Bringing Monochrome to Life: Colorization of Grayscale Images Using CNN

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Abstract**—** The process of image colorization has gained popularity, especially for converting old black and white photos into colorful ones, which provides a more immersive view of historical material. This process holds significant relevance for historical preservation and storytelling, providing a means to visualize the past with enhanced accuracy and realism. There are two primary approaches to image colorization: manual and automatic. Manual colorization relies on skilled individuals using software like Adobe Photoshop to meticulously add colors to grayscale images. This method demands expertise to ensure the chosen colors align with the historical context and period depicted in the image. In automatic colorization represents a newer advancement driven by deep learning technologies, such as convolutional neural networks. This technique determines the appropriate colors for a given image by analyzing its grayscale values. It frequently achieves these results with little assistance from a human. Moreover, preserving the original integrity of the image poses another challenge. While colorization can enhance visual appeal, it must be done sensitively to avoid altering the original meaning behind the image. Striking a balance between enhancing visual aesthetics and preserving historical authenticity is crucial to ensure that colorization efforts remain respectful to the original image's significance.

Keywords**—** Convolutional Neural Network(CNN), Mean Square Error(MSE) ,peak signal noise ratio(PSNR),Structural Similarity(SSIM),Gray Scale , RGB Scale.

A. INTRODUCTION:

Colorization is the process of adding color to a black and white image without user intervention. However, due to the complexity of objects having multiple colors and variations, this task is challenging without prior knowledge. Prior knowledge can be provided through user intervention, where the user selects colors for objects in the image, helping to guide the colorization process. User-based methods allow users to select more color points, providing indirect information on color boundaries and leading to better results for the entire image compared to fully automatic methods. For automatic colorization, a convolutional neural network architecture is created. The model predicts the correct color images given grayscale input.

The L channel is used as the input and the ab channels are used as the output, utilizing the Lab color space. After prediction, the channels are combined to create Lab images, which are then converted back to the RGB color space for visualization.

B. LITRATURE SURVEY:

Completely Acquiring Knowledge of Worldwide and Local Picture Priors for Automatic Image Colorization and Concurrent Classification: We offer a novel method that utilizes both local image features and global priors to automatically colorize grayscale photos. Our convolutional neural network-based deep network features a fusion layer that lets us merge local data derived from small image patches with forward-looking global computations in an elegant manner using the entire image. [1]

Colorful image colorization: this work addresses the task of generating a credible color rendition of a grayscale image given as input. Previous attempts have either resulted in desaturated colorizations or relied heavily on user input, despite the obvious limitations of this situation. We provide a completely automated method that yields realistic and vivid colorizations. [2]

Using CNNs and Inception-ResNet-v2, deep koalarization is one of the most recent techniques for applying deep learning techniques to colorize grayscale photos. Motivated by these, we suggest a model that blends high-level characteristics taken from the InceptionResNet-v2 pre-trained model with a deep Convolutional Neural Network that was trained from scratch.[3]

Deep Convolutional Neural Networks for Image Colorization: We provide a convolutional neural network-based system that accurately and autonomously colorizes black and white photos. Colorized images produced by our final classification-based model are noticeably more aesthetically pleasing than those produced by the baseline regression-based approach. [4]

Deep convolutional neural networks have made colorization of grayscale photos a more investigated field in recent years. This is particularly valid when it comes to colorizing black-and-white photos. We suggest and contrast two unique convolutional neural network designs trained under different loss functions in order to put it into practice. [5]

Image colorization has transitioned from classical heuristic methods to deep learning techniques, particularly CNNs like autoencoders and GANs. These models learn mappings from grayscale to color images, with conditional models and attention mechanisms improving accuracy. Evaluation relies on metrics like SSIM and PSNR, alongside user studies.[6]

Image colorization research has progressed from manual techniques to deep learning approaches. Convolutional neural networks (CNNs), especially conditional generative models, have become popular for this job. Utilizing large-scale datasets and integrating self-attention techniques are examples of recent advances. Evaluation involves both quantitative metrics and qualitative assessment.[7]

Significant progress has been made in applying deep learning for automatic colorization of black and white photographs. Convolutional neural networks (CNNs), including conditional generative models, are commonly used. These models follow an encoder-decoder architecture and often incorporate data augmentation techniques. Evaluation involves both quantitative metrics like SSIM and qualitative assessment. Challenges include preserving semantic consistency and avoiding artifacts. Future directions may focus on incorporating semantic information and improving model robustness.[8]

Image colorization using deep convolutional neural networks (CNNs) involves training models to predict color values for grayscale images. Common architectures include encoder-decoder structures. Conditional models, loss functions, and data augmentation techniques are used for training. Evaluation includes quantitative metrics like SSIM and qualitative assessment. Challenges include semantic consistency and avoiding artifacts. Future research may focus on incorporating semantic information and improving model robustness.[9]

Automatic cartoon colorization with CNNs involves training models to convert grayscale cartoons into colored versions. This is achieved using encoder-decoder architectures and conditional models. Key aspects include dataset preparation, loss functions, and evaluation metrics. Challenges include maintaining artistic style and minimizing artifacts. Subsequent research endeavors to enhance model efficacy and tackle residual constraints. [10]

CNN learns to match grayscale images with corresponding colors. This process involves taking a grayscale image as input to the CN N and optimizing its parameters (weight and bias) to minimize the difference between predicted and actual colors. The goal is to extra ct the features of the grayscale image and create the appropriate col or. Techniques such as data augmentation and regularization can b e used to increase the overall capacity of the network and prevent o verfitting. Colorize the grayscale image.[11]

A common method for color recognition involves training a convol utional neural network (CNN) on a large dataset of black and white images and their corresponding colors. These networks learn to pr edict the most likely color of a grayscale input image. The coloring process generally involves preprocessing the image, creating a suit able CNN architecture for the coloring process, training the networ k with poor performance, and reusing postprocessing techniques. A lthough there is no information specifically for Chinese black and white films in 2018, design ideas for color images can be used for t his feature with appropriate information and consideration of cultur al nuances.[12]

A description of various methods for detecting shadows in images. It can extend traditional methods based on crafts, statistics, and mo deling, machine learning methods including deep learning, and met hods that use data from the body or context. This research provides insight into the current state and future directions of shadow resear ch by discussing the pros, cons, and uses of each method.[13]

The integrated end-to-end learning system combines global and local image processing to improve the color process. Greater accuracy and visual beauty is achieved by taking into account the entire background and local features of the image. The article can discuss the structure of their model, the relevant training process, and experimental results to demonstrate the effectiveness of their method compared to existing models. This work contributes to computer vision and image processing studies, leading to advances in automatic image colorization technology.[14]

The intersection of image synthesis, deep learning and computer vi sion. It solves the difficult colorization task in computer vision by providing a way to create truecolor images from drawings using de ep neural networks. This approach extends the application of advan ced learning techniques to image processing tasks and contributes t o the extensive literature on deep learning methods for image synth esis. The research has practical applications that demonstrate its im pact and impact beyond science, in fields as diverse as computer-aided design, digital art, photo editing software, and augmented rea lity.[15]

These studies collectively provide insights into the state of the art in enhancing historical images through grayscale to RGB image processing. They highlight the importance of customized approaches for different types of historical materials and the potential of advanced image processing techniques for preserving and sharing cultural heritage.

C. METHODOLOGY:

In the realm of black and white image colorization, previous methods heavily relied on labour - intensive human annotation, often resulting in lackluster and unrealistic outcomes. Zhang et al. took a different approach by employing Convolutional Neural Networks to predict how a grayscale image would appear when colorized, essentially "hallucinating" colors. We trained network using the ImageNet dataset, converting RGB images to the Lab color space, which better represents human color perception.

Similar to the RGB color space, the Lab color space comprises three channels. However, Lab encodes color information differently than RGB color space:

- Lightness intensity only is encoded by the L channel;
- Green-red is encoded by the a channel.

Additionally, the b channel encodes yellow-blue.

It is outside the purview of this to study the Lab color space in detail, but the main point is that Lab represents color more accurately than humans do. We may utilize the L channel as our grayscale input to

the network as it just encodes intensity. It is outside the purview of this to study the Lab color space in detail, but the main point is that Lab represents color more accurately than humans do. We may utilize the L channel as our grayscale input to the network as it just encodes intensity. The network then has to develop its ability to forecast the a and b channels.
We can then create our final output image using the input L channel and the anticipated ab channels.

The full procedure can be summed up as follows:

1. Change the RGB color space of every training image to the Lab colorspace.
2. Train the network to predict the ab channels by feeding it the L channel as input.
3. Integrate the anticipated ab channels with the input L channel.
4. Return the Lab image to RGB format.

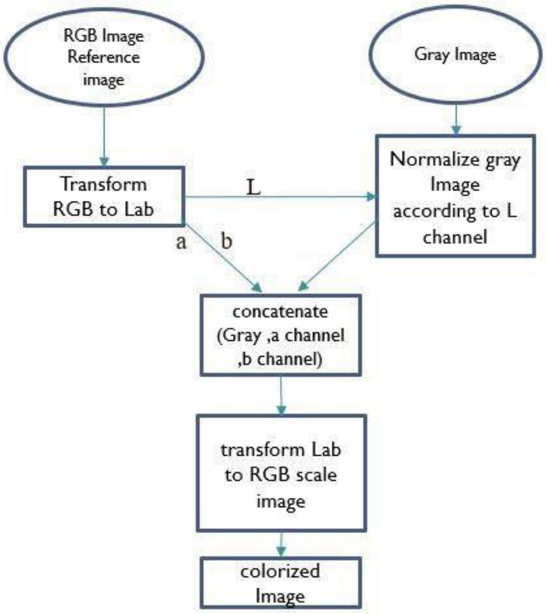

Fig 1. Image colorization Flowchart

D. PROPOSED SYSTEM:

The proposed system aims to enhance old grayscale images by converting them into RGB color format using deep learning techniques. The primary goal of the research is to colorize grayscale photos using the LAB color space by applying Convolutional Neural Networks (CNNs).

Through deep learning techniques, grayscale images are transformed into LAB space, where CNNs predict the A and B channels. These channels are then combined with the original intensity channel to produce colorized images. The system aims to explore the effectiveness of this approach in accurately colorizing grayscale images, offering insights into advancements in image processing techniques.

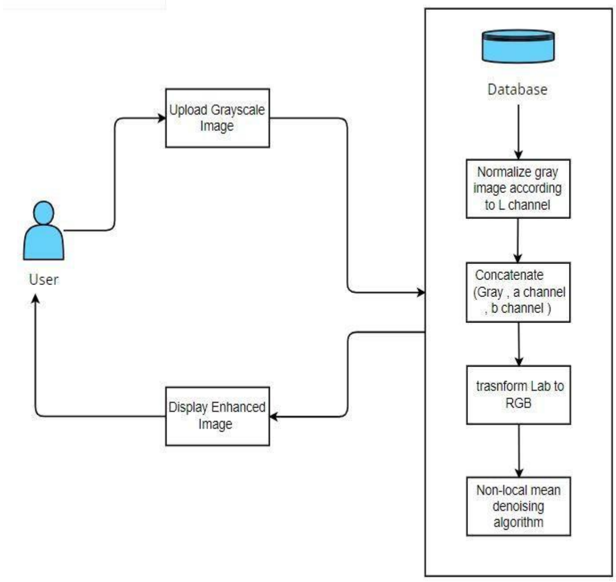

Fig 2. System Design

E. CONCLUSION:

The study revealed that the image colorization system achieved high accuracy and quality in generating colorized images, as evidenced by metrics like MSE, SSIM, PSNR. It also demonstrated efficiency in processing a large number of input images quickly. These results highlight colorization's promise in computer vision, image processing, and multimedia applications. The project's methodology and outcomes serve as a valuable groundwork for future research and development in this domain. Ultimately, the implementation of this model showcases its viability and effectiveness in generating colorized images from grayscale inputs, promising significant applications across various fields with further advancements.

F. FUTURE SCOPE:

Future developments in colorizing historical images are expected to leverage advanced technologies such as image processing and CNNs, potentially enabling real-time colorization with enhanced accuracy. These advancements may prioritize preserving the authentic features of documents while considering cultural sensitivities. Adding more sophisticated neural network topologies, such CNNs, could be one way to further enhance the caliber of the produced colorized photos. Subsequent investigations may also examine the application of alternative loss functions or optimization techniques to enhance the system's overall efficiency.

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