Aesthetic Communities Detection Using Latent Semantic Analysis For Image Enhancement

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Abstract — *The use of image enhancement application has increased considerably in recent years due to their greater availability and ability to increase an image quality. Image enhancement is important and challenging task in many real time applications like vision impairment in medical area, finding 3D position from an image etc. Image enhancement provides better result in by transforming representation for future automated image processing. Image enhancement is the process of increasing the aesthetic appeal of an image, such as changing image aspect ratio and spatial recomposition. In this paper, aesthetic community detection and image enhancement is proposed. In particular, latent semantic analysis is used to detect aesthetic community and then probabilistic model is developed to maximally transfer the visual features of images from multiple aesthetic communities into a target photo is performed. Thus, the implementation of image enhancement using similar topics extracted with the help of tags provides a more efficient way of enhancing image in image processing. Experiments are conducted on different images and downloaded from the Internet. The promising results indicate the effectiveness of proposed framework.*

Keywords - Aesthetic community, community detection, Hue, Image Enhancement, Image processing, LSA, Topic Model, parameter calculation

I. INTRODUCTION

Image processing is processing of images using mathematical operations by using any form of signal processing for which the input is an image, a series of images, or a video such as a photograph or video frame; the output of images processing may be either an image or parameters related to the image. Image enhancement has become an essential technique in various image applications. It is widely used in printing industry, cinematography, graphic design, medical forensic purpose, image analysis from satellite, atmospheric sciences, oceanography etc. Image enhancement is the process of increasing the aesthetic visual appearance of an image such as resolution change, spatial recomposition, image aspect ratio etc [1].

Image enhancement techniques mainly improve the quality of images for human viewing, remove blurring and noise, increase contrast and reveal details known as enhancement operations. It is required to enhance the images values hence certain Image enhancement techniques have been in use. The existing techniques of image enhancement can be categorized into Spatial domain and Frequency domain enhancement. Spatial domain techniques are those techniques which directly deal with image pixels. The pixels values are operated upon and manipulated to achieve the desired enhancement. Frequency domain techniques are based on the manipulation of the orthogonal transform of the image rather than the image itself. The principle behind frequency domain methods of image enhancement consists of computing 2-D discrete unitary transform of the image.

Digital photography provides the way through which anyone can take image from camera whether it is available on mobile phone or DSLR camera itself. Nowadays mobile phones are available in cheapest rate and having internet facility. This helps to share the images on social media like Instagram, Facebook etc. as day by day popularity of image sharing sites are increasing. Large amount of images are being captured and shared on social media, due to growing interest in aesthetics quality improvement. The aspect of photography that contributes to high quality images is image composition through its aesthetics features. Image enhancement provides unified way to design aesthetically pleasing images like wallpaper [2]. Due to growing interest in aesthetics quality improvement, image enhancement received considerable research interest in the recent years. Most of the researchers have proposed numerous image enhancement techniques that utilizes, colorization to feature in the resulting images. Knowledge of image enhancement can provide users the interest for further image quality improvement. The goal of the image enhancement is to improve the understandability or approach of information in images for observers and to provide better input for other automated image processing techniques.

Many image enhancement algorithms have been proposed in the literature which gives promising results. However, conventional approaches are still faces many problems like an ideal image enhancement framework can be build by professional photographers with their experiences but it will be difficult for the photographers to give each aesthetic topic and add their experiences into image enhancement system. Describing the aesthetic interest of photographers is difficult task as most of the photographers upload thousands of the images from image hosting site like Flicker while some peoples upload very few images, it will cause the over fitting problem. Image tags reflect human visual perception at high

level but along with image appearances to model the aesthetic interest is challenging as many image tags are noisy or missing. As image enhancements includes a series of operations like retargeting, recompositions, colorization but few operations can guarantee that the aesthetic cues are optimally preserved. Many image enhancement algorithms rely on human computer interaction to achieve good results. This requirement might be impractical for large scale image processing. To solve the above problems, a unified framework is proposed to enhance the image by detecting aesthetic communities using topic model. For making framework various image enhancement tasks are combined using a probabilistic model. For regularized topic model firstly have to extract the tags associated with images. Most of the images uploaded on image hosting site like Flickr have tags associated with it. Tags are the extra information with images. Aesthetic community defines the users of having similar aesthetic topics which are densely connected. The image enhancement framework defines the socially aware model that gives more image attractiveness which can be increased due to detecting aesthetic communities. A classic topic model with aesthetic topics of Flickr users describes the latent topics. The unified image enhancement framework describes the visual features which help in enhancing the given image [2].

II. RELATED WORK

The literature survey basically focuses on different approaches and algorithms used for aesthetic community detection and image enhancement for different images. Enhanced images increase the visual appeal. Unified image enhancement framework which can be used to detect the aesthetic topic and forming the different communities using similarity measure between them. The related work is partitioned into two classes such as image aesthetic models and detecting aesthetic community are as follows:

A. Image Aesthetic Models

There are various conventional aesthetic models are present and also researched. Some of them are included in literature. Aesthetic image defines artistic, creative image including its beauty. The aesthetic specifies the critical reflection on art, culture and nature. Aesthetic also refers to a set of principles underlying the works of a particular art movement or theory.

Image aesthetic model gives the visual features extracting from the image. Different aesthetic features and factors which can be extracted from aesthetic image gives the entire story. The aesthetic quality classification of photographs helps peoples to organize large photo collections [3]. A significant correlation between various properties of photographic images and their aesthetics ratings are important. Using a community based database and ratings that gives visual properties for aesthetic quality and the global image features proposed 58 low level visual features to capture photo aesthetics [4]. In [5] author extracted three types of visual features which includes global image features, salient regions features and features that depict the subject background relationship [5]. Attention of the user is very important to attract the users which are the main base in [6]. The image content gives the details about local and global features. In [7] content based photo quality assessment is explained which mainly focuses on subject area detection with new global and regional features.

Multimedia application [8] which most of the time users use for assessing the aesthetic quality of a photographers using geometric rule of composition. The spatial structure i.e. local and global between image region from multiple channels are used to assess image aesthetics [9]. Semantic relations are considered for optimization between foreground objects [10] which is the image enhancement method for optimizing image composition. In human scenery aesthetic composition [11] author which mainly implements the system on an android platform and produces souvenir images as a result. Aesthetic classifier [12] trained on compositional, content and sky illumination attributes which provides good results for human quality judgments for images. The aesthetic driven image recomposition techniques survey [13] explains the number of image recomposition problem, objectives, complete analysis of effectiveness of each technique for obtaining the recomposition objectives. Semantically rich photos can be retargeted [14] by finding image meaning by its tags, which by a multilable SVM. Latent stability discovery (LSD) is a key technique used as a generative model.

B. Detecting Aesthetic Community

The main goal of community detection is to identify the structure of community in network. Community can be defining as a group that has particular characteristics in common. It indicates the situation of sharing or having certain attitudes and interests in common. A community also defines clusters of densely connected vertices that are loosely connected to other vertices. In [15] author described two community detection schemes, modularity optimization and Potts model clustering, on a set of benchmark graphs. A new class of graphs for testing algorithms which is used to identify communities [15] by testing modularity optimization and a clustering technique based on Potts model. Image annotation approach [16] explained labels latent semantic community with multikernel learning.

Constructing a labels concept graph indicates the concepts relationship. Semantic communities are discovered using an automatic community detection method. The generative probabilistic modeling [17] is used to detect community in which every community is a combination of semantic topics. Author explains entropy filtering Gibbs sampling [17]. In [18] author systematically evaluated a set of community detection methods and observed that the structures of the discovered communities are complex. Clustering algorithms can identify communities based on node features or graph structures. In [19], author proposed a socially-aware model to estimate multiple peoples occupations. Dense local patches scheme is applied to detect human body parts, thereby visual attributes are learned through assembling discriminative filters to bridge the semantic gap. Finally, social context is added in order to formulate a score maximum model for occupation estimation.

III. PROPOSED SYSTEM

In this section, the aesthetic community detection and enhancement is represented in the form of work flow structure illustrated in Figure 1. The proposed system comprises data acquisition, preprocessing, feature extraction, detecting aesthetic communities, image enhancement through retargeting and recomposition and finally parameter calculation of the proposed system.
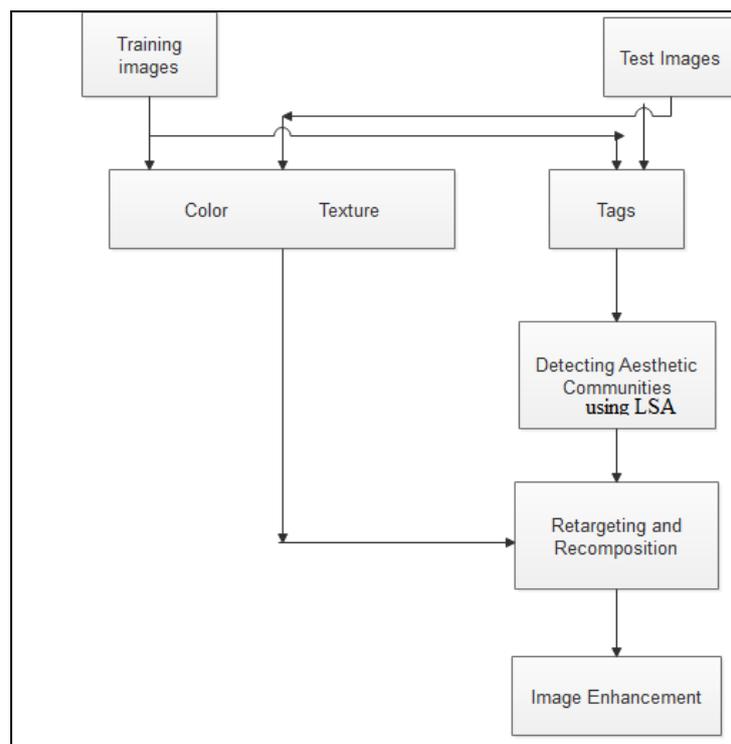

*Figure.1. System Architecture of proposed system*

The proposed system is used to enhance the image by using tags of the images with high accuracy. For enhancing the image features associated with it are gathered. Aesthetic communities are formed whos having the similar topics of each image users. On the basis of it, different densely connected aesthetic communities are formed. Finally the maximum features are transferred by using probability model.

Figure 1 shows the architecture of the proposed system which comprises taking input image from dataset. System architecture shows fully automatic framework which is proposed to enhance and increase the image visual appearance by discovering communities consists of aesthetics by using a latent semantic analysis topic model. Probabilistic model combines different image enhancement techniques. Firstly, extract a set of visual features for expressing each image from multiple channels. A tag wise regularizer latent semantic analysis (LSA), a topic model is used which is learned from image appearance features and the aesthetic topic of each image user is shown by latent aesthetic topics. Cosine Similarity represent the similarity of aesthetic topics among users. These users having similar aesthetic topics which are closely related. These are used to form the aesthetic communities. Finally in the probabilistic model, the extracted visual features i.e. color and texture are transfer to the test image and various image enhancement operations mainly retargeting and recomposition is used to enhance the image. This socially aware model helps to grow the image attractiveness. This can be achieved by discovering aesthetic communities from images by discovering topic model. The visual features or appearance is used to make the image enhancement framework.

In preprocessing, the original image is taken from the dataset then color and texture are used to obtained image aesthetic features which gives the hue, saturation, value. The details are as follows:

i) Color Channel

An image has multiple channel out of which colors are the important channel of the image. Harmonic template is used to show the image. It is the property that contain aethetically pleasing color according to human viewpoint. These colors are represented by hue wheels are as follows:
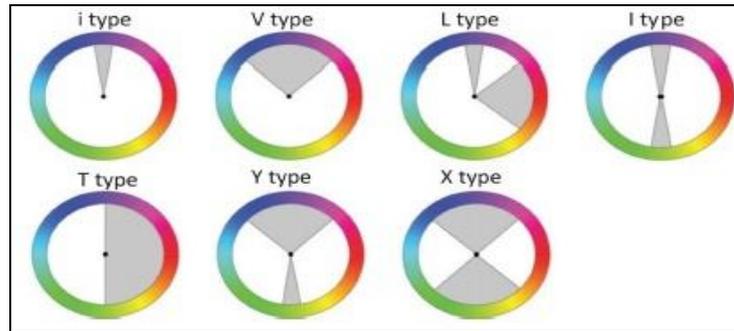
Figur2 . Seven hue wheels in harmonic template [2].

Hue wheels give either single sector or double sector and it indicates the gray color in which colors are fallen are fixed. For finding color harmony of each image, firstly see whether it will comes under single sector T_1 or double sector T_2.

$$\arg\min_{T_k} \sum_{i \in I} D(H(i), T_k).S(i) + \alpha A(T_k)$$

…… (1)

Where H(i) and S(i) denote the hue and saturation of the ith pixel in photo I respectively, D(H(i), T_k) is the arc length of H(i) to the closet sector border and if H(i) falls into the sector of the template, then D(H(i), T_k) = 0. Large arc-length sectors are mostly fitted by an image, therefore setup a regularized term where A(T_k) is the arc-length (single-sector) or accumulated arc-length (double-sector) of each harmonic template and α is a free parameter. It is checked whether image I can be fitted by a single sector or double-sector harmonic template, characterize the color distribution of an image by a four-dimensional feature vector:

$$x_c = \begin{cases} (\alpha_1, S_1, 0, 0) & if\ I\ in\ T_1 \\ (\alpha_1, S_1, \alpha_2, S_2) & if\ I\ in\ T_2 \end{cases}$$

…........... (2)

Where α_1 and α_2 are denote the center angles of the sectors. S_1 and S_2 are the average saturation of harmonic colors, i.e., the colors inside the gray areas of a hue wheel. Adopt color saturations here because the low and highly saturated harmonic colors are distinguishable based on human perception.

ii) Texture Channel

For finding the textural property of an image the prominent lines are used. The location and gradients of prominent lines are utilized for this channel. It is extracted by Hough transform and then differentiates into horizontal and vertical lines according to slope. A horizontal prominent line having slope between -1 and +1 and vertical if its slope is larger than +1 or smaller than -1. The average orientations of horizontal and vertical lines are denoted $\overline{O_h}$ and $\overline{O_v}$, the average vertical position of horizontal as $\overline{P_h^V}$ and the average horizontal position of vertical lines as $\overline{P_v^h}$, a four-dimensional feature vector:

$$x_t = \left(\overline{O_h}, \overline{O_v}, \overline{P_h^V}, \overline{P_v^h} \right)$$

………….. (3)

Represent the appearance of each image by a 8-dimensional feature vector   x = [x_c, x_t].

iii) Tag Channel

Tags reflect the information about image. It explains the semantic of an image associated with it. Like color and texture, the tags assist to learn the latent aesthetic topics from images. Creating bag of words extract the most frequent tags from the training set.

In feature extraction, after detecting color and texture features, hough line transform is used to show prominent line indicated in hough line image. The main step is discovery of aesthetic communities using LSA (Latent Semantic Analysis) is a topic extraction model likewise LDA which is used to extract the topic from corpus of users. The similar aesthetic values share similar latent aesthetic topics. A similarity measure by using cosine similarity is used to describe aesthetic similarity between users. These similar aesthetic topics of users belong to the same community so forming the aesthetic communities. The last step is image enhancement: Image Enhancement can be represented as transferring maximum aesthetic features from training images to target images from various aesthetic communities. Firstly retargeting is used in which a greedy scheme is utilized in which image is divided evenly into a number of grids then sequentially shrink either each row or column. After retargeting, recomposition is used in which the objectness measure determines different object regions in an image and moves it one by one to an optimal position in the target image.

IV.   ALGORITHM

The proposed system implements following algorithm:

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Algorithm: Image enhancement using aesthetic communities using LSA.

- **Input : Image**
- **Output: Enhanced image**
- **Begin**
  - **Step 1: Load the images from the dataset**
  - **Step 2: Preprocessing of the image**
  - **Step 3: Feature Extraction**
  - **Step 4: Aesthetic community detection using LSA**
  - **Step 5: Image enhancement**
- **End**

The graph shifting algorithm is iteratively used to get the aesthetic community where for each community 5-component Gaussian Mixture Model (GMM) is utilized in image such as:

$$p(x|\theta) = \sum_{i=1}^{5} \eta_i N(x|\varphi_i \Sigma_i)$$ .... (4)

 where x is the 8-dimension color and texture feature vector of an image, $\{ \eta, \varphi, \sum \}$ are the GMM parameters. Every aesthetic community contains image users with a specific aesthetic topic. The probabilistic model combines connection between training image with test image. The five layers are represented. The first layer shows the training images I^1………. I^L, the second layer shows the visual features X from the training images, the third layer is the detected aesthetic communities C, the fourth layer represents the visual feature x* from a test photo, and the last layer denotes a test photo I*.

Image enhancement can be represented as maximally transferring aesthetic features from the training images into a test photo, based on the perception of image users from different aesthetic communities. This process can be formulated as:
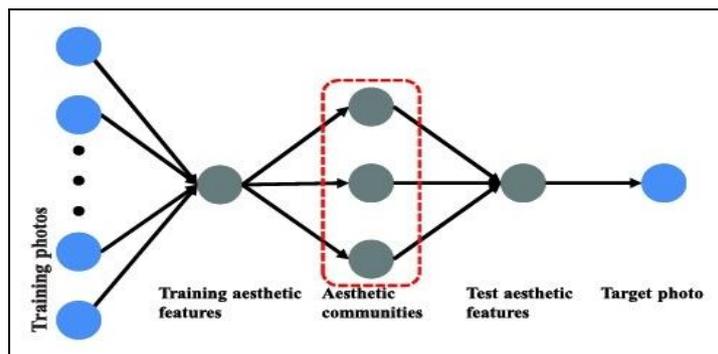

Figure 3. Probabilistic model for image enhancement [2]

$$\max_{I^*} p(I^*|I^1, \ldots \ldots I^L) = \max_{I^*} p(I^*|x^*) \cdot p(x^*|C) \cdot p(C|X) \cdot p(X|I^1, \ldots \ldots I^L) \qquad \ldots\ldots\ldots \textbf{(5)}$$

Where probabilities $p(I^*/x^*)$, $p(C/X)$, $p(X/I^1,\ldots\ldots,I^L)$ are all equal to one. The probability $p(x^*/C)$ is calculated are as follows:

$$p(x^*|C) = \prod_{i=1}^{H} p(x^*|C_i) = \prod_{i=1}^{H} p(x^*|\theta_i) \qquad \ldots\ldots\ldots\ldots (6)$$

Where H is the number of detected aesthetic communities. C_i denotes the ith aesthetic community and Θ_i is the corresponding GMM parameters.

Equation 5 does not have an analytic solution as all the pixels within a image have to be optimized simultaneously. A gridy scheme is used to solve this problem. Divide a photo evenly into a number of grids for retargeting and then sequentially shrink each column (or row) until $p(X/I^1,\ldots\ldots,I^L)$ is maximized. For recomposition use the objectness measure to localize different object regions in a photo and index them based on the posterior probability $p(obj \mid region)$ then move each of these regions one-by-one to an optimal position in the test photo, aiming to maximize $p(X/I^1,\ldots\ldots,I^L)$. Finally, render the background area to make the resulting photo look natural.

V. RESULTS AND DISCUSSION

A. DataSet

The data set is generated by collecting different images from sites like Flickr, Instagram that are freely available online. Images are stored in different public groups like Fabric, Glass, Metal, Leather. Tag dataset is also created which explains the extra visual information of image. For more images datasets can be downloaded from this site : "http://press.liacs.nl/mirflickr/"

B. Results

The system has been implemented for detecting aesthetic communities and enhancing images to evaluate the proposed aesthetic community detection. The first experiment is to evaluate the technical components of the proposed detection approach such as GMM modeling and LSA. Compare their performances to aesthetic community detection in terms of average error rates BER. Table 1 shows groups which contains the aesthetically pleasing images. To calculate the adjustment between a predicted community and a ground truth group, Balanced Error Rate (BER) is calculated. Many times the similarity is unknown between detected aesthetic communities and the ground truth group so the optimal match is explained.

Table 1. Average BER scores of different communities

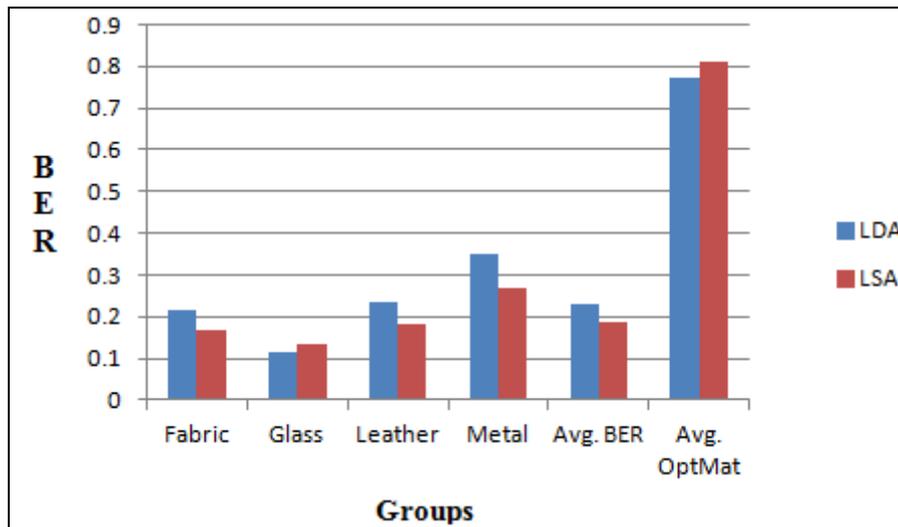| Groups	LDA (Existing System)	LSA (Proposed System)
Fabric	0.2167	0.1667
Glass	0.1167	0.1333
Leather	0.2333	0.1833
Metal	0.3500	0.2667
Average BER	**0.2297**	**0.1875**
Average Optimal Match	**0.7708**	**0.8125**

Figure 4: Comparison of the BER scores of the groups.

The Figure 4 shows the graph of BER score comparison of different groups for existing method (LDA) and proposed method (LSA), where x-axis shows different groups and y-axis shows BER scores. Using LSA will help to get more accurate correctly aesthetic community for transferring visual features from images for getting enhanced image. Also accuracy and performance will be parameters on which further results can be examined and improved.

VI. CONCLUSION AND FUTURE WORK

Aesthetic community detection and image enhancement of images is proposed. In this paper, latent semantic analysis is used for aesthetic community detection where as retargeting and recomposition is used for image enhancement. The objective is to effectively extract visual image features and using probabilistic model transfer maximum features from target to test image for better image enhancement. For many fields such as printing industry, cinematography, graphic design, social media etc. these system performance and accuracy plays an important role. From the point of view of practical application, it is necessary to consider the robustness of images based on LSA to scale of dataset. The problem with existing system is that it gives less accuracy and more time for the aesthetic community detection. So, the proposed system is more effective than existing system. Since, it helps improve. For the achieving accuracy, time and better performance, algorithm will be used. Also the performance of this approach will be compared with the performance of existing system. For Future work, we intend to extend framework to support more image enhancement operations like high dynamic range.

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