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Review on Different Methods of Image Colorization

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ABSTRACT

This review paper is to showcase some of the different methods that have been tried out for the process of image Colorization. There have been different ways to colorize images since early times. Today's trend is focused towards fully automatic image Colorization techniques. This paper gives an overview of some varied methods that have been tried and implemented, along with their advantages and disadvantages, and a comparison between them.

Keywords: Colorization

I. INTRODUCTION

Image Colorization is the process of adding colors to Grayscale images, to make them aesthetically appealing and to have a better visual perception from the image. This could be used to colorise old photos and videos to make them more appealing, CCTV footages to have better understanding of the scenario and make sharper inferences, and possibly even to MRI images, making is easier for doctors to identify problems.

There have been various methods used to colorise images, but it used to be a very sophisticated task, requiring a lot of human intervention. Hence people have been trying different methods to ease this process.

On a broad perspective, Image Colorization techniques can be classified into Manual approach, Scribble based approach, Example based approach, Learning based approach. Currently, the attempt is to produce a system which could colorise images in a fully automatic manner, using deep learning methods.

In this paper, we summarize the different techniques that have been tested along with their comparison of results.

The organization of this document is as follows. In Section 2 (**Literature Survey**), a detail study of existing methods are done. In Section 3 (**Overview of Literature Survey**), we have discussed about the different methods and its limitations. Discussed in Section 4 (**Conclusion**) we have concluded our research.

II. LITERATURE SURVEY

A. Colorization of Grayscale Images and Videos using a Semi-Automatic Approach

This paper [3] presents a semi-automatic approach for Colorization. They make use of segmentation, and color different areas of images should be colorized. The algorithm adds color to each pixel by considering the position of color markers. It first segments the image and then colorises it. They also attempt to colorise videos, by some frames, colorising them, then transferring the color to other frames. Keyframes are selected local minima of block motion. Segmentation is done using rain water simulation technique of

watershed segmentation [1]. This method of segmentation leads to over-segmentation merging operations. of a unique segment, each with a marker after the process. Their results looked visually good for a large number of images.

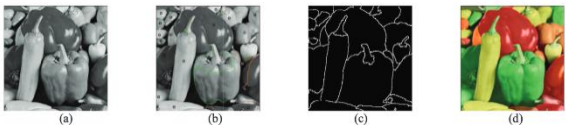

Figure 1. Comparisons with (a): Grayscale image (b): Grayscale image with color markers (c): Segmented image (d): Colorised output image.

B. Infrared Colorization Using Deep Convolutional Neural Networks

The paper [4], deals with Colorization of Near-infrared (NIR) images of road scenes captured from cameras of cars. They make use of a multi-scale deep convolutional neural network. The approach consists of 3 parts, namely pre-processing, inference, and post-processing.

In pre-processing stage, they make up an image pyramid of the input image in multiple resolutions.

Then for inference, each element of the pyramid passes through several convolutional layers and max pooling layers.

After this, the result of each element passing through the deep CNN is merged using a fully connected layer.

A bilateral filter is applied onto the result of above, as post-processing, to reduce noise produced in the result.

The disadvantage of this method is that the resulting colorised images looks more like paintings that real world pictures.

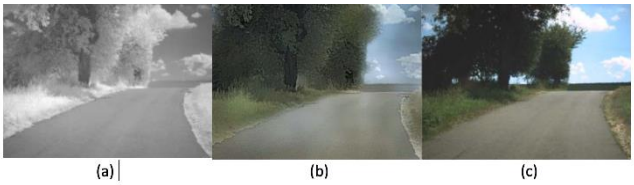

Figure 2. (a): Source image (b): Colorised image (c): Target output.

C. Fully automatic image Colorization based on Convolutional Neural Network

In this paper [5], a feed-forward, 2 stage architecture based on Convolutional Neural Network is used, to predict U and Color channels of an input Grayscale image. Colorization is looked at as a regression problem and is resolved using Anstey make use of the pre-trained VGG-16 classifier, which is already trained on a million images. The architecture consist of the VGG-16 model along with a 2 stage CNN that outputs the predicted U and V color channels of the image. They have used the YUV color model because it has the minimum correlation between the 3 coordinate axes. It produced very good results for some images. They evaluated the performance of the system using Quaternion Structural Similarity Index Measure (QSSIM)[8] , and obtained better values of QSSIM for their results than many of the previous methods which they compared with. Drawbacks of this method are that, if the system cannot clearly identify semantic information in the image, it tends to blur the output with a sepia or brownish tone. Also, sometimes the color information of the bigger semantic regions of the image get transferred to the smaller semantic regions

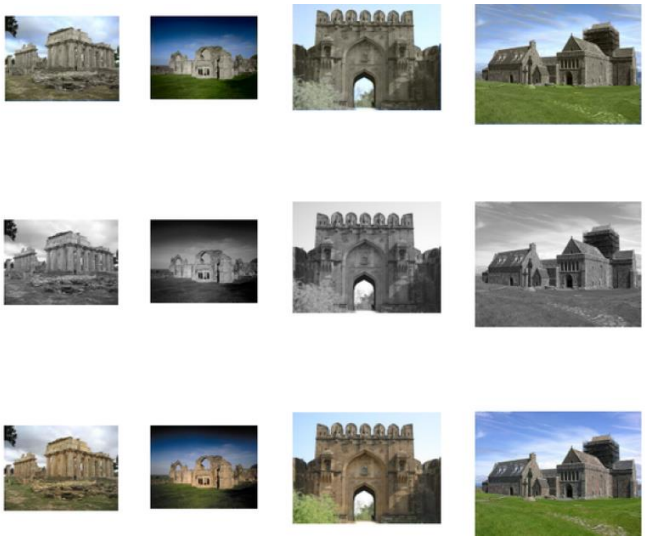

Figure 3. First row shows colorised output images. Second row shows the Grayscale input images , and third row shows the ground truth images

Figure 4. First row : Sepia tone of output image on the right side, with ground truth image.
Second row : Spreading of green color.

D. Patch-Based Image Colorization

In this paper, a simple patch-based image Colorization based on an input image as a color example. This method which is based on patch descriptors of luminance features Anda color prediction model with a general distance selection strategy. A Total Variation (TV) regularization is also per-formed on the colorized image to ensure the spatial color coherency of the final result. Experiments show the potentiality of our proposition in order to automatically colorize Grayscale images. The color prediction is performed from the luminance channel of both images. One drawback of automatic color-inaction is the spatial coherency during the color transfer leading to possible inconsistent Colorization in the final result. The image Colorization scheme is described based on patch features as pixels descriptors to capture image textures or complex structures.

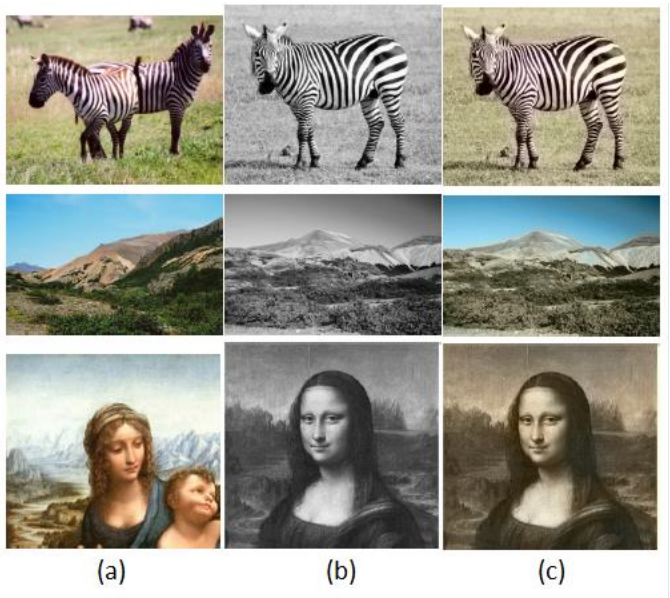

Figure 5. Comparisons with (a): Source image (b): Target image (c): Results

E. Manga Colorization

This Paper [7], Colorization technique that applies color over certain to the pattern continuity as well as that region. This black and white manga or cartoons which has drawing with the intensive number of strokes, halftoning and screening. intensity introduce many kinds of difficulties to Colorization methods which depend on intensity once the user marks on the drawing, a local, statistical-based pattern feature mechanism obtained with Gabor wavelet tarsi's applied to find the pattern-continuity. The boundary is then propagated by the level set method that monitors the level of. regions with same can be segmented by a single scribble. On these segmented regions, various Colorization techniques can be applied to replace Colors, colorize with stroke preservation, or even convert pattern shading

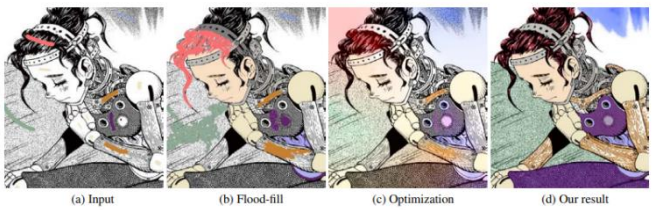

Figure 6. Colorization of pattern-continuous and intensity-continuous regions in manga

This method starts by drawing the desired interested regions. It automatically propagates the color within the pattern-continuous regions. The coloring stops change at the abrupt change, no fixed outline. Figure 5(c) demonstrates our Colorization result after faithfully segmenting the regions with similar patterns. screening pattern (background and bed in Figure 5(a)) or as stochastic as hand-drawn hatching expressing textures and/or structures (hair and wooden arms). any of these methods 1) leak-proof Colorization of intensity-continuous regions even when the boundaries are open or drawn casually 2) Colorization of pattern-continuous regions while preserving textures or structures of the patterns 3) for patterns expressing shading only.

III. OVERVIEW OF LITERARTURE SURVEY

Table 1

Title	**Year**	**Method Used**	**Limitations**
Colorization of Grayscale Images and Videos Using a Semi-Automatic Approach	2009	Segmentation and Color Markers	Depends on human interaction
Infrared Colorization Using Deep Convolutional Neural Networks	2016	Multi-Layer Deep Convolutional Neural Network	Colorised images tend to look less realistic due to smoothening filter
Fully automatic image Colorization based on Convolutional Neural Network	2016	2-Stage Feed- Forward CNN with VGG-16 Classifier Model	Incorrect recognition leads to results being brownish. Color of larger semantic parts affect that of smaller ones
Patch- Based Image Colorization	2012	Patch Based Method -Based on Patch Descriptors of luminance Feature.	The colorized result can be seen with a desaturation effect
Manga Colorization	2006	It propagates color over regions exhibiting pattern	Intensity continuity and When two patterns overlap the system identifies them as a distinct pattern

IV. CONCLUSION

Image Colorization had always been a tedious task, and much attempts have been done to automate this task. In this review paper, we have seen different methods of image Colorization that have been modelled and their results and drawbacks. We have seen approaches that are semi-automatics well as the current models of fully automatic image colorisation using convolutional neural networks and classifiers. We have also seen that the best results for automatic image Colorization so far, has been obtained by using Multistage convolutional neural networks along with classifiers.

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