malignant mammary glands to detect and cure them as soon as possible.

In this paper CNN technology is used to predict the breast cancer. The process involves testing image, pre-processing, feature selection, feature extraction and dividing into separate classes. Feature learning is done by convolution and pooling process. By using CNN classifier normal and abnormal images can be obtained.

2. Existing method

In the existing method Support Vector Machine (SVM) and neural network method to detect breast cancer. They may be sometimes a self-interpretability issue while diagnosing breast cancer. This issue can be solved by SVM method. The malignant breast growth can be detected by constrast pattern mining.

There is both normal and cancerous tissue images, In this method we use local characteristics learning which involves the division of small patches from the image. For the best classification this method needs the perfect key parameters that suits the given problem which in turn leads to poor classification and accuracy. The block diagram for existing method is shown in the Fig.1.1.

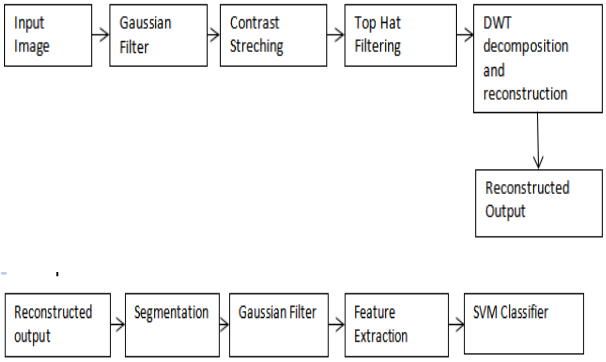

Figure 1.1: Block Diagram for existing method

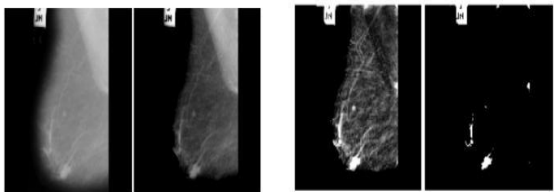

Figure 1.2: Result of Mammographic image for existing method

2.1 Image Enhancement

Image Enhancement refers to conversion of image quality to most understandable level. Firstly based on standard deviation, gaussian filter filters the mammogram images. Then using structural element morphological top hat filtering is performed on the gray scale input image. Then they are converted to binary values through thresholding at different values. When background is dark top hat filtering is used to convert illumination that is uneven. Using DWT it is decomposed to two scales then the image is reconstructed.

2.1.1 Segmentation and Feature Extraction

This segmentation and feature extraction is used to detect the properties like area, centroid, major axis length, length, eccentricity, orientation, filled area, extrema and solidity. Centroid is a vector that computes the tumor region.

2.1.2 SVM Classifier

A discriminative classifier called SVM classifier is determined by separating hyperplane. Among different classes the decision plane separates between the objects having different membership. Each instance consists of target and value and several features.

Here higher dimensional space is mapped by x_i vector. The linear separating hyperplane with maximun margin is detected by SVM. Linear polynomial, RBF and sigmoid which are the types of linear kernels are used in SVM models. One of the most popular choice is RBF which is used in SVM. The relavant application of breast cancer diagnosis is used in medical imaging. To minimize the generalisation error support vector is an innovative approach which are produced by locating the planes

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which separate more than two classes.For Gaussian radial basis function:

$$K(x, x') = \exp(-|x-x'|^2/(2\sigma^2)). \longrightarrow 1$$

By using the obtained support vectors kernel it is modified in data dependent way. Modified kernel is used to obtain the final classifier. By using this method the output obtained is shown in the fig.1.2

3. Proposed Method

In the proposed system, convolutional neural networks is used to reduce number of parameters. Convolution layer plays an important role in feature extractor in convolutional neural networks. CNN is used in pattern and image recognition, video analysis, processing the language and analysing the video. The output layer should contain the same number of nides as the softmax layer. The fully connected layer (FC) works on the flattened input which is connected to all neurons. Here the vector is a common output which is allowed to pass through softmax to represent the classification. The figure 1.3 depicts the block diagram of the proposed method. CNN is a good extension from deep learning algorithm operates on a flattened input where single input is connected to multiple neurons.Convolutional neural networks works because it's a best suited one among the standard deep-learning algorithm. The mammographic image obtained after image enhancement is shown in the fig.1.4

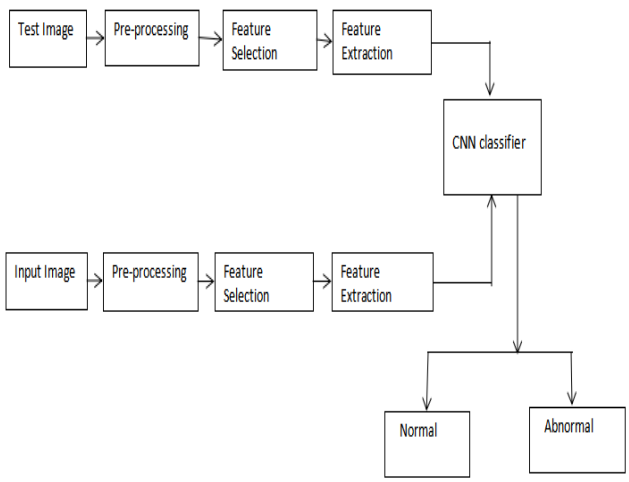

Figure 1.3 Block diagram for proposed system

3.1 Pre-processing

The pre-processing of image is used to eliminate the redundancy present in the images that are captured, without affecting the overall process. The input image is converted into gray scale images. Then the path is stored into image dataset and then the function to load folders containing Pixel value of the images is created. Thus, pixels of resized image varies from original image. Through interpolation method intensity values of additional pixels are obtained when size of image is increased. Image smoothing techniques are good in removing small amount of noise due to Gaussian Blurring, Median Blurring. So that the image would be clear. Noise is a random variable with zero mean. Consider a noisy pixel,

$$p = p_0 + n \longrightarrow 2$$

3.1.1. Feature Selection

In Feature Selection the method called Discrete Wavelet Transform (DWT) is used. It is a spectral evaluation approach used for studying non-desk bound information, and affords time-frequency representation of these information. DWT have been extensively used for studying facts, since facts contains non-desk bound traits. At low frequencies DWT uses long term home windows and at high frequencies it uses and quick time windows, which results in good time– frequency localization. By using consecutive excessive-bypass and coffee- pass filtering of the time domain DWT decomposes a sign into a set of sub-bands. The discrete wavelet is denoted by g which is high-skip filter out and at the same time the replicate model is denoted by h which is low-pass filter. The first stage approximation (A1) and detail coefficients (D1) which are first filters alerts down sampled images. By using the approximation coefficient of the previous degree the approximation and detail coefficients of next stage are received. Depending on the dominant frequency components of the statistics variety of decomposition ranges is decided. Scaling feature is based on low skip filter and wavelet feature is based on high skip filter. When compared to other wavelet transforms, a key benefit is, it captures not only frequency but also location information (location in time). The Haar wavelet transform is used to pair up input values by storing the difference and passing the sum. This process is recursively done, the sums are paired up to prove the next scale, which gives differences and a final sum

3.3 Feature Extraction

This method is used to extract the required features. It is also called as co-occurence distribution. To measure the variation in intensity at the pixel of interest the contents of the GLCM is used by Texture feature calculations.A virtual variable which is produced by GLCM texture feature represents a stexture calculation on a echogram.

Virtual variable creation steps:

3.1 Quantizing the image: Each sample is treated as a single image pixel and its value determines the given pixel's intensity. These intensities are then further quantized to specified number of discrete gray levels, called as Quantisation process.

3.2 Creating the GLCM*:* The result will be the square matrix N x N in size where N denotes number of levels.

Steps for matrix creation are:

3.2.1 Let U denote the sample used for calculation that is taken for consideration

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3.2.2 Let W be the set of samples which surrounds the sample U.
3.2.3 In a set W, define each element i, j of the GLCM.
3.2.4 The Sum of all elements i,j gives the total number of times the relationship occurs.
GLCM is made symmetric

i. The copy of GLCM is created
ii. Add the copy to GLCM itself which results in a symmetric matrix in which determines the relationship i to j is indistinguishable for the relationship j to i shown in fig 1.6.1

3.2.5 GLCM is made to normalize

i. Each element is divided by element's sum
ii. The probabilities of finding the relationship i,j in W can be determined by the elements of GLCM
iii. The features like Energy, Entropy, Contrast, Homogeneity and correlation is obtained from GLCM

It accepts a volume of size A1B1xC1 the four hyper parameter required:

1) N Number of filters
2) Spatial extent F
3) The stride W
4) The amount of zero padding P Q

Volume of size A2xB2xC2 is produced
where

The final value of the neuron is detected by this layer and it is also used to increase non-linearity of the network. Faster training can be done by using rectified linear unit results.The vanishing gradient problem is addressed by leaking rectified linear unit addresses.

4. Traditional Neural Network

A Convolutional Neural Network is based on Deep Learning which can take in an input image and can able to differentiate one from the other by assign importance to various objects in the image. Convolutional layers convolves the input image and pass its result to the next layer. This is similar to the response of a neuron to a specific stimulus in the virtual cortex.

The architecture of convolutional layer is shown in fig-1.5

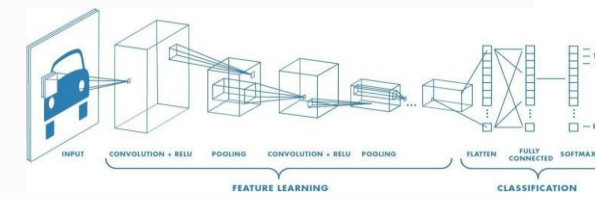

Figure 1.5 Architecture of Convolutional neural networks

5. Convolutional Layer

In the original images filters are applied by l convolutional layers. The filters are also applicable to other features of the map in CNN. The filter has the same number of layers as input volume channels. The filters are applied to original image and detect the features present in the image and it is also used to increase non-linearity of the network. Faster training can be done by using rectified linear unit results. The vanishing gradient problem is addressed by leaking rectified linear unit addresses.

6. Softmax

It is usually used at the end of Fully Connected Layer outputs and it is a special type of activation layer. It can be viewed as a fancy normalizer and produces a discrete probability distribution vector and when is done along with cross entropy loss it is very easy.

$$P(y = j \mid \mathbf{x}) = \frac{e^{\mathbf{x}^\mathsf{T}\mathbf{w}_j}}{\sum_{k=1}^{K} e^{\mathbf{x}^\mathsf{T}\mathbf{w}_k}}$$

Given sample vector input **x** and weight vectors $\{\mathbf{w}_j\}$, the predicted probability of y = j

⟶ 3

Figure 1.7: Convolution Maps – Region of Image

7. Pooling Layer

Pooling layer is another layer of CNN is which is used to reduce the spatial size to lower the number of parameters and in network computation. This layer operates independently on each feature map. The idea is that a convolution maps a region of an image to a feature map which resembles as mentioned in the fig 1.7

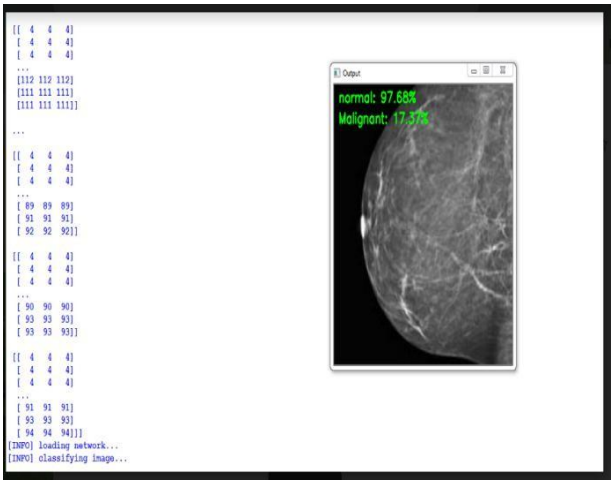

Figure 1.8 Result obtained using CNN method

8. Result and Discussion

In this proposed method an input image is taken and pre-processing is done on the image by removing the redundancy present in the captured images and from that feature is selected using Discrete Wavelet Transform (DWT) in which we take only Low-High frequency (LH images) and High to Low frequency(HL images) while eliminating the High-High Frequency(HH images) and

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Low-Low Frequency (LL images) and then the feature is extracted using Gray Level Coordinate Matrix(GLCM) and then sent to CNN classifier which classifies with the help of values and detect the percentage of malignant and normal cancer. We obtain the result as shown in the fig 1.8.

Table 1: Accuracy determination of existing and proposed method

DATASET	ACCURACY OF USING SVM(EXISTING METHOD	ACCURACY OF USING CVV(PROPOSED METHOD)
INDIAN PIPELINES	90.1%	97.054%

9. Conclusion

To summarise the developed method the input image is tested with the test image and the features are extracted and classified using CNN classifier. Based on that classification, percentage of malignant and normal breast cancer is detected. So that it would be easy for the doctors to proceed with the appropriate treatment and cure them Easily.

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