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Colourisation of Grayscale Images and Videos

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ABSTRACT:

The colorization of images and videos is a process of adding color values to the figures on the screen to a given input of grayscale images and videos. Grayscale image or video chrominance values does not change much but when it comes to the colorized image or a video in the RGB model, it maps to different coordinate values. The need to convert the grayscale image or a video is that it gives a modernized and realistic look to the old media and also many documents like scientific research and other works recorded have to be converted because they give a clear structure. Converting the values to the RGB values is the actual concern. Therefore, the methodology implemented here includes the most efficient image-processing AI technique which is known as the Convolutional Neural Network (CNN). Our model is designed to outperform the existing techniques with less interference from humans and give an efficient output as per the user requirements.

Key Words: Artificial Intelligence (AI); Convolutional Neural Network; Open CV

INTRODUCTION

The literature review is the first and foremost step while taking up any project. The idea of a literature survey or review is to obtain knowledge about the chosen topic or the title based on the previous theoretical and practical experiences of either students, engineers, or developers. It also gives us an idea about how the project has been approached and its detailed status of it such as its contributions, initial objectives, methodologies, number of objectives that had been satisfied, the challenges faced, and any enhancements that can be made described by many different authors. This gives a clear idea about the project and the further approach that can be taken.

Images and videos from the monochrome film have strong artistic appeal and many important historical facts and lessons. However, it tends to look very old-fashioned to some viewers. Therefore, to convey the world of the past to viewers in a more engaging way, there have been many reports on accurate still-image colorization techniques. However, the colorization results obtained by these techniques are often different from the user's expectations.

LITERATURE SURVEY

[1] In order to add clarity and detail to the image or video, colorization, a coloring procedure, is applied. According to the GLCM texture feature (grey level co-occurrence matrix), grayscale pictures and color image pixel blocks were matched in this investigation and colored using a sum of absolute differences. The smallest or nearly zero value in the color block is obtained by subtracting the values of both GLCM texture feature blocks and comparing them to find similarities between the two image blocks. Grayscale image blocks are used as targets and color image blocks are used as templates. Two grayscale image blocks are the smallest in the color image block since they both have comparable characteristics.

[2] Image colorization is indeed the method that involves adding RGB values to a grayscale. Grayscale refers to a picture with simply intensity values. Colorization is an essential but complex operation since any grayscale input should be transformed into a natural-looking color image. Because it can handle large image datasets, deep convolution network-based colorization is chosen among the other colorization algorithms. The neural network-based colorized version approach is a fully automatic method that doesn't need any help from humans, in contrast to the earlier methods. It makes use of the idea of machine learning, where computers use datasets to learn the answer and draw a conclusion. It consists of model generation, feature extraction, segmentation, and pre- processing.

[3] The technique of adding colors to a grayscale image is called colorization. Traditionally, the grayscale image needs to be colored and tagged with color by hand. By applying optimization techniques to spread the scribbled colors around the image. Prior to not too long ago, colorization was practically impossible without human assistance. Due to the accessibility of large datasets, colorization using neural networks has recently experienced great success. This study uses a pretrained VGGFace descriptor as a global feature extractor and convolutional neural networks to color exclusively portrait photos. It has been established that utilizing two distinct networks— one to extract 3x3 patch-sized features, also known as local features, and the other to extract global features—leads to colorization outputs of greater

quality.

[4] The main goal of this paper is to provide a general understanding of how the colorization problem can be used to transform a grayscale image into a colorful image that can then be used to color a video. It typically takes manual reconciliation to achieve artifact-free quality, making it a very difficult problem. A careful selection of vibrant allusion photos is usually necessary for the technique. No prior publications or research projects have addressed the topic of applying deep learning approaches to colorize videos, therefore this work sets out to develop a high-quality totally autonomous colorization system and also seeks to apply this notion to our best understanding.

[5] In this paper, they have provide a grayscale image colorization approach utilizing neural networks and optimization. For an exercise training set that contains the features of particular places of interestin each pixel in the image is then extracted from the related color images using our approach, whichsplits grayscale images into video frames. The obtained characteristics and their RGB values are input to each pixel's trained colorization neural network. The created color spots are subsequently propagated by our technology to surrounding pixels for better colorization outcomes, producing superior image colorization effects in less time. They haveoffered a cost function for color propagation to formalize the notion of a number of pixels must have the highest feasible positive comparison in terms of sensitivities and colors.

[6] Vintage grayscale aerial photography is one of the most important sources for studying how the environment used to be and how it relates to the present. However, these images lack spectral information, making it challenging to use them in modern remote sensing methods that depend on spectral data to characterize surfaces. This studypresents a conditionally deep convolutional model, a fully convolutional model, to improve historical images by forecasting color features for such an input grayscale image. Two orthophotographs of the entire Eurométropole de Strasbourg obtained in 1956 and 1978, respectively, were colorized using this method. Two methods were proposed to test the effectiveness of the model: first, colorized photographs were evaluated using PSNR or the structural similarity index. measures (SSIM).

[7] It has been extensively studied how to colorize monochromatic still photos using convolutional neural networks (CNNs). The outcomes of automatic colorization, however, frequently diverge from user wishes and historical truth. To create a colorized video, there is still a lot of color correction work to be done. This poses a serious issue in situations like broadcasting production when it is necessary to correctly colorize material in accordance with historical facts. In this paper, they suggested a useful methodology for video colorization that can quickly represent user intents. The suggested system effectively does the rectification task by combining two CNNs—a user- guided still-image-colorization CNN and a color-propagation CNN.

[8] It takes a lot of time and effort to color an image. The color scheme must be harmonious for a such model to function properly. This is a key element in determining if the product is excellent or subpar. Therefore, automatic image coloring is a subject with significant application potential and research significance. Machine learning technology has produced positive outcomes in the area of automatic color as a result of the advancement of computer hardware. The three categories of automatic coloring systems discussed in this study are interactive coloring, previous knowledge-based image coloring, and reference image-based image coloration. The user cannot see several items of different colors in comparison graph he can view in one image, despite the dyeing process being able to suit the expectations of the majority of users.

[9] In this paper, they have proposed a new method to colorize grayscale images from reference images.

Instead of relying on comparing a grayscale image to a reference image based on the luminance value of each pixel and neighborhood statistics, this method takes into account the continuity and spatial coherence of patterns. Process pixels in a grayscale image from higher levels to get a global result. This is better than results based on local statistics. Another advantage of our method is that it requires less human intervention than previous methods. This is very useful for colorizing videos. Our method focuses on coloring cartoon images and videos. For cartoon images, texture analysis based on pattern continuity yields better results. For cartoon videos, this method automatically generates scribbles instead of the user drawing them. Once the representative frame is colored, all other frames are colored sequentially. This is a huge improvement over automatic coloring.

[10] Colorization is an exciting area in the world of image processing. It has been used to enhance the visual appeal of images such as old black-and- white photographs, classic movies, and scientific illustrations. It was also very important in compressing color images and compressing videos. Colorization, the task of coloring a grayscale image or video, involves assigning intensities or luminance from one dimension to varying magnitudes in three dimensions as follows: B. Red, green, and blue channels. Various coloring techniques are prevalent, including hand coloring, semi-automatic coloring, and automatic coloring. Hand dyeing and semi-automatic dyeing require intensive and thorough human intervention. It introduces a method that automatically adds color to grayscale images and takes very little runtime. For this purpose, color images with content similar to grayscale images are obtained as input source images using various image reconstruction techniques. The best source pixel is then determined using a luminance-matching technique on each pixel of the destination grayscale image. Once the best source pixel is found, its chrominance value is assigned to the target pixel while preserving the target pixel's original luminance value.

[11] Manually coloring black-and-white images is cumbersome and inefficient. Photoshop editing has been attempted but has proven difficult as it requires extensive research and can take up to a month to colorize an image. A practical approach to this task is to implement sophisticated image coloring techniques. The literature on image colorization has been of interest over the last decade because it lies at the confluence of two of his esoteric fields: digital imaging and deep learning. Taking advantage of the increasing accessibility of end-to-end deep learning models, efforts have been made to take advantage of transfer learning. Deep learning models such as convolutional neural networks (CNNs) can be used to automatically extract image features from training data.

[12] In this publication, an automatic black-and- white image coloring method was proposed. This research is based on his CNN (Convolutional Neural Network), the most famous deep learning algorithm. The developed model takes input in grayscale and predicts image colors based on a trained data set. The color space used in this work is the Lab color space. This model uses the L channel as an input and the ab channel as an output. Using the Image Net dataset, they have randomly selected images, they have created a mini dataset of images containing 39,604 images split between 80% training and 20% testing.

[13] They have presented a convolutional neuron network-based system that faithfully colors black and white photographs without direct human assistance. They have explored different network architectures, purposes, color spaces, and issues. In the final classification-based model they produced much more aesthetically pleasing colored images than those produced by the baseline regression-based model, demonstrating the viability and viability of our methodology. It shows promising avenues for future work.

[14] It takes a lot of time and effort to color an image. The color scheme must be harmonious for such a model to operate normally. This is a key element in determining if the product is excellent or subpar. Therefore, automatic image coloring is a subject with significant application potential and research significance. Machine learning technology has produced positive outcomes in the area of automatic color as a result of the advancement of computer hardware. The three categories of automatic coloring systems discussed in this study are interactive coloring, previous knowledge-based image coloring, and reference image-based image coloration. The user cannot see several items of different colors within the comparison graph he can view in one image, despite the dyeing process being able to suit the expectations of the majority of users.

LITERATURE SURVEY

Papers	**Year of publication**	**Methodology and approaches**	**Gaps**
[1]	2017 Authors- Muhammad Sipan, Supeno Mardi Susiki N, Eko Mulyanto Yuniarno	Title- Image Block Matching Based on Gray level Co-occurrence Matrix (GLCM) Texture Feature on Grayscale Image Auto Colouring The overall approach was- Image Block Matching Based on GLCM (Gray Level Co-occurrence Matrix) Texture Feature on Grayscale Image Auto Colouring.	These approaches are not appropriate for textures with high degree of randomness as structural approaches are based on regularity.
[2]	2018 Authors- Swathy Titus & Jenc Rena N.M	Title- Fast colourisation of Grayscale Images by Convolutional Neural Network They have also followed the conceptof Convolutional Neural Network (CNN) which works well with large image datasets.	Encoding the position and the objects orientation was a failure and classifying images with different positions was hard.
[3]	2019 Authors- Naimul Haque & Samin Shahriar Tokey	Title- Grayscale Portrait colourisation using CNNs and Pretrained VGG-Face Descriptor They have attempted to colourise portrait images only by using the VGGFace descriptor as a global feature extractor along with Convolutional Neural Network. The model is trained to have overall colouring effects on the grayscale portrait using fusion technique. Mean Squared Errors (MSE) and Mean Absolute Errors (MAE) have been used to evaluate model performance.	VGG16 network is a huge network and used to take more time to train parameters. This model size is more than 533MB because of its depth and number of fully connected layers.
[4]	2019 Authors- Sinhuja Kotala, Srividya Tirummalsetti, Vudaru Nemitha, Swapna Munigala	Title- Automatic Colourisation of Black and White Images using Deep Learning This method is aimed at the process of high-gradefully unmanned colorization.	Needs to work with a huge number of datasets and the colorization of videos still can be brushed.

Papers	**Year of publication**	**Methodology and approaches**	**Gaps**
[5]	2020 Authors- Shaohua Wan, Yu Xia, Lianyong Qi, Yee-Hong Yang & Mohammed Atiquzzaman	Title- Automated colourisation of a Grayscale Image with Seed PointsPropagation They approached a method called Seed Points Propagation which involves the concepts of super pixelsand also used Neural networks.	The shape information in boundaries of the regions detected by a segmentation method cannot be harnessed using high level CV algorithms. Hence clear definition of segmentation is not present even there aremany algorithms present.
[6]	2020 Authors- Quentin Poterek, Pirre- Alexis Herrault, Grzegorz Skupinski and David Sheeren	Title- Deep Learning for Automatic Colourisation of Legacy Aerial Photographs They have used a deep learning model called conditional generative adversarial network, by predicting color channels for an input grayscale image to enrich legacy photographs.	The two networks the generator and the discriminator (GAN) compete against each other constantly which leads to slow and unstable training.
[7]	2021 Authors- Rei Endo, Yoshihiko Kawai & Takahiro Mchizui	Title- A Practical Monochrome Video Colourisation Framework for Broadcast Program Production The approach has been taken by the combination of two CNNs. They are- 1) a user guided still-image- colourisation CNN and 2) color propagation that allows efficient color correction.	The drawback was that there was still a considerable amount of color discontinuity in videos, more human intervention, and failed to maintain image quality.
[8]	2022 Authors- Jiayi Fan, Wentao Xie & Tiantian Ge	Title- Automatic Gray Image Colouring Method based on Convolutional Network They have used a convolutional network along with the color image segmentation and image fusion technology.	It has the disadvantage of Consuming more time as it has to work with more number of layers.
[9]	2015 Authors- Zhong Zhen, qquad Gui Yan, qquad Ma Lzhuang	Title- An automatic image and video colourisation Algorithm based on Pattern Continuity. Here they proposed a method known as pattern continuity and spatial consistency by automatic generation of color scribbles.	The drawback is it was supposed to classify the grayscale image into different classes of pixels that are segmented priorly by the user from the reference image which was a time-consuming and complex process.

[10]	2016 Authors- Divyang Patel & Shankar Parmar	Title- Image retrieval Automatic Grayscale Image Colourisation The techniques are called- the image retrieval technique, luminance matching technique, and match pixel count technique for automatization of coloring grayscale mages and videos.	It is a long process while the PCA-based approach efficiency is less and is about 71% only.
[11]	2021 Authors- Abhishek Kumbhar, Sagar Gowda, Ruchir Attri, Anjaneya Ketkar	Title- Colorization of Black and White Images Using Deep Learning Efforts have been made to use the ever-increasing accessibility of end-to- end deep learning models and leverage the benefits of transfer learning. Image features are extracted using CNN.	the used inception -resnetv2 based model was too sophisticated on the simplest dataset which is the reason for its poor performance.
[12]	2019 Authors- Omar Abdulwahhab Othman, Betül Uzbaş and Sait Ali Uymaz	Title- Automatic Black & White Images colorization using Convolutional neural network The Lab color space is used and the L channel is taken as input and the ab channels as output by the CNN model.	In this approach the colour consistency is very minimal. Meaning, there is no consistency in coloring of the black and white images.
[13]	2019 Authors- Jeff Hwang and You Zhou	Title- Image Colorization with Deep Convolutional Neural Networks The most efficient model CNN is used along with various network architectures, objectives, colour spaces, and problem formulations.	There is a lack of efficiency to input data to be spatially invariant.
[14]	2020 Authors- Varun D Trivedi, Hussain Saifuddin, Shubham Gudadinni, SoyashS Sondhi, M.A.R. Shabad	Title- Automatic Colorization of Black and White Images Based on CNN to calculate the user-defined features using the local loss functions for the color at each pixel of a grayscale image and result in better colorization.	The drawback was that there was still a considerable amount of color discontinuity in images and a failure to maintain image quality

EXISTING SOLUTION

There have been many methods and algorithms developed over recent period of time in order to automatically or semi-automatically map and convert greyscale images to colourised images. However, there is no such thing called as the most optimum or the best solution for this problem of ours - "Colourising greyscale images and videos". As it so happens, even though as mentioned above there are many techniques available for solving this problem the colourised output for the greyscale image or videos is sometimes quite different from the ground truth. Here, ground truth refers to the

conceptual knowledge or truth that we have perceived or we can perceive by directly observing or measuring it and can be quite different from the information provided by deduction.

Colourisation by scribbling is a colourised based technique introduced based on scribbling. This is a semi-automatic technique that requires intervention of the user to manually select few colour scribbles on the greyscale image to be colourised. This is based on the idea that the nearby similar intensive pixels share same color. But this approach yields poor quality and hence has been refined by many scientists over a period of time. This approach is still not adaptive to novice users but this approach was used by graphic artists to colourise old films manually up to some extent

Sparse Representation is another technique available that can be used to colourise old greyscale images to colour. This approach requires a image referred to as the reference image and is a colored image and of course we should also provide the greyscale image or video frames to be colourised. This method is very efficient in nature because it works at the level of super pixels. Low, middle and high characteristics of each single super pixel is extracted and encapsulated together. The corresponding super pixel's intensity values of target and the referenced image inputted at the beginning are differentiated. For the preservation of edges and boundaries, a preserving filter is created for chrominance channels. Though this approach provides arguably good results, it has high complexity of computation and hence this approach is carried out at the level of super pixel as mentioned above by graphic artists to convert old greyscale images to colourised images.

PROPOSED SOLUTION

We model a Convolution Neural Network to try to create a mapping between the greyscale images and colorized images (or frames in videos). We try to set up this mapping by treating the need of converting the greyscale images to colourised images as a multinomial categorization. In order to convert greyscale to colorized images, we provide the lightness of the image to convert to the CNN model. The CNN model is trained in such a way that, depending upon the given value of the lightness channel in the CIE LAB space of animage, our CNN model tries to anticipate the a and b channel values in the CIE LAB space. We then smoothen out the distribution of empirical by estimating its probability in the quantized space of ab. Then we map the distribution that we predicted to an estimate in space ab.

CONCLUSION

Although image and video colourisation are a boutique computer graphics function, they are also an occurrence of a difficult pixel prediction issue in computer vision. Here we have expressed that colourisation with a deep Convolution Neural Network and a competently chosen objective function can come nearer to fabricating outcome indistinguishable from actual colour photos and videos. Our approach not only delivers a practical graphics result, but also can be perceived as a pretext function for presentation training. Even though only trained to colour, our model learns a presentation that is stunningly handy for object categorization, recognition, and partition, executing vigorously contrast to other self- supervised trained methods.

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