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Department of Computer Engineering,
St. Vincent Pallotti College of Engineering & Technology, Nagpur,

Colorization Model for Black and White Images

Vibhuti Khodke Dept. of Computer Engineering
SVPCET, Nagpur, MH,
India.

Treesa Shibu Dept. of Computer Engineering
SVPCET, Nagpur, MH,
India.

Sarang Maske Dept. of Computer Engineering
SVPCET, Nagpur, MH,
India.

Siddhesh Yawalkar Dept. of Computer Engineering
SVPCET, Nagpur, MH,
India.

Prof. Pallavi Wankhede Dept. of Computer Engineering
SVPCET, Nagpur, MH,
India.

Abstract— In recent years, researchers' interest in image colorization has grown significantly, particularly with regard to deep learning-based image colorization approaches (DLIC). This work takes a novel deep learning-based approach to analyze the most recent developments in image colorization approaches methodically and extensively. It tackles the issue of imagining a believable color version of a grayscale image given only the input. Previous solutions have either required a lot of user engagement or produced desaturated colorizations, but this work provides a fully automated method that results in vivid and accurate colorizations. This paper discusses the introduction and effectiveness of Open CV and Generative Adversarial Networks (GANs) for automatic picture colorization. It focuses on the introduction and effectiveness of Open CV and GANs, their structure, functionality and extent of research for image colorization. It also discusses results, several open issues of image colorization and outline future research directions. This paper can serve as a reference for researchers in image colorization and related fields.

I. Introduction:

Image colorization is an important area of research in computer vision that aims to add color to grayscale images. The task of Image colorization has numerous applications, including restoration of old photographs, digital art, and image processing for visually impaired people etc. Traditional methods for colorizing images rely on hand-crafted elements and demand a lot of human labor. Convolutional Neural Networks (CNN) have been demonstrated to be successful in solving this issue since the development of deep learning. We are using two separate techniques to color images those are CNN and Generative Adversarial Networks (GANs) respectively.

Here, we solve this challenge using a statistical learning-driven methodology. A black-and-white image serves as the input for the convolutional neural network (CNN) we design and construct, which generates a colored version of the image as its output; Figure provides an example of such an input output pair. Without any additional human input, the system creates its output based entirely on previous photos that it has "learned from". After reaching error rates of less than 4% in the ImageNet challenge, CNNs have become the de facto norm in recent years for resolving picture classification issues [1]. The success of CNNs can be attributed in large part to their capacity to recognize and identify colors, patterns, and forms in images and link them to different object classes.

II. Literature Review:

The issue of image colorization has been addressed using a variety of ways, including classic computer vision methods and deep learning strategies. We examine the existing work on image colorization using OpenCV and GAN models individually in this section. Image colorization techniques based on OpenCV have been around for a while. The open-source computer vision library known as OpenCV offers a number of tools for processing and analyzing images. Histogram equalization (Acharya and Ray, 2005), neural network-based colorization (Bhargava and Agarwal, 2013), and color transfer approaches (Reinhard et al., 2001) are only a few of the research that have employed OpenCV-based methods for picture colorization.

Convolutional Neural Networks (CNN): CNNs are a class of neural networks that are specifically designed to work with images. CNNs are a subclass of neural networks created primarily to process visual data. They have been effectively used for a variety of computer vision applications, including style transfer, image segmentation, and object detection. By training a neural network to link a grayscale image to a corresponding color image, CNNs can colorize images. A sizable dataset of color and grayscale images is used by the CNN to learn this mapping.

Any grayscale image can be colored using the CNN once it has been trained. Several CNN-based methods for image colorization have been put out in recent years. These strategies make use of various network structures, loss functions, and training techniques. A few cutting-edge methods additionally use self- attention mechanisms and adversarial training to improve the colorization quality.

Prior work on Colorization: Previous colorization research: Colorization algorithms vary mostly in how they gather and handle the information needed to understand how grayscale and color correlate. Non- parametric approaches define one or more color reference images (provided by a user or automatically retrieved) to be used as source data first, given a grayscale input image. Then, utilizing the Image Analogies framework, the color is transferred from comparable regions of the reference image(s) onto the input image.

On the other hand, parametric approaches define the problem as either regression into continuous color space or classification of quantized color values and use enormous datasets of color images to learn prediction functions during training. Our approach also learns to categorize colors, but it does so with a bigger model, more data for training, and several innovations in the loss function and mapping to a final continuous output. [1] Concurrent work on colorization Richard Zhang, Phillip Isola, Alexei A [1], Larsson et al. [9], and Iizuka et al. [10] have created comparable systems that make use of big data and CNNs concurrently with our paper. The CNN architectures and loss functions used by the methodologies vary. While we here are using a classification loss, with rebalanced rare classes, Larsson et al. use an un-rebalanced classification loss, and Iizuka et al. use a regression loss. In conjunction with our architecture, we compare how each of these loss function types affects things. We use a single- stream, VGG-styled network with added depth and dilated convolutions [13,1], while Larsson et al. use hyper columns [11] on a VGG network [12] and Iizuka et al. use a two-stream architecture that fuses global and local features. Additionally, Iizuka et al. train their model on Places Zhang, Isola, and Efros while Larsson et al. train their models on ImageNet [14]. Fig. 1. Each convolution layer in our network architecture, developed by Richard Zhang, Phillip Isola, and Alexei A [1], refers to a block of two or three repeated convolution and ReLU layers, followed by a BatchNorm [30] layer.

The net has no pool layers. All changes in resolution are achieved through spatial down sampling or up sampling between conv blocks. Following shows the respective figure of the model architecture.

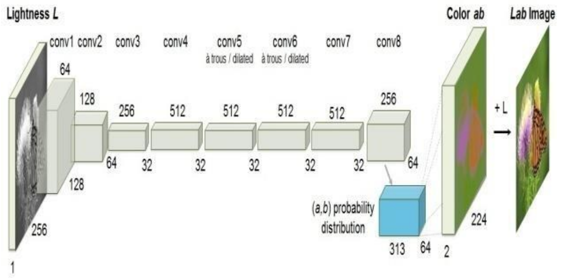

Figure 1: A block of 2 or 3 repeated convolutional andReLU layers is referred to as a "conv

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layer."

Generative Adversarial Networks (GANs) have become a popular tool in image colorization. GANs are a type of deep neural network that can be trained to generate realistic images. In the context of colorization, a GAN is trained to generate a color version of a given black and white image. There are several variations of GANs used for image colorization, such as conditional GANs (cGANs) and pix2pix. cGANs are trained to generate images conditioned on a given input, while pix2pix uses a paired dataset of black and white and color images to train a network to generate the color image from the black and white input. Generative Adversarial Networks (GANs) have been successfully applied in various computer vision tasks, including image colorization. Colorization of black and white images is one such task, where GANs have shown promising results.

In this literature review, we will discuss some of the recent works in this area.

1. "Colorful Image Colorization" [6]: A deep learning- based method to colorize black and white photos was presented in this paper. A GAN-based framework with a generator network and a discriminator network was suggested by the authors. The black and white image is fed into the generator network, which then produces the appropriate color image. The discriminator network assesses the generated color image's realism. On numerous benchmark datasets, the suggested technique delivered cutting-edge results.

Figure 2: Example of Colorization of an Image

2. "Deep Koalarization"[7]: In order to colorize black and white photographs, this research developed a deep learning-based method using convolutional neural networks (CNNs) and the Inception-ResNet-v2 architecture. After extracting features from the black and white image using a pre-trained Inception- ResNet-v2model, the authors employed a CNN to create the equivalent color image. On numerous benchmark datasets, the suggested technique produced positive results.

Figure 4 shows some failure cases

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"Deep Exemplar-based Colorization" [8]: This research proposes a deep learning-based method for colorizing monochrome photos using examples. A GAN-based framework with a generator network and a discriminator network was employed by the authors. The generator network produces the corresponding color image from the input black and white image and an example. The discriminator network assesses the generated color image's realism.

Figure 3 shows some successful image colorization

On numerous benchmark datasets, the suggested technique delivered cutting-edge results. The task of image colorization has shown significant potential for GANs, and numerous recent research publications have put forth creative ideas for enhancing the process' accuracy and effectiveness. These methods have been tested on numerous datasets and have produced cutting-edge outcomes, demonstrating the potential of GANs in this area. We talked about some of the most current research on GAN-based colorization of monochrome photos. These works demonstrated promising results and state-of-the-art performance. There is certainly potential for improvement, and future work might concentrate on creating GAN-based colorization frameworks that are more effective and efficient.

III. **Discussion:**

Image colorization using Convolutional Neural Networks (CNNs) has shown promising results in our project. CNNs are powerful machine learning models that can learn features directly from the raw image data, making them suitable for a wide range of image processing tasks, including image colorization.

The process of image colorization involves predicting the color values of each pixel in a grayscale image based on the surrounding context. This can be done using a CNN-based model that takes the grayscale image as input and outputs a colorized version of the same image. One of the major advantages of CNN- based image colorization is that it produced high- quality colorized images with fine details and realistic colors. This is because the model is trained on a large dataset of color images and learns to replicate the color patterns and textures seen in the training data.

CNN-based image colorization is used to colorize old black and white photos, bringing them to life and making them more engaging. This has applications in fields such as historical preservation, art restoration, and visual storytelling. However, there are also some limitations to CNN-based image colorization. One challenge we faced is that it can be computationally. intensive, especially when processing large images or working with complex color palettes. Another challenge is that the model may struggle with certain types of images, such as those with low contrast or ambiguous edges, leading to inaccurate colorization results. Despite these challenges, CNN-based image colorization has shown great promise and is likely to become even more effective as the technology advances. With continued research and development, it has the potential to

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revolutionize the way we view and interact with images, particularly those that were previously only available in black and white.

IV. Conclusion:

In this research paper, we have provided a comprehensive survey of the existing literature on image colorization using CNNs. We have analyzed the current state-of-the-art approaches and evaluated their performance based on various metrics. Our analysis reveals that CNN-based approaches have achieved impressive results in image colorization, and have the potential to revolutionize this field. We have also identified some of the key challenges that need to be addressed in order to further improve the performance of CNN-based approaches. These challenges include improving the robustness of the models to variations in input images, developing models that can better handle complex textures and shapes, and addressing issues related to computational efficiency. Despitethese challenges, we believe that the future of image colorization using CNNs is bright.

We anticipate that future research will focus on developing more sophisticated architectures, exploring novel training techniques, and incorporating additional contextual information to improve the quality of the colorization results. In conclusion, image colorization using CNNs is an important area of research in computer vision that has the potential to have a significant impact in a variety of fields. The advances in deep learning and CNNs have made it possible to achieve impressive results in image colorization, and the field is rapidly evolving. We hope that this research paper has provided a useful overview of the current state-of-the-art, and has identified some of the key challenges that need to be addressed in future research.

References:

Richard Zhang, Phillip Isola, Alexei A. Efros {rich. zhang, isola, efros}@eecs.berkeley.eduUniversity of California,
Berkeley Colorful Image Colorization

[1] Saeed Anwar, Muhammad Tahir, Chongyi Li, Ajmal Mian, Fahad Shahbaz Khan, Abdul Wahab Muzaffar Image Colorization: A Survey and Dataset

[2] Olga Russakovsky* · Jia Deng* · Hao Su · Jonathan Krause · Sanjeev Satheesh · Sean Ma · Zhiheng Huang · Andrej Karpathy · Aditya Khosla · Michael Bernstein · Alexander C. Berg · Li Fei-Fei ImageNet Large Scale Visual Recognition Challenge

[4]. Jeff Hwang jhwang89@stanford.edu You Zhou youzhou@stanford.eduImage Colorization with Deep Convolutional Neural Networks

[5]. Zhang, R., Isola, P., Efros, A.A. (2016). Colorful Image Colorization. In: Leibe, B., Matas, J., Sebe, N., Welling, M. (eds) Computer Vision – ECCV 2016. ECCV 2016. Lecture Notes in Computer Science (), vol 9907. Springer, Cham. https://doi.org/10.1007/978-3-319-46487-9_40

[6]. Colorful Image Colorization" by Zhang et al. (2016)

[7]. Deep Koalarization: Image Colorization using CNNs and Inception-ResNet-v2" by Baldassarre et al. (2017)
[8]. Deep Exemplar-based Colorization" by Cheng et al. (2018)

[9]. Learning representations for automatic colorization by G. Larsson, M. Maire, and G.

Shakhnarovich. 2016 European Computer Vision Conference.

[10]. Let there be Colour!: Joint End-to-end Learning of Global and Local Image Priors for Automatic Image Colorization with Simultaneous Classification by S. Iizuka, E. Simo-Serra, and H. Ishikawa. ACM Transactions on Graphics (SIGGRAPH 2016 Proceedings) 35(4) (2016).

[11]. Hariharan, B., Arbel´aez, P., Girshick, R., Malik, J.: Hypercolumns for object segmentation and fine-grained localization. In: Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. (2015)

[12]. Simonyan, K., Zisserman, A.: Very deep convolutional networks for large-scale image recognition. arXiv preprint arXiv:1409.1556 (2014)

[13]. Deeplab: Semantic picture segmentation with deep convolutional nets, arous convolution, and fully connected crfs. Chen, L.C., Papandreou, G., Kokkinos, I., Murphy, K., Yuille, A.L. (2016) arXiv preprint arXiv:1606.00915

[14]. ImageNet large-scale visual recognition task.Russakovsky, O., Deng, J., Su, H., Krause, J., Satheesh, S., Ma, S., Huang, Z., Karpathy, A., Khosla, A., Bernstein, et al. 115(3) (2015) 211-252 International Journal of Computer Visi