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Deep Convolutional Neural Network for Natural Image Matting using Initial Alpha Mattes

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Abstract – *One of the major challenges in image processing is the classification of images. Several algorithms such as Closed Form matting, KNN matting, Fuzzy C-means algorithm, Maximum likelihood algorithm had been proposed in the past to resolve this problem in image processing. In this paper, we propose Deep Convolutional Neural Network (Deep CNN) to solve the problem in Image matting. In this design, we analyze the classification of images through Convolutional Neural Network. We considered two complementary forms of image matting principles such as Closed Form matting and KNN matting. These two methods can take different local image structures as inputs. We train the network through standard image dataset. To achieve higher accuracy, we combine the results of KNN and Closed Form matting. The results prove that foreground extraction in image matting is much more accurate than the existing methodologies.*

Key Words: **Image matting, KNN matting, Deep CNN matting, JPEG artifacts, CNN matting.**

1. INTRODUCTION

Any input image contains foreground, background and unknown pixels. These pixels were mixed around boundaries. Image matting calculates the transparency of the foreground from an image dataset. This dataset will contain trimap of foreground part, background part and unknown part. The alpha values for all these parts has to be calculated to classify the images. Several methods in the past was proposed for the classification of images. Closed Form matting is a local principle based method, which assumes local color distribution model. For this assumption, Laplacian coordinates had been taken to solve image matting in closed form. The alpha mattes of foreground regions were estimated through Laplacian. This methodology violated the principles of image matting and therefore achieved unsatisfactory results. K-Nearest Neighbor approach (KNN) is a non-local principle, was also proposed to classify the images through searching non local neighbors and color samples. In general, local methods had proved a better accuracy than the non-local methods. Because, non-local methods work on several assumptions such as non-local image matting Laplacian form and image features such as structure of an image and similarity present in the texture of an image. Non local methods works better in long hair structures whereas alpha mattes from local methods works better in any image.

Image classification is the process of categorizing images to one of the many predefined set of classes. This categorization could be easier for humans but is difficult for a machine. To solve this problem, machine learning algorithms had been proposed. Deep learning algorithm is one form of a machine learning algorithm, a neural network in which every layer is responsible in the extraction of one or more features in an image. To achieve higher accuracy in image classification, we therefore choose Convolutional Neural Networks.

2. RELATED WORKS

Though there are several approaches in image matting principles, propagation based image matting by Levin et.al [1]; Chen et al., [2] Zheng and Kambhamettu, [3] dragged attention because of its higher efficiency in achieving the results. Similar techniques to propagation based image matting use the similarities in the pixels to propagate the values of alpha mattes. These alpha mattes are grabbed from the regions which are drawn manually but the alpha values were only known to the unknown regions. This methodology easily measured the similarity in the pixels from a complex image structure. It resulted in a smooth matte by solving the matte in closed form. Since the existing methods related to propagation based image matting concentrated only on the pairwise similarity in low levels or some other visual features which are hand designed, Levin et al [4] concentrated on visual features. Since image matting requires pairwise similarity in semantic level, Liu et al [5], adopted semantic level techniques. This technique was adopted by Cho et al. [6] in deep learning techniques. They used a trimap with image to learn an alpha matte.

Tianmei Guo et.al.[7] concentrated on CNN and belief networks in deep learning. For image classification, CNN proved improved performance. He conducted experiments using MINIST and CIFAR-10 datasets through neural network. Image classification is done through CNN by learning and through various optimization algorithms.

Xu et.al.[8] adopted Convolutional neural networks for deconvolution. Burger et al. [9] did mapping for clear and noisy image patches through neural networks. Cengil et.al [10] tried various image classification algorithms since CNN haven't invented then. Travis Williams et.al.[11] proved that CNN overwhelmed other forms of deep neural networks in image classification. He underwent a study for the

classification of handwritten digits through CNN. He achieved satisfactory results after the application of raw pixels of images by CNN. But, the overall efficiency of the algorithm reduced in the spatial domain. The algorithm worked well while the images were converted to wavelet domain.

Sayali Jog et.al [12] determined remote sensing using as a technique to identify and evaluate the features through electromagnetic energy derived from heat, light and radio waves. Image classification can be defined as deriving spatial variation of a one or a small number of images from a remotely sensed image. Remotely sensed image refers to a satellite image and the accuracy of image classification depend on the quality of the satellite image. The steps involved in image classification are preprocessing an image, feature selection and calculating the accuracy of image classification. Several classifiers such as SVM, Maximum likelihood, minimum distance and parallel piped were considered. The accuracy and performance of the above said classifiers is determined through Kappa coefficient.

Xin Shang et. al [13] used CNN methodology to classify spam images. He used CNN network to identify abnormal contents in the mail. He used Support Vector machine(SVM) in learning the inputs. The CNN model comprised of five convolutional layers and also 3 completely connected layers with few neurons. The output of the last layer in the three completely connected layer is further connected to the layer of SVM to classify images through Deep CNN training. The weights of the end layer learning are done by back propagation from the first layer of SVM. This methodology proved to gain good performance in the classification of spam images.

Qing Li et.al [14] adopted medical image application field and he used classification of patch images. He took different images of lung disease patterns and applied those images to a CNN network for image classification. But, accuracy in the results were challenging because of the large number of visual variation in the images of the same class. Therefore, an automatic neural network became essential to identify the images of the same class and also to do image classification by training samples at the same time. He applied drop out algorithm to improve the accuracy and performance of the system.

3. PROPOSED SYSTEM

In our proposed system, we used deep CNN method for natural image matting. This method uses one or more initial alpha mattes from the existing techniques. Deep learning is applied to the input RGB color images and reconstructed alpha mattes. We had taken the existing methods as initial alpha mattes such as Closed form matting and KNN matting i.e., we compute alpha values derived after the image classification to deep CNN architecture. The two previously used methods were in contrast to one another where closed form matting is a local image matting concept whereas KNN matting is a nonlocal image matting concept. We had taken dissimilar image structures and used in both of these existing methods and achieved satisfactory quality alpha mattes than the applied inputs. The alpha mattes from the two existing methods were further applies to deep CNN architecture for image classification. Though several algorithms were available for network training, we had used the standard methodology. CNN matting proved to achieve higher performance and accuracy than the previously used methods in image classification. We construct a convolutional neural network with six layers to find and classify the images to one of the already defined classes. Therefore, we achieved an improved performance by combining the inputs from closed form matting and KNN matting. In contrast to the fully connected layers in the previous methods, we have used convolutional layers through which there is no limitation in the size to process the data. We also achieved higher quality alpha mattes from the two inputs of the previous methods: Closed form matting and KNN matting.

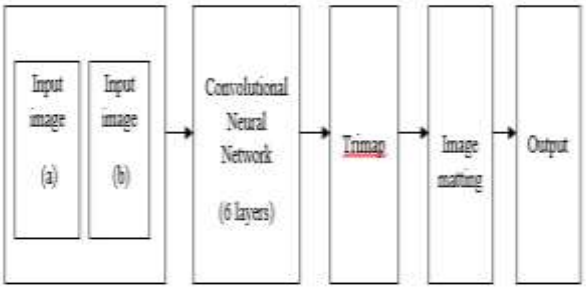

Fig-1: Pipeline of our proposed system

The pipeline of the proposed Deep CNN methodology is shown in the figure 1. The input images are labelled using Convolutional neural network with trimap. The processed image is further image matted and the output of the extracted foreground is displayed. We take input as some image I and the result of the image is an alpha matte. We construct a CNN network with trimap labelling and modules needed for image matting technique.

Every trimap consists of three classes: foreground, background and unknown pixels. Labelling of trimap is done to identify the probability that the pixel presents in the image belong to any one of the three classes mentioned. The input image is processed and namely three channels are formed. Every channel consists of the scores of pixels. Depending on the highest score probability, the pixels can be grouped to one particular class. As per the scores in three channels, the probability of foreground and background pixels' identification is done. Similarly, we calculate the

values of alpha mattes through propagation. Loss function is computed to calculate the error between the identified alpha matte and ground truth. Loss function is needed because only 5% pixels present in the image consists of alpha values non zero or 1. The proposed CNN network learns the predicted alpha matte from the input image. Before the process of image matting, we compute tramp channel. Instead of directly learning the tramp, this method produces better accuracy and performance. This computation is done through the process called back propagation. During training, the ground truth of the trimap is resulted as per the predicted alpha mate in which we fix the values of the pixels between 0 and 1.

4. RESULT AND DISCUSSION

We have proposed CNN network for image matting using Matlab. Matlab is an environment for numerical computing and is the programming language developed by Math Works Laboratory. Matrix computations, several algorithms development, plots of various functions and data, user interfaces creation, and several other programs from various programming languages. Matlab is used for machine learning algorithms because of its user friendly syntax. Even complex machine learning techniques can be easily implemented through Matlab. Initially, we generate automatic trimap through image segmentation technique through graph cuts. Identification of sensitive regions is computed through feature points. Around these feature points, we collect color samples and they are set as foreground. We randomly sample the background regions.

Fig-2: Results of the proposed system

Then, we evaluate the trimap through image segmentation and through which we predict an alpha matte for closed form matting. Similarly through clustering technique, we perform KNN matting to predict an alpha matte. Clustering is a technique to group similar data. This technique is employed in KNN matting to identify the nearest neighbors. According to the pixel values, the values are grouped in three channels: foreground, background and unknown. As per the probability of scores in these three channels, foreground pixels are identified and an alpha matte is produced. Since this method used learning through tramp, we achieved satisfactory results. The proposed technique identifies foreground, background and unknown regions from a given image through trimap labelling and also adjusts the trimap through the image matting layer.

5. CONCLUSION

We proposed an image matting process through Deep CNN methodology. Convolutional neural network by deep learning extracts the foreground through trimap labelling. This method is based on creating an end to end Convolutional neural network with trimap labelling, shape masking and designing layer by matting. We used standard datasets with high quality alpha mattes to build a Convolutional neural network to train and test the system. Our proposed method achieved good performance and better quality without any user interaction. The foreground extraction results were compared to the existing methodologies and proved to be better than the existing methods. Various images are taken as inputs for processing and almost all images achieved better results in foreground extraction.

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