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Image Colorizer using OpenCv and Convolutional Neural Networks

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Abstract— Given a grayscale photograph or video as input, this project attempts to create a plausible color version of the photograph. This problem is clearly underconstrained, so previous approaches have either relied on significant user interaction or resulted in desaturated colorizations. We propose a fully automatic approach that produces vibrant and realistic colorizations. We embrace the underlying uncertainty of the problem by posing it as a classification task and use class-rebalancing at training time to increase the diversity of colors in the result. Colorizing images has a significant impact in different fields, such as photography of astronomical objects, the visuals of electronic microscopes, and CCTV surveillance systems. Using Deep Learning algorithms, we can build an automated system for analyzing color grayscale images.

Keywords: Image Colorization, Convolution neural networks, Feature extractor, Decoder

I. INTRODUCTION

Imagining a grayscale image as a color image by using a black-and-white image as input and obtaining the output in RGB format is a process called Image Colorization. There has been an increase in the use of colorization in a wide range of fields where the technique has been found to have a major effect, for example the photography of astronomical objects, visuals took with an electronic microscope, and CCTV surveillance. Grayscale images are generally a poor representation of reality as the information available is too low to understand the image. Therefore, coloring the images helps us to understand the semiotics of the image better. For example, in old-fashioned model implementations, a grayscale shirt image cannot be distinguished between colors such as red or blue.

The process of image colorization is generally considered as a simple process since we were children, coloring in the missing colors in drawing books by grasping that apples are red, parrots are green, the sea is blue, and banana is yellow. The process of adding colors to images has provided good results in various fields. The medical field, for example, has gained more insight due to this colorization. Since most of the equipment used in the medical field generates grey scale images during scanning, surgeries. Coloring those images helped researchers, doctors to interpret them in a better way. Till now so many manual methods are provided for colorization, like hand drawn images, general color assumptions were supplied, or similar images were provided that are more semiotic to the grayscale image that they can move shade of the color from, or the keys defining the image, to even search the internet for the similar images automatically[1].

Although so many techniques were used, it has been a difficult task. Due to this, many solutions are being considered, and convolutional neural networks are one among them.

In the field of artificial intelligence, deep convolutional neural networks have attracted so much attention as solutions to complete visual understanding of objects. In order to colorize an image, there are several subtasks that need to be solved such as localization of colors, classification of objects and understanding segmentation. From hand colorization in the past to automated solutions today, technology has greatly improved. Deep learning technology is also advancing rapidly. In this project, we design and develop a model using convolutional neural networks [2]. Now-a-days the approach for coloring images has progressed from human-assisted to fully automated solutions. Typically, these solutions are implemented using neural networks. In neural networks, researchers have been working toward making the colorization process cheap and efficient, which allows it to be implemented on a wide scale [3].

Now, most people are utilizing cameras with high definition features to take pictures or capture videos. In the past, however, most cameras and videos used to capture images and videos were black and white. Whenever we asked our grandparents, they would describe the scene in a colorful way and when we see the photo it will be in black and white [4]. Therefore, coloring those images is not only helpful to viewers, but also to their own minds, as it helps them remember those moments from the past. In the USA, Legend Films has used a technique to automatically color the old films in which every frame of video is colorized. In India, movies like Mayabazar, Mughal-e-Azam which were blockbusters were premastered into color which attracted so

many audiences to watch and made the theatres crowded.

II. LITERATURE REVIEW

Various methods are employed in order to produce strong and satisfying colorized gray-scaled pictures.

Anat Levin et al., [5] proposed a manual colorization method. Here this technique brings color to the grayscale image. If the component has a constant price and the same intensity, then it'll show a colorized image. It's totally different from alternative manual techniques, where the user applies color to each component or highlights object boundaries. This method is advantageous because it saves time and avoids unnecessary colors.

L.Yatziv et al., [6] developed a unique technique to color the grayscale image into a colored image. Diverse ideas, including luminance-weighted chrominance mixing and quick intrinsic distance computations, resulted in high-quality videos and pictures in less time with a lower procedure cost. To convert the grayscale pictures to colored pictures we tend to use quick Colorization during this model.

Raj Kumar Gupta et al., [7] presented a technique for coloring grey pictures by the victimization of similar example pictures and they explained a replacement example-based technique to colorize a grey image that works at pixel resolutions. During this, they receive a spread of options from the example images as well as the grayscale image. They developed a framework for picture house balloting. This provides proof from neighbor superpixels of invalid color assignments and allows them to be corrected.

A technique was developed by Bekir Karlik et al., [8] on image colorization. It copies color shades from a particular supply input-image to the image which needs to be colorised using ANN in deep learning is developed. To get higher results we tend to use most well liked algorithmic rule referred to as back propagation is employed in neural networks.

Aurelie Bugeau et al., metallic element [9], presented a simple technique for coloring grayscale images with patches. Here a distance-based technique is used to predict the color. Here, two ways are used principally. They have predefined the color inputs in the first technique. In the second technique, they consider an entire colored image as an example of color. However here the resultant image is unrealistic and desaturated.

Rasoul Kabirzadeh and Patrick Blaes [10] developed machine-learning techniques for assigning inventive and plausible colors to black-and-white pictures. A map is chosen from an identical coaching image. A drawback of a model is that it doesn't differentiate things in general. For instance, this algorithm rule has a problem in differentiating between grass and plants.

A spread approach is proposed by Aur´elie Bugeau et al.,

III. in which selected energy is assumed to model both the color choice and the spatial constraint at the same time. The color of the input knowledge is obtained from a supply image thought of as a similar image. This has resulted in a collection of very attractive colors due to variations in formulation, a decrease in energy, and patch-based construction techniques. A simple example-based mostly image colorization framework is employed to colorize the grayscale images.

IV. SYSTEM ARCHITECTURE

Based on the use of convolutional neural networks, our system consists mainly of four phases. Each phase features a particular function.

They are:

- Encoding
- Feature Extracting
- Fusion layer
- Decoding

The brief explanation on image formats, pixels and working of neural network are as follows:

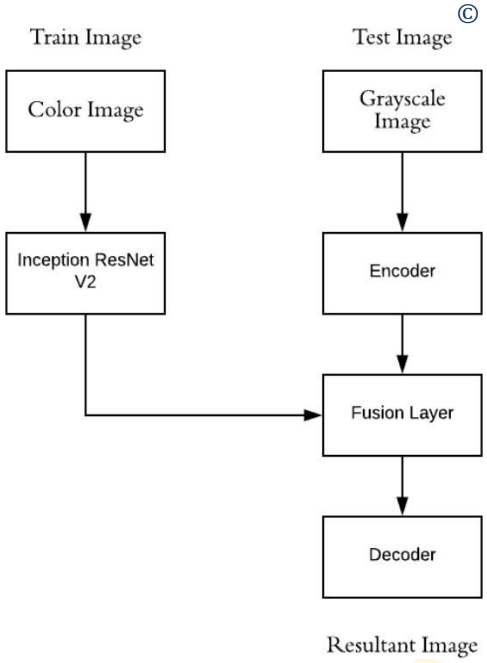
An image in grayscale is shown as a grid of pixels ranging from 0-255, indicating the brightness of the image. Unlike black and white images, color images are composed of three layers: Red, Blue and Green. Each image consists of all these three layers. For example, blending equal amounts of blue and red will give bright green color. Each layer of color image will have values ranging from 0-255.

First, the image is preprocessed by converting it into an array of pixel values. Now the images are in RGB color format. Encoder processes input image of dimensions h*w and generates an image of dimensions h/8*w/8*512. Now this encoder uses eight convolutional layers (3*3 filters). In this Encoder phase, in order to save the initial dimensions of the layer, the padding attribute is used.

In the feature extractor step, features are extracted and classification of patterns is done using Inception ResNet V2 which is one of the most accurate classifiers. This neural network model has trained on a huge dataset of nearly 1.3Million images.

At the fusion layer, the feature vector obtained from Inception ResNet V2 is repeated h*w/8*2 times and combined with the output from the encoding phase in depth-axis. This generates a single layer of encoder image with mid-level features of dimensions h/8*w/8*1257. The feature vector is repeated and combined. It makes sure that the information conveyed by the feature vector is evenly distributed over the entire image region. By this we can take any size of input and apply 256 convolution kernel of filters 1x1 size that generates h/8*w/8*256 dimensional output. The output of the fusion layer is sent to the Decoding phase. The convolution layer and up sampling layer are applied to the input layers of h/8*w/8*256. This process is repeated until the dimension becomes h*w*2. The generated output is the final output.

As shown in the below figure, these steps are followed by implementing the architecture of the system.



Architecture design of the system

V. IMPLEMENTATION

Dataset:

Training pictures contain colored pictures with high resolution. Nearly 30,000 distinct images were collected from the ImageNet Dataset. Testing pictures contains grayscale pictures (black and white). Almost five hundred images are collected from the source - unsplash.com.

Algorithm:

Convolutional Neural Networks (CNN):

CNN is the algorithmic program employed in this paper. CNN is one of the kinds of neural networks used to process images. There are different types of hidden layers in CNN. The hidden layers of a CNN generally comprise convolutional layers, pooling layers and absolutely connected layers. As part of convolution and pooling, ReLu is employed as an activation performance.

ReLu:

This is the corrected linear measure that uses the activation function. It gives zero for any negative pixel value; similarly it gives the same value for any positive pixel value.

Epoch:

The forward and backward passes on all the training data, or simply the entire iteration process on all the training data. The epoch will be determined by the batch size and the data count.

V. RESULTS

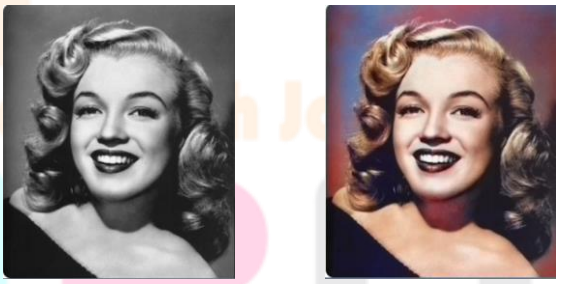
This model is implemented using convolutional neural networks. Inception ResNet V2 is used to extract the features of the model, whereas convolutional neural networks are used for the implementation. In order to observe the results, it is necessary to increase the epoch values gradually in order to comprehend the neural network. We need to understand the terms epoch, steps per epoch, and batch-size in order to gain a better understanding of the model and how it is implemented.rms epoch, steps per epoch and batch-size. Basically, the epoch is a collection of all of the training data that has been iterated forwards and backwards as many times as necessary. In this case, the epoch is determined based on the batch size and the number of data in the batch. The steps per epoch are calculated simply by dividing the number of images in the dataset by the number of batches in the dataset. During the forward and backward passes of the training algorithm, a batch size can be defined as the number of training examples taken during each of the two passes.

Input Grayscale images: The input grayscale images can be in any of the formats like png, jpeg, jpg etc.

Testing Images 01:

Grayscale input to network

Grayscale input to network



Conclusion

So far, the results are looking realistic. Thus the model constructed using convolutional neural networks is performing satisfactorily. This model has increased the efficiency in both coloring and processing. The model we developed has improved accuracy and performance. The complexity is also decreased. It is observed that the grayscale image is colored efficiently. When compared to previous studies, we have also found that the loss rate in this study is low.

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