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Research Article

Medical Data Technology for Automatic Diagnosis System

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ABSTRACT

New industries utilising image processing technology in the medical business, notably for sickness detection, are emerging as a result of the popularity of image processing and its benefits. Grayscale images, such as X-rays and CT scans, provide a classification problem in medical applications since only grey channel information is available and no chronic information is available. A convolutional neural network (CNN) is utilised to detect breast cancer in this study, with huge coloured MRI images used to train the CNN model. Other models used were Random Forest, K-nearest Neighbour, and Nave Biase. CNN's cancer prediction accuracy of 95.12 percent may be maintained in the future.

Keywords: Machine Learning, CNN, AN, Random Forest, KNN, Naïve Bays, Preprocessing

INTRODUCTION

Data collection techniques are also necessary for efficient data mining because data is so vital in defining future corporate strategies in a wide range of sectors in today's world. However, data is collected using effective methods such exact data input and registration systems, sensors, digital devices for gathering client feedback, and so on [1]. Medical data has been used to help in the accurate detection of diseases and the creation of systems that may forecast sickness based only on medical tests and examination reports. Those systems' accuracy is constantly being improved [2]. The extraction of information from a visual, its translation into multiple useful formats, and the recognition of image objects are all part of picture processing. Pattern recognition, personal verification, and security systems are all uses of this discipline of computer science [3]. In this study, deep learning and machine learning paradigms are being used to investigate breast cancer. The remaining portions of this chapter deal with topic formulation, research objectives, and thesis chapter definition through the thesis organisation section.

According to the literature study mentioned in chapter two, machine learning-based medical applications that may predict patient scenarios or, in other words, identify case objects for infections in various illnesses. The current use of such research is still in the early stages of development and has yet to be put into practise. For data classification, several papers in the literature employ neural networks with a large number of hidden layers, which has an impact on the overall model's performance since it consumes a significant amount of computational cost and hence increases processing time [4]. In today's world, photographs are used in pattern recognition, security systems, facial recognition, remote sensing, and other applications. Image processing in medical applications is an important part of enhancing human life. New industries based on image processing technology, such as medical image processing for diagnosis, are emerging as a result of the increased popularity of image processing applications. The accuracy of the diagnosis is limited by the amount of information or the quality of the information preserved in each pixel. The problem emerged when some/specific photographs had inadequate pixel information, leaving them unsuitable for processing in all of the aforementioned programmes. To put it another way, the quantity of data held by each picture is proportional to the amount of data kept by each pixel. Because only grey channel information is supplied and no chronic information is available, this issue reveals itself in grayscale images (which are widely utilised in medical applications). As a result, grayscale images are inappropriate for image processing since each image's pixel is represented by only one value (grayscale channel), and no substantial association between any two grayscale images (assumed for the same event/object) can be ensured. The use of many channels while digitally processing an image is required and is the only way to correlate two pictures in applications such as face recognition or pattern recognition because noise interference with the image has the potential to modify the information in each channel, and the noise influence varies per channel. When dealing with a signal channel, such as a grayscale image, noise can harm all of the information held in the pixel, but when dealing with a multi-channel image, noise has a reduced impact. Even though colorful images, such as MRI scans, provide a new challenge owing to the amount of data and variance across instances, accuracy difficulties have arisen.

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IMAGE DECOMPOSITION

Digital photos are used in study and engineering because of their efficiency in prescribing natural objects. On the other hand, the term "digital" refers to images that assign a value to each dot. As a result, pictures are composed of a large number of dots of varied intensity (value), which constitute the final tent of the image. Giving it a finished look that is visible to the naked eye [5][6]. With the development of digital systems, new cameras are designed to intake the colour images instead of old fashion crystallizing image. The digital images are now providing a clear colored image with multi-channel.

Images of interest are depending on the cameras can be classified into Red, Blue, Green and under infrared channel. A binary image is in turn represents the image with only black and white colours and is representing the pixels with binary value more likely zeros and ones. Figure 1 demonstrates the four bands that are aforementioned above along with the united colours image that termed as colored image that includes all channels above. It's worth mentioning that the same image may be used for particular applications such as remote sensing in satellite image processing, which can give extra information that assists in the detection of geological objects from satellite images.

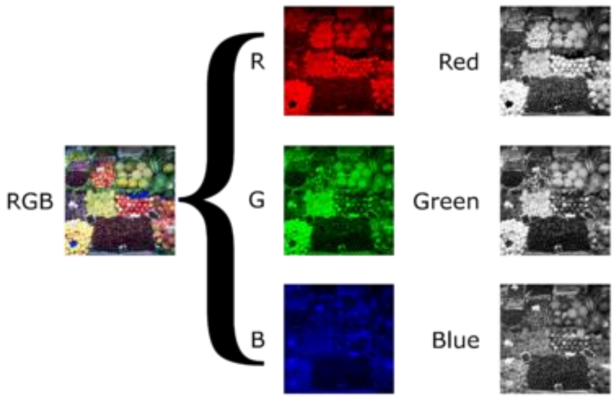

Figure 1: Colored and RGB channels of image

The main purpose of image processing is to determine what mathematical scale the images are equal to. The information from their (three-four) channels is always combined to generate the final picture colours. A colour image can be represented as a three-dimensional matrix with dimensions of x, y, and z.

The very standard image representation is of the binary image which allots every pixel with a value of zero or one depending on the pixel location and intensity and formulate the final shade of the image. We may represent picture s as follows if we assume it is a binary image with nine pixels.

$$s = \begin{matrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \end{matrix}$$

Whereas, the colored image is a combination of three channels namely, red, blue and green and in some cases the under infrared channel is implemented. So, let the red colour is represented by the matrix R and blue and green colours are represented by the matrixes B and G respectively.

$$R = \begin{matrix} 1.2 & 0.5 & 1 \\ 1.25 & 0.98 & 1.8 \\ 1.32 & 2.1 & 0.84 \end{matrix}$$

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$$B = \begin{matrix} 1.8 & 0.89 & 0.25 \\ 0.112 & 0.285 & 1.69 \\ 1.12 & 1.1 & 1.07 \end{matrix}$$

$$G = \begin{matrix} 1.879 & 0.213 & 0.748 \\ 0.396 & 0.203 & 1.369 \\ 1.102 & 1.279 & 0.258 \end{matrix}$$

So, the combination of the three channels can yield the final.

$$Colour = \begin{matrix} R & & \\ & B & \\ & & G \end{matrix}$$

NEURAL NETWORK MODELLING

As a consequence of the evolution of machine learning algorithms, new techniques to provide improved learning capability and increased prediction performance have been introduced. The neural network is based on how neuron cells work in the human brain. It follows the same principles as human learning. Algorithms that represent the next generation of machine learning technology are referred to as "artificial." Learning and testing are the two steps of neural networks in general [7].

The neural network analyses the data and the target throughout the learning phase, finally arriving at a concept that relates the data at the input and the outputs (or the expected results). Consider the following stapes [8] while in the training stage.

The three layers that make up a neural network are the input layer, hidden layer, and output layer. The number of hidden layers ranges from one to several, depending on the design requirements. Figure 2 depicts the evolution of a single hidden layer neural network.

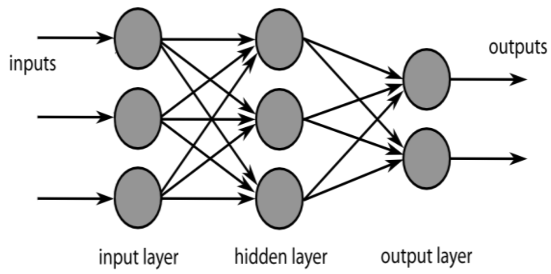

Figure 2: Neural network fundamental structure

A neural network's layers are made up of many (plural) nodes; the number of nodes is dictated by the input length, and a high number of nodes might slow down the network's execution.

Weights are used to link nodes, and they function similarly to neurons in the nervous system. These weights are represented by a numerical value that shows the number used to scale the input as it progresses through the layers.

Let x[n] be a single-dimensional array with one column and n rows that is fed into the neural network model at the input layer. The output of the hidden layer is indicated by y[n] and may be expressed as:

$$\mathrm{y[n]} = \sum_{\mathrm{n=1}}^{\mathrm{n=N}} \mathrm{x[n]}.\,\mathrm{w_i} \quad (1)$$

The hidden layer's output, on the other hand, may be expressed as z[n] in the equation below.

$$\mathrm{z[n]} = \sum_{\mathrm{n=1}}^{\mathrm{n=N}} \mathrm{y[n]}.\,\mathrm{w_h} \quad (2)$$

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It is worth to say that three different weight coefficients to be presented on the network namely input layer weight, hidden layer weight and output layer weight. However, the final output of the network model can be expressed as in equation below which entitled as

On the network, three separate weight variables must be displayed: input layer weight, hidden layer weight, and output layer weight. The final output of the network model, on the other hand, may be written as the equation below.

$$\mathrm{m[n].m[n]} = \sum_{n=1}^{n=N} \mathrm{z[n].w_o} \tag{3}$$

The goal of training a neural network on a set of data is to provide it all the knowledge it needs about the data's structure and nature, as well as how the data pieces connect to one another and to the objective. This is a crucial stage in the operation of the neural network. The precision of the neural network's goal is determined by the weight allocation precision.

Weight distribution's main purpose is to satisfy the equation (4). Weight is the most important part of the output generation process, or, to put it another way, the process of mapping an input to a certain class.

Assume the input is x[n], the output is y[n], and the weight general formula is W, with the output represented by the equation below after passing through the weight.

$$\mathrm{W} = \frac{\mathrm{x[n]}}{\mathrm{y[n]}} \tag{4}$$

Knowing that a weight vector might include hundreds or thousands of items and that the amount of weights in the vector is proportional to the number of dataset components.

The LM method, which is a standard weight generation strategy in neural network models, is most likely employed to give weight to the neural network model.

METHODS OVERVIEW

Using various hyper parameters, convolutional neural networks (CNNs) are often employed to predict the presence of cancer in a database (configurations). The experiment employed a total of 2215 coloured MRI scans. The SKLEARN model is used in Python contexts to carry out the procedure. Images are initially downsized to new dimensions, i.e. 50 pixels by 50 pixels, before being fed into CNN; after that, the photos are subjected to the following operations:

a> Image scaling to new dimensions, such as 50 × 50 pixels, in order to lower the payload on the proposed classifier by deleting undesired portions from photos.

b> A unique reshape is used to convert the pictures (each one) into three-dimensional arrays that can be input into CNN. A new 50 by 50 by 1 form has been added to each image.

c> Image pixel normalisation, where the value of each pixel is a fraction of one and the image's peak value is one. This method is used to reduce variation and enhance classification results. The actions done on the pictures prior to the training are depicted in Figure 3.

Model education: Approximately 20% of the images are utilised for testing, while the remaining 80% are used for training. The combinations shown in Table 1 are the most prevalent uses of CNN. Table 2 shows the training coefficients.

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Table 1: Main CNN is used in the configurations

Layer	Information
Sequential CNN	Main model type
Conv2D	First layer with 32 filters and (3,3) kernel size and “linear” activation
LeakyReLU	Second layer with alpha transfer function
MaxPooling2D	Third layer with (2, 2) kernel size
Conv2D	Fourth layer with 64 filters and (3,3) kernel size and “linear” activation
LeakyReLU	Fifth layer with alpha transfer function
MaxPooling2D	Sixth layer with pool size is (2, 2)
Conv2D	Seventh layer with 128 filters and (3,3) kernel size and “linear” activation
LeakyReLU	Eighth layer with alpha transfer function
MaxPooling2D	Ninth layer with pool size is (2, 2)
Flatten	Tenth layer
Dense	Eleventh layer with 128 filters
LeakyReLU	Twelfth layer alpha transfer function
Dense	Last layer with 3 filters

Table 1: CNN model training coefficients

Parameter	Value
Training method	Adam
Batch size	64
Epochs	10
verbose	1

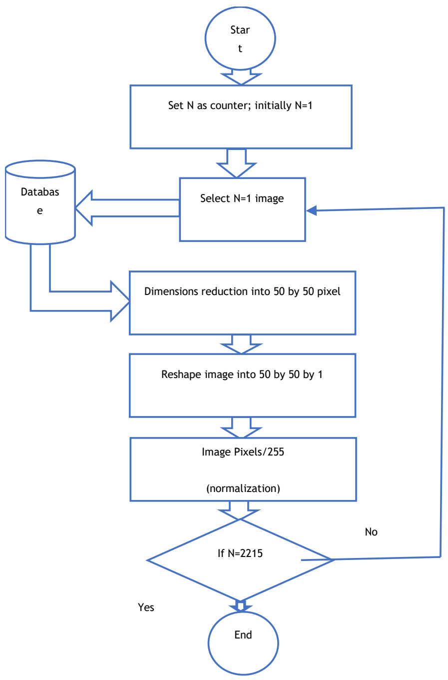

Figure 3: Preprocessing model flow diagram

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RESULTS AND DISCUSSIONS

The CNN model was subjected to numerous iterations in order to discover the optimal parameters. To achieve this, the kernel size, layer number, and filter number of the primary model were adjusted. After the CNN models are analysed, each picture is transformed to a signal row array (single dimensional array) and fed into algorithms such as those listed in Table of all algorithms in illness prediction, with performance metrics obtained and published in Table 3 and Figure 4.

Table 3: Accuracy pf prediction measure for all the algorithm

Tool	Accuracy
N. Bays	33.035
RF	66
KNN	61.195
CNN	95.12

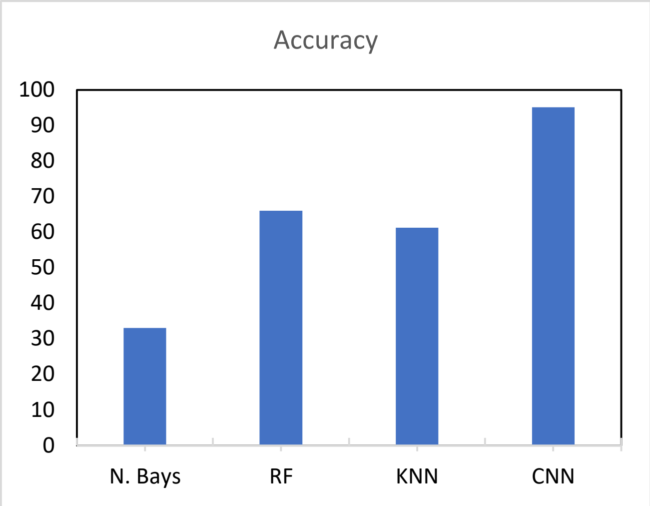

Figure 4: Accuracy pf prediction measure for all the algorithm.

CONCLUSION

In today's technology context, deep learning methods have become increasingly important. It was employed in a range of engineering and scientific projects. Artificial intelligence and machine learning are also applied in medical applications. Both employ past data such as raw values (numbers or characters), photographs, and even videos to predict disease or sickness.

To diagnose breast cancer illness, a CNN neural network is used with an ideal model structure to reduce overfitting and provide the highest possible prediction accuracy.

Because of its flexible and helpful structure, CNN may be used to analyse enormous volumes of data with great efficiency and minimal training error. The breast cancer database will be used in this investigation. The accuracy, MSE, MAE, and RMSE are then used to evaluate the system's performance.

The findings are compared to K-nearest neighbours, Random Forest, and Nave Bays, as well as other machine learning algorithms. The convolutional neural network beats the others, according to the data. The findings of utilising a Convolutional Neural Network instead of other methods show that it has a prediction accuracy of 95.12%.

The Random Forest Algorithm can likewise attain great prediction accuracy, but it does so at a large cost in terms of time, which is a key source of performance loss. Other methods produced varying degrees of accuracy, all of which were less precise than our model.

Furthermore, the CNN model surpasses the other deployed models since there is no extra strategy for converting a multi-dimensional picture into a single-dimensional array, and it also includes feature extraction, which is not included in deep learning paradigms. In our predicted state of the art, the findings are more reliable than other available approaches.

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