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COLORING OLD BLACK AND WHITE IMAGE USING DEEP LEARNING

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ABSTRACT:

Manual colorization of black and white images is a laborious task and inefficient. It has been attempted using Photoshop editing, but it proves to be difficult as it requires extensive research and a picture can take up to one month to colorize. A pragmatic approach to the task is to implement sophisticated image colorization techniques. The literature on image colorization has been an area of interest in the last decade, as it stands at the confluence of two arcane disciplines, digital image processing and 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 can be automatically extracted from the training data using deep learning models such as Convolutional Neural Networks (CNN). This can be expedited by human intervention and by using recently developed .implement image colorization using various CNN models while leveraging pre-trained models for better feature extraction and compare the performance of these models.

Key Words: Deep learning, Pre-trained model, CNN, image colorization.

1.INTRODUCTION:

In old times when photography was starting out, most images were in black and white(B&W). Hence efforts to colorize old B&W images started taking place to give the image a different perspective and a beautiful insight into the captured moments. Colorization efforts started to appear in the early 1900's,using paints and brushes. This painstaking process took days, sometimes weeks to generate a rough recreation of reality. The trend has shifted to use of computer software such as Adobe Photoshop, GIMP etc but the procedure remains the same. The present-day techniques for manual colorization of these B&W images are: Cleaning the Image, Adjusting the image tones and contrast, converting the image to CMYK and finally adding solid color to specific entities in the image. But even digital colorization using softwares like photoshop, that helped in colorization, pixel by pixel, along with improvements handling color bleeding and color continuity, and reduced manual work to some extent, now seems to be a tedious task. In the present times, a massive gallery of photographs is available, thanks to the color cameras. It offers an abundance of information to determine the color schemes of commonobjects, scenes, lighting conditions and color intensities. With advancement in technology and extensive research in the field of deep learning, models can be trained to learn the knowledge and then apply it to colorize old photographs. Using such techniques to colorize the photographs can modernize and automate the way how things are done and relieve the pressure on the colorizing artists to some extent. We implemented different CNN and GAN models used for image colorizing and provided their quantitative and qualitative comparison. We also show that incorporating pre-trained models can improve the performance greatly while making the training and hyperparameter tuning process less cumbersome. We created a custom dataset of high-resolution images; categorized according to scenery, background and artistic theme since the colors involved in such images are generic and are not complex.

2.RELATEDWORK:

Richard Zhang [1] In this paper he introduced an optimized solution by taking a huge data-set and single feed-forward pass in CNN. They used a custom multinomial cross entropy loss with class rebalancing and by using humans as subjects they were able to fool 32% of them by their results. They used prior color distribution obtained from the training set to predict a distribution for each output pixel.

David Futschik [2] In this paper he made use of several variants of CNNs and compared their performance on the data, using two different NN architectures; one traditional, plain CNN, and other being inspired by residual CNNs, which had not been used for colorization previously. Despite the smaller fewer parameters, this model was able to generate results that surpass plain CNN in generalization to unseen/test data.

In [3], automatic image colorization with two different CNN models is proposed. They train a classification and regression model on CIFAR-10 dataset using Lab color-space. They train the classification model from scratch and also by transfer learning from a pretrained VGG16 network. They also use the Annealed-mean technique with the model to map prediction distribution to single output prediction and show that it can produce vibrant and spatially more consistent results.

Larsson et al. [4] In this paper They train their model on ImageNet dataset to predict per-pixel color histograms and made use of convolutional layers from VGG16 network layer to predict pixels' values, which are pre trained on the image classification task and fine-tuned for colorization.
Image Colorization technique turned into supposed to put off the attempt giving the inputs to the version. In this System, the coloring version turned into primarily based totally on neural networks which have been skilled on a training set of images. This automatic the coloring manner and 30% of the outputs gave great results. Also, the neural networks-primarily based totally version required as much less as 20pixel as a way to color pixel.

The set of rules provides color to every Image through thinking about the location of color markers. It first segments the picture after which colorizes it. They additionally try and colorize videos, through a few frames, colorizing them, then moving the color to different frames. Key frames are decided on nearby minima of block motion. Segmentation is executed the usage of rain water simulation approach of watershed segmentation

3.METHODOLOGY:

3.1.BRIEF APPROACH

Our goal is to take an input grayscale image, a single channel of image data, and transform it into a standard RGB image, an image with three channels of data. The CIE Lab colorspace is used to represent the input and output images of the model, since it separates the lightness(intensity) and color components of an image.

We train CNN models to map the input grayscale image to colorized Lab space image, which is then converted to RGB image. Specifically, given an input L channel(grayscale) image $X \in RH\times W\times 1$, the objective is to learn a mapping $\hat{Y} = F(X)$ to the two associated color channels (a, b channels) $Y \in RH\times W\times 2$, where H, Ware image dimensions. The predicted color channels a and b are then combined with the input L channel image to give the predicted colorized Lab space image. We use the Euclidean loss L2 function, also known as mean squared error loss, between predicted and ground truth Lab images as the objective function. The architecture of the CNN models used is described in section 3.2.

3.2 Architecture

3.2.1 Baseline CNN Model:

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d_217 (Conv2D)	(None, 256, 256, 32)	320
conv2d_218 (Conv2D)	(None, 128, 128, 32)	9248
conv2d_219 (Conv2D)	(None, 128, 128, 64)	18496
conv2d_220 (Conv2D)	(None, 64, 64, 64)	36928
conv2d_221 (Conv2D)	(None, 64, 64, 128)	73856
up_sampling2d_3 (UpSampling2	(None, 128, 128, 128)	0
conv2d_222 (Conv2D)	(None, 128, 128, 64)	73792
up_sampling2d_4 (UpSampling2	(None, 256, 256, 64)	0
conv2d_223 (Conv2D)	(None, 256, 256, 32)	18464
conv2d_224 (Conv2D)	(None, 256, 256, 2)	578

Total params: 231,682
Trainable params: 231,682
Non-trainable params: 0

Fig 1: Custom CNN Architecture

3.2.2 Inception-resnetv2 based CNN:

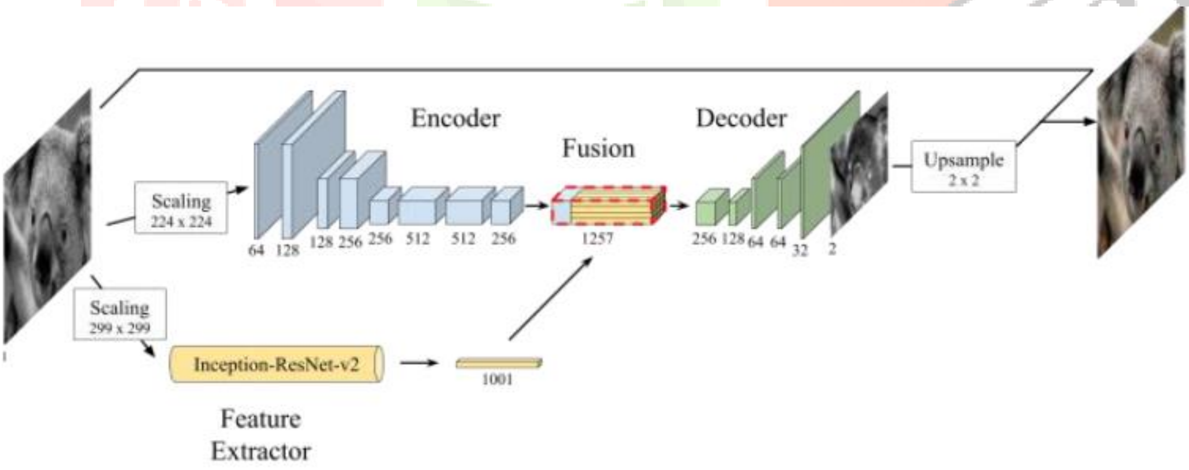


Fig 2: Inception-resnetv2 based Architecture from

We implement this model exactly as defined in the original paper [3].

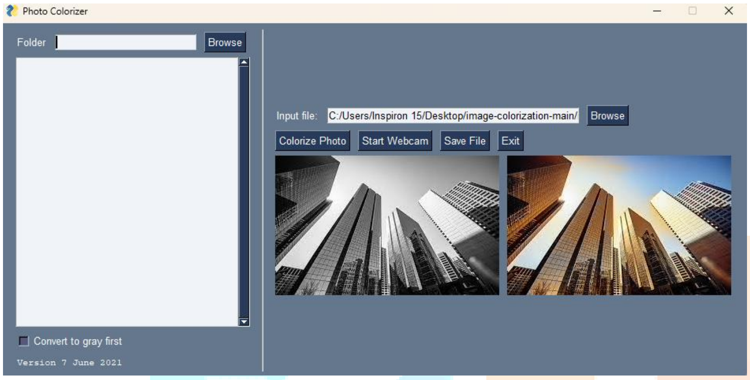
The **Encoder** processes H x W grayscale images, learns features using convolutional layers while down sampling and outputs a H/8 x W/8 x 512 feature representation. This part is exactly like our previous CNN model.

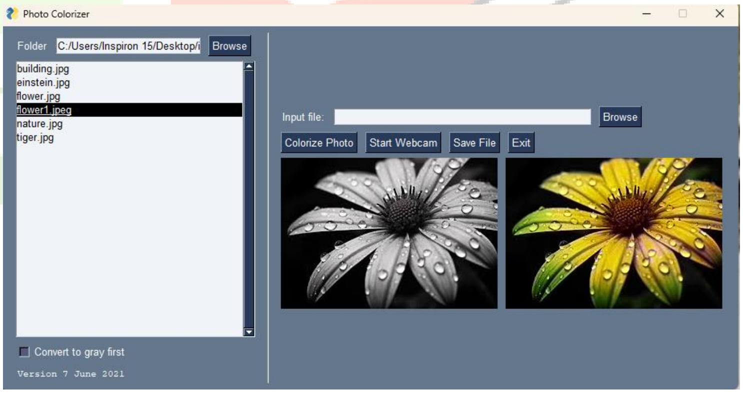
The **Inception-Resnetv2** model is a pre-trained model trained on the large ImageNet dataset. It is used here as a high-level feature extractor. We feed the input grayscale image and extract the output of the last layer before the soft-max function which results in a 1001x1x1 embedding.

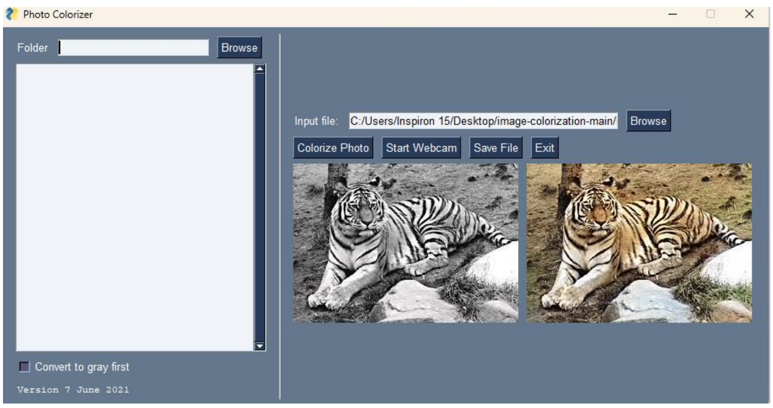
The **fusion** layer this embedding, replicates it H/8 x W/8 times and combines it with the feature representation obtained from the encoder. Then we apply 256 convolutional kernels of size 1x1, ultimately generating a feature volume of dimension H/8 x W/8 x 256.
Finally,

the **decoder** takes this H/8 x W/8 x 256 volume and applies a series of convolutional and up-sampling layers in order to obtain a final layer with dimension HxWx2. Up-sampling is performed using the basic nearest approach so that the output's height and width are twice that of input. To map the output values between -1 and 1, we use the *tanh* activation function and the ground truth values lie in range -128 to 127 which are also normalized to -1 to 1. The loss function used here is also Mean squared error (MSE) loss.

4. RESULTS







5. FUTURE WORK

Our future work will encompass the colorization of historic motion pictures. This approach will reason the vintage documentaries appearnce visually attractive. Altogether, a few human intervention is needed in photo colorization approach however nevertheless it has a awesome future potential.

CONCLUSION:

In conclusion, the end over to colorize black and white images using deep learning with OpenCV represents a captivating intersection of technology and art. Through the exploration of advanced neural network architectures and the seamless integration with the versatile OpenCV framework, this research seeks to unlock the latent potential of historical and monochromatic images, bridging the gap between the past and the present. The comprehensive pipeline, from dataset curation to model training and integration with OpenCV, underscores the intricate dance between data and algorithms. The success of the colorization process hinges on the diversity and quality of the dataset, the thoughtful design of the neural network architecture, and the continual refinement through training and evaluation.

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