International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Artificial Intelligence in Medical Image Processing

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Submitted: 05/10/2023 **Revised**: 26/11/2023 **Accepted**: 07/12/2023

Abstract: Neural networks have been used to solve an increasing number of very complex real-world problems. Their biggest advantage is by far their capacity to resolve problems that are too complex for conventional technologies. These problems are usually related to pattern recognition and forecasting. Artificial neural networks (ANNs) are being used in a variety of fields, including medical imaging, computer-aided diagnosis, medical image registration, segmentation, and edge detection for visual content analysis. In this work, we fill in the blanks in CT and MRI scan images by interpolating medical images using artificial neural networks (ANNs). In this way, we may remove artifacts from the image and see a new image that is much more similar to the original. It is feasible to use these processed images for diagnostic purposes or for radiation therapy. The exact implementation details could change depending on the interpolation task and the type of medical images. This technique explains how to use Matlab's Neural Network Toolbox, which makes it easier to create, train, and test neural networks for interpolation tasks, to improve the quality of images.

Keywords: *AI, medical images, neural networks, interpolation*

1. Introduction

Medical imaging comes in two flavours, as is well known: digital and analog. Digital images are created using a computer, while analog images are directly captured using radiological films. An agreement that places a numerical value in accordance with a colour or grey level allows physical signal information to be coded and shown as an image. This is known as a digital picture. The digital image is then represented as an L-row, C-column numerical table. [1]. Since L = C = N, we shall assume that the images are square. The term "pixel" refers to each "box" image (picture element). The value of the pixel in row (l) and column (c) of the given (l, c) is written I (l, c). It is useful in computing that the coordinate axes have an odd orientation whereby rows are numbered from top to bottom and columns are numbered from left to right [6]. Spatial resolution and intensity resolution are fundamental features of a digital image [10]. Both the number of rows and columns in an image affects its spatial resolution. A decrease in spatial resolution significantly worsens the quality of the image. The amount of possible values that a pixel can have in terms of intensity, independent of how it is displayed visually, is known as resolution.

The extent of the computer memory that captures the look of each pixel is how this resolution (or depth) is expressed. values that correspond, derived through interpolation from known values. Sets of one or more neuronal layers interconnected form Artificial Neural Networks. One or more neurons can be found in a layer. A connection that multiplies the input quantity (p) with the weight (w) and adds a bias (b) is used to transfer the data. The output, a, is a linear conversion, and each neuron reflects an established transfer function, f.. The two adjustable factors of the neuron are parameter W and parameter b. It is common practice to train, or modify, neural networks such that they provide a desired output based on an input. A comparison of the value of output and the value of the target is used to modify the network until the output satisfies the aim [7]. Preprocessing methods for medical images are used, including Hopfield Neural Network, Feed forward Neural Network, Self-organizing map Neural Network, Fuzzy Neural Network, Cellular Neural Network, etc [10].

2. Methodology

Depending on the technology employed, several approaches can be utilized to obtain digital images. Positron Emission Tomography (PET-CT), magnetic resonance imaging (MRI), and computed tomography (CT) are three most significant methods for producing digital medical pictures [3]. Many factors, including the patient's movements, imperfect instruments, human error, etc., can affect the quality of medical images during the archiving process. These factors can result in many significant artifacts that need to be comprehended and examined first in order to correct them.

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Fig. 1. CT abdominal

An artificial image can be reconstructed in a certain direction by using the interpolation method, which starts with a series of medical images captured in one direction and can be used to provide a selected area of a medical image. To make a piece of a computer image appear "natural," an interpolation of data is required. The process of interpolating involves changing each tile's pixel values to create the appearance of continuity [8], [9]. In this work, we will employ artificial neural networks (ANNs) to enhance the resolution and fill in the gaps in MRI and CT image data. The medical image's missing pixels values, will be estimated, and their values will be replaced with computed values from neural network after being removed.

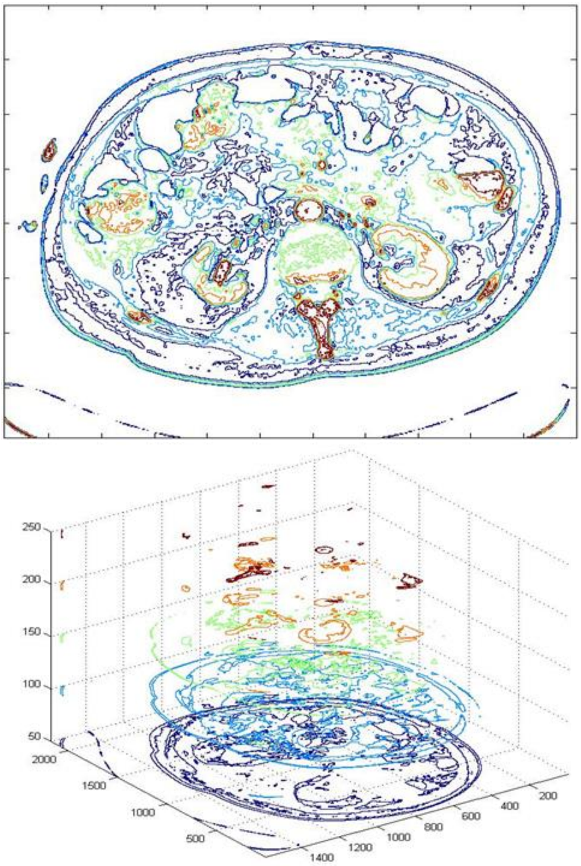

Fig 2. The Matlab image segmentation in 2D case (a) and 3D case (b)

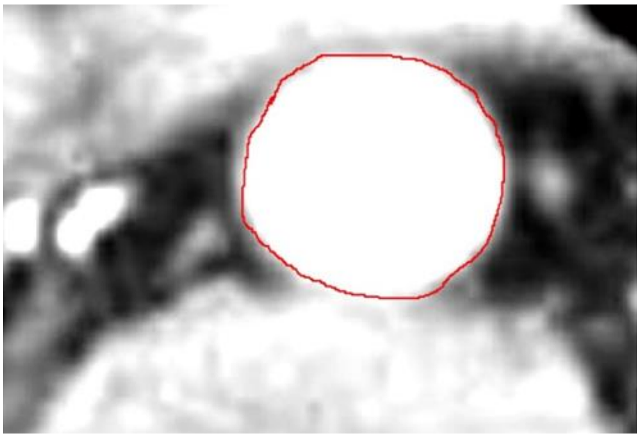

Fig 3. The selected structure of medical image

As we have stated, the primary objective of our work is to show the potential of artificial neural networks for the correction of flaws and artifacts in medical photographs. Assume for the moment that there is a defect in our image such as a contoured area in 2.b and showed in figure 3.

In command editor (Matlab), we can import and visualize the image using the *imread* function and than convert in an output that form a matrix A (1560 x 2178) with different values for all α_{ij} = [0 - 255] of the color of gray. All pixel's numbers on the selected area, should be recalculated with right numbers calculated by artificial neural network.

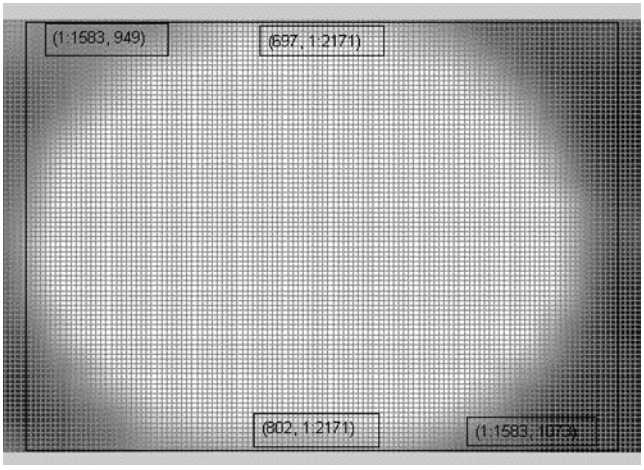

Fig.4. The region of image converted it into a matrix A (1560 x 2178)

3. Results

In this work we want to remove artifacts in a medical image using a neural network of the pixel's values inside the red contour because (with 0 value after deleting the previews values). The pixels values outside contour will have the main role on neural network training process. Our image resolution R is 3506692, where 1401121 pixels have the value = 0, [10]. We use Matlab's "contur2" (2D) function to apply the segmentation procedure to this image, focusing exclusively on the pixels inside it.

The isolines of matrix A, are shown how the image will split into its component areas or objects, as figure 2.a illustrates. encompasses all of the CT image's pixels outside of the contour. The 3D "Contour3" function creates a contour graphic of matrix A. The number of contour levels and their values are automatically determined by taking into account the minimum value and maximum value of the pixels, as shown in figure 3.b. We obtain a total of n = 1320 row vectors with various dimensions from the A matrices. We feed these kinds of data into neural networks. To the best of our knowledge, artificial networks can function in two different ways: testing and training. Throughout the learning process, the network is provided a set of values and examples. At the beginning of the training phase, the network "guesses" the result for each sample. But as training progresses, the network internally changes until it reaches a stable point where the outputs are satisfactory. Learning is essentially an adaptive process whereby all of the coupled neurons' weights vary to provide the optimal response. [7]. We created a neural network with feed-forward back propagation (*ffbp*) using the Matlab graphical users' interface for *nnstart*. It is made up of three layers: input, concealed, and output. Training, validation, and test sets are automatically created from the input and target samples. The training set is used to train the network. Training will continue as long as the network continues to improve on the validation set. The network is trained using the training set. As long as the network keeps getting better on the validation set, training will keep going. The test set offers an entirely objective assessment of network accuracy. Only through the concealed nodes does information move forward from the input nodes to the output nodes. [2]. We can utilize all vectors in this instance as inputs. Pixel a_{ij} (700, 1000) is the center of the area we have chosen on matrix A. The boundaries and limits of this area to the left, right, and up and down are as follows: row: c_1 = A' (1:1500, 950), c_2 = A' (1:1600, 1050), column: l_1 = A' (702, 1:2200), l_2 = A' (813, 1:2190). The weights calculation and the neural networks training process, is the most crucial step in the ANN run. Weights in a network are adjusted during learning to maximize the network's response to an input (l_1, l_2, c1, and c_2). The process of learning and rule specifies the adaptation process for these weights. Plots comparing the riht values of the selected region and the values computed by the *ffbn* in the selected area's center (both vertically and horizontally) are displayed in figures 4,5.

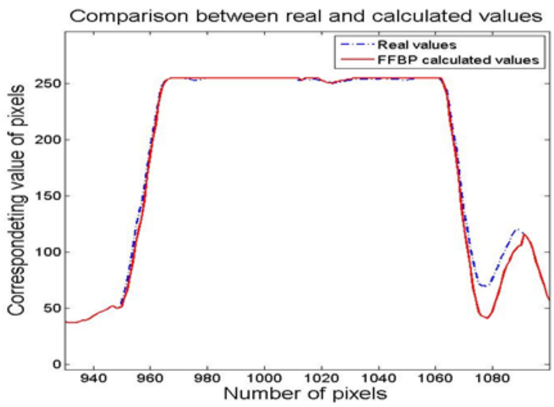

Fig 4. The difference from real values to calculated values (horizontal values)

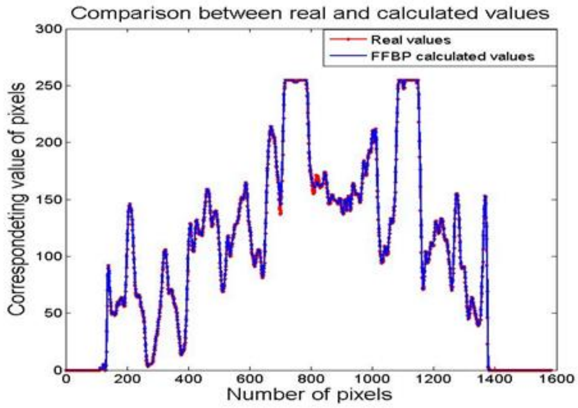

Fig 5. The difference from real values to calculated values (vertical values)

The charts above show that the NN's calculated values are getting closer to realistic ones. We may compute the values of every pixel in the contoured area in the same manner. This is a challenging and time-consuming process when we have a lot of pixels, like we do. In the future, we intend to concentrate on these subjects by creating a function that encompasses all computational stages.

4. Conclusions

In the field of medicine, neural networks have been used for signal processing, picture analysis, and clinical diagnosis. These applications provide an overview of FFANN (Feed Forward Artificial Neural Networks) applied in medical picture processing. As we demonstrate, image artifacts can be removed with these techniques. Additionally, the revised image which is far more similar to the intended one is visualized. Radiologist and technician options to apply various techniques for the visualization and completeness of missing data in MRI and CT images are thus provided. It is feasible to employ Neural Network for tumor diagnosis or computation during tumor treatment, particularly in radiotherapy and diagnostics.

Acknowledgements

This paper was done as part of the project "*Development of* *simulation and forecasting models and integration with the TCIA database of medical images*", supported by NASRI (National Agency of Scientific Research and Innovation) in Albania. The authors would like to thank also READ (Research Expertise from Academic Diaspora), ALBMEDTECH, AAMP, EFOMP.

Conflicts of interest

The authors declare no conflicts of interest.

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