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A STUDY ON THE DETECTION OF BREAST CANCER USING NEURAL NETWORK WITH CONVOLUTIONAL APPROACH

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Abstract :

Breast cancer is one of the most common and rapidly increasing diseases globally. This illness predominantly affects women. Detecting the disease early can help manage breast cancer effectively. A woman's likelihood of developing breast cancer nearly doubles if she has a first-degree relative—such as a mother, sister, or daughter, who has been diagnosed with it. Early diagnosis of breast cancer through mammogram images is a crucial step in the process of disease detection. Therefore, having effective screening methods is essential for identifying the early signs of breast cancer. Different imaging methods are utilized for screening and diagnosing this illness; the common techniques include mammography, ultrasound, and thermography. Among these, mammography stands out as one of the most crucial methods for the early detection of breast cancer. In light of these concerns, radiography might overlook small tumors, while thermography could prove to be more effective than ultrasound in identifying smaller cancerous lesions. A Convolutional Neural Network (CNN) approach is employed for breast mass detection to reduce the burdens associated with manual assessments. This system leverages several CNN architectures to identify breast cancer and evaluates the outcomes against those obtained from machine learning algorithms.

KEYWORDS: Breast Cancer, Convolution Neural Network, Mammogram.

I.INTRODUCTION:

Breast Cancer is an uncontrolled growth of breast cells, cancer occurs as a result of mutations or abnormal changes. These cells usually form a tumor often seen on X-ray or felt as a lump. The tumor is malignant (cancer) if the cells can grow in surrounding tissues or other body parts. Breast cancer is also a very life-threatening disease of women after lung cancer. A convolutional neural network (CNN) method is proposed in this study to boost the automatic identification of breast cancer. The proposed system uses various convolutional neural network (CNN) architectures to automatically detect breast cancer, comparing the results with those from machine learning (ML) algorithms. Validation tests were done for quantitative results using the performance measures for every methodology. Breast cancer can be effectively treated through its early detection. Thus, the availability of proper screening methods is important for detecting the initial symptoms of breast cancer. Various imaging techniques are used for the screening to identify this disease; the popular approaches are mammography, ultrasound, and thermography.

One of the most significant methods of early detection for breast cancer is mammography. Considering these issues, small masses can be bypassed by radiations from radiography and thermography may be more effective than the ultrasound technique in diagnosing smaller cancerous masses.

On the other hand, digital pathology (DP) is a way of digitalization of histology slides to produce high-resolution images. These digitized images are used for detection, segmentation, and classification through the application of image analysis techniques. Extra steps are required in deep learning (DL) using CNNs, such as digital staining, to understand patterns for image classification. The proposed system is found to be successful, achieving results with good accuracy, which could reduce human mistakes in the diagnosis process. Moreover, our proposed system achieves accuracy higher than the normal accuracy of machine learning (ML) algorithms.

The testing techniques that are being currently used for BREAST CANCER detection are Taking X-rays of breast tests take much time for prediction, and also due to the limited availability of these test kits, early detection cannot be done which in turn increases the spread of disease. In this epidemic situation, Artificial Intelligence (AI) techniques are becoming vital.

In this project, a deep learning model using CNN, that takes an image as input and gives the probability of predicting the BREAST CANCER as output is presented and acts like an aiding tool for pathology. This was trained to predict 20 different pathologies. Since this model was already trained on Breast cancer during the development we can get better and more accurate results of prediction using this. So, to increase the Breast Cancer rate we can use images of the breast to test as preliminary and if the detection test results are positive then the patient can undergo the treatment.

II. TYPES OF NEURAL NETWORK AND WORKING:

Deep Neural Network: It is a neural network with a certain level of complexity (having multiple hidden layers in between input and output layers). They are capable of modeling and processing non-linear relationships.

Deep Belief Network (DBN): It is a class of Deep Neural Network. It is a multi-layer belief network.

Steps for performing DBN:

- Learn a layer of features from visible units using the Contrastive Divergence algorithm.
- Treat activations of previously trained features as visible units and then learn features of features.
- Finally, the whole DBN is trained when the learning for the final hidden layer is achieved.

Recurrent Neural Network – Allows for parallel and sequential computation. Similar to the human brain (large feedback network of connected neurons). They can remember important things about the input they received hence enabling them to be more precise.

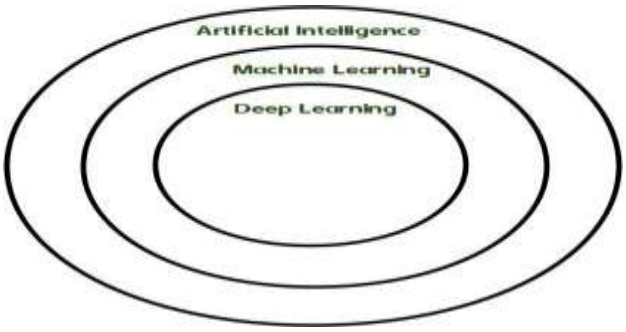

Fig 1. Representing Deep Learning of Artificial Intelligence

WORKING:

- First, we need to identify the actual problem to get the right solution and it should be understood, the feasibility of Deep Learning should also be checked (whether it should fit Deep Learning or not).
- Second, we need to identify the relevant data, which should correspond to the actual problem and should be prepared accordingly.
- Third, Choose the Deep Learning Algorithm appropriately.
- Fourth, an Algorithm should be used while training the dataset. Fifth, Final testing should be done on the dataset.

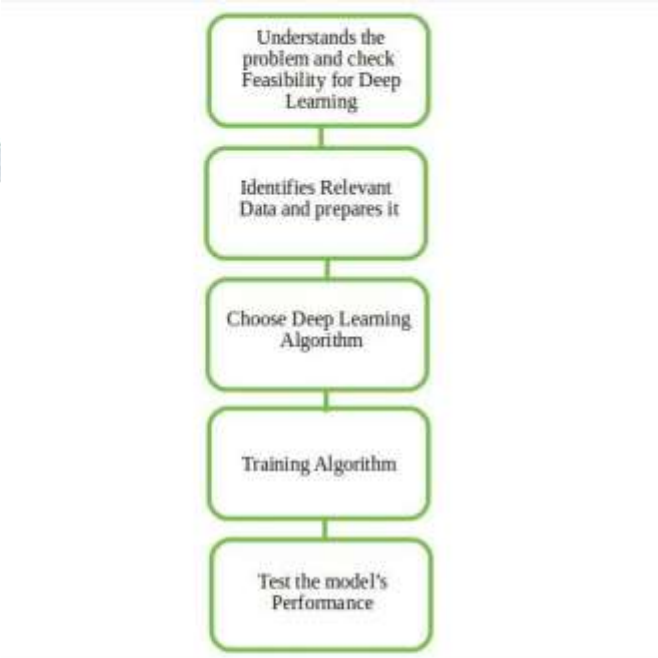

Fig 2. Steps for representing Deep Learning

III. EXISTING SYSTEM:

Currently, a significant number of women are impacted by breast cancer, which ranks as one of the deadliest diseases globally. Over the past five years, survival rates for breast cancer patients in the USA have improved, while reports from India show concerningly lower rates. It is critical to understand that breast cancer can sometimes be detected only after symptoms arise; however, many women are diagnosed without any noticeable symptoms.

This reality underscores the necessity of regular breast cancer screening, despite the lengthy process of obtaining results. There are various effective methods for detecting breast cancer, and these tests play an essential role in identifying and monitoring the disease. Typically performed in hospitals, these screenings are vital for early detection. It's important to be aware that screening test results may occasionally appear abnormal, even when no cancer is present. False-positive results—which indicate cancer when it is not present—are not uncommon and often lead to further testing, such as a biopsy, which can carry additional risks. Nevertheless, it is crucial to remember that the majority of abnormal test results do not indicate cancer. False-positive results tend to occur more frequently in specific circumstances, including:

The existing system has several disadvantages:

1. The detection accuracy is low.
2. Test results take too long.
3. Tests are performed mainly in hospitals or clinics.
4. There are long turnaround times.
5. Some individuals find the procedures uncomfortable.

IV: PROPOSED SYSTEM:

The patient has invested significant time and money in developing a system for image detection aimed at analyzing breast cancer. In the proposed system, we are using a Convolutional Neural Network (CNN) algorithm. This technology will enhance accuracy and provide the necessary outputs to users. It allows users to check their results using images and effectively detects the spread of infection. Overall, this model has been extended to analyze all the mammograms in the dataset. The trained model predicts whether an input mammogram image indicates the presence of breast cancer or not.

Advantages of the Proposed System –

1. Early detection of breast cancer.
2. Requires less storage space.
3. Reduces human effort and it is less expensive.

V. IMPLEMENTATION:

A neural network computing system consists of several simple, highly interconnected processing elements that process information based on their dynamic response to external inputs. Neural networks are typically organized into layers. Each layer is made up of multiple interconnected 'nodes' that contain an 'activation function.' Patterns are presented to the network through the 'input layer,' which communicates with one or more 'hidden layers' where the actual processing occurs through a system of weighted 'connections.' Finally, the hidden layers link to an 'output layer,' where the result is produced.

CONVOLUTIONAL NEURAL NETWORK

A Convolutional Neural Network (CNN) is a type of deep learning algorithm inspired by the visual processing system of animals. It is particularly effective for tasks involving image and video recognition, classification, and analysis.

It uses a specialized kind of linear operation called convolution in place of general matrix multiplication in at least one of its layers. It consists of convolutional layers, pooling layers, and fully connected layers, allowing it to automatically and adaptively learn spatial hierarchies of features from input images.

KEY COMPONENTS INCLUDE:

- **Convolutional layers**: Apply convolution operations to the input to extract features such as edges, textures, and patterns.
- **Pooling layers**: Reduce the spatial dimensions of the data, making the computation more efficient and the network more resilient to small translations in the input.
- **Fully connected layers**: Perform high-level reasoning in the network, resulting in final classification or output.

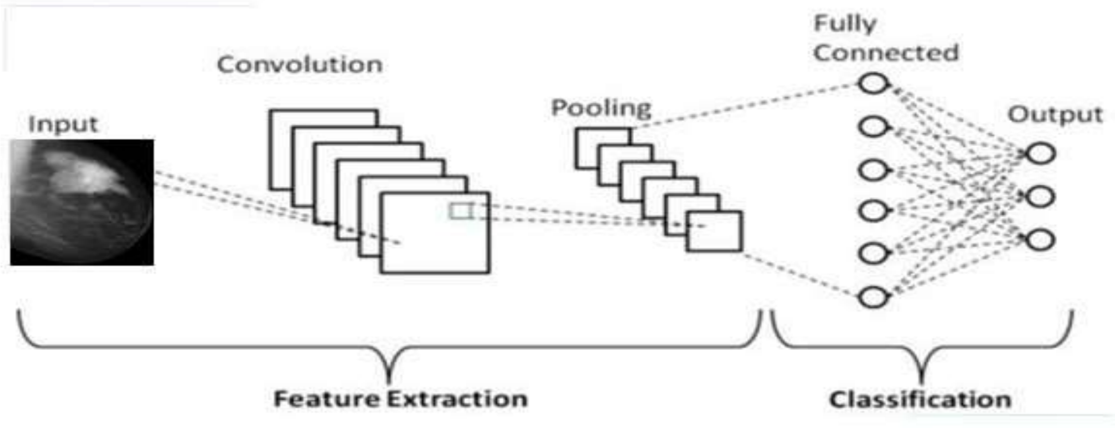

Fig 3. System Architecture of CNN

LAYER TYPES:

There are many types of layers used to build convolutional neural networks, but the ones we are most likely to encounter include:

1. Convolutional Layer, 2.Pooling Layer, 3. Fully connected Layer, 4. Dropout Layer

As considering the requirement of the project we are using Convolutional (CONV), Pooling (POOL), and Fully Connected (FC) as our layers in the model.

Stacking a series of these layers in a specific manner yields a CNN. We often use simple diagrams to describe a CNN:

INPUT => CONV => RELU=> POOL => FC=> SOFTMAX.

Here we define a simple CNN that accepts input, applies a convolution layer, then an activation layer, then a fully connected layer, and finally, a SoftMax classifier to obtain the output classification probabilities.

The SoftMax activation layer is often omitted from the network diagram as it is assumed it directly follows the final fully connected layer.

CONVOLUTION LAYER:

The CONV layer is the core building block of a Convolutional Neural Network. The CONV layer parameters consist of a set of K learnable filters (i.e., “kernels”), where each filter has a width and a height, and is nearly always square. These filters are small (in terms of their spatial dimensions) but extend throughout the full depth of the volume.

For inputs to the CNN, the depth is the number of channels in the image (i.e., a depth of three when working with RGB images, one for each channel). The depth will be the number of filters applied in the previous layer.

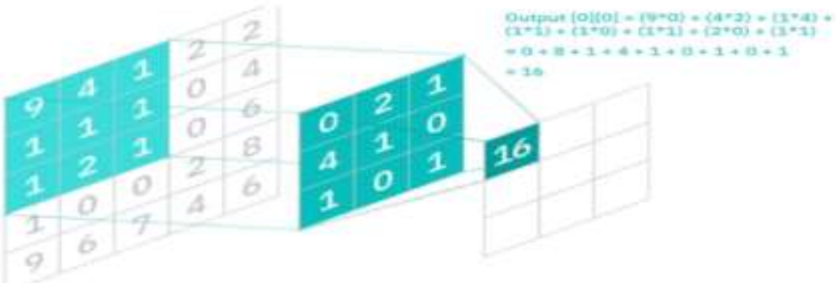

Fig 4. Convolution Operation

KERNEL:

A filter, or kernel, is a key element in a layered architecture. It is a smaller matrix compared to the dimensions of the image and contains real-valued entries. These kernels are convolved with the input volume to generate activation maps. Activation maps highlight the activated regions, specifically those areas in the input where features corresponding to the kernel have been detected.

STRIDE:

We described the convolution operation as "sliding" a smaller matrix over a larger matrix. At each coordinate, we perform an element-wise multiplication followed by a summation, and then we store the resulting output. This process resembles a sliding window that moves from left to right and from top to bottom across an image.

ZERO PADDING:

To retain the original size of an image when applying convolution, it is necessary to "pad" the borders. This process is also relevant for filters within a Convolutional Neural Network (CNN). By using zero padding, we can add padding along the borders of our input so that the output volume matches the size of the input volume. The amount of padding applied is controlled by the parameter known as "padding."

This technique becomes particularly important when dealing with deep CNN architectures that apply multiple convolutional filters in succession. For example, consider applying a 3x3 kernel to a 5x5 input image with a stride of 1. Without zero-padding, the spatial dimensions of the input volume would decrease too rapidly, making it difficult to train deep networks, as the input volumes would become too small to learn useful patterns. To compute the size of an output volume as a function of the input volume size (denoted as W, assuming the input images are square, which is typically the case), we need to consider the receptive field size (F), the stride (S), and the amount of zero-padding (P). To construct a valid convolution layer, the following equation must result in an integer:

$$(W - F + 2P) - S) + 1$$

If the result is not an integer, it indicates that the strides are set incorrectly, and the neurons cannot be arranged symmetrically across the input volume.

POOLING LAYERS:

There are two methods to reduce the size of an input volume-CONV lavers with a stride > 1 (which we've already seen) and POOL layers. It is common to insert POOL layers in between consecutive CONV layers in CNN architectures:

INPUT -> CONV => RELU=> POOL=> CONV => RELU => POOL>FC

The primary function of the POOL layer is to progressively reduce the spatial size (i.e., width and height) of the input volume. Doing this allows us to reduce the number of parameters and computations in the network- pooling also helps us control overfitting.

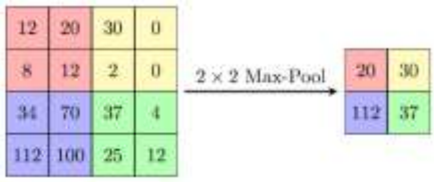

Fig5: Pooling Layers

FULLY CONNECTED LAYERS:

Neurons in FC layers are fully connected to all activations in the previous layer, as is the standard for feedforward neural networks. FC layers are always placed at the end of the network (i.e., we don't apply a CONV layer, then an FC layer, followed by another CONV) layer. It's common to use one or two FC layers before applying the softmax classifier, as the following (simplified) architecture demonstrates.

INPUT-> CONV-> RELU => POOL=> CONV-> RELU=> POOL-> FC.

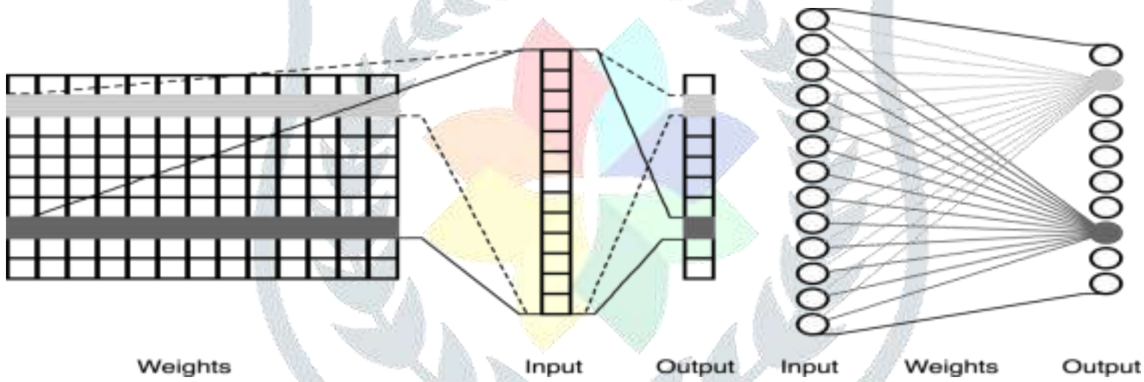

Fig6: Fully Connected Layer

VI. TESTING:

As the coding is completed according to the requirements, we have to test the quality of the software. Software testing is a critical element of software quality assurance and represents the ultimate review of specification, design, and coding. In addition, data collected as testing is conducted to provide a good indication of software reliability and some indications of software quality as a whole. To assure the software quality we conduct both white box testing and black box testing.

1. WHITE BOX TESTING

White box testing is the testing process in which a tester can perform testing on an application without having any internal structural knowledge of the application.

2. BLACK BOX TESTING

Black box testing is the testing process in which a tester can perform testing on an application with internal structural knowledge.

VII. SYSTEM TESTING:

It is designed to uncover weaknesses that were not detected in the earlier tests. The total system is tested for recovery and fallback after various major failures to ensure that no data are lost. An acceptance test is done to validity and reliability of the system. The philosophy behind the testing is to find errors in the project. There are many test cases designed with this. The flow of testing is as follows.

1. CODE TESTING

Specification testing is done to check if the program does with it should do and how it should behave under various conditions or combinations and submitted for processing in the system and it is checked if any overlaps occur during the processing. This strategy examines the logic of the program. Here only the syntax of the code is tested. In code testing syntax errors are corrected, to ensure that the code is perfect.

2. UNIT TESTING

The first level of testing is called unit testing. Here different modules are tested against the specification produced running the design of the modules. Unit testing is done to test the working of individual modules with test oracles. Unit testing comprises a set of tests performed by an individual programmer before the integration of the units into a large system.

3. SYSTEM TESTING

The next level of testing is system testing and acceptance testing. This testing is done to check if the system has met its requirements and to find the external behavior of the system.

VIII: Results :

Fig7: Home Page for Cancer Detection

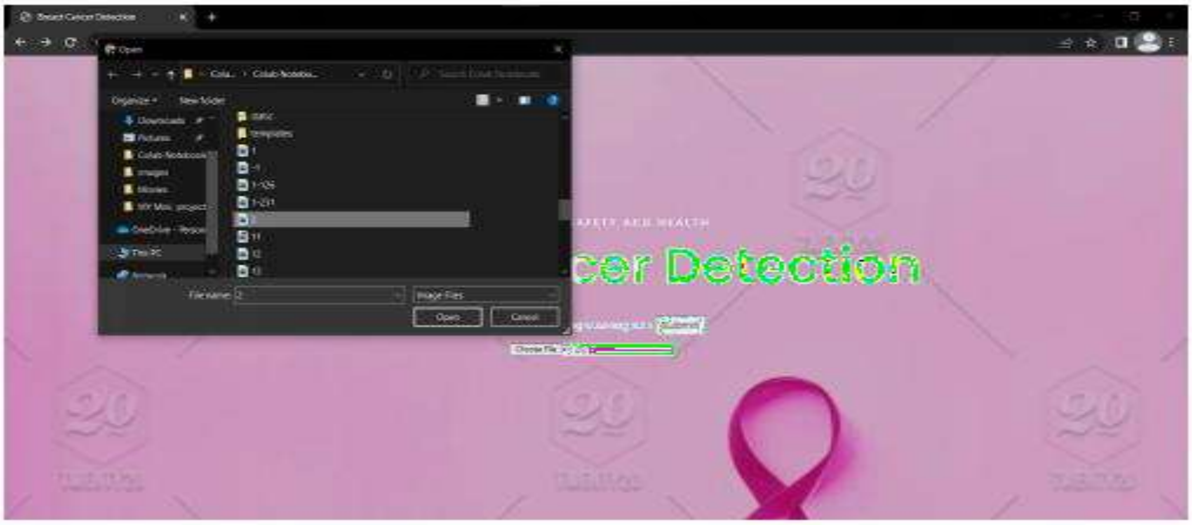

Fig8: Uploading Images from the Dataset

Fig:9 Submitting the image for Detection

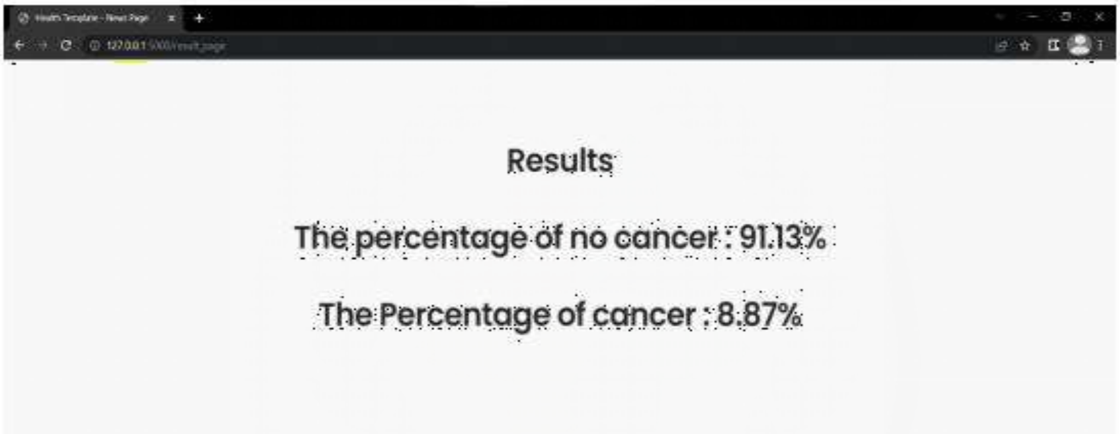

Fig10: View the result

Fig11: Uploading another image

Fig12: Uploading an image for Detection

Fig13: View of Result of Cancer

CONCLUSION:

In this project, a deep learning approach using transfer learning was proposed for breast cancer detection. This model demonstrates that computer vision has the potential to bring about significant advancements in the analysis of radiological images. Consequently, a time-efficient solution can be developed to identify and isolate infected patients. Despite being trained on a small dataset, the proposed model achieved exceptional results, with validation showing high accuracy. It also outperforms all other models that have worked with X-ray data.

This success is attributed to the combination of various models and a customized deep neural network (DNN) that together enhances performance compared to existing models based on mammogram images. Moreover, as the dataset continues to grow, the model will become increasingly accurate and robust.

The future scope of this research includes testing and improving the model's performance for other breast diseases as well.

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