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A PROPOSED METHOD FOR COLORIZING GRAYSCALE IMAGES

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ABSTRACT

In this paper a new method is proposed that leads to colorize a grayscale images. The proposed technique colorizes grayscale images by transferring colors from a reference (source) color image to a destination grayscale image. A feed forward artificial neural network (ANN) is constructed and trained by mapping the pixels from a grayscale space (grayscale version) into a color space of the selected reference (source) color image that has a similar "mood" of the destination grayscale image. The proposed algorithm has two main phases of action. Phase one is setting up the (ANN) and training it using Levenberg-Marquardt training algorithm. From the grayscale image version, the gray intensity of each pixel, average and standard deviation of the intensities of the 8 - surrounding pixels are used versus the color components (RGB) form the color version. The second phase is the colorization phase of the destination grayscale image by using the trained neural network. The results showed color photos in an acceptable and very distinct look.

KEYWORDS: Color Images, Colorizing, Gray Scale Images, Neural Network

INTRODUCTION

Gray image colorization is a new image processing topic, and although different trials for manual gray movies colorization were found in 80's, researches for automatic colorization appear in the last few years. Different techniques appear in the literatures and the number of researches and technologies are growing up every day. The colorization technology leads researchers during the last few years to find more applications for this technology, not only giving colors to uncolored images (Colorization) but also eliminating colors from the color images and videos (Decolorization) and recoloring them back to make benefit from black and white images and videos features. Colorization can be classified into three categories: *Hand coloring, Semi- automatic coloring, and automatic coloring* [1].

Gray image coloring or "colorization" means to give colors to gray images. It becomes a new research point area since it is utilized to increase the visual appeal of images such as old black and white photos, movies or scientific illustrations. In addition, the information content of some scientific images can be perceptually enhanced with color by exploiting variations in chromaticity as well as luminance. The general problem of adding color to a grayscale image has no exact and objective solution, since one single grayscale value may correspond to a range of different colors. Since it's known that the gray image loses the information of its real color, and since the gray bandwidth consists of 256 colors only while the real color has a bandwidth of 256×256×256, it's impossible to find a direct way to get the original color back [2]. The goal of all colorization processes is to replace scalar value or luminance, saved in each pixel of gray scale image with a vector in three dimensional color space (for example a red, green, blue vector in the RGB color space). The earliest examples date back to the early 20th century, but it has become easier and more common since the development of digital image processing. During the late 50s and 60s, the colorization process was done by tracing the original black and white frames onto the new animation cells, and then adding color to those new cells [3] ,

RELATED WORK

Different techniques appear in the literature and the number of researches and technologies are growing up every day. Kaleem and Vanmathi proposed a method which uses true color image colorization with 256x256x256 image which contains all the colors. Their Colorization process has three main steps. The first is find out the reference image from the image database using content based image retrieval system. Second step is to find the pixel that matches the source color image to the target gray scale image. The third step uses 256x256x256 true color image to search and find the best matching pixel value and this step is used only when there is no pixel value found from the reference image [4].

Welsh *et al* introduced a general technique for “colorizing” greyscale images by transferring color between a source, color image and a destination, greyscale image. Their approach attempts to provide a method to help minimize the amount of human labor required for this task.

Rather than choosing RGB colors from a palette to color individual components, they transfer the entire color “mood” from the source to the target image by matching luminance and texture information between the images. They choose to transfer only chromaticity information and retain the original luminance values of the target image. The procedure is further enhanced by allowing the user to match areas of the two images with rectangular swatches [5].

Koleini *et al* presented a method for machine-based black and white films colorization. The kernel of their proposed scheme is a trained artificial neural network (ANN) which maps the frame pixels from a grayscale space into a color space. They employed the texture coding method to capture the line/texture characteristics of each pixel as its most significant gray scale space feature, and using that feature, expect a highly accurate B/W to color mapping from the ANN. The ANN would be trained by the B/W-color pairs of an original reference frame [3].

THE PROPOSED APPROACH

Since different colors may have the same luminance (intensity) value but vary in hue or saturation, mapping between intensity and color is not unique, and colorization is ambiguous in nature, requiring some amount of human interaction or external information.

This work presents a technique of the gray image coloring by using external information which can be obtained from an external reference color image (source colored image). It’s preferred to select a source colored image that has the same flavor, mood or nature of the gray scale image (destination image). So, Colors are transferred from the source image to destination grayscale image. The present technique is based on a simple premise: neighboring pixels in space-time that have similar intensities should have similar colors. The algorithm has two main phases of action:

Setting up and Training of the ANN

In this phase, an artificial neural network is set up that consists of three layers, input layer, hidden layer and the output layer. The training of this ANN relies on the neighborhood effect analysis of pixels of the source color image and its gray scale version. The input layer of the designed ANN consists of three input nodes that take the information from the gray scale version of the source image. These three inputs are:

- The luminance (L) or (intensity) of the processed pixel,
- The average of its 8-neighbours (μ), and
- The standard deviation of these neighborhood pixels (σ).

The output layer is also consists of three nodes that represent the three components of the colored version of the source image (RGB). Phase one of the algorithm has five parts of action, as following:

- Accepting the colored source image.
- Converting that image to a grayscale image and extract the L (luminance) value out of given RGB image; using formula Gray(L) = 0.299 Red + 0.587 Green + 0.114Blue.
- Each pixel of the grayscale version is processed in which its luminance, average (μ) and the standard deviation (σ) of its 8-neighbours are recorded in a table called learning table. These three columns (the intensity of each pixel, the average of 8-neighborhood pixels, and the standard deviation of 8-neighborhood pixels) are applied as inputs to the 3 nodes neural network.
- The target data are prepared by recording the RGB values of each pixel of the colored version. So, there will be three inputs, and three targets.
- The whole dataset is divided to three subsets in a full random procedure, % 60 for training set, % 20 for testing set and % 20 for validation set. Figure (1) shows the block diagram for the first phase.

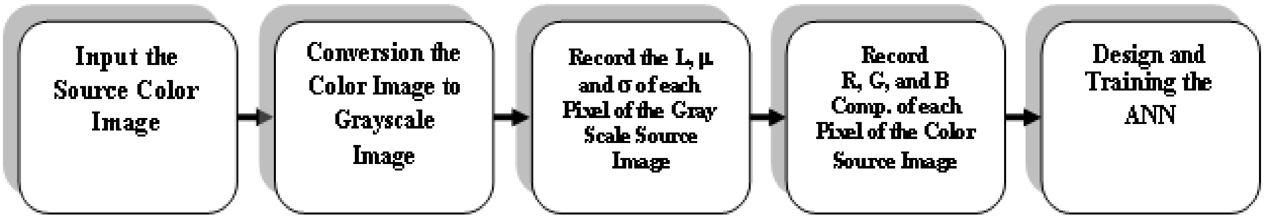

Figure 1: A Simplified Block Diagram of the First Phase of the Proposed Technique

Colorizing of the Target Grayscale Image

Once the neural network is trained it can be directly used to colorize the destination grayscale image. The following points explain the second phase of the technique:

- Accepting the gray scale image (destination image to be colorized).
- The luminance (L) of pixel values of the grayscale image will be determined and recorded as well as the average (μ) and standard deviation (σ) of its 8-neighborhood pixels.
- The variables (L, μ, σ) are applied as inputs to the trained ANN to produce three values which are the R, G, and B components of the colored version.
- The output RGB components are rearranged in three layered matrix to reconstruct a colored image. Figure (2) shows the block diagram for the second phase.

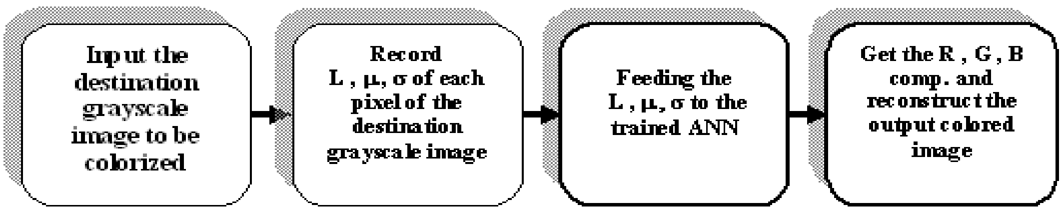

Figure 2: A Simplified Block Diagram of the Second Phase of the Proposed Technique

ARTIFICIAL NEURAL NETWORK STRUCTURE

The multilayer feed-forward network is the most popular type of neural networks. The network was trained using an error backpropagation training algorithm. This algorithm adjusts the connection weights according to the backpropagated error computed between the observed variables and the estimated results. This is a supervised learning procedure that attempts to minimize the error between the desired and the predicted variable.

The neural network used consisted of three layers: an input layer of three neurons (one for each input variable), one hidden layer of twenty neurons (it is the number which gives the best prediction result) and an output layer of three neurons which are the output variables. The transfer functions used in hidden layer nodes are hyperbolic tangent function, while for output layer is a pure line function. The Mean Squared Error (MSE) is used as a performance measuring function. Levenberg-Marquardt method is used in backpropagation learning algorithm [6] [7]. Figure (3) shows the hyperbolic tangent function and the pure line function. Figures (4) and (5) show the constructed ANN used in the proposed technique in the training and colorizing phase respectively.

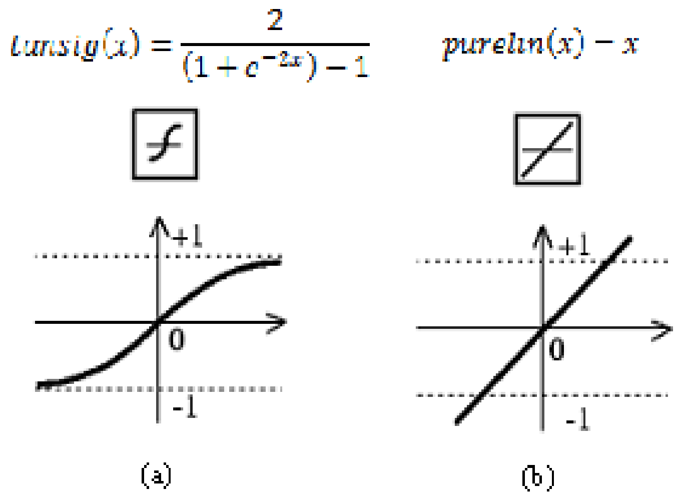

Figure 3: (a) Hyperbolic Tangent Function (b) Pure Line Function

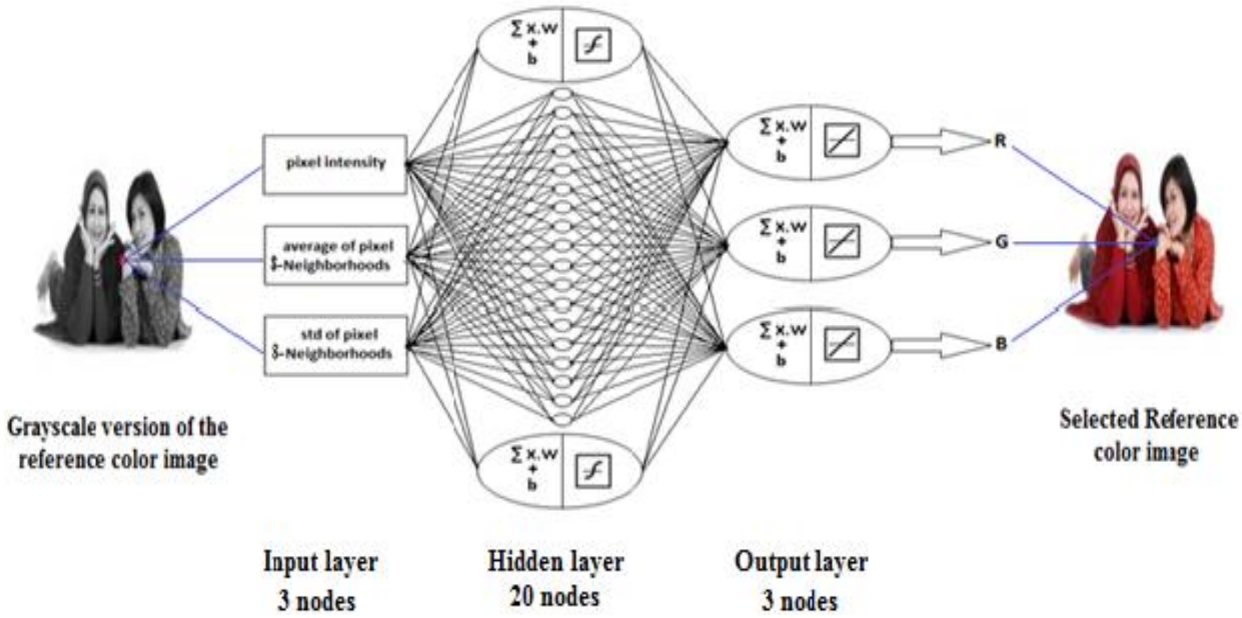

Figure 4: The Training of Constructed ANN

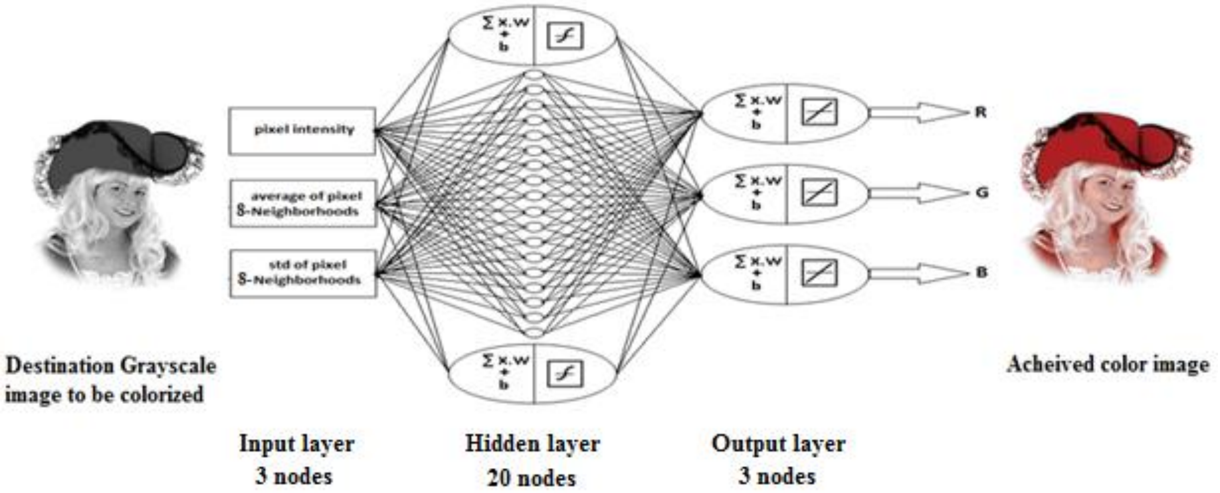

Figure 5: Colorizing by Using the Trained ANN

EXPERIMENTAL RESULTS

The proposed technique is tested and evaluated by using some sample images and the outputs are shown below in Figure (6). The images processed using the above technique is to be found with very good visual quality of the colorization. Column (a) is the destination grayscale images to be colorized, column (b) are the selected reference color images and the column (c) is the achieved colorized images.

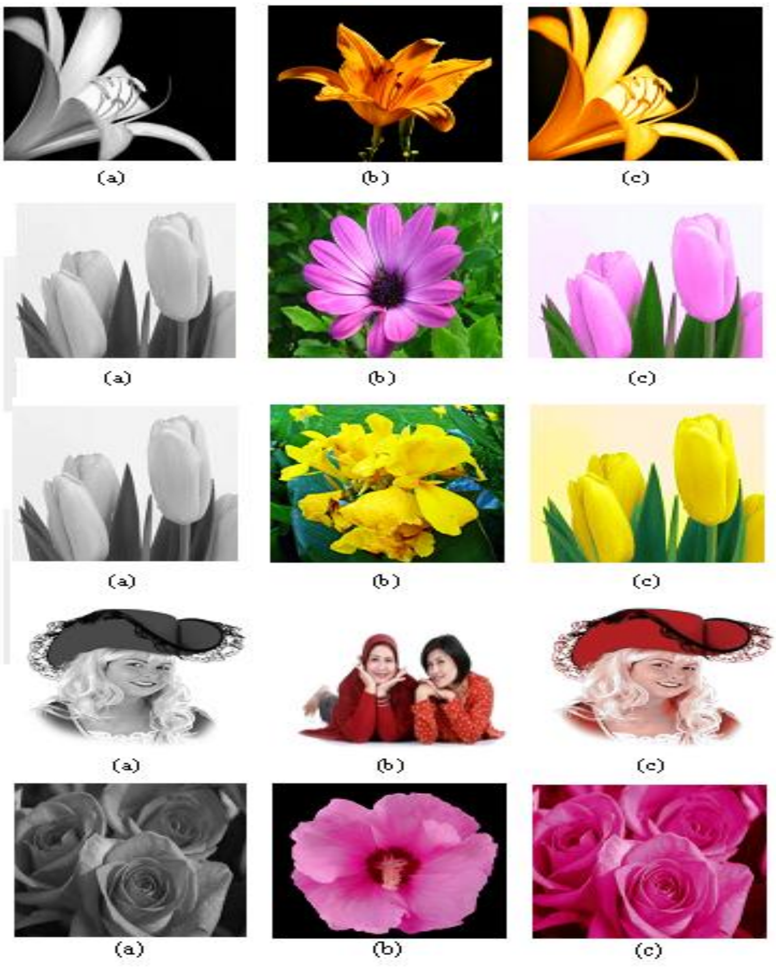

Figure 6: (a) The Grayscale Images to be Colorized, (b) Color Source Image, (c) Achieved Colored Image

CONCLUSIONS

This paper presents a new idea for colorizing grayscale images. From the achieved results it can be concluded that the mapping of the pixels from a grayscale space (grayscale version) into a color space of the selected reference (source) color image that has a similar "mood" of the destination grayscale image is useful to colorize the grayscale images. Three information from the grayscale image version are used, namely (the gray intensity of each pixel, average and standard deviation of the intensities of the 8 - surrounding pixels) versus the three components (RGB) form the color version. In this work, a merging between the usage of color transferring and the usage of the ANN is done and gives very acceptable results. A constructed ANN and the training using Levenberg-Marquardt training method is also an acceptable method to do this objectives. The proposed technique gives a high flexibility to users to choose colors and source images as they prefer, also the best colored image can be chosen among several alternatives as shown in 2nd and the 3rd rows of Figure (6).To reduce the redundancy and o increase the speed of the program execution, the training set can be reduced by avoiding taking all pixels of the source image. Close pixels to each other can be ignored, because it's found that they don't affect the resulted colored image if they are considered.

REFERENCES

1. Noura Abd El-Moez Al Sebaey Semary, "Image Coloring Techniques and Applications ", Ph.D. Dissertation, Department of Information Technology, Faculty of Computers and, Information, Menofia University, July 2011.
2. N.A.Semary, M.M.Hadhoud, W.S.El Kilani, N.A.Ismail, "Texture Recognition Based Natural Gray Images Coloring Technique ",24th National Radio Science Conference Faculty of Engineering, Ain shams Univ., Egypt, (NRSC), 2007.
3. Kaleem Ahmed Qureshi and C. Vanmathi , "Automated colorization of grayscale images". IRACST – International Journal of Computer Science and Information Technology & Security (IJCSITS), ISSN: 2249-9555, Vol. 2, No.2, April 2012.
4. T. Welsh M. Ashikhmin K. Mueller, "Transferring Color to Greyscale Images ", ACM Transactions on Graphics (TOG) – Proceedings of ACM SIGGRAPH 2002 , Vol 21, Issue 3 pages 277-280, 2002.
5. Koleini M., Monadjemi, S. A. H., and Moallem, P., , "Film Colorization Using Texture Feature Coding and Artificial Neural Networks," Journal of Multimedia, Vol. 4, No. 4, pp. 240-247, 2009.
6. S.Sapna1, Dr.A.Tamilarasi2 and M.Pravin Kumar , "Backpropagation Learning Algorithm Based on Levenberg Marquardt Algorithm ",Computer Science & Information Technology (CS & IT), pp. 393–398, 2012.
7. Kuryati Kipli, Mohd Saufee Muhammad, Sh. Masniah Wan Masra, Nurdiani Zamhari, Kasumawati Lias, Dayang Azra Awang Mat, "Performance of Levenberg-Marquardt Backpropagation for Full Reference Hybrid Image Quality Metrics ", Proceeding of the International MultiConference of Engineers and Computer Scientists, (IMECS) , March 14 -16, Hong Kong , 2012.