Image Colorization

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***Abstract*—In this research paper, we study and review patch based image colorization by luminance factor match, which is a simple and unsupervised fast patch based technique for colouring grayscale images by simply transferring color square patches from a source color image to target grayscale image. The reviewed patch based approach attempts to match the luminance and texture information between the two inputs - target grayscale and reference colour image patches, and transfer the entire color mood i.e chromatic information of the best matching source patches to the target patches.**

***Index Terms*—Image colorization, Luminance factor, Patch based matching, chromatic information patches, Unsupervised.**

I. Introduction

Grayscale picture colouring is more complicated than it appears, since it entails giving 3-D(RGB) pixel values to an image whose elements (pixels) are defined solely by Luminance. In short, it's a method for converting a given grey image to a color one. What makes coloring a grayscale image is the fact that grayscale images just have one characteristic-luminance values and using this one value only, 3 parameters (RGB) is to be calculated for every pixel. Each channel of RGB has a range of 256, which implies that for every pixel of grayscale, there are over 16 million choices. This makes it a mammoth of a task. In general, colorization of grayscale images has several challenges including ambiguity, fuzzy boundary identification. The challenge of colourizing a grayscale image has no fundamentally "right" solution since distinct colours might have the same luminance despite variances in saturation. Taking the aforementioned challenges into account, the proposed method of grayscale image colorization using patch based technique attempts to satisfy -

Fig. 1. Example

Fig. 2. R,G,B planes

- Quality: It produces pleasing accurate results
- Generality: It works for a wide range of images
- User-friendly: The inclusion of GUI makes it easier to upload the input images.
- Simplicity: Straightforward algorithm of matching luminance
- Time-Saving: Low on computational cost as compared to other methods like DeepLearning.

Identify applicable funding agency here. If none, delete this.

A. Patch based Image Colorization

A small portion of an image grouped together into blocks is called a patch of the image. Due to the smaller size of the patch many image processing algorithms such as colourization,etc are easily operated on the patches rather than working on the whole image itself. Basily these algorithms split images into many smaller sized patches and operate on individual patches so that we could get desired output. Colorization is a process of adding colors to the gray scale image. This colorization technique is commonly used in picture editing and research illustrations.

In this method, simply the luminance layers of both the target grayscale and reference color image are compared and the best matching luminance component of color image's chromatic components are transferred to grayscale pixels. It runs pixel by pixel of grayscale image and by the end of it we have all three components - YCbCr for the target image.

II. Literature Review

A. Using a Semi-Automatic Approach to Colorize Grayscale Images and Videos:

Proposed by Vivek George Jacob, Sumana Gupta in the year 2009.This method is semi-automated and it first segments the image, and colours different areas of the image. To apply colour to each pixel, this approach uses the coordinates of colour markers.The results of this process look good for a large dataset.

B. Infrared Colorization Using Deep Convolutional Neural Networks:

Proposed by Matthias Limmer, Hendrik P. A. Lensch in the year 2016. Colorization in the infrared Colorization of Near-infrared (NIR) photographs of road scenes acquired by automobile cameras is addressed using Deep Convolutional Neural Networks. They employ a deep convolutional neural network with many scales. Pre-processing, inference, and postprocessing are the three components of the technique.

C. Convolutional Neural Network-based fully automated picture colorization:

Proposed by Domonkos Varga, Tams Szirnyi in the year 2016. convolutional neural networks are feedforward two-stage architectures for fully automated image colouring. A convolutional neural network is used for this. Predicts colour channels for grayscale inputs image. The VGG-16 classifier is used, which has previously been trained on a million photos.

D. Manga Colorization:

Proposed by Y. Qu, T. Wong, P.A. Heng, in the year 2006. Manga Colorization is a colorization technique that applies colour to a specific location while maintaining the pattern's continuity. This is a black and white manga or animation with a lot of strokes, halftoning, and screening.

E. Patch- Based Image Colorization:

Proposed by Aurelie Bugeau and Vinh-Thong Ta, in the year 2012. patch-based Colorization is done using a colour example from an input image. Brightness feature patch descriptors and a colour prediction model with a general distance selection mechanism are used in this method.

III. Dataset

In the dataset we have used, it consists of nearly 20 types of fruits, vegetables images like peaches, tomatoes, etc, greyscale images and are of fixed dimensions. The aim of this project is to convert these grey scale images into color(RGB) images; this dataset is basically recommended for the image colorization process. Below-mentioned pictures are some samples from our dataset.

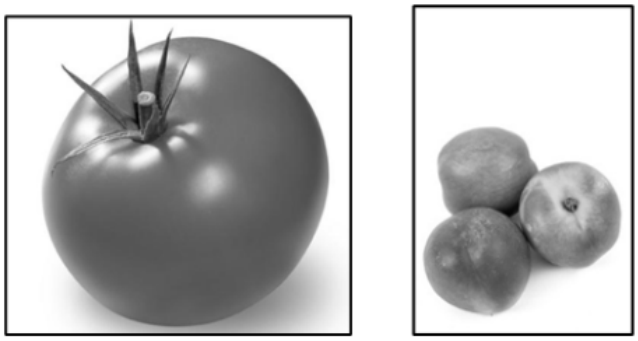

Fig. 3. Samples of Datset

IV. METHOD

A. MAIN CODE

Here we discuss the simple yet fast patch-based algorithm for transferring colors. The method of colorization relies on searching luminance information from a target colored image pixel by pixel (called pixel-based approach), and applying their chromatic information to pixels of the target grayscale image. The steps of the proposed patch-based algorithm can be simply stated as follows. First, by clicking on the "Upload Grayscale Image" button, the target grayscale image is chosen. Similarly we choose and upload a reference color image. On hitting the "Convert Image" button the program begins to process. Secondly, preprocess both the source/ reference color image and target grayscale image to YCbCr space, where Y component is a measure of luminance, i.e the brightness of the color and Cb and Cr components are chromatic information where Cb is the blue component relative to the green component. In relation to the green component, Cr is the red component which is related to green component and luma component Y is more sensitive when compared to chromatic components to the eye(human) Third, after preprocessing it to the YCbCr plane, we derive the Luminance (Y) component plane of both the target gray image (pg) and the reference color image (py). Next we normalize the values of both these

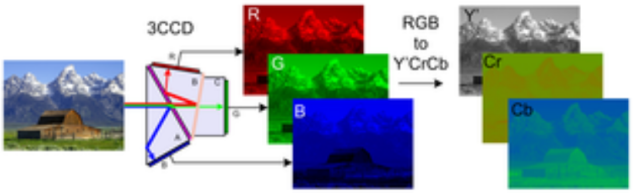

Fig. 4. rgb to ycbcr

obtained Luminance (Y) planes. Normalization,which is the method used for the convertion of Numerical numbers in a dataset with out distorting or changing the ranges of values and converting them into common scale The reason behind normalisation in this patch based method is the fact that it involves calculations on two different Luminance (Y) plane values. Fourthly, a pixel by pixel loop is run for grayscale image's luminance plane. For every pixel, its luminance value is subtracted from the whole luminance plane (py) of the color image. Using min2d() function, the minimum absolute value is scanned in the py plane. After obtaining the nearest pixel luminance to that of the color image, the CbCr values of the color image pixel are stored as chromatic components of the grayscale image.

B. GUI

After implementing the code and evaluation metrics, we implemented GUI for easy usage for users. We added a Background image for the GUI window, a TextBox where The title lies. Then we added 3 buttons:

- Upload Grayscale images.
- Upload Color images.
- Convert

1) Upload Grayscale images.:

- For this We'll create a push button.
- Then we need to create a global variable to access the image in all our GUI code
- Then we need to read that image and We'll display that image

2) Upload Color images.:

- This button will upload the image that is required to take the required features.
- Steps are the same as above.

3) Convert:

- In this button we'll import the images which are taken from inputs and we'll keep them in the code
- Steps are the same as above.

Fig. 5. GUI

V. RESULTS

This section reports some of the experimental results obtained with the proposed patch-based colorization technique. We have deployed evaluation metrics like Mean-Squared Error (MSE) and Peak Signal-to-Noise (PSNR) ratio for our test dataset, to see the performance of our patch-based colorization technique. As the images are rgb images we are calculating MSE and PSNR for each R,G,B planes.

A. Experiment 1

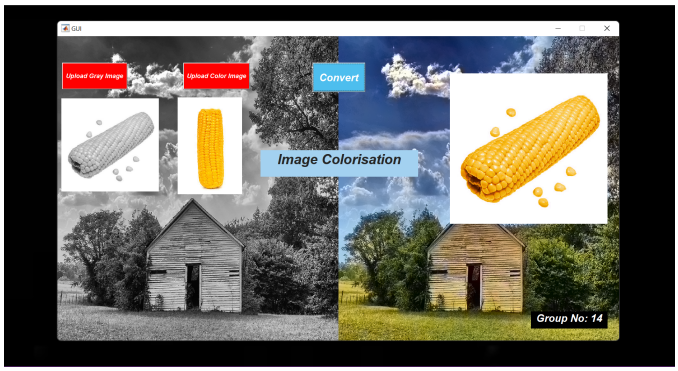

Fig. 6. OUTPUT 1

```
The MSE value is 0.0809
The Peak-SNR value is 59.0846
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Fig. 7. Evaluation Matrices

B. Experiment 2

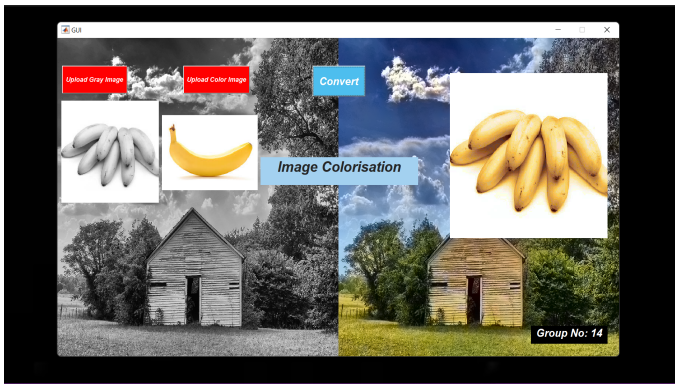

Fig. 8. OUTPUT 2

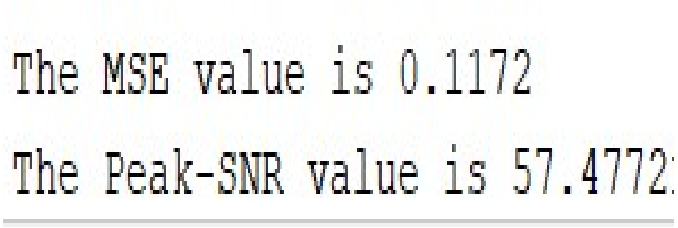

Fig. 9. Evaluation Matrices

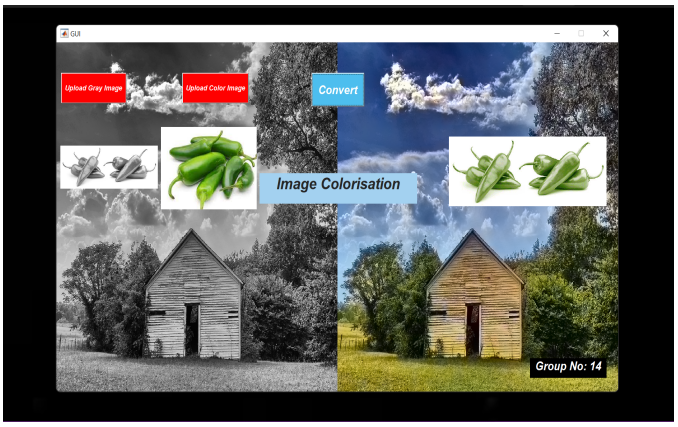

Fig. 10. OUTPUT 3

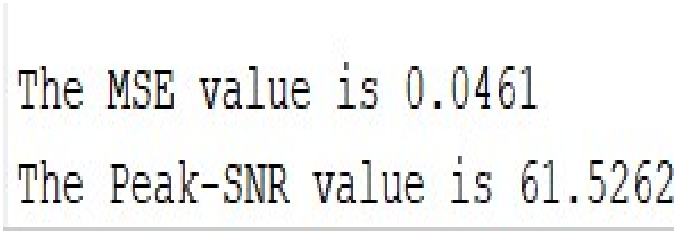

Fig. 11. Evaluation Matrices

C. Experiment 3

VI. CONCLUSION

First we learned about the importance of this image Colorization. The process of colourizing an image has a greater influence in a variety of disciplines, including astronomy photography, image colorization in the entertainment business to make old black and white films appealing to young people and Surveillance cameras. In this report the method we opted to do the image colorization is patch based image colorization. The main theme of our solving is to compare the luminous quantities of color images and then we'll check the most accurate pixel luminance feature and then we'll replace that luminance feature with the gray part. So finally we are creating a color image from a black and white. Then after completing that we tried a gui and made a user interface for easy use of our code.

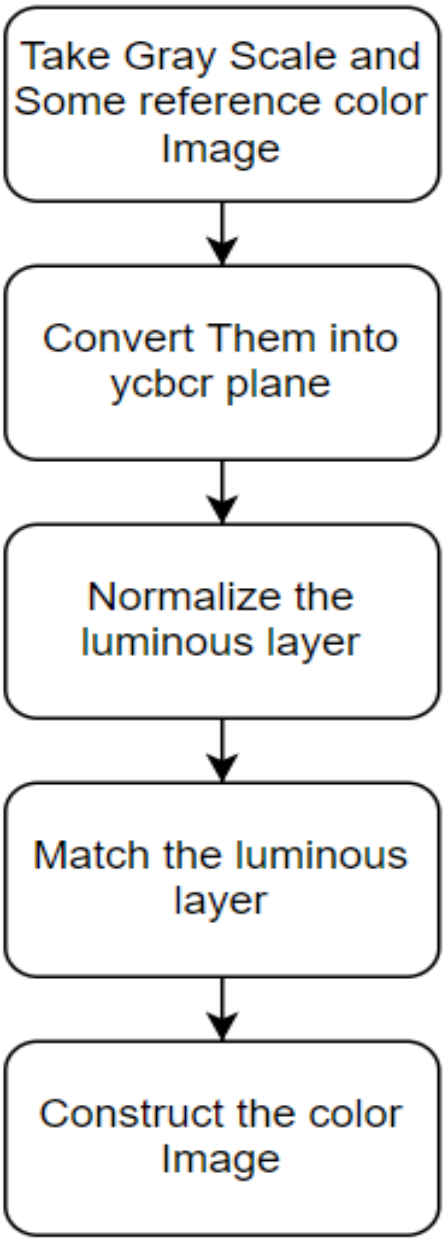

Fig. 12. NutShell

A. Total Implementation in Nut Shell

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