Impact Factor-2.031 *e-ISSN: 2581-6667*
International Journal of Engineering and Creative Science, Vol. 2, No. 9, 2019
www.ijecs.net

A Study on Automatic Grayscale Image Coloring

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Abstract –*This survey paper explores the problem of coloring the grayscale images and videos in fully automatic methods. The paper starts with a brief history of the problem followed by the scope of the solution of this problem. Then it discusses the abstract of the process of solving this problem and the different techniques proposed to solve this problem. a scenario based on automatic image Colorization which is the technique of adding colors to grayscale images. The image coloring process have been addressed in different methods and techniques. Our study focuses on the automatic approaches used to solve this problem. In this study we will discuss the grayscale image coloring and the impact of the image coloring on different domains. We will study some of the implemented approaches and will discuss the effectiveness and the drawbacks of these approaches. This paper discusses several methods that are used to solve this problem automatically without the need for human intervention, and its challenges are addressed.*

Keywords-*Automatic image coloring, pseudo-coloring; image retrieval; color transfer, image processing.*

I- INTRODUCTION

Colorization is the process of adding color to a black and white image or movie. Hand coloring of photographs is old as photography itself. The coloring process is used in motion pictures in the early 1900s, where many image frames in movies were processed manually by hand. It was also commonly used for filmstrips into the 1930s. The first computer application used in image coloring was introduced in 1970 for adding colors to the black and white films. The image coloring problem have been addressed in different methods and techniques. Starting by using the manual coloring by hand with beginning of the colored image photography. Coloring grayscale images can have a larger effect on a numerous type of domains, for example historic old images or films, astronomical pictures, improving the feeds from the surveillance cameras, In medical field the image scanning machines like (MRI) Magnetic Resonance Imaging, (CT) Computerized Tomography images and X-ray can be enhanced and made clear with color for demonstrations and presentations. The image coloring is not limited to the above-mentioned domains it can also be used to improve the image quality and make it more plausible. Most of the great movies produced in the past can be improved and enhanced by adding the colors to it.

II-THE PROCESS OF IMAGE COLORING

To understand the process of grayscale image coloring we need to understand the representation of the grayscale image and the colored image. The pixels of grayscale image or what called black and white image or frame of video is composed of single 8 bits value. This 8-bit value is called byte image format where the 8 bits value of the pixel is used to represent the intensity of the black color [2]. The value of the pixel gives the different shades of the gray color hence it called grayscale image. The value ranges from 0 to 255 where the value '0' is presumed to be black and the value '255' presumed to be white. In the other hand for the colored image the pixels are represented in different models of image representation like RGB, CMY and HCI model. Now let's see the most widely used model which is the RGB model. In the RGB model the pixel is represented in a set of three vales namely (RED, GREEN and BLUE). The combination of these values results in the color of the pixel.This model is called additive model where each value of the three set values represent the intensity of that color. The addition of these intensities produces the

color of the pixel. The higher the value of the individual color the results in a shade of color near to the highest valued color [4]. For an example if the pixel's set of values are (255,0,0) then the resultant color of the pixel is red. When the values of the pixel's set are (255,255,255) result in white color where in the other hand when the values are (0,0,0) then the resultant color is black. To color the image, we need to calculate the values of set representing the pixel's color from the scalar value of pixel which represents the intensity of the black color as mentioned earlier [3]. This calculation is not possible to be done using the linear technique. There are nonlinear methods of calculating these values which ranges from mapping the values from similar images to the calculation of these values using data set of trained neural network as discussed in the next section.

III- IMAGE COLORING TECHNIQUES

There are different techniques categorized by the resultant colored image into pseudo coloring which also called false coloring and the true coloring. The pseudo coloring results a plausible colored image with enhanced and rich features [4]. The assigned colors might not be the true colors for an example car might be colored to red where in the real color of the car is blue. This type of image coloring is widely used for the easiness of detecting the objects and assigning the colors to theme. In the true coloring the assigned colors are matching true colors of the objects as it appears to the observer. These two categorizes have three methods of assigning the colors. (a) user involved method where the user should set and select the source image and assign the regions with the colors using the tools provided to him like brush tool. This method is expensive and time consuming. (b) semi-automatic method where the user must select the source image to map the colors from it to the target image. (c) automatic method where the colors are mapped without the need of the human assistance either by automatically select the source image or by assigning the colors from different sources like a database a dataset of a trained machine learning algorithm [5].

IV- LITERATURE REVIEW

In this section we discuss some of the proposed automatic approaches to solve the image coloring problem.

Mayada F et al [1] proposed a new novel approach to solve this problem by storing the reference pixels rather than storing reference images to color the images. The proposed approach divided into two main parts. At first, we populate the database the reference pixel's data. At the second stage we prepare the target pixels for querying the database to use it in coloring the grayscale image. The process starts with the RGB values of the pixel are processed to the de-correlated space. Here we use the lαβ color model and values of lαβ model saved in the database. Next step we convert the RGB values to the luminance (grayscale) value using the RGB ratio as 30:59:11 for further processing.

To calculate the standard deviation of the Luminance l we use the following equation:

$$\text{Standard Deviation I} = \sqrt{(Y - A)2\ /(M - 1)}$$

The used variables in the above equation are described below:

Y: The value of the luminance for each individual pixel's neighborhood.

A: the average of the values,

M: the total count of the pixels

After we calculate the standard deviation and the luminance of each pixels, we store these data in the database. To color the grayscale image, we read the pixels of the image and calculate the luminance and the standard deviation of each pixel. We convert the luminance of the pixels into the lαβ space.

Now we query the database for the exact value of the luminance or approximate luminance and standard deviation. If the query was successful, the lαβ values is used to build the colored image. When the colored image is constructed, we transform it into the RGB values.

(a) Original image. (b) Grayscale as input image (c) Output image

Fig 1 coloring result of the proposed system

OUTCOME

The proposed system delivered the promised results. By using a database of pixels instead of a database of images yields benefits and drawbacks. The system can be used for different unrelated applications and not be depended on any specific application. The use of database of pixels introduce performance bottleneck due to the need of querying the database for each pixel. This problem gets worst when the size and resolution of the image get increased. Another drawback is that when the database grows large the management get complex and the efficiency of the database is decreased.

R. Jayadevan et al [4] have proposed a technique for selecting the source images for the grayscale image coloring. The proposed system has two stages (a) the image retrieval from the database (b) transferring colors to the target image from the retrieved image. In this paper they have focused on the method of storing and retrieving the source images. The source image is processed to the Contourlet transform representation to be stored into the database. The given grayscale image is processed into the Contourlet representation to query the database for the source image with similar characteristics. To transfer the color from the retrieved reference image to the grayscale image both the target and retrieved source image are converted into the YCbCr model. The conversion of the images to the YCbCr model is done to limit the leakage and cross-channel artifact. The block diagram shown below in Figure 2 shows the process of the proposed method.

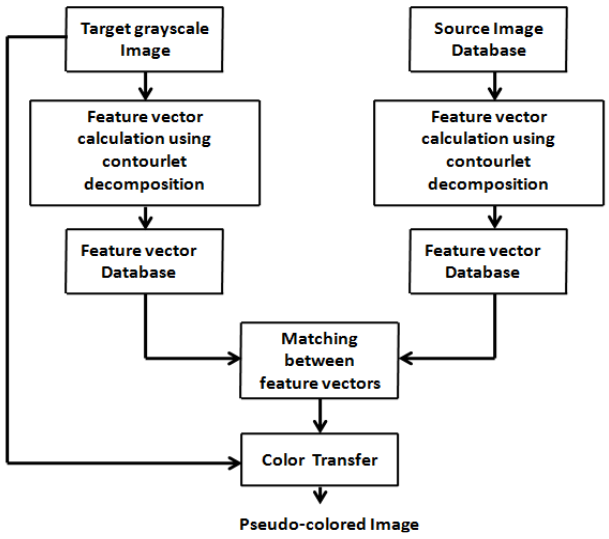


Fig.2. Block diagram of the pseudo coloring process

After the target image is processed and the color is transferred to the target image finally, we convert the resultant image to the RGB model.

(a)Input grayscale image. (b) retrieved reference image. (c) Result image

Fig 3 coloring result of the proposed system

OUTCOME

In this work the author has used the Contourlet transform representation as the way to store the source images and the base for retrieving the source images. The use of Contourlet transform representation increases the accuracy of retrieving the source images with similar characteristics which results in accurate coloring. The downside of this system is that the target images can be colored if a similar source image is present in the database. Hence, we need a large database to cover most the required applications.

Bekir Karlık and Mustafa Sarıöz[3] have proposed a mothed for solving the problem of coloring grayscale image using artificial intelligence ,this method has two phases pretraining and training phase and testing(coloring) phase.at the pretraining phase the RGB image is segregated into red, green and blue and the values of each color is fed to the neural network for processing. The same image is converted to grayscale image and the value is fed to the three networks as shown below figure.

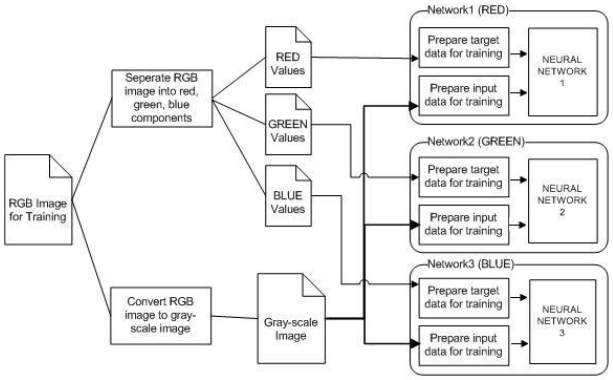


Fig.4. The training phase of the model

In the testing(coloring) phase the gray image imputed to the pretrained networks namely (Red, green, blue). The output of these three networks predicts the values of the RGB color, these values are combined and the RGB colored image is constructed as the below fig.5.

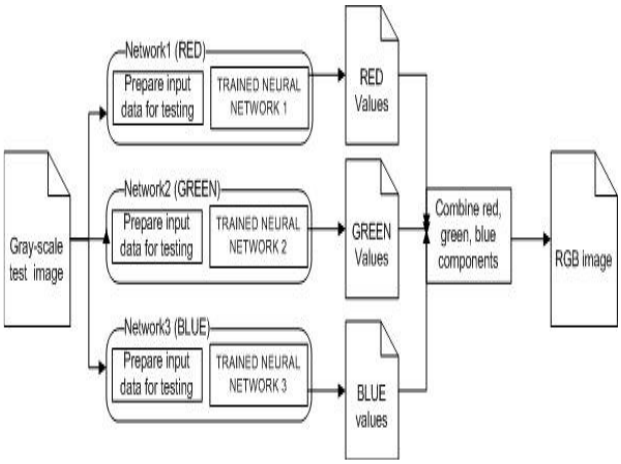
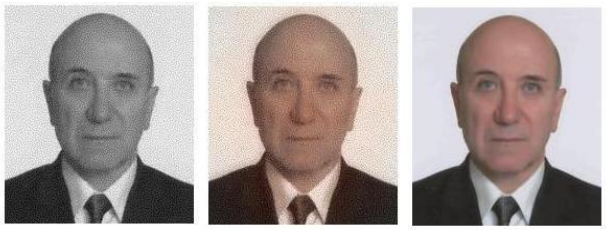


Fig.5 The testing(coloring) phase of the model.



(a) Input image (b) Result image (c) original image
Fig 6 coloring result of the proposed model

OUTCOME:

The proposed system utilizes the artificial intelligence to solve this problem. The system has showed good result when its trained with a large set of images. The drawback of this system is that it must get trained with similar images to get better results. The system also takes a huge amount of time during the training phase.

V- CONCLUSION

There is no definite method or technique to solve this problem. As we saw in this paper there are many attempts to get optimized solution for this problem. The researchers have explored various techniques to solve this problem starting with storing the individual pixel to the use of artificial intelligence.

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