MEDICAL IMAGE ENHANCEMENT BASED AI TECHNIQUES: A REVIEW

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ABSTRACT

Image enhancement is a type of image processing that improves the image's suitability for specific uses. Image enhancement's primary goal is to improve an image's visual look, or to provide a "higher transform features of an image". The goal of the paper is to analyze and formulate several image enhancing strategies that can be used in a variety of medical applications. A survey of various picture enhancement techniques is presented in this work. More specifically, the suggested research would focus on improving medical photos captured in low-light conditions, foggy environments, and speckle noise, among other things. Developing algorithms to aid clinicians in diagnosing the disease at its earliest stages.

KEYWORDS: *ANN, FuzzayLogic, Image enhancement, Image noising.*

I. INTRODUCTION

An image is a set of signals with a two-dimensional function written by f(x,y), where x and y are spatial coordinates and the intensity or gray level of each point is supplied by the amplitude of f at any pair of coordinates (x,y).The image is called as digital image when the amplitude values of f, x and y are all finite discrete quantities. A digital image is composed of a finite number of elements which is referred as a pixel and it has a particular location and value. The elements of a digital image is usually denoted by the pixel. Image enhancement consists of techniques that seek to improve the visual appearance of an image or it makes an image better suited for analysis by a human or a machine. The Image enhancement techniques can be categories into three groups. Spatial domain methods: It directly operate on pixels. Frequency domain methods: It operate on the Fourier transform of an image. Fuzzy domain: When it comes to human perception, it is difficult to determine what good image enhancement is. If it looks good, quantitative measures are used to determine which techniques is most appropriate, when image enhancement techniques are used as pre-processing tools for other image processing techniques. This paper is organized as follows. In section II we introduce related work. In section III, we presented ANN. In section IV fuzzy logic. section V, Image processing.

II. RELATED WORK

This section summarizes a review of literature of several image enhancing approaches carried out by different researchers. It's been proven that the corona virus exists. In pathological diagnostics, a real-time PCR (polymerase chain reaction) is a commonly used diagnostic tool. Chest x-rays are a better option than PCR for COVID-19 screening. In this scenario, however, precision of results is crucial. This research proposes a diagnosis recommender system for reviewing lung pictures that might assist physicians while also reducing their effort. To achieve the highest degree of precision, CNN is used [1]. A fusion of convolutional neural network (CNN), support vector machine (SVM), and Sobel filter is given to detect COVID-19 using Xray images. A new X-ray picture collection was obtained and handled with a high pass filter utilizing a Sobel filter to get the edges of the images.

The pictures are then fed into a CNN deep learning model, which is subsequently followed by a ten-fold cross validation SVM classifier. According to our findings, the proposed CNN-SVM with Sobel filtering (CNN-SVM+Sobel) has a maximum classification accuracy of 99.02 percent in successfully detecting COVID-19 [2].

The Contrast Limited Adaptive Histogram Equalization (CLAHE) and Convolutional Neural Networks (CNN) approaches are utilized to assess the dataset with two scenarios in order to obtain detection results. The results of this study reveal that when applying CNN and CLAHE, the accuracy of Covid-19 detection is likely to suffer. Furthermore, the CNN basic model outperforms the VGG16 transfer learning method [3]. A tooth caries diagnosis system based on a back propagation (BP) neural network is developed for analyzing dental X-ray images. The neural network used the inter-pixel autocorrelation as an input feature. The classification accuracy is satisfactory when compared to the diagnosing technique performed by a rule-based computer assisted software and a group of doctors, and tooth caries detection is clearly improved [4].

The author de-noises, enhances, segments, and detects edges in the X-ray image to extract the nodule's area, perimeter, and shape. These retrieved features are sent into a neural network, which is trained and utilized to determine if a nodule is cancerous or not. This research focuses on recognizing nodules that develop in the lungs of cancer patients at an early stage. The bulk of the nodules are visible after a careful selection of parameters. The training dataset of X-ray images is processed in three steps to increase the quality and accuracy of the result [5].

The method used in this research is an image processing technique that employs various filters to reduce noise and segment the lung in order to detect anomalous sections in the X-ray image, as well as extracted regions that depict the area, perimeter, and shape characteristics of lung nodules. These form traits are utilized to train a neural network that determines if a site is a malignant nodule or not. This research focuses on recognizing nodules that develop in cancer patients' lungs during the early stages of the disease. The bulk of the nodules are visible after a careful selection of parameters. The training dataset of lung cancer X-ray images is processed three times in order to increase the quality and accuracy of the observational results [6].

Comprises five image processing steps: noise reduction with a high boost filter, enhancement with adaptive histogram equalization, statistical feature extraction, and classification. To categorize the given input X-ray photographs into the categories head, neck, skull, foot, palm, and spine, probabilistic neural networks, back propagation neural networks, and support vector machine classifiers are employed. The results reveal that the proposed technique may be used to classify X-ray images with a 92.3 percent overall accuracy [7].

A hybrid technique that combines a Bayesian classification framework and a Hopfield Neural Network has been proposed for neonatal skull segmentation (HNN). Because of the non-homogeneity of skull intensities in MR images, local statistical parameters are used for adaptive training of Hopfield neural networks based on Bayesian classifier error. The experimental results, which were obtained using high-resolution T1-weighted MR images of nine neonates with gestational ages ranging from 39 to 42 weeks, show that our approach [8]. The CHEFNN (competitive Hopfield edge-finding neural

network) is a two-layer Hopfield neural network that locates the edges of CT and MRI images.

The CHEFNN extends a one-layer 2-D Hopfield network at the initial picture plane to a two-layer 3-D Hopfield network with edge detection that can be implemented in the third dimension, unlike typical 2-D Hopfield neural networks. The improved 3-D architecture of the network allows it to incorporate contextual information about a pixel into the pixel-labeling procedure [9].

III. ARTIFICIAL NEURAL NETWORKS

It is usually called as "Neural Network" (NN), are computing systems made up of interconnected nodes that function similarly to neurons in the brain and a computational system that tries to simulate the structure and functional aspects of neural networks [12]. They can discover hidden patterns and correlations in raw data using algorithms, cluster and categorize it, and learn and improve it over time. The basic processing element of neural network are called neurons. Artificial neural networks (ANN) come in a variety of shapes and sizes. These networks are known as formal operations and a set of parameters that must be met in attempt to decide the result.

They processes information using connectionist approach to computation. NN are nonlinear statistical data modeling tools. They can be used to find patterns in data & also to model complex relationships between inputs and outputs. It is one of the simplest mathematical model which is defined as a function f: X→Y. NN is very popular because of its learning capability. Learning can be supervised, unsupervised and recurrent. An important concept in learning is a C cost function which is a measure of how far away are from an optimal solution to the problem that are solving. In order to find a function that has the smallest possible cost, learning algorithm search through the solution space [4] in general the main content of neural network input layer, hidden layer and output layer as shown in Figure 1.

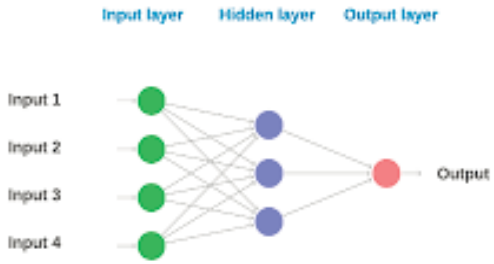

Figure 1. Simple structure of ANN [14]

A. Feed forward Neural Network – Artificial Neuron

One of the most basic types of ANN is one in which the data or input only moves in one direction. The information is sent through the input nodes and out the output nodes. The hidden layers may or may not be present in this neural network. In simple terms, it uses a classifying activation function to produce a front propagated wave with no back propagation. Feed forward neural networks are used in computer vision and speech recognition to identify target classes that are difficult to classify.

B. Radial basis function Neural Network

Consider the distance between a point and the center. RBF functions contain two layers: the inner layer combines the features with the Radial Basis Function, and the outer layer considers the output of these features while calculating that very same output in the following time-step, which is essentially a memory. This neural network has been applied in Power Restoration Systems.

C. Kohonen Self Organizing Neural Network

Map is a discrete map made up of neurons that accepts input vectors of any dimension. The map must be trained in order for it to organize the training data on its own. There are either one or two dimensions to it. The position of the neuron remains fixed when training the map, but the weights vary depending on the value. To recognize patterns in data, the Kohonen Neural Network is employed. Its use in medical analysis to group data into distinct groups is a good example.

D. Recurrent Neural Network (RNN) – Long Short Term Memory

Works on the premise of preserving a layer's output and sending it back into the input to aid in forecasting the layer's outcome. The first layer is built in the same way as a feed forward neural network, with the sum of the weights and features as the product. Once this is computed, the recurrent neural network process begins, which means that each neuron will remember some information from the previous time step from one time step to the next. Recurrent Neural Networks (RNNs) are used in text to speech (TTS) conversion algorithms.

E. Convolutional Neural Network

Resemble feed forward neural networks in that the neurons' weights and biases can be learned. It has been used in signal and image processing, and it has replaced OpenCV in the field of computer vision. Because of their accuracy in picture classification, convolutional neural networks dominate computer vision approaches.

F. Modular Neural Network

Having a variety of diverse networks all working together and contributing to the final product In comparison to other networks creating and performing sub-tasks, each neural network has a set of inputs that are unique. In order to complete the tasks, these networks do not communicate or signal one another. Several distinct neural networks are trained for a specific sub-task at the same time, and their outputs are then integrated to accomplish a single task.

IV. FUZZY LOGIC

In image processing applications, fuzzy logic is used. Because it provides an intuitive tool for inference from faulty data, fuzzy image processing is an attempt to convert this skill of human reasoning into computer vision problems.

In comparison to other computer vision approaches, fuzzy image processing is unique. It does not describe a specific solution for a specific problem, but rather a new class of image processing approaches. It introduces a new methodology to complement classical logic, which is an essential component of any computer vision program [10].

It is necessary to establish a new sort of visual comprehension and treatment. Fuzzy image processing can be a stand-alone image processing technique or an add-on to a larger image processing chain. Fuzzy logic has become increasingly important in control theory and computer vision during the last few decades. Simultaneously, it has been relentlessly criticized for two key reasons: It was once thought to be devoid of a solid mathematical foundation and to be nothing more than a cunning cloak for probability theory. It. Fuzzy systems are made up of two main components: fuzzy sets and fuzzy set operations. These operations define fuzzy logic rules, which are based on combinations of fuzzy sets. Every image appears or does not appear at all.

In addition, noise may cause the edge to be distorted. A noisy edge can be recognized using probabilistic methods that compute the likelihood of the noisy measurement belonging to the edge class. Classify an image with a gray-value slope by defining the edge. Even if all noise is eliminated, a noisy slope remains a slope. If the slope extends throughout the entire image, it is not commonly referred to be an edge. However, if the slope is "steep" enough and only stretches over a "limited" area, it is more likely to be referred to as an edge. The question immediately arises: how big is "high" and what does "narrow" mean?

To quantify the shape of an edge, you'll need to have a model. The probabilistic technique then allows us to extract model parameters that represent edges in different shapes. But how can we deal with this issue if we don't have a model to work with? Many real-world applications are too complex to model all of the aspects required to quantitatively characterize them.

Models are not required for fuzzy logic. It can deal with ambiguous data and incomplete knowledge, and integrate it using heuristic principles within a well-defined mathematical framework. The most compelling argument to study the possibilities of fuzzy approaches for image processing is that fuzzy logic offers a robust mathematical foundation for representing and interpreting expert knowledge. The concept of linguistic variables, as well as the fuzzy if-then rules, are important here. Fuzzy inference engines can be constructed employing expert knowledge to enable human-like processing.

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

V. IMAGE PROCESSING

G. Method in Image Enhacement

There are certain methods for Image Enhancement some of them are listed below [11-12]:

- Histogram matching: Histogram matching is the process of altering an image so that its histogram aligns with a specified histogram. The well-known equalization approach for histograms is an uncommon example in which the specified histogram is continuously applied.
- Contrast-limited adaptive histogram equalization (CLAHE): By altering the grayscale image assumed as I, it is used to improve the contrast. Instead of working on the entire image, CLAHE focuses on tiles, which are small portions of the image. Because the contrast of each tile is increased, the output region's histogram closely resembles the histogram defined by the "Distribution" option.
- Wiener filter: is a filter that uses linear time-invariant (LTI) filtering of an observed noisy process, accepting known stationary signal and noise spectra, as well as additional substance noise, to generate a gauge of a desired or target arbitrary process. Between the evaluated random process and the desired method, the Wiener filter restricts the mean square error.
- Median filter: The median filter is a nonlinear computational filter that is commonly used to remove noise from images. Noise reduction is a common pre-processing procedure used to improve the outcomes of subsequent processing, such as image edge identification. Because it keeps edges while reducing noise under certain conditions, median filtering is widely used as part of digital image processing.
- Linear contrast adjustment: In this the contrast adjustment block changes the contrast of an image by linearly scaling the pixel values amongst lower and upper limits. Pixel values that are below or above this range are saturated to the lower or upper limit value, individually.
- Unsharp mask filtering: Unsharp masking (USM) is an image sharpening method, frequently accessible in digital image processing software. The "unsharp" of the name gets from the way that the procedure utilizes an obscured, or "unsharp", negative image to make a mask of the original image. The unsharped mask is then joined with the positive (original) image, constructing an image that is less blurred than the original. The subsequent image, in spite of the fact that clearer, might be a less precise portrayal of the image's subject.
- Deep neural network: Execute image processing undertakings, for example, removing noise from images and constructing high-resolution images from low-

resolutions images, utilizing convolutional neural networks. Deep learning utilizes neural networks to learn valuable portrayals of highlights straightforwardly from information. For instance, you can utilize a pertained neural network to recognize the images and remove various type of noise from images.

H. Image Noise

Image noise is a sort of electronic noise that causes erratic changes in image brightness or color information. It can be done with the image sensor and electronics of a scanner or digital camera. Image noise can also be caused by film grain and the unavoidable shot noise of an ideal photon detector.

There are many type of Gaussian noise: It's statistical noise with the same probability density function (PDF) as the normal distribution, generally known as the Gaussian distribution [13]. Salt and pepper noise is a type of noise that appears on photographs from time to time. It's sometimes referred to as impulse noise [13]. Sharp and rapid disturbances in the visual signal might create this noise. It appears as white and black pixels that are poorly distributed.

The statistical nature of electromagnetic waves like x-rays, visible lights, and gamma rays causes this noise to appear. The number of photons emitted per unit time by the x-ray and gamma-ray sources [13]. Brownian Noise or Fractal Noise Brownian noise, pink noise, flicker noise, and 1/f noise are all examples of colored noise. The power spectral density of Brownian noise is proportional to the square of frequency over an octave. i.e., its power falls on ¼ th part (6 dB per octave). Brownian motion produces Brownian noise. Brownian motion is observed in fluids due to the random movement of suspended particles [13].

I. Challenge in Image Enhancment.

The need to use technology to continually improve the quality of care, the need to cope with ever-growing image utilization needs, and the problems associated with a fragmented IT infrastructure are all imaging concerns for enterprises that come with new technologies. Adaptable image analysis methods enable for more efficient development. The goal is to create tools and methodologies for creating ground truth data quickly and efficiently. Another challenge is developing medical image processing techniques for a wide range of image data.

V. CONCLUSION

We thoroughly examined the numerous image enhancement research approaches employed by various researchers. The merits and negatives of the reviewed work are described in a comparative study. However, it has been shown that a superior technique, based on a hybrid approach of ANN and fuzzy logic, is required to successfully and efficiently enhance the image.

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