Grayscale Image Colorization using Deep learning Approach

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Abstract

In today's life, images become vital for various applications such as pattern recognition, security system, face recognition, remote sensing, etc. Due to the popularity of image processing applications, new fields begin to establish using the technology of image processing such as image colorization. In this paper, development of accurate convolutional neural network (CNN) based image colorization technique is performed. The performance of the said CNN to be optimized by optimizing each layer of the classifier. Performance of proposed classifier have been found equal to 95.91 Percent.

Keywords: CNN, Colorization, RBG, Bands, Normalization, Pixel, Neural network.

1 INTRODUCTION

Extraction of information form an image, converting it into other useful formats or recognizing of image objects are folded under image processing which is part of computer engineering that incorporated with plenty of applications related to pattern recognition, personal verification and security systems. Image colourization is gained wide attentions in current days as path of image processing that keen one converting the gray scale image into colored one [1,2]. The process of image colorization is vital technological operations since it deals with regeneration (reproduction) of information in an acceptable error rate [3,4,5]. Colored image reveals more information than the normal (gray scale) image and hence the idea of colorization is raised for fulfilling of such needs. This application has been widely utilized in coloring of historical images and old movies for appealing more visuality. Colored image consisting of three main channels called as red, blue and gray. Such image format is called tri-channel format or RBG which is representable by three-dimensional matrix. Coloring of image involves generating of the more two scales (channels) namely red and blue channels. Combining of those three channels is resulting the final color image. The gray-scale image is one dimensional matric including the gray channel information only with no details about the other blue and red channels. Colorization technology is widely used in the ancient studies for coloring of old paints on the situated on the caves walls and others that sketched on leaves [6-10]. More recently, image colorization is performed using the deep learning approaches where large number of images in colored form and uncolored form are fed into pattern recognition paradigm where supervised learning can take place. The algorithm can predict the other red and blue scales on the input gray scale image resulting colored image as accurate as the training phase is. The main idea behind image processing is information preserved by each pixel. However, such information is considered as corner stone for all applications folded under the image processing e.g. (face recognition). Problem raised when no enough pixel information in some/specific images making it unfit for processing under all mentioned applications. In other word, the value of information preserved by any image is a function to what each pixel preserved. This problem is manifested in grayscale images where only information about gray channel is available and no chronic information is existed. Due to that, grayscale images are unfit for image processing since the pixels information of the image is represented by one value only (grayscale channel) and no strong correlation can be ensured between any two images in grayscale (assumed for the same event/object). Considering that noise interference with the image could manipulate the information of every channel and the noise impact is different in each channel. Then need of multiple channel while processing the image digitally is must and is only way to correlated two images with each other in applications alike face recognition or

Manuscript received on: 01.04.2021
Accepted on: 01.05.2021
Published on: 02.05.2021
Issue DOI: doi.org/10.52688/iss2

pattern recognition. Noise impacting in signal channel such as grayscale image may corrupt all information preserved in the pixel while the noise impact is lesser while dealing with multi-channel image. The current state of art is using the machine learning approaches for image colorization has left the colorization accuracy in dispute due to the uncertainty of the machine learning performance in colorization of image.

2 IMAGE DECOMPOSITION

Digital images are populated in the science and engineering domains due to their efficiency of prescribing the natural objects. However, the term digital is called to those images that allotting a value to each dot. Images as a result are contained of large number of dots with different intensity (value) which produce the final tent of the image. Giving it the final look that can be sensed by naked eye [11]. 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 [14-15]. 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 colors 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 colors image that termed as colored image that includes all channels above. It is noteworthy statement of the under infrared images channel that the same image can be used with special applications such as remote sensing in satellite image processing which can give the other information that helps to recognize the geological objects from satellite images.

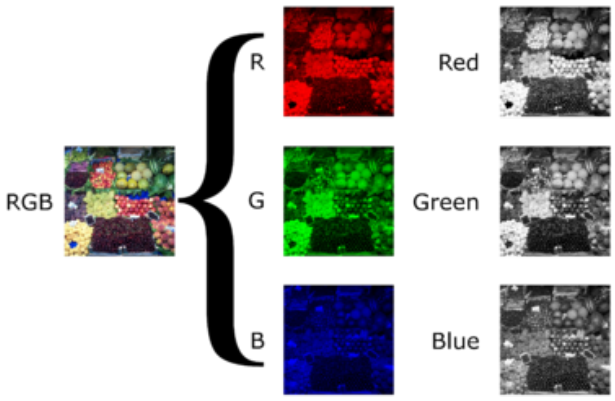

Figure 1: Colored and RGB channels of image.

Generally, the main point of image processing is understanding what the images equal in mathematical scale are. Image can always represent by combination of their (three-four) channels information that forms the final image colors. The colour image can be represented with three dimensional matrixes 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. If assuming that image s is a binary image of nine pixels, the representation of that can be as in following.

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

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 colors are represented by the matrixes B and G respectively.

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

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

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

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

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

3 MODEL ESTABLISHMENT

In order to perform the image colourization, model is established using deep learning approach and inspired by conventional neural network. Hence, model is made to perform image colouring by prediction the value of each pixel in the image. Model in firstly trained with large dataset that includes hug number of colored images and however, model is trained with thirty-two category of images in order to inject the neural network with complete knowledge about the object colours so that it can deal with various number of images. In those thirty-two training stages, thirty-two hidden layer were established and hence each hidden layer is trained with particular data in order to provide the network with complete understanding of diversity of objects. Training of each layer imply allowing the layer to gain popular with images so that network can recognize the image group and hence predict the colour of its pixels accordingly. The training stage is demonstrated in the Figure 2.

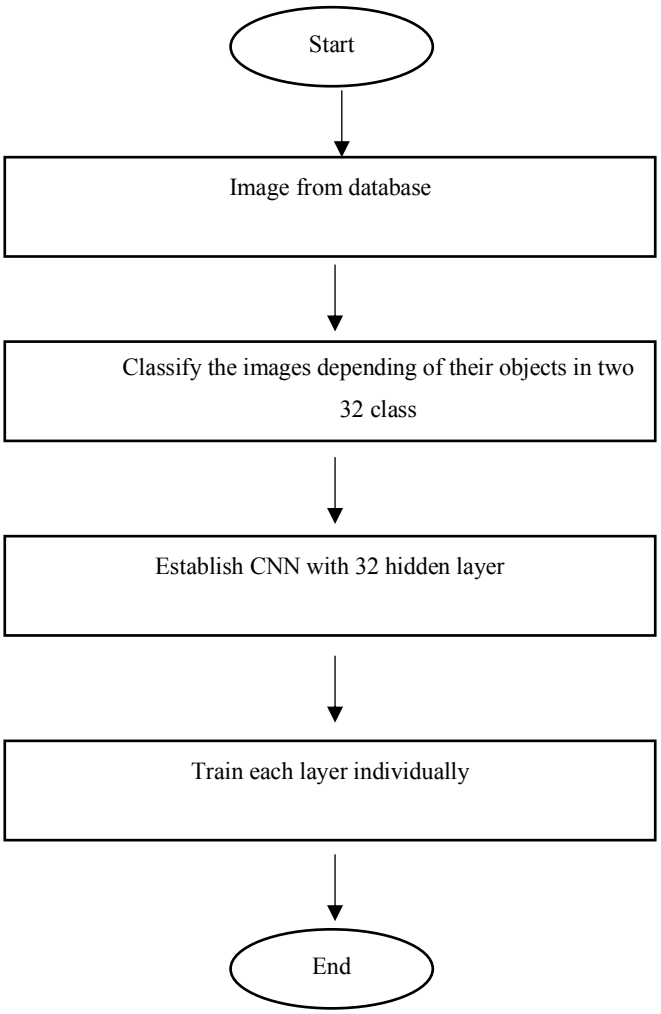

Figure 2: A demonstration of CNN training processes.

The process of training will be controller by how well model is doing. So-to-say, training algorithm with is integrated with the neural network model might monitor the performance of the network by evaluating the results accuracy and accordingly the optimization algorithm might regenerate the weight in order to minimize the error in the results until reaching the minimal error in the output. Figure 3 is representing the training process of neural network model.

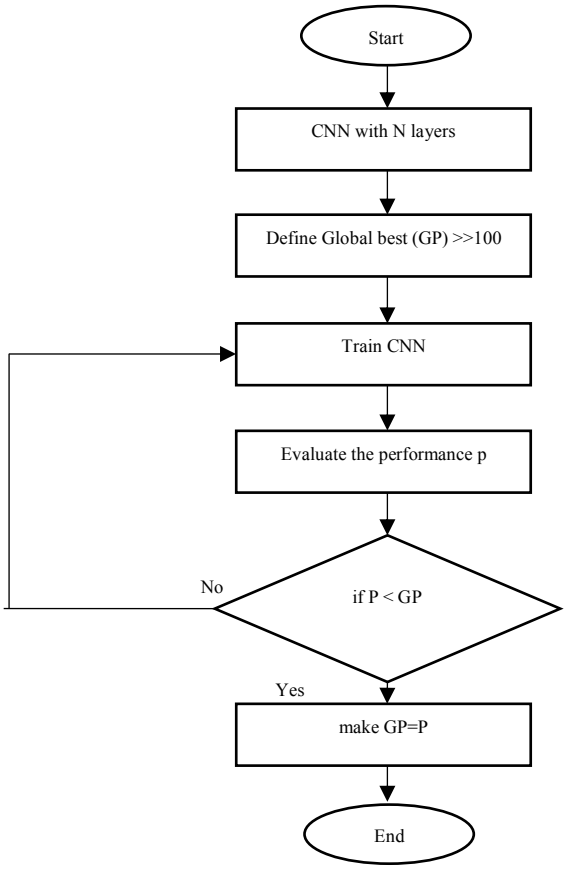

Figure 3: CNN training model procedure.

The training process is beginning by generating a random member and allotting those numbers to the weights and hence after evaluating the performance of the machine using the fitness function. So-to-say, training process night be repeated periodically I during the training stages until reaching the weight values that minimize the fitness function. Fitness function in this case is the mean square error. Figure 2 is demonstrating all the process of the said training model. The testing stage will begin by applying a test data at the input of neural network model in order to perform the colourization process. Neural network will study the input data and accordingly will predict the value of each pixel. However, this model is design to intake the binary images and colored images at any time of execution. However, the colored

images are converted first into binary image and then it is used for colourization process.

4 RESULTS AND DISCUSSIONS

As system is established using conventional neural network as a tool to predict the new pixel value to convert that pixel in to colour shade. Model was made with thirty-two hidden layer and all are trained for best model tuning. However, a seven hundred images are used in the testing phase where the model is set to predict the colour valued of the images. It is noteworthy to mention that all images in the database are with same pixel dimensions and the system is performable with any image after resizing it into the dimensions that used while training. Hence, model is tested with all those images and performance of colour prediction is monitored using six performance metrics namely: accuracy and pixel to noise ration.

Table 1: The performance metrics results of the model (Pixel-SNR).

Simulation trails	**PSNR**
run 1	31.13
run 2	31.19
run 3	31.09

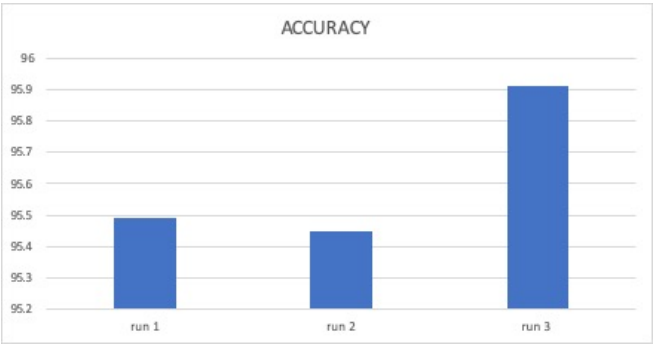

Figure 4: The colourization accuracy demonstration for all the runs.

a> Results were taken after determining the performance metrics for the said model after it predicted the colourization in each image. That means seven hundred value of each performance metric are yielded. The procedure is involved determining the average value of each metric during each run of the model and the same is tabled in Table 1.

b> Results are realized with very less variance during all the runs of the model.

c> The difference between the best colourization accuracy and worse colourization accuracy is only 0.42 percent which occurred between the run 2 and run 3.

d> System reported with 95.91 percent of colourization accuracy in 0.86 second. That was the best results produced by the model.

5 CONCLUSION

In our approach, image colorization is conducted using the smart machine learning approach with objectives to minimize the time and enhance the overall performance. The project made to draw a high performance of colorization by reducing the error to the minimum. Hence, average 95% accuracy is obtained. Time was notably low which highlights a big contribution over the current studies in image colorization. From the other hence, system is less computational complex as CNN predictor is used with good training performance which dispensed the need of involving a complex computational method such as Pseudo coloring and histograms.

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