INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Survey: Deep Learning for Video Aesthetics

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Abstract: Aesthetics is defined by the properties of arts and beauty. In our day to day lives with the increase of multimedia requirements the aesthetic sense of images and videos has gained much importance. The earlier research was based on the Handcrafted features to assess the aesthetics of videos and images. In this paper, we review the deep learning techniques which effectively automate the video and image aesthetics analysis. Deep learning achieves an impressive performance in automated aesthetics analysis in comparison to Handcrafted features.
Keywords: Video aesthetics, Feature extraction, Deep learning.

I. INTRODUCTION

This paper is an effort to review the recent computational techniques for assessing images and videos with a special emphasis on videos. Section II explains the introduction to the generic concept of aesthetics in images and videos followed by the handcrafted assessment methods as described in section III. Section IV explores the literature on deep learning for images and video aesthetics. The field of image aesthetics using deep learning has been explored well by the research community in comparison to deep learning using video aesthetics that promises a lot of scope for future research. Section V mentions the gaps between the handcrafted feature techniques and deep learning methodologies followed by Section VI that presents a discussion on possibilities of exploring the usage of deep learning for video aesthetics. Section VII describes the application of video aesthetics in our daily lives.

II. INTRODUCTION TO AESTHETICS

Aesthetics is a study that relates to the relationship between the mind and emotions in assessing beauty[1]. The aim of aesthetics analysis is to define the science in assessing the aspects of arts and beauty sought in images and videos. In the earlier research, aesthetics was defined by Handcrafted and learned features[2].The aesthetic quality of images and videos are judged by their low, middle and high level properties. The low level properties of an image are that of color, texture, edges and intensity[3]. The middle level property is the object in the image or video. And the high level properties are the photographic rules, mainly comprising of the Rules Of Thirds (RoT), Visual Balance (VB), Diagonal Dominance (DD), Simplicity and the Depth of Field (DoF) [3]. Aesthetics assessment is a subjective field [4] because individual preferences differ according to personal taste too, thus what may be pleasing to one person may not be pleasing to the other. Therefore different communities define aesthetics differently, based on psychological and emotional aspects[1]. Let us now bifurcate into individual streams of image and video aesthetics.

A. Image Aesthetics

Image aesthetics pertains to the assessment and evaluation of aesthetics in images. In current times, due to increase in smart phones with the high-quality cameras, photography and creating videos is now possible at the click of one's hand contributing towards its popularity amongst the young and old alike. People are being more expressive in conveying their feelings through the medium of beautiful images. Quantification in assessing beauty of an image is a challenging task. Fig 1 depicts the low, and high lighting effect in an image. Needless to say, that the image which looks illuminated finds more appeal amongst its viewers than the dimly lit images. Fig 2 (a) and Fig 2(b) depicts the high and low color contrasts respectively. High color contrast images have a better appeal than a low color contrast images [5]. Texture also plays a major role in aesthetics with course textures as depicted in Fig 3(a) having less acceptance in comparison to smooth textures [2] depicted in Fig 3(b). Again, this aspect is very subjective depending upon the object under consideration. Fig 4(b) showcases sharp edge detection and Fig 4(c) showcases smooth edge detection, contributing towards a generic acceptance for smooth edges than sharp ones [6]. The high-level properties of images are depicted in Fig 5(a) that shows the Rule of Thirds, which states that if the object in the image is placed on the intersection of four lines that divide the screen in 9 parts then the overall image has an added appeal to it that enhances the image acceptance. 5(c) that shows the Depth of Field in which the object is retained in its clarity but its background is blurred; Fig 5(d) depicts the visual balance wherein all components of the image are spread-out evenly in the image giving it a balanced symmetric look [7]. Fig 5(e) depicts the Diagonal dominance placing the line of eye-sight along a specific path on the image. This aspect contributes in giving importance to the aligned object in the image [1].

a) High lighting effect   b)Low lighting effect
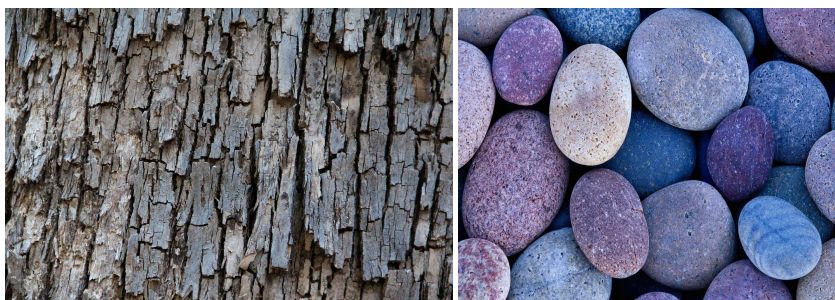
Fig.1. Lighting Effect

a) High Color Contrast   b)Low Color Contrast

Fig. 2. High and Low Color Contrast

(a) Sharp Texture   (b) Smooth Texture

Fig.3. Texture properties

(a) Original   (b) Sharp Edge   (c) Smooth Edge

Fig. 4. Edge detection

(a) Nine parts of Rule of Third

(b) Object on cross point

(c) Depth of Field

(d) Visual Balance

(d) Diagonal Dominance

Fig.5. High Level Features

B. Video Aesthetics

Video is a temporal sequence of multiple images also called frames. When expressions through words fell short, they were replaced by images, and when images fell short to express an event in its totality, videos replaced them. Today, uploading videos to express and showcase various aspects of talent has become very popular and easy. Aesthetically and beautifully shot videos are finding acceptance amongst different communities across the web [8]. Videos are analyzed by their per frame analysis followed by the aggregation of individual frames to formulate the result analysis. Video framing creates a lot of frames depending upon the video length. Key framing technique is applied on the created frames to filter out the redundant frames and retain frames that provide unique information to analyze a video [9]. With the increasing demand for video based applications, the reliable predictions of video aesthetics have increased in importance. The reliable assessment of video quality plays an important role in meeting the promised quality of service (QoS) [9] [10]. Video aesthetics plays a major role increating effective advertisements, academic-learning films, cinematography and many more.

III. HANDCRAFTED METHODOLOGY FOR IMAGE AESTHETICS AND VIDEO AESTHETICS

Hand crafted features are the features that are decided upon by the researcher [11]. Hand crafted features combined with the supervised learning classifiers achieve good assessment results of image and video aesthetics.

The handcrafted features are aesthetically driven, they have some disadvantages as they can never cover all possible photographic principles, also they are computational expensive and use heuristics, which may not generalize well to similar applications. Hand crafted methods are the state-of-art methods in which, we extract features according to experience and use different methods to assess aesthetics [13] [14].

A. Image Aesthetics

The aims of Image aesthetic assessment are to distinguishing high quality from low-quality images based on photographic rules, and get the results in binary classification types or quality ratings of images [3].

A different type of algorithms has been proposed in the previous literature to solve this challenging or subjective problem of image aesthetic assessments. A framework for image aesthetics analysis that can be utilized in the current photo editing software packages for providing aesthetic guidance to the users [4]. Efficient image aesthetic quality assessments method obtain by different factors like, preserving the salient regions in image, structures of images, photographic rules and symmetry in the images. And it is defined by the objective assessment method [56]. To retrieve the objective feature of image aesthetics, the edge histogram (EH) and the color layout (CL) define to assess the content similarity in two images.

The earth-mover's distance algorithm (EMD) and SIFT-flow (SFlow) were used in to assess image retargeting methods [57].The rule of center is and diagonal dominance for image aesthetics is high level photographic rules, used to retrieve the centre of an image where the object is located and increased the quality of aesthetics.

B. Video Aesthetics

Different researches on image and video aesthetics has been done by researchers worldwide. In comparison to image aesthetics, there is a growing scope on video aesthetics [14] [15]. A video aesthetics quality assessment method combines the representation of each video according to a set of photographic and cinematographic rules, with the use of a learning method that takes the video representation's uncertainty into consideration [16].

Specifically, the information is derived from both low and high level analysis of video layout, leading to a photo and motionbased video classification methodology using Support Vector Machine (SVM) representation scheme [9]. A video is analyzed at multiple granularities employing strategies that cater to specific aspects of aesthetics. Each video is divided into shots and for each shot, key frames are selected [17].

Following this, features are selected at three levels cell, frame and shot level [18].Using a standard classification method,effective analysisof a comprehensive set of features,ranging from low-level visual features, mid-level attributes and a computational approach to automatically evaluate the aesthetics of videos is accomplished with particular emphasis on identifying beautiful scenes in videos[16].

For assessing the video aesthetics quality, there are many dependent and independent aesthetics quality attributes [19].

IV. IMAGE AND VIDEO AESTHETICS USING DEEP LEARNING

A. Introduction to Deep Learning

Deep learning provides an analytical accuracy over the Handcrafted features [13] [20]. Despite the success of handcrafted and generic features for analyzing image aesthetics problems, unifying the automatic feature learning and classifier training using deep neural networks has shown promising performance in various applications [21] [22] [23]. The deep learning neural network provides automatic aesthetic assessment [24] [25].

Hand crafted feature refer to properties derived using various algorithms. To extract the features using the algorithms is based on the user experiences. This feature change according to different people psychologies [11].

This different psychology and the working of human brain helped to develop a new architecture called Artificial Neural Network (ANN) shown in Fig, which is purely based on the structure of human brain. All the working elements of brain like, cell, dendroid, soma, axon, synapse as similar work into the summation, interconnection, net input, output and weight in artificial neural network.
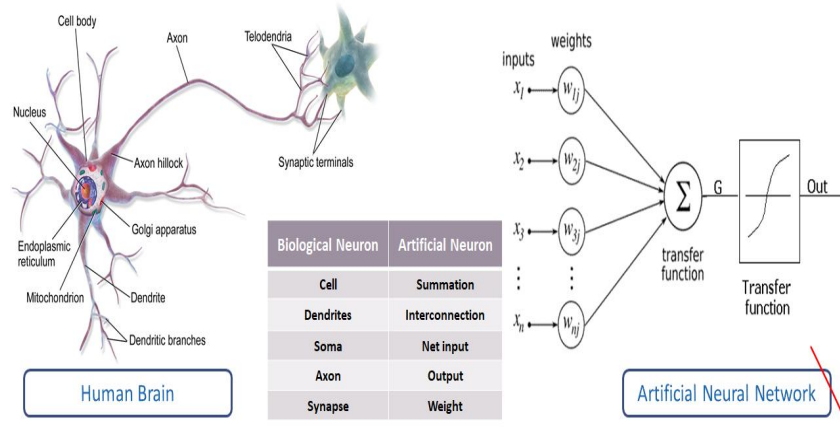
Fig. 6 Human Brain and Artificial Neural Network

An artificial neural network Fig. 7 (a) and the Deep Neural Network (DNN) Fig. 7 (b) both are similar, only the difference is the number of hidden layers is more in the deep neural network [2] [3]. These hidden layers process the inputs and extract the more optimal results as compare to handcrafted features and artificial neural network [3] [22].
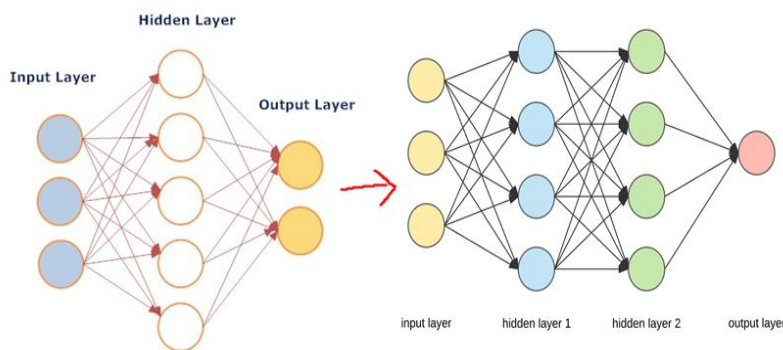
a) Artificial Neural Network   b) Deep Neural Network
Fig. 7 artificial neural network and the Deep Neural Network

The deep convolution neural network (DCNN) is the most powerful Deep Neural Network (DNN) architecture in classification vision as specified in Fig.3.The Fig.3, explains the deep convolution neural network which processes the input using multiple hidden layers [3]. The first layer of the neural network provides an input sequence and this input is multiplied with weight of individual inputs. This result is given to the next hidden layers as their input. After calculation of values by all layers, the output is calculated using additive activation function [2]. Then we calculate the cost function by subtraction of the expected output and resultant output. If an error is encountered in this cost function, we back-track the process layer by layer and again calculate the weight of layers   to get a new output [3].
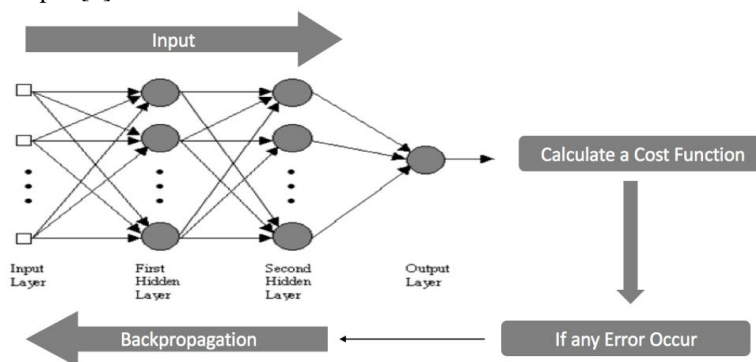

Fig.6. Deep Convolution Neural Network (DCNN)

B. Image Aesthetics

In comparison to other deep learning architectures that include Deep belief network, Restricted Boltzmann machines (RBM), and Recurrent neural networks [26], in the deep convolution neural network, the hidden layer processes the images or videos to give an accurate assessment of image and video aesthetics [27]. Deep neural network approach allows unified feature extractions and classification training to estimate videos and images aesthetics. The double column deep convolution neural network is used to support heterogeneous inputs, i.e., global and local views, in order to capture both global and local characteristics of images [2] [22]. To describe the unique aesthetic attribute of images, a query-dependent model is learned from the query image and videos in both visual and textual spaces [28]. In the Handcrafted feature extraction method, the users create or modified the images according to experience and psychologies. In the Deep learning method, the entire feature extraction task is done automatically, so there is no dependency on the user interferes. Convolution neural network processed all feature extractions using the multiple hidden layers [26]. These layers automatically work and find out the best solution on the feature extraction and classifications [2]. In handcrafted analysis, the classification is done by different algorithms like SVM, K-Nearest Neighbor, decision trees, and many more. Every algorithm considered has its own advantages and disadvantages [1] [3] [4] [15]. The underlying aesthetic abstractions automatically use powerful deep convolution neural networks (DCNNs) [29]. The convolutional network is fed raw pixels and trained end to end, thereby cancelling out the shortcomings of hand-engineered features. When compared with Handcrafted features, these automatically trained aesthetic features will produce representations that can better capture several general underlying aesthetic characteristics from massive training image datasets [3] [30] [31] [32] [33] [34] [35] [36].

V. COMPARISION BETWEEN DEEP LEARNING AND HANDCRAFTED FEATURES

In the Handcrafted features of aesthetics analysis, quality of aesthetics is judged by the commonly available photographic rules [37]. Fig.4 shows the deep convolution neural network that processed all levels of feature extraction using the multiple hidden layers [2]. These layers automatically work and find out the best solution on the feature extractions and then train the classifiers. In handcrafted method, the features are extracted according to the user requirements and then the classifiers are trained [13].
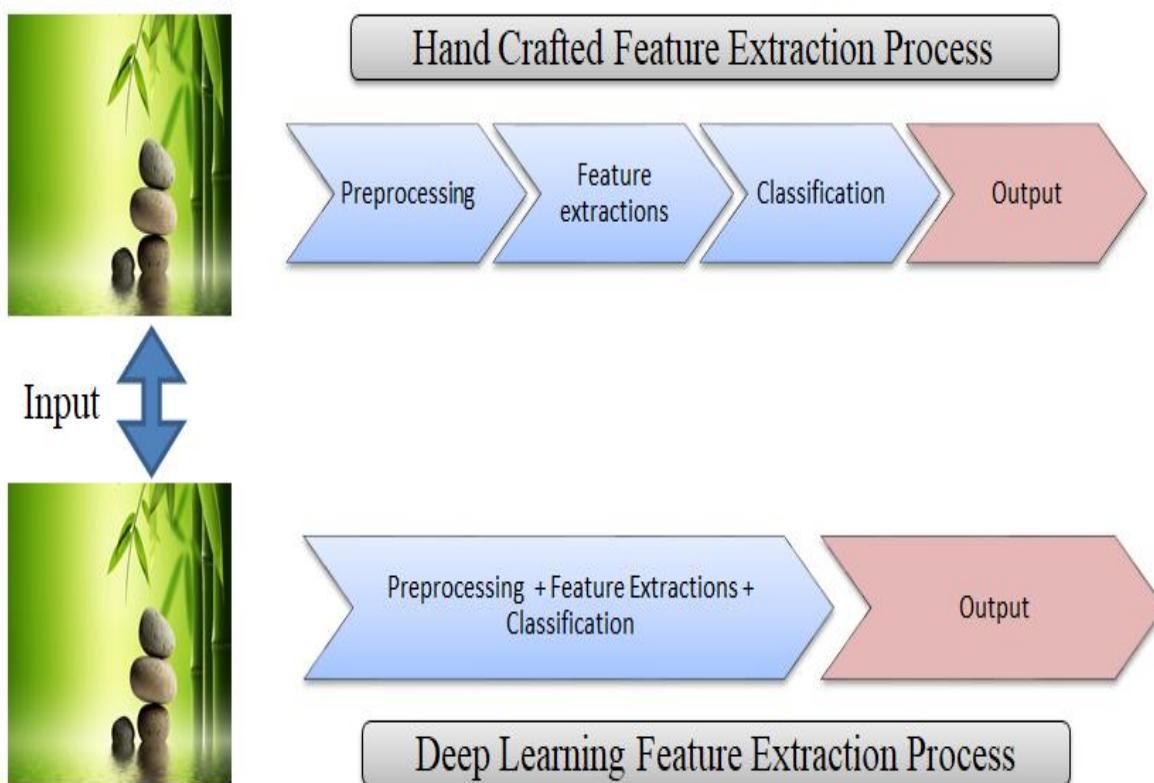

Fig.7 Comparisons in feature extraction methods

The comparisons and advantages of DCNN methodology described in the table

Handcrafted method	Deep learning method
Handcrafted features are judged by commonly established low level characteristics and high level photographic rules, thus greatly depending upon human intervention [2].	Deep learning methodology is an automated approach that allows maximum feature set extraction and has less human intervention [10].
Handcrafted method is time consuming in the long run [13].	This is a parallel methodology, requiring less amount of time [2].
This method follows only specific rules at a time thus do not perform in totality [27].	This method obeys all the rules and extraction terminologies thus have more overall coverage mechanism for the features [7].
This method depends on human experience and human temperament [2].	This method depends on large datasets. There is less dependency on human intervention [4].
Forward and backward tracking mechanisms possible with ease [13].	Backward tracking is possible when errors occur, otherwise the output proceeds towards optimization [13].
Classification is done on the basis of handcrafted features [13].	Classification is done by multiple hidden layers and this result in enhanced accuracy [27].
Handcrafted technology follows the sequential methodology	Deep learning has no sequential processing, all features are extracted by the hidden layers in black box.

VI. DISCUSSION

Section IV, describes the differences between the Handcrafted methods and Deep Learning [13]. In the Handcrafted methodology, depends on the user experience and psychological thinking over the beauty of videos and images. The main limitation is the excessive time consumption and the accuracies of aesthetic assessments. There are many researches done on the image aesthetics using hand crafted as well as deep learning methods [16]. In the field of video aesthetics using deep learning there exists a scope for future research as this field is less explored [31].

In the domain of video aesthetics or video aesthetics using deep learning, it is explored that the motion and color combination properties of a video play a major role in its assessments[38].Extraction of both the features of videos is a highly subjective task because different people have different psychologies and emotions on viewing, understanding and assessing videos[10].Deep learning provides a good opportunity for the video aesthetics assessment improvement by enhancement of feature extraction accuracies[33].In this method, the hidden layer of neural network processes the video features[31].To understand Deep Convolution Neural Network, let us see Fig. 8 where we comprehend the differences between the Handcrafted method and Deep Convolution Neural Networks[13].In the deep neural network, there are different models like Recursive Neural Network(RNN), Deep Convolution Neural Network(DCNN) and Recurrent neural network(RNN) etc. In the DCNN there are additional hidden layers that provide more accuracy in feature findings [39].
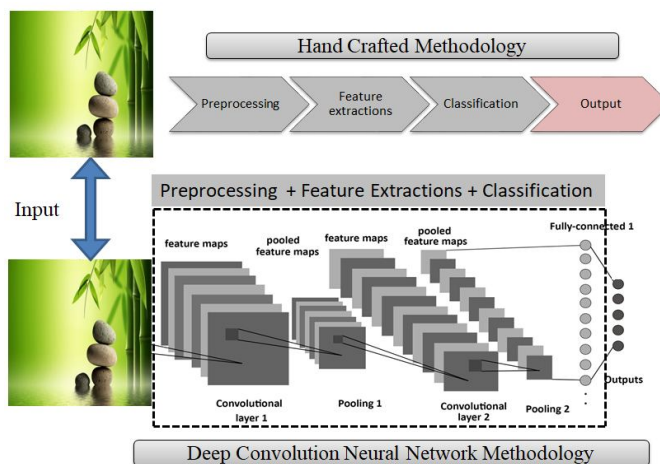

Fig.8. Depiction of Handcrafted Method and Deep Convolution Neural Network Method.

Video aesthetics is a subjective and challenging task [33], we can propose the concept of combining motion and color contrasts for objects in videos for assessing aesthetics using deep learning.

A. Initially proposing an architectre for Video Aesthetics using Motion and Color combination properties based on handcrafted methods.
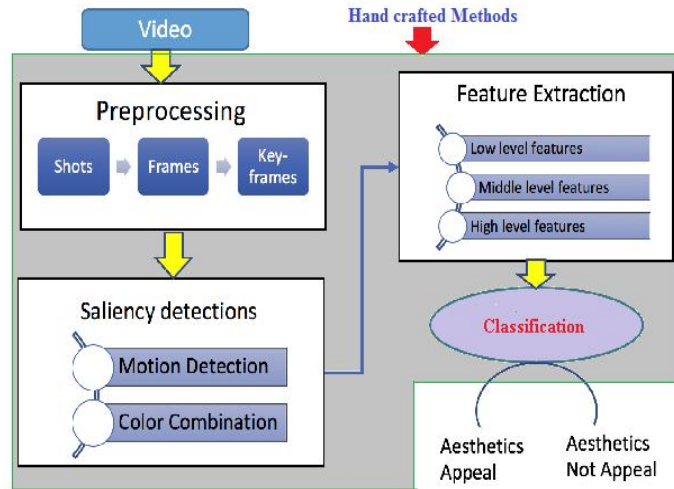

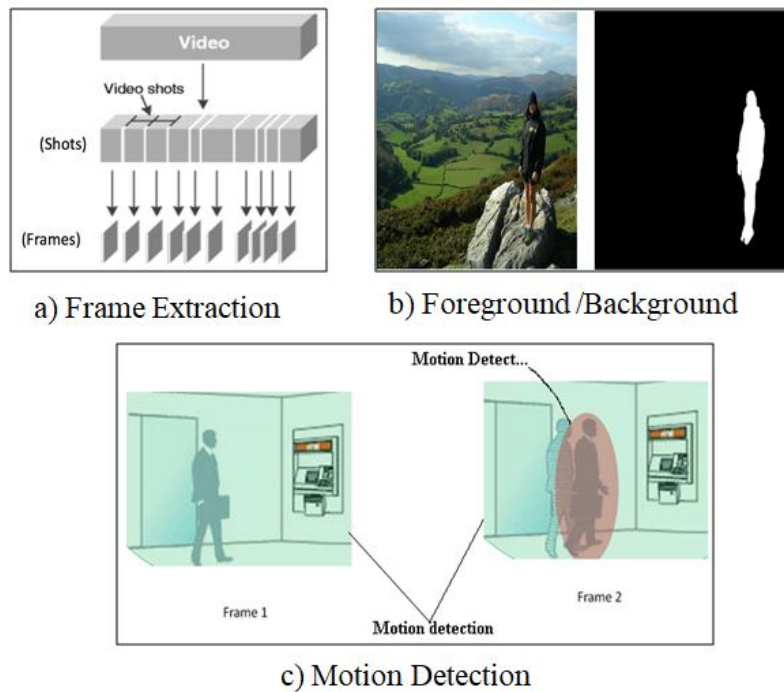Fig. 9. Flow Architecture of Video Aesthetics Using Handcrafted Methods

Fig. 9. Example of Preprocessing (a), Saliency detection (b,c) based on Handcrafted methodology

B. Proposing an architectre for Video Aesthetics using Motion and Color combination properties based on Deep Convolution Neural Network(DCNN).

Video aesthetics based on the deep convolution neural network is a subjective task because it is depends on the emotions and thinking psychology of users [2]. There are many researches done on the image aesthetics using the DCNN, because the images is in the fixed in nature and we can apply the algorithms [3] over it but in the videos the movements and the other properties like, color combination and motions of objects is continuously changing at time to time [24]. So, these limitations of the videos are causes to less research done and the region of highly subjective tasks. The main task of video aesthetic is to convert video sequences into the frames. The video sequence contains the multiple frames/images [9] [14].

Fig.6 shows the architecture for the video aesthetics assessments based on preprocessing, salient (color, motion) features and three levels of feature extraction.

Following are the salient steps/points of this architecture which is processed by hidden layers of DCNN:

a) *Pre-Processing Techniques:* Pre-processing techniques are required to extract the video into the multiple shots, frames and key-frames Fig. 10. Shot detection method [24], candidate selection method [27] and gradual shot detection method [34] using convolution neural network in which the shot detection is done by CNN networks Shot is a sequence of frames and key-frames in a video. Key-frame is the frame of video which contains the important information. Deep learning provides the automatic key-frames extraction method by using deep convolution neural network [24] [25].

b) *Saliency Detection Techniques:* Salient features detection is an important tasks of video aesthetics to detect the object motion [32] and the color contrast of object [31]. CNN network processes the individual frame [30] to detect the object from the frames, this feature based on the intrinsic properties of CNNs. Saliency detection method is useful to understand the salient object [38] from an images and videos. Saliency detection is a way to give less amount of time and energy to determine the most relevant part into an images and videos [37][39] [40].

c) *Feature Extractions/ Classification:* Feature extraction method defined the different level, feature used in the increasing the quality of the images and videos. Feature extraction described into the three different categories. This are low-level, high-level, and the middle level feature extraction, the classification method is used for classify the aesthetic appealing quality and giving the rating on the quality of the images over the other not appealing aesthetics images [2] [27] [34] [39] [41].

VII. APPLICATIONS OF VIDEO AESTHETICS

A. Video aesthetics in Advertisements

Now a day, the increasing in the population the requirement of the peoples goes on high demand. The increasing in the industries product the advertisement is a good communication medium to sell the products [53]. Video aesthetic used to advertisement of the product using good feature video for improve the attraction of the peoples.
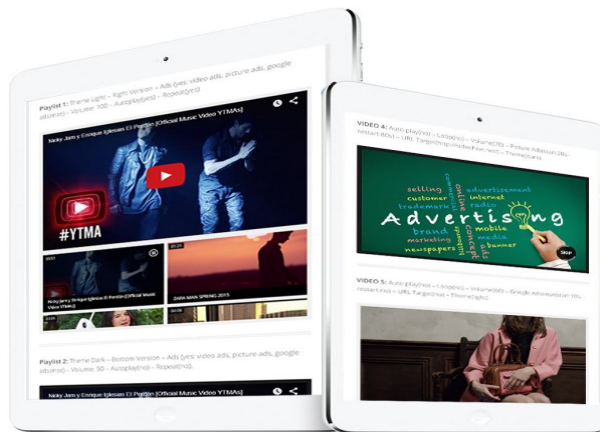

Fig.12. Advertisement using video and images

B. Video Aesthetics In Learning

Video conferencing is the good way to learn from the video any time and any ware [54]. The good quality video is needed for the conferencing.

Fig.13. Video Aesthetic in learning

C. Video Aesthetics in Gaming

Aesthetics quality of the camera direction in video game scenes rendered in real time, while the game is being played [55]. The goal of the video aesthetics is to improve the visual aesthetic quality of computer-generated images and videos using a computational aesthetics approach.

Fig.14. Gaming using video and images

VIII. CONCLUSION AND FUTURE WORK

Aesthetic assessment of videos and the images is a challenging field. Many researchers are working on the classification techniques and they find that there is no foolproof technique for the classification and prediction [2].The field of aesthetic assessment is subjective [17] and thus deep learning provides a multi-level learning method to get accurate classification [25]. Here deep learning provides the automatic aesthetic assessment for videos and images [27]. The image features provided for the video motion feature are extraction, which can provide to be broadly applicable for videoaesthetic assessments. The frame conversion and the shots detection is help tounderstand the characteristics of video motion to good shot quality of videos. In the future, the feature extraction and the classification both using the deep learning to take more accurate result on aesthetics. Many editor are working on the animation work in the videos, using deep learning we can modify and get the better result over that videos. The video transmission is based on the video size, so we can use the deep learning base aesthetic video transmission with less size and high aesthetic assessments.

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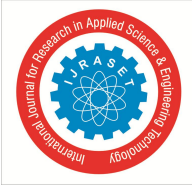
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