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Semantic Difference Method for Artificial Intelligence Assisted Cruise Ship Cabin Design

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ABSTRACT

Artificial Intelligence (AI) generated design solutions have been widely applied in the field of environmental art design today. However, AI still has shortcomings in understanding human emotional judgments, which are reflected in the difficulty for AI to accurately generate the design requirements described by humans. This study is based on the Semantic Differential Method, dividing AIGC prompts into nouns, adjectives, numerals, etc., and focuses on extracting crucial adjectives from prompt words. It involves conducting a corresponding survey between adjectives and pictures to determine their relationship degree. Taking cruise cabin interior design as an example in this research, we extract relevant adjectives for cruise interior decoration as key prompts for AIGC to generate designs of cruise interiors. We devised a set of semantic scales for cruise interior decorations to guide AIGC in generating prompt words for cabin designs and assist designers in accomplishing more precise innovative designs for cruise interiors.

Keywords: Cruise ship cabin design, Human-computer interaction, Semantic differential method, Artificial intelligence, Prompt

INTRODUCTION

In traditional design, designers often need to produce hundreds or even thousands of sketches before the final form of a product is determined. However, this issue becomes more complex in the field of cruise interior decoration design. Each large cruise ship has thousands of rooms which, due to restrictions by room type and user demand, must maintain their own independence while also aligning with the theme of the cruise ship. Thus, during the process of designing cruise interiors, designers often need to draw several thousand detailed interior design drafts. Faced with such an enormous workload under industrial conditions undoubtedly places significant pressure on designers (Chen, Cheng, & Simatrang, 2021).

As we gradually step into an era dominated by artificial intelligence (AI), AIGC-assisted software such as ChatGPT and Midjourney greatly enhance efficiency for designers (Dodge & Karam, 2017). Yet there are notable differences between AI-generated technology and human understanding when it comes to image interpretation--the focal point for this study: biases exist between how humans perceive vocabulary compared to machines.

Against this backdrop, focusing on examples from within cruise interior designs aims at not only exploringdeep-seated cognitive biases between AI and humans but also generating corresponding semantic evaluation scales for future designer +use in creating images.

This study applies the research methodologies of Kansei Engineering and AIGC to the relatively novel field of cruise ship interior design assistance, utilizing cluster analysis and semantic differential techniques. Theoretically, this paper explores the differences between AI and human cognition of adjectives through Kansei Engineering methods, generating a semantic evaluation scale for cruise ship interior design, thereby enriching the content related to interior design evaluation in the cruise industry. Practically, this study introduces AIGC-assisted interior design generation, significantly enhancing designers' efficiency.

TECHNOLOGICAL PATHWAY

This research is conducted in two stages:

(1) Collection of adjectives and images related to Kansei engineering, using the semantic differential method to evaluate these images, thereby generating a semantic scale for cruise ships (Wang & Hsiao, 2018).

(2) Utilization of this cruise ship semantic scale for generating AIGC images, followed by verification of the validity of this scale.

The main experimental process comprises two steps: firstly, evaluating existing cruise cabin photographs using the semantic differential method; seeking experiment participants to score these photos and collecting their scoring data. The second step involves feeding selected adjectives, data and original photos into our chosen AIGC software to generate new pictures. Based on image quality we continuously adjust chosen adjectives until they achieve substantial generation effects with their corresponding datasets - thus giving birth to a relevant semantic scale for cruise ships. Applying this scale generates pertinent AIGC imagery for cruises which are then compared against non-scale-applied pictures from before - yielding final conclusions (Huang, Chen, & Khoo, 2012).

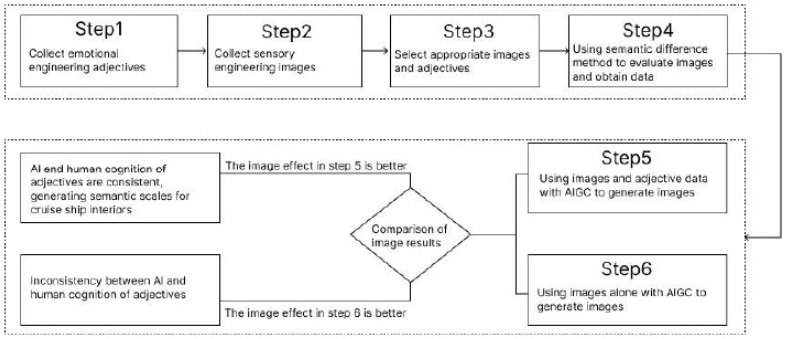


Figure 1: Technology roadmap.

SEMANTIC WORDS AND IMAGE COLLECTION

Semantic Words Collection

Adjectives related to cruise ship furniture and cabins were collected from magazines, newspapers, and the internet. The collection criteria included adjectives describing cruises. The method involved identifying relevant sentences that described a cruise ship on the internet and extracting appropriate adjectives from these sentences (Lai, Zhang, Mao, Liu, & Chen, 2022). After eliminating duplicates, deleting words irrelevant to cruise ship furniture and interior decoration, as well as further part-of-speech filtering, a total of 115 words were selected for further evaluation.

Excluding certain words unrelated to cruises and preliminary synonym categorizations were carried out. The principle of classification is to merge as much as possible the vocabulary with similar or close meanings in order to reduce research workload. For instance, regarding the expression "luxury", we collected synonymous adjectives like "luxurious", "top-notch", "opulent", "enjoy luxuriously","top-grade","honorable","exclusive","revered","indulge fully","gorgeous", "high-end", "ultimate" and "expensive". Eventually, we chose "luxurious" as representative vocabulary.

By filling the researched semantic words with antonyms, adjective pairs can be formed which serve as semantic scales for later research evaluations. For example - if you select ten vocabularies such as 'Luxury', Understated', 'Friendly', 'Spacious', 'Bright','Fashionable','Simple','Comfortable','Novelty' and 'Exquisite' serving evaluative standards; then these ten vocabularies could be assigned their respective antonyms thereby forming descriptive pairs readying them up for next step: Semantic Evaluation.

1. Luxurious - Cheap
2. Understated - Ostentatious
3. Friendly - Alienated
4. Spacious - Cramped
5. Bright - Dull
6. Fashionable - Outdated
7. Simple - Complex
8. Comfortable – Uncomfortable
9. Novelty - Antique
10. Exquisite - Rough

Semantic Images Collection

A wide range of images from mainstream cruise ships was extensively collected and classified according to categories such as interior cabins, ocean-view rooms, balcony rooms, deluxe suites, standard suites, and duplex suites.

The research images can be specifically selected or suitable ones can be identified through cluster analysis for studies. The principle of clustering is that the individual objects contained in the same category or cluster have a high degree of similarity while those in different categories or clusters have significant differences. Based on this principle, we ultimately chose ten pictures for use in experiments.

Considering the inconsistent quality of online images, both excessively low or high pixel count can affect test subject judgments. Therefore, our first criterion for image selection is similar pixel counts; living cabins can be divided into interior cabins, ocean-view rooms, balcony ocean-view rooms and suites based on functionality and characteristics. Consequently, our second standard for image selection was to uniformly select from interior cabin options; there are many types of cruise ship brands online but we aimed to select those well-known among the public as they would hold more representativeness which served as our third criterion for picture selection. By adhering to these three criteria mentioned above - we were finally able to filter down ten images.

EXPERIMENTAL DESIGN

Compilation of Semantic Differential Method Research Software

The semantic differential method software employs several pairs of antonyms to evaluate multiple images, such as ten bedroom design diagrams using words like "luxurious-cheap", "exquisite-rough" etc. The space between the words is divided into several grades. Users can select which end of the word their impression of the image leans towards (Li, Luh, & Chen, 2023).

1. The primary function of the software is to efficiently rate subjective impressions of schemes (images, physical objects, spaces etc.) through semantic word pairs.
2. The software allows for importing sets of words and pictures, for example word pairs such as "advanced-backward", "exquisite-rough", and a number of images that need evaluation.
3. After importing suitable photos, it could be handed off to test subjects who would operate this tool in order to score these evaluated items.
4. Post-scoring - results are exported in a format recognizable by Excel for potential further statistical analysis.
5. The evaluation form uses a Likert scale ranging from -2 to 2.
6. Firstly, based on Windows platform we have written research software.
7. After completing the software development, multiple rounds of debugging and optimization were carried out, and it was eventually used for experimentation.

Upon conducting survey experiments using the Semantic Differential Method, analysis results can be exported.

Experiment and Statistics

Fifteen subjects were selected for the study. The experimental process involved importing ten pre-selected cruise interior pictures and ten groups of vocabulary into the software, using a -2-2 level Likert scale to have the fifteen subjects score.

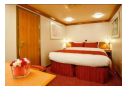
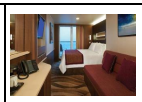
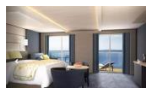
Figure 2: The semantic evaluation software.

Experiment Result

Following data visualization, the results are as follows.

Figure 3: Visualized results data is retained to three significant figures.

Table 1. Detailed data.

Image / Vocabulary										
Luxurious - Cheap	−1.40	1	−0.667	−0.267	−2.67	1.67	−1.4	−0.667	0.4667	−1.733
Understated - Ostentatious	0.133	0.067	−0.933	−1.2	−0.6	0	−1.47	−1.267	−0.533	−1.4
Friendly - Alienated	−0.133	0.333	−0.8	0.533	−1.27	0	−0.667	−0.867	0.4	−1.467
Spacious - Cramped	−0.933	1.67	−0.6	1.33	−2.6	1.8	−1.067	−1.467	−0.8	−1.867
Bright - Dull	−0.466	0.867	−1.067	1	−2.133	0.267	−0.933	−1.133	1.333	−0.867
Fashionable - Outdated	0.0667	1.60	−0.467	0.6	−1.67	0.6	−1.2	−0.1333	1.467	−1
Simple - Complex	0.867	−0.533	−0.867	−0.667	−0.6	−0.667	−1.067	−1.333	−0.0667	−1.8
Comfortable - Uncomfortable	−1.2	0.667	−1.4	0.0667	−2.27	0.667	−1.933	−1.333	0.0667	−2
Novelty - Antique	0.133	1.20	0.133	1	−1.33	0.467	−1	0.467	1.2	−0.933
Exquisite - Rough	−0.933	0.667	−0.533	0.0667	−1.46	0.467	−1.733	0.1333	1	−3

EXTRACTION OF SEMANTIC WORDS FOR USE IN ARTIFICIAL INTELLIGENCE-ASSISTED DESIGN

Application of Word Description in Artificial Intelligence Systems

The AIGC model we selected is MidJourney. (Insert introduction to MidJourney). Since MidJourney restricts the use of compound keywords to no more than seven at a time, and it tends to generate content unrelated to the theme when there are significantly more adjectives than nouns (**Figure 4**), we chose the highest and second-highest scoring adjectives for each image. These adjectives can significantly represent the features of the images. Using these adjectives along with the original images helps assist AIGC in generating designs. If there is a tie for the average score of secondary keywords, we then select the adjective with the lowest average score to assist in design generation.

Figure 4: Disordered AI-generated images.

Image Generation Results

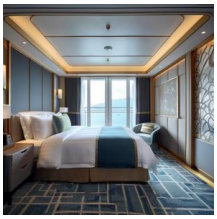
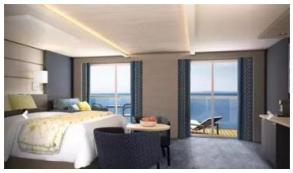
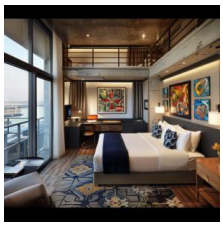
Table 2. Experimental results.

Before adding the semantic scale of the cruise ship	**After adding the semantic scale of the cruise ship**		**Oringinal picture**
		Luxurious : : 1.4, comfortable::1.2, cruise standard room	

Table 2. Continued

Before adding the semantic scale of the cruise ship	After adding the semantic scale of the cruise ship		Oringinal picture
		Cramped : : 1.67, outdated : : 1.6, cruise standard room,	
		Comfortable : : 1.4 , bright::1.067, cruise standard room	
		Understated : : 1.2 , Cramped : : 1.3, cruise standard room	
		Luxurious : : 2.67, Spacious::2.6, cruise standard room	
		cheap::1.67 ,cramped::1.8,cruise standard room	
		Spacious::1.47,Rough::0.133,cruise standard room	

Table 2. Continued

Before adding the semantic scale of the cruise ship	After adding the semantic scale of the cruise ship		Oringinal picture
		comfortable::1.933,Exquisite::1.733,cruise standard room	
		dull:1.33,outdated::1.467,cruise standard room	
		spacious::1.867,simple::1.8,cruise standard room	

CONCLUSION

Experimental Conclusions

(1) Construction of Cruise Ship Design Feature Scales Using Adjectives: The key adjective library for cruise interior styles obtained through the semantic differential method can serve as a scale to measure the style characteristics in interior design.

(2) Enhanced AI Understanding Through Adjective Inclusion: Comparing images generated by AI before and after incorporating adjectives reveals that the use of precise adjectives enables AI to produce images that better align with human expectations, thus generating more accurate pictures.

Applications of Conclusion

The experimental results of this study demonstrate that using the semantic differential method along with artificial intelligence technology to assist interior design allows AI to generate more accurately styled images. This conclusion has several practical applications:

(1) After determining the theme and layout of cruise interiors, this method can be used to optimize design images, ensuring that more images meet designers' requirements while aligning with the interior theme.

(2) This research provides new insights into applying artificial intelligence in the design field. Utilizing adjectives within the semantic differential

framework can offer AI clearer and deeper instructional understanding, effectively assisting in interior design processes and thereby promoting a more efficient and personalized approach to styling within cruise ship designs and related industries.

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REFERENCES

Chen, D., Cheng, P., Simatrang, S. & Joneurairatana, E. (2021). Kansei Engineering as a Tool for the Design of Traditional Pattern. Autex Research Journal, 21(1), 125–134. https://doi.org/10.2478/aut-2019-0052

Dodge, S., & Karam, L. (2017). A study and comparison of human and deep learning recognition performance under visual distortions. In Proceedings of the 26th International Conference on Computer Communication and Networks (ICCCN '17), Article No.: 1–7, Vancouver, BC, Canada. https://doi.org/10.1109/ICCCN.2017.8038465

Huang, Y., Chen, C. H., & Khoo, L. P. (2012). Kansei clustering for emotional design using a combined design structure matrix. International Journal of Industrial Ergonomics, 42(5), 416–427.

Lai, X., Zhang, S., Mao, N., Liu, J., & Chen, Q. (2022). Kansei engineering for new energy vehicle exterior design: An internet big data mining approach. Computers & Industrial Engineering, 165, 107913.

Li, X., Luh, D. B., & Chen, Z. (2023, August). The Application of Kansei Engineering System for Vehicle Interior Color Design. In 2023 IEEE International Conference on Image Processing and Computer Applications (ICIPCA) (pp. 1186–1192). IEEE.

Wang, M. F., & Hsiao, S. W. (2018, May). A Kansei-oriented method for interior design. In 2018 IEEE 22nd International Conference on Computer Supported Cooperative Work in Design ((CSCWD)) (pp. 485–490). IEEE.