

A Proposed Grayscale Face Image Colorization System using Particle Swarm Optimization

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ABSTRACT

The proposed work is a novel grayscale face image colorization approach using a reference color face image. It takes a reference color image which presumably contains semantically similar color information for the query grayscale image and colorizes the grayscale face image with the help of the reference image. In this novel patch based colorization, the system searches a suitable patch on reference color image for each patch of grayscale image to colorize. Exhaustive patch search in reference color image takes much time resulting slow colorization process applicable for real time applications. So PSO is used to reduce the patch searching time for faster colorization process applicable in real time applications. The proposed method is successfully applied on 150 male and female face images of FRAV2D database. "Colorization Turing test" was conducted asking human subject to choose the image(close to the original color image) between colorized image using proposed algorithm and recent methods and in most of the cases colorized images using the proposed method got selected.

KEYWORDS

Colorization, Exhaustive Method, Particle Swarm Optimization, Patch Matching

INTRODUCTION

Color information is a key attribute of an image which finds extensive uses in various important fields like medical image processing, facial image processing, satellite image processing, video processing etc. (Umbaugh, 1998, Gonzalez, 2001, Gonzalez, 2010). Colorization is process to convert a grayscale image into a color one and it is a long sought after goal in field of image processing (Zhang, 2016). Colorization has a wide application in the area of archaeology, medical application, entertainment, law enforcement etc. In archaeology, the gray scale archive documents can be preserved by enhancing it into a colorized one. In entertainment, manual colorization of old movies and video clips (grayscale model) is normally a laborious process (Zhang, 2016). Moreover, a color face contains information like complexion, hair color, eye ball color etc. which are required for searching a face image from color face database and hence colorization of grayscale face image is important. As the gray scale face images do not contain any color information, no color based face image processing algorithms (Hadid, 2002, Bhattacharjee, 2009, Chai, 1999) can be applied on them. Our goal is not to recover

the actual ground truth color but to convert the grayscale image into a visually compelling color image so that it looks natural.

A few research work found on colorization of grayscale image in the literature. For example, Haldankar et al. proposed a system in 1989 which modifies a gray scale image into a color one by the luminance effect of the source image. But the time needed for colorization is huge for a large size image and hence the method is less effective in real time system. In 2001, for a general color correction, Reinhard et al. proposed a method that takes one image's color characteristics from another using statistical analysis to make a synthetic image that takes on another image's look. But this one is not actually a method of grayscale image colorization. A semi-automatic neighborhood statistics based colorization approach was proposed by Welsh, et al. in 2002 which retains the original luminance channel and transfers only chrominance values for a pixel of query gray image from reference image. A fast anti-pole tree clustering method was given by Di Blasi et al. in 2003. In 2005, Levin et al. presented a method based on the neighboring pixels in space-time that have similar intensities and colors. This method is formalized by using a quadratic cost function and is generalized into an optimization problem which could be solved using a standard optimization technique. In 2006, Yatziv et al. proposed a method where a graph is formed by considering each pixel as node and intrinsic distance is used to measure the similarity of colors. Here, user colorizes some regions of the grayscale image which are used as sample color. Kang et al, 2007 proposed a different variational model using chromaticity color components which colorizes the gray scale image by minimizing the total variation. But here also, the sample color samples are taken from the user. In 2010, Sathik et al. (2010) proposed a method to convert a gray scale X-ray image into a RGB space to diagnose the fracture properly which works for only certain types of images. In 2014, Bugeau et al. designed an energy based methodology whose minimizers may select the best color for each pixel from a set of candidates automatically. In their methodology, several suitable color values are computed using different features and associated metrics and then finally best color is chosen by solving a variational model which allows the automatic selection. Bugeau et al. 2014 concluded that their method produces unsatisfactory result for face image colorization. Recently in 2016, Zhang et al. proposed a generalized Convolution Neural Network based grayscale image colorization system. In their model, initially the model is trained using huge number of images. Once the model is trained, it may be applied to colorize any image.

Problems with these existing methodologies are quite a few. Firstly, lots of user interaction is needed in the colorization process, secondly required time for colorization is reasonably high and thirdly spatial incoherency during the color transfer can lead to possible inconsistent colorization in the final colorized image. In this work, a new concept called FAcE COLORization SYStem (FACOSYS), is proposed to overcome the difficulties of the existing methodologies for colorization of a gray scale face image. The proposed methodology aims to convert a gray scale face image into color one using a reference image in a fast and simple method. The proposed method works on patch based colorization to preserve spatial coherency. Besides these, this method is fully automatic- user's interaction during the colorization process is not required.

The face colorization method works in two steps: (1) Colorization phase to colorize the query gray image using patch matching technique. (2) Tuning phase to remove the noise generated by some erroneous patch selection so that the colorized image looks natural.

Evaluation of the quality of the synthesized images is notoriously difficult (Zhang, 2016). For performance evaluation, initially color images were converted into a grayscale images and then those images were colorized. The proposed method is successfully applied on 150 male and female face images of FRAV2D (2004) database. Experimental results show the effectiveness of the proposed system. Also evaluation of the proposed method is done using "colorization Turing test" (Zhang,

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