An Aesthetic Reasoning System of Artistic Creation Based on Factor Space of Memory-Perception

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Abstract. In order to build an intelligent art design system with human-computer interaction, this paper proposes an aesthetic learning model based on memory mapping and perception inversion. Through the relationship construction of practical aesthetic model and on-the-spot model, it sets up a couple of mapping models aesthetic information acquisition. The study shows that the premise of aesthetic reasoning is to set up fuzzy perception of human aesthetic, on the basis of the fuzzy perception, we can analyses the aesthetic relation among memory and object, and discuss the fuzzy perception characteristic of aesthetic process, and then obtain some conclusions and results. A simple example on how to create and apply the model is give. The presented model can be applied conveniently by selecting suitable ACDS in accordance with the give aesthetic judge and computing the best decision from the rules in those ACDS.

1. Introduction

To mimic the aesthetic capacity of human being is one of the most basic and important task of artistic creation design system (ACDS) [1], the way to do that is neither merely a pure reasoning algorithm, nor completely relies on some knowledge. From the research achievements of AI in recent years, the original intention of researchers is that computers can substitute for the reasoning of human beings, thus acquire the aesthetic design capacity of human beings. However, to study the aesthetic reasoning as an issue in intelligent system for artistic creation has hampered the system development. No matter in the aspects of aesthetic knowledge and aesthetic expression, though great research achievements have been obtained (especially the introduction of artificial neural network and fuzzy sets provides many new tools for development of aesthetic reasoning), few successful aesthetic reasoning model are available. [2] Many scholars believe that the key to build ACDS is the measurement and effective use of rule-based aesthetic knowledge system [3].

The “effective use” means whether the rule in the ACDS synchronize with the thinking of the actual aesthetic reasoning, which is also the difficulty in ACDS development. Fuzzy sets theory has achieved great success in aesthetic reasoning, but in reality, there are too few cases with fixed rule (knowledge). Does this prove that the research is going farther and farther away from our goal? Any kind of advanced and effective theory and method must have its generative background, and also can better reflect the reality. In the research and development of ACDS, it has been found that the formation of specific technique and method comes from the aesthetic experience perception of people in dealing with routine duties, and this aesthetic experience perception is fuzzy, nonlinear and with optimum perception and non-optimum perception. In addition, aesthetic knowledge and common sense are different from each
other. Do all problems in reality correspond to some complete knowledge? Aesthetic experiences in the field for different objects are obviously inconsistent. Accordingly, in the development of applied ACDS, the first thing is the self-organization of knowledge system and the self-learning of aesthetic experience system. This paper discusses the development of ACDS through practical examples of aesthetic reasoning and gives some new points of view which are believed to be applicable in the research and development of ACDS in many fields.

The objective of this paper is to analyse virtual aesthetic learning environments and to discuss a method for designing ACDS based on the theory of aesthetic factor learning. The paper also discusses a prototype called trust aesthetic along with an application involving the environment of an intelligent art design system.

The paper is structured as follows: First we propose a basic concept of Aesthetic Factor Space (AFS), and the relationship between object perception and aesthetic is analyzed in section 2. In the section 3, a novel aesthetic reasoning system is established based on the aesthetic characteristic index. In section 4, a simple example on artistic creation design how to create and apply the model is give. Finally, we conclude with a summary and future research direction in section 5.

2. Aesthetic Reasoning System Based on Factor Space

2.1. The concept of aesthetic factor space

In research of artistic creation design system (ACDS) [4], we have discussed relevant issues of the selection of aesthetic reasoning model. Here, the key is the good combination of aesthetic memory factors and research object factors. In fact, these combination implements two kinds of reasoning that is the memory-based reasoning and the similarity reasoning.

Definition 2.1[5] Let \( S^m = (f^m, R^m) \) be a factors space of aesthetic memory, \( S^o = (f^o, R^o) \) be a factors space of object, where \( f^m \) is a factors set of aesthetic memory, \( f^o \) is a factors set of object, \( R^m \), \( R^o \) are factor relationship of aesthetic memory and object. In the aesthetic reasoning system, if there exists a confirmable aesthetic memory factor that can be associated with an object factor (or be called the mapping of aesthetic memory to object), then there exists an aesthetic from memory fields to object fields, it is called aesthetic memory mapping inversion (AMMI), namely:

\[
S^m \xrightarrow{f} S^o \xrightarrow{P} I(f) \xrightarrow{f^{-1}} I(f(u)),
\]

where \( I(f^o) \) is an aesthetic factor set of \( f^o \), \( I(f(u)) \) is an aesthetic-state set of object. The basic framework of definition 2.1 is shown in Fig.1:

![Figure 1](image)

Figure 1: the basic framework of AMMI

From Fig.1 it could be discovered that expresses an aesthetic factor space with object relationship, if we can seek out a reversible and memory shaping for all such factor space based on AMMI, object factor can be determined according to similar aesthetic memory factor (namely turned known into object with perception degree). In a problem domain of artistic design, the formation of the aesthetic of object factor
is compared to perception degree of aesthetic process according to aesthetic learning. In fact, human brain, for a recognition problem of object factor with complexity and uncertainty, undergo limited process of AMMI, then form trust discrimination. That is to say, the solution of with aesthetic object factor is a process based on n phase memory mappings and n phase trust aesthetic inversion, and is the aesthetic reasoning which the perception of the object factor based on the memory factor. Therefore, the process of this aesthetic reasoning is called n phase AMMI process. The research purpose of AMMI is design a models of trust aesthetic which use of human computer interaction. [6]

2.2. Aesthetic feature index
Aesthetic factor perception process is so ordinary that we cannot give an exact definition. It is the focus of study objects; its meaning is found expression in aesthetic characteristic selection of objects, such as temperature, size and so on. Meanwhile we assume the factor perception field is presented accordingly when a perception process of study objects is pointed out. Consequently any object in the perception field is one-to-one correspondence with the set of its perception process. It includes the following: The judgment of aesthetic is needed to appoint its perception process. The same object will have different intuition characteristics in different perception process. In fact, the computing model of human brain is an aesthetic model based on the comparison of optimum perceptions (acceptable perceptions) and non-optimum perceptions (unacceptable perception). [7] According to definition 2.1, we have as follows definition 2.2:

Definition 2.2 Let \( I(f) = \{I_1(f), I_2(f), \cdots, I_n(f)\} \) be an aesthetic-state set of factors (aesthetic attributes set \( A \) ), then there exists a \( I(f) \xrightarrow{p} R(u, I(f)) \), where \( R(u, I(f)) \) be a relation of \( u \in U \) and \( I(f), P = P(f) = p^+(f) \cup p^-(f) \) is perception of object, and the \( p^+(f) \) is positive perception (optimum perception), the perception degree is \( \rho^+(f) \in [0, 1] \), \( p^-(f) \) is negative perception (non-optimum perception), the perception degree is \( \rho^-(f) \in [-1, 0] \), then \( R(u, I(f)) = \{< \rho^+(f_i), \rho^-(f_i) > | \rho^+(f_i) \in \rho^+(f) \wedge \rho^-(f_i) \in \rho^-(f) \} (i = 1, \cdots, n) \) be called a set of sub-optimum perception relationship of \( I(f) \). \( R(u, I(f))=I_T(f) \) is also called an aesthetic index of factor perception (AIFP), without loss of generality, we have

\[
R(u, I(f))=I_T(f) = \begin{cases} 
1 & \rho^+(f_i) = 1, \rho^-(f_i) = 0 \\
0 & \rho^+(f_i) = 0, \rho^-(f_i) = -1 \\
\frac{1}{2}[1+\rho^+(f_i)+\rho^-(f_i)] & 0 < \rho^+(f_i) + \rho^-(f_i) < 1 \\
0.5 & |\rho^+(f_i)| = |\rho^-(f_i)| 
\end{cases}
\]

In an illustration of an aesthetic process, the N phase analysis of AMMI induces different level cognition process on aesthetic reasoning. This process eventually results in two conclusions. Small shapes such as circles or diamonds represent intermediate conclusions with certainty levels that are reinforced during the course of reasoning, and the grey area indicates “sub-conscious thought” that occurs when the magnitude of cognitive activity exceeds the limit of conscious awareness. Different AMMI approaches, therefore, either artificial or human, can be considered as aesthetic to various degrees. [8]
3. Aesthetic Reasoning System for Artistic Creation

3.1. The factor space of artistic creation

3.1.1. Information factors of creation
(1) Social status factor: The state of the social system, social relations, production, economy, science, culture, etc.
(2) Factors of consciousness: ideas and knowledge in philosophy, politics, history, aesthetics, art, ethics, science, etc.
(3) Factors of creation skills: methods of image thinking, conception, layout, techniques, techniques, style of artistic creation, and methods of logical thinking related thereto. In artistic creation, human being is the subject, information factor is the object, and artistic works are the creation results of designers based on factor analysis.
(4) Aesthetic factors: social beauty, natural beauty, formal beauty, art beauty and other forms of beauty, these (positive, negative) beauties reflects the social status quo and social consciousness, in addition to the beauty of art, their state is the main source of information for artistic creation.

3.1.2. The conscious factors of creation

The factor of consciousness is formed in the relationship between memory and perception, and memory and perception are the basis of thinking. In fact, the basic principle of the reasoning system with memory and perception leads to an aesthetic design thinking, which determines an artistic design result. These include the following factors of consciousness:

(1) Philosophy, politics, aesthetics, art, history, science and other concepts, as well as the ability to use, understand and think logically in connection with the accumulation of knowledge in this field. By inputting the positive (optimum) and negative (non-optimum) beauty information factors into the reasoning system, they can be identified, judged and analyzed.

(2) It is the accumulation of social beauty, natural beauty, formal beauty, and the resulting image thinking ability, creative ability, artistic accomplishment, interest, etc. These are the main conscious factors of artistic creation. After input of factor information into the reasoning system, the system will use these reserves to associate, imagine, focus and sublimate.

(3) Psychological status: emotion, emotion, wills temperament, etc. It restricts the depth, breadth, form, style and so on of artistic creation.

These factors restrict and permeate each other, forming the artistic feeling of creative information. The brain then gives play to image thinking (mainly), logical thinking (auxiliary) and the information storage and function of artistic creation, conceives and creates, and sublimates feelings into works. Each factor is related to the input information, to the whole, and to the output. [9]
3.2. Aesthetic learning system of artistic creation

As a subsystem of the information flow, the output information, the composition of its factors is roughly as follows: positive or negative social beauty, the depth and breadth of natural beauty. This is the first level of its composition, which restricts the artistic technique, skill and style of the work; this is the second level, which determines the appeal and entertainment of the work and the degree of positive or negative beauty emotion aroused by readers, thus forming the breadth, speed, effect and value of the information transmission of the work.

In each stage of artistic creation, non-superior (deviation) should be discovered timely, the causes of non-superior should be analyzed, corrective measures should be taken to correct, the aesthetic feedback should be given to its corresponding links, and the ratio and composition of factors of input, transformation or output should be adjusted. For example, the idea is not superior, the target is wrong, so that the objective input and transformation have problems, then feedback information to the idea of the storage for improvement and adjustment, if it is a problem of conception ability, then aesthetic feedback to the link of transformation, strengthens the idea of the weak link. The repeated artistic creation is the comparison of aesthetic optimum perception and non-optimum perception.[7] Through feedback self-regulation, the aesthetic reasoning system is constantly modified, supplemented and replaced, so that the input, conversion and output of the aesthetic index close to the ideal value, so as to get better works of art.[5]

In the Fig. 2, after factor firing, recurring outputs of the same attribute of an aesthetic factor are consolidated so there is only one instance for each attributes of that intuitive factor. The consolidated attribute values of aesthetic factor become inputs for the next iteration. For example, in the first iteration two aesthetic factors perception might fire which result in fuzzy variables, the first giving a fuzzy subset A1 with a height of 0.5 in the fuzzy set “Medium” and an associated AIFP of 0.6, and the second giving a fuzzy subset A2 with a height of 0.8 in the fuzzy set “Medium” with IIFP2 of 0.7. After consolidation, those two variables will be combined into a single one, with a new fuzzy subset A in “Medium” and an associated AIFP. [8]The iterative process continues until no more factors perception can be fired. Numerical values of the seven factors mapped onto five fuzzy subsets, i.e., Very Low perception, Low perception, Medium perception, High perception, Very High perception, or five “classes”, for each factors. Each numerical value then was represented by the fuzzy subset (class) in which it had the highest membership. For the sake of simplicity, the operation of fuzzy variables was not implemented in this experiment. The variables representing the seven factors, after their values being mapped into classes, were considered ordinal variables and the case type variable was considered a categorical variable. As shown in Fig. 2:

Figure 3: The structure of aesthetic fuzzy reasoning system
That is to say, the aesthetic reasoning system must have the feedback aesthetic perception information in order to be credible. Feedback aesthetic information factor input to the memory system, constantly improve the credibility of the aesthetic reasoning system. The following functions can be realized: (1) the beauty contrast between the works and the things reflected; (2) Contrast with the ideal beauty pursued; (3) Comparison with the beauty of the recipient of the works; (4) Contrast with good works in reality. The input and output of aesthetic evaluation information of artistic creation is a reasonable choice of various factors based on the space of aesthetic factors. [10]

4. Conclusion
In this paper, we presented an aesthetic learning approach to search for artistic creation design system. We discuss the critical issues in establishment of aesthetic reasoning system that should be paid attention to through practice of trust intuition learning work. The development of the aesthetic reasoning system must be grounded on AMMI, otherwise this work is of little significance or value. Simultaneously, the aesthetic reasoning should be distinguished reasoning from memory to perception. For different artistic creation domain, fuzzy perception is variable. Only by combining the two together with memory artistic to reach trust artistic can they possibly play their roles in reality. Besides, the operation mechanism of the ACDS should apply the AMMI principle, a very useful intellectual system, which is certain to play a guiding role in the development of automatic reasoning computer. In future work, the method presented here will be expanded upon. The representation formalisms employed to describe states and events in artistic process will be elaborated.

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References
[1] Yumeng He. Design of Artificial Music Intelligence System Based on Fuzzy Perception Learning. Journal of Physics. 2019.
[2] Yung-Chien Sun, Grant Clark. A Computational Model of an Intuitive Reasoner for Ecosystem Control. Expert Systems with Applications, 2009, 36, pp. 12529–12536.
[3] Pei-Zhuang Wang, author Zeng-Liang Liu, Yong Shi, Si-Cong Guo. Factor Space, the Theoretical Base of Data Science. Annals of Data Science, 2014, 1, pp. 233–251. DOI: 10.1007/s40745-014-0017-5.
[4] Adam Bear, David G. Rand. Modeling Intuition's Origins. Journal of Applied Research in Memory and Cognition, Volume 5, Issue 3, September 2016, pp.341-344.
[5] Yumeng He. Computing Model of Musical Multiple Perception Based on Memory Mapping Perception Inversion. Advances in Intelligent Systems and Computing. 2020.
[6] Anderson, John, Matessa, Michael, and Lebiere, Christian. ACT-R: A Theory of Higher Level Cognition and Its Relation to Visual Attention, Human-Computer Interaction, 1997, 12, pp.439-462.
[7] Ping He. Maximum Sub-optimum Decision-Making Based on Non-Optimum Information Analysis. Advanced Science Letters, 2012, 5, pp. 376-385.
[8] L.A. Zadeh, A new direction in AI: toward a computational theory of perceptions, AI Magazine, 2001, 22, pp.73–84.
[9] Wang Perzhuang, Factor spaces and factor data-bases, Journal of Liaoning Technical University (Natural Science), 2013, 32, pp.1297-1304.
[10] He Ping, Theories and Methods of Non-optimum Analysis on Systems, Journal of Engineering Science, 2004, 2, pp. 73-80.