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A Tool for Ranking and Enhancing Aesthetic Quality of Paintings

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Abstract. Measuring aesthetic value of an artwork is a significant task in the field of visual & performing arts. Artists follow several techniques manually using traditional methods to balance the visual aesthetic value of different aesthetic products such as a film, a drama, a painting etc. Today, artists are enthusiastic on emerging information technology techniques for judgment and enhancement of designed product aesthetically and efficiently while applying traditional concepts to design initial form of the artwork. Computational aesthetics is the research of computational methods that do make applicable aesthetic decisions in a similar fashion as human can. This paper introduces a new tool that can be used to rank a given digital image of paintings based on a common parameter set with their weighting factors which are supposed to be adjusted for changing the aesthetic level of a particular painting in the area of computational aesthetics.

Keywords: computational aesthetics, aesthetics quality, artwork (painting) evaluation, analytic hierarchy process (AHP).

1 Introduction

The theory of aesthetics introduced by George David Birkhoff (1933) in his book *Aesthetic Measure* involves a lot of computational methods. Aesthetic quality assessment is a challenging task as it is a subjective matter and there are not clear standard procedures which can be applied directly to measure it. Therefore, particular area is needed to study well in terms of evaluation and enhancement of a given artwork in different field of visual & performing arts. Practically, it depends on the quantitative and qualitative parameters which lead to change the aesthetic feelings of human beings regarding the particular product that we are concerning. In case of comparing a given set of aesthetic products, evaluators may follow particular criteria and rank them as very good, good, bad etc. Basically, it is a qualitative measurement and a team of judgers will end up with a result like first place, second place etc. Therefore, it is required to proceed with the observations made by them using a particular hierarchical methodology and to find an approach to propose a model which is applicable to rank them quantitatively.

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In this paper, it will propose a new tool using a mathematical approach, called Analytic Hierarchy Process (AHP) [1] for ranking and enhancing digital image of paintings. Further, this paper discusses pros and cons of the experimental results of that approach to justify the suitability of the proposed tool. The paper is organized as follows. The first section contains a discussion on what aesthetics quality is and the importance of computing aesthetics using a model. The second section discusses about related work while emphasizing the challenges of aesthetic computing and enhancement of the particular aesthetic product. Next section discusses about the tool for ranking aesthetic quality of paintings. Then experimental results have also been presented there followed by evaluation and discussion. After that, conclusion and future work have been appended ending with references.

2 Related Work

Only a few research works have been published as aesthetic visual quality assessment is still a new research area. Especially for assessing paintings, we were able to find two previous works to our best knowledge [1], [2]. It is required a multi-criteria decision making method for computing aesthetic value, since it depends on several parameters of an artwork. Thus, a new approach called AHP was applied as the core theory of this tool implementation. According to Wickramasinghe et al., AHP is a multi-criteria decision-making method originally developed by Thomas L. Saaty (1980). It can be used to select the best painting with relative weights of its parameters that contribute to the final goal: *highest visual aesthetic value*. When dealing with aesthetic decisions in artworks, normally, evaluator or a group of evaluators will have to express satisfaction feelings based on the aesthetic quality of the artwork. In the current tool, a set of different image groups (paintings) that can be analyzed based on their form (physical attributes, shape, composition, etc.) were given as the input paintings selected by referring some reputed painting archives publicly available[3],[4].

3 Proposed Tool for Ranking Given Set of Paintings

According to AHP theory, a hierarchy of parameters was set up having main goal in the top level with level 1 parameters and level 2 parameters in next two levels by consulting experts and conducting a preliminary survey. Parameters of Level 1 were selected as the most significant criteria (factors) to achieve the final goal. Level 2 parameters are sub criteria of selected level 1 parameters. Then, it was done a survey by selecting 50 participants and data were collected for three different paintings under five painting themes for the above mentioned hierarchy. After formulating pair-wise comparison matrixes for each criteria and sub criteria, relative weights (priority vectors) should be calculated. There are several methods for calculating the eigenvector (priority vector). Multiplying together the entries in each row of the matrix and then taking the n^{th} root of that product gives a very good approximation to the correct answer. Comparison matrix data were directly entered to an online AHP calculation tool [8] and relative local weights were calculated separately for each and

every member in the survey. After getting relative weights (priority vectors) for all members, mean relative weights were calculated using a Microsoft Excel data sheet. Accordingly, global weights were calculated using AHP theory. A painting which was taken maximum total (global) weight is the one which is having the highest visual aesthetic value. Therefore, this approach is specific where comparison results have to be used only for the cases similar to given data set, neglecting the variety inbuilt with the available digital image of paintings to be compared. So, authors plan was to go beyond this limitation of the AHP technique providing more rooms to accommodate comparisons to the diverse category of paintings. One of the possible solutions is to develop a tool (system) to get online response from the user/users and do the comparisons for the given set of paintings. Then, AHP theory can be utilized as the main technique to do all the required calculations to rank the given set of paintings. To proof the concept, comparisons for three digital images of paintings were selected in the current proposed tool. The architecture of this tool is given below (figure 1).

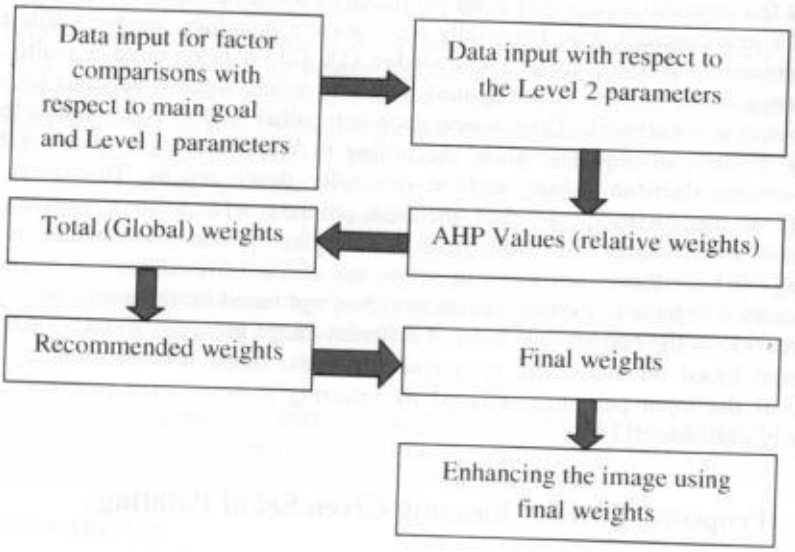

Fig. 1. The architecture of the tool

4 Implementation and Experimental Results

To generalize the above concept, tool was developed having three main windows. Net beans [9] software was used as the main IDE and some other open source software like ImageJ[10] developed by National Institute of Health, USA was integrated to the developed tool specially for the enhancement of the digital image. User will have to follow the scale of measurement from -9 to +9.

In this tool, second window will appear by clicking start comparisons button on first window. There, user has to enter responses within the given scale (-9 to +9) by comparing level 1 parameters two by two with respect to the main goal. And also, all

level 2 parameters will have to be compared with respect to the level 1 parameters. In third window, responses should be entered by comparing three paintings (painting 1, painting 2 & painting 3) two by two with respect to the level 2 parameters.

4.1 Example Test Case: Three Animal Theme Paintings

There were three input painting sets used for the comparisons by different users. Following figures (figure 2, figure 3 and figure 4) will show one of the example test cases for the purpose of explaining the output results.

Fig. 2. Painting 1

Fig. 3. Painting 2

Fig. 4. Painting 3

Fig. 5. Adjusted painting 1

Fig. 6. Adjusted painting 3

According to the responses given by a particular user for three paintings under animal theme, tool will calculate AHP (relative weights) values and the total weights of the parameter contributions (table 1).

Table 1. Total weights of parameter contributions

Painting	Total weights
Painting 1	33.6
Painting 2	34.6
Painting 3	31.6

According to AHP theory, painting 2 (table 1) was selected as the best aesthetic quality painting comparing to other two paintings. Painting 2, Painting 1, Painting 3 is the ranking order. Now an extension work can also be done based on the findings. Now, painting 1 and painting 3 can be enhanced to the aesthetic level of painting 2 by changing their individual parameter weights to the same values as the painting 2. That enhancement can

be done using another tool called ImageJ[10] which is integrated to the developed tool. In this enhancement, Authors decided to exclude three parameters called texture, straight lines and curve lines as those are directly connected with the initial design of the painting. So, remaining 6 parameters are considered and weights are adjusted accordingly and displayed as recommended weights in the proposed tool (table 2).

Table 2. Recommended weights of parameter contributions

Painting	Dark Color	Light Color	Low Contrast	High Contrast	Low Brightness	High Brightness
Painting 1	32.5	10.3	13.9	12.9	14.8	15.6
Painting 2	21.6	17.2	12.6	15.3	16.2	17.2
Painting 3	23.8	15.1	15.8	13.6	18.7	13.4

It is assumed that dark color or light color will dominate the other. And also, same concept can be applied to the contrast and brightness. So, ultimately, following three parameters are most critical parameters that should be adjusted in painting 1 & 3(table 3).

Table 3. Adjusted weights of parameter contributions

Dark Color	High Contrast	High Brightness
21.6	15.3	17.2

As the throughput of dark color and high brightness is dark color or low brightness and weight should be the difference of those two values, final weights will be displayed as in table 4.

Table 4. Final weights of parameter contributions

Dark Color or Low brightness	High Contrast
4.4	15.3

After adjusting these weights of those painting 1 & 3 by using ImageJ, final out put can be seen as in figures 5and 6.

5 Evaluation and Discussion

In the evaluation of the results set, feedback was taken from 3 experts in the subject area. They agreed to the final output, as the tool is straightforward to get the output within short period of time. And also, they were able to compare the dynamic views of more than one user, even though, it limits for only three given painting comparisons. Rather than the appearance of the final output, they agreed to the flexibility to get the dynamic views of several participants. Specially, they commented on the behavior of the tool which is considered any type of paintings for the comparisons. One of them commented on the limitation of the system only for three painting comparisons.

6 Conclusion and Future Enhancement

According to the evolution and comments of the experts, we can conclude that tool will do a satisfactory job in the area of computational aesthetics. Currently, there is an online tool available only for computing AHP values [8]. It is limited for comparing a particular local parameter set only. But our tool facilitates to compare a hierarchy of factors related to a set up goal to be achieved. And also, there isn't any system or tool available for comparison of paintings using a computer. Therefore, this will play an important role for the artist who is really looking at emerging IT techniques for their aesthetic decisions. This was developed as a proof of concept and there is a chance to enhance the tool for more than three paintings as a future enhancement of this work.

References

1. Wickramasinghe, W.A.P., Dharmarathne, A.T., Kodikara, N.D.: A mathematical model for computational aesthetics. In: Proceedings of the International Conference on Computational Vision & Robotics (ICCVR 2010), Bhubaneswar, India, pp. 130–137 (2010)
2. Li, C., Chen, T.: Aesthetic Visual Quality Assessment of Paintings. IEEE Journal of Selected Topics in Signal Processing 3(2) (2009)
3. Kalwick, W.J.: Painting archives, http://www.kalwick.com
4. Potter, J.: Painting archives, http://www.johnpotter.com
5. Saaty, T.L.: The analytic Hierarchy Process. McGraw-Hill, New York (1980)
6. Birkhoff, G.D.: Aesthetic Measure. Harvard University Press, Cambridge (1933)
7. Goldman: Aesthetic value, Westview Press, Colorado (1995)
8. Tools, Canadian Conservation Institute, http://www.cci-icc.gc.ca/tools/ahp/index_e.asp
9. NetBeans IDE 7.0, http://netbeans.org/
10. ImageJ: Image Processing and analysis in java, http://rsbweb.nih.gov/ij/download.html