

The Impact of Integrating Chinese Cultural Elements into urban Housing Design on Residents' Quality of Life

Geng Wang¹, Gangqiang Li²

¹Department of Chinese, School of Culture and Media, Huanghuai University, Zhumadian 463000, Henan, China

²Department of Information and Communication Engineering, School of Computer and Artificial Intelligence, Huanghuai University, Zhumadian 463000, Henan, China

Corresponding author: Gangqiang Li (e-mail: llgq202020@163.com)

ABSTRACT Integrating Chinese cultural elements into urban housing design often faces problems such as superficial symbol application, discontinuous spatial organization, and homogenized residential experience. To address these issues, this paper proposes a design approach based on Semantic Spatial Encoding and the Residential Behavior Perception Model. The research is conducted in three stages. First, cultural spatial semantics are extracted from 10 urban communities, and correlations among architectural symbols, color systems, and human psychology are analyzed. Second, SSE is used to construct a multidimensional spatial feature matrix covering morphology, imagery, and linguistic symbols. Third, RBPM optimizes spatial design using residents' activity trajectories and preference data. The method is applied in three pilot communities. The results show that residents' cultural identity increases by 23.6%, psychological comfort scores rise from 3.8 to 4.5, and space utilization efficiency improves by 18.2%. The study verifies the effectiveness of semantic cultural-space design in enhancing residents' sense of belonging and quality of life, and provides a quantifiable method for embedding cultural heritage into modern urban housing systems.

INDEX TERMS chinese cultural elements, urban housing design, quality of life, semantic spatial encoding, residential behavior perception

I. INTRODUCTION

A major issue with current urban housing design is that they are usually plagued by matters like the disruption of the cultural weave and the falsification of spatial symbols, resulting in a fragmented environment where the essential threads of heritage are stripped from the functional fabric of the residence. This lack of structural interlacing between identity and architecture leads to a superficial aesthetic that fails to maintain the integrity of the cultural within modern living spaces. The architectural designs tend to be shaped by their functional efficiency and the structural design does not consider the profound relationship between people and culture, which is why there is a progressive corrosion of the residential environment in terms of words and ethos [1,2]. Being one of the significant bearers of social psychology and spatial symbols, Chinese culture has its own spatial order and imagery value in its textual structure, aesthetic logic and symbol system. But it has been applied in the residential design practice and often simplified to decorative signs and has no systematic support of space logic. This formalized design which is not tied to the semantics of life undermines psychological integrity of the living experience and renders the residential space incapable of expressing the sense of

cultural belongingness. Weakened emotional identification, lessened life satisfaction, and lessened social cohesion are some of the problems to be exhibited by residents when they are using long-term. Housing is a physical space to survive in, whereas housing is a continuation of cultural vision. A discussion of the ways to incorporate Chinese cultural contents into the spatial system in a way that is not only visible but also habitable has turned out to be one of the major directions of refining the contemporary urban living environment.

Reconstructing urban housing space based on Chinese cultural semantics allows for the interweaving of traditional logic into the modern architectural fabric, reshaping the contextual order of daily life much like realigning the warp and weft to restore the structural integrity of a heritage. By extracting the spatial logic corresponding to the form and semantic features of characters, the interaction and unity of environment and emotion can be achieved, making the living space a co-existing interface of cultural memory and behavioral experience [3,4]. The value of this research lies in constructing a spatial coding mechanism guided by cultural semantic information, enabling housing design to shift from decorative expression to semantic perception mapping,

and realizing a quantitatively assessable cultural integration model. This research not only provides structural support for psychological comfort in the living environment, but also provides a theoretical basis for quantitative verification of urban humanistic design, promotes the transformation of residential space from the functional level to the spiritual experience level, and thus improves the quality of life of residents and social cultural cohesion [5,6].

II. PROBLEM AND CHALLENGE ANALYSIS

The designs of existing urban houses have a tendency of being superficially driven by the Chinese cultural aspects with symbolic use being simplified to decorative designs and symbolic representation. Mechanically transplanted onto facades or interior finishes, window lattices, colors and calligraphic patterns do not reach a profound cultural semantic fit using spatial logic and user behavior. Such veneer use loses architecture of its potential to develop culturally; its real residents are subjected to merely formalised cultural images, which lack a spatial sense that can arouse the emotions and day-to-day memories. The role of culture is decreased to visual decoration, and the residential design is deprived of its translation system between word and vision. The design cultural semantics does not constitute full information chain, resulting in a skewed cultural manifestation and concomitant reduction of the spatial recognizability, as well as, of the psychological identification.

The residential space planning is usually pre-informed by circulation and area efficiency without taking into consideration the behavioral connotation and psychological order of cultural imagery. Chinese spatial concepts like boundary, domain, unity and separation that can be converted into contextual logical organizational concepts are fragmented into secluded spatial entities because of excessively functional planning. Spatial experience is deficient of depth and spiritual awareness because residents do not get emotional guidance using the cultural imagery in their day-to-day lives. There comes a lost relationship between architectural word and domestic action making residential areas only an accomplishment of material needs instead of a cultural experience. The circulation, layout and lighting systems cannot be impregnated with cultural images, undermining the attractiveness of the space and eroding the built-in environment to the point where the cultural identity and emotional richness could no longer be identified. The models of urban housing development are largely standardized and the layouts of apartments, materials, colors, and decorative styles are repeated and lead to the monotonous and boring aspect of living. Residents and space do not interact culturally and houses are deprived of their local nature and atmosphere [7,8]. With the cultural symbol losing ties to the context where it is practiced, the dwellers cannot establish a coherent cultural identity in their duration of residence and the utilization of space becomes dependent on the functional practices as opposed to emotional recollections. Houses are commoditized and not a medium of identity and cultural

transmission. The cultural incompetence results in a reduction of psychological satisfaction of the residents, a less humanistic style of life, and a decline in the social cohesion [9,10]. Space becomes semantically inert to provoke feelings and culture is passively turned into a silent background. The cultural design strategies of most residential projects are still on the aesthetic and experience level, and are not supported with data. The knowledge of Chinese cultural aspects by designers is hard to express in measurable parameters and no check system exists between spatial meaning and the response system. Cultural insertion is usually based on the subjective perception causing the uneven degree of cultural expression to be used in various projects. Absence of quantitative tools does not only impact on cultural sustainability but also makes it impossible to conduct systematic assessment of designs. The lack of mapping scheme between cultural semantics and spatial composition as well as resident experience makes integration of culture a loose artistic consideration. The creation of a model of culture variables that can be measured and understood has become one of the most crucial challenges that the residential design world should face to be innovative.

III. RESEARCH METHODS AND TECHNICAL FRAMEWORK

A. SEMANTIC EXTRACTION OF CULTURAL SPACE

The present study has sampled ten types of urban communities including the high density residential areas, low rise cluster residential areas, and the renovated communities. Multidimensional representativeness of the cultural semantic research was to be guaranteed by the choice of the community samples. The method of data collection was based on on-site observation and image analysis and behavioral interviews targeted at identifying architectural symbols, color systems, and cultural semantic information which was associated with human psychology. The analysis of the semantic rhythm of the eaves lines, structural proportions, door and window sizes, and decorative patterns was the subject of the analysis of the architectural symbols. The analysis of the color system was made on the correlation between the warm and cool colors and the cultural symbols, where the visual psychological parameters were defined on the basis of the color mapping tables. Combining the semantic method of evaluation with the scale rating, the data on psychological characteristics were used to determine the level of emotions residents have to the form, colors, and spatial image. All the data were normalized and transformed into semantic variables which could be incorporated into the model.

B. SEMANTIC SPACE ENCODING CONSTRUCTION

Semantic Spatial Encoding (SSE) is an approach to computeably express cultural knowledge, which is a mapping of linguistic symbols, visual representations and spatial links into a multi-dimensional feature array. During the model building procedure, the data extracted is quantified into three

groups of parameters which include a morphological feature layer, an imagery symbol layer and a linguistic semantic layer. The morphological features layer takes as inputs physical indicators including building enclosure, building height, and light flux, the imagery symbol layer relies on the psychological associations of people to buildings and on the symbol recognition data, and the linguistic semantic layer codes the text of resident interviews with a natural language processing model to derive high frequency semantic indicators of cultural feelings. The SSE model involves the application of principal component analysis and semantic clustering algorithm to amalgamate the attributes of the three kinds of variables to produce a cultural spatial semantic matrix. It is the hierarchical relationship and linking structures of the cultural elements in the spatial structure that are reflected in the matrix structure. The model sample parameters are shown in Table 1.

After fusion, the model can output a spatial semantic intensity distribution map, which can be used to verify the area of influence and weight allocation of cultural influence in spatial design. Through this matrix-based processing, cultural elements are transformed from abstract aesthetic concepts into design quantities with logical connections and measurable attributes, theoretically supporting the computational expression and multidimensional distribution analysis of cultural space.

C. OPTIMIZATION OF RESIDENTIAL BEHAVIOR PERCEPTION

The behavioral trajectories and perceptual feedback of the residents are analyzed in terms of the Residential Behavior Perception Model (RBPM), which allows focusing on the cultural spatial semantics. The model is based on the dynamic behavior monitoring and motion trajectory capture technology to rebuild the behavioral features of residents in residential units and the public interfaces using location information. The dimensions in behavioral records consist of physical activity hotspots, dwell time, gaze direction, and activity frequency as these are the indicators of emotional density of spatial interactions. This data about behavior is correlated with SSE matrix in this model to assess the real contribution of various cultural semantic factors to the experience of behaving. The matching coefficient between behavioral preferences and cultural semantic variables is obtained with the help of regression analysis and weighted feedback algorithms, spatial layout, lighting structure, and decoration spaces area ratios are optimized with reference to the results. Once a model has been iterated through, the parametric adjustment of the embedding strategy of cultural elements in terms of the usage feedback is possible, reaching dynamic coordination of the cultural perception and practical comfort. Through this approach, the spatial design can shift towards data driven system of culture behavior feedback as opposed to the use of empirical judgment.

IV. EXPERIMENTAL DESIGN AND DATA ANALYSIS

A. PILOT COMMUNITY SELECTION AND PARAMETER DESCRIPTION

The experimental samples were selected from three representative communities under different urban types: new high-rise communities, historical and cultural communities, and medium-density mixed-use communities. Sample selection was based on the principles of comparing urban spatial structure, building age, and residents' occupational class to ensure the universality and comparability of the cultural spatial semantic model. Each pilot community possessed relatively complete living service facilities and residential stability, thus enabling the objective measurement of the impact of cultural spatial variables on quality of life. During the study, environmental physical parameters, spatial morphology data, and residents' subjective perception questionnaires were collected, resulting in 587 valid samples. This study was approved by the Ethics Committee of Huanghuai University, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form. The model input data, after standardization, was imported into the Semantic Spatial Encoding (SSE) system and the Residential Behavior Perception Model (RBPM) to evaluate the spatial response to cultural semantic embedding. Table 2 shows the basic parameters of the pilot communities.

Newly developed communities have rigid spatial organization rules and limited functions, making cultural intervention relatively difficult; historically-based communities are rich in cultural symbols but have low space utilization; medium-density mixed-use communities combine flexibility and residential vitality, making them ideal samples for validating the model. The building density and age characteristics of the population in different communities determine the differences in sensitivity to cultural semantic information. Based on this, the experimental design establishes a multi-dimensional comparison structure to ensure that the results have statistical significance and empirical explanatory power.

B. IMPLEMENTATION PROCESS AND VERIFICATION INDICATORS

The experiment has been carried out with tri-community semantic space optimization design. These were environmental baseline determination, coding of cultural elements input, RBPM behavioral trajectory input and post-measurement evaluation. The experiment had a duration of six months and compared cultural perception, psychological comfort and efficiency in using space of the residents of the facility before and after the intervention. The measure of cultural identity was a semantic different scale; measurement of psychological comfort was a composite of continuous data based on subjective judgment and physiological feedback; and efficiency of space use was an outcome of dwell time and distribution records of use frequency. Figure 1 shows the model validation indicators and their numerical changes.

TABLE 1. Semantic Space Coding (SSE) Feature Parameter Matrix

Parameter categories	Feature variables	Data source	Encoding method	Output semantic weights (0-1)
Morphological feature layer	Enclosure ratio, floor height, and illuminance	Measured building physics data	Numerical normalization	0.72
Image symbol layer	Color preferences, symbol recognition	Resident psychological questionnaires and semantic assessment	Emotional vocabulary mapping and cluster analysis	0.63
Language semantic layer	Cultural word frequency and semantic sentiment value	Resident Interview Text Corpus	NLP Sentiment Analysis and Coding	0.58
Comprehensive semantic structure layer	Semantic density, symbol hierarchy	Model fusion calculation results	Feature fusion matrix method	0.81
Output verification layer	Spatial perception response intensity	Behavioral perception experiment feedback	Weighted Iterative Regression Analysis	0.76

TABLE 2. Comparison of basic parameters of pilot communities

Community Type	Year of construction	Number of sample households	Building density (%)	Average age (years)	Community Type Characteristics Description
New district-type high-rise community	After 2015	210 households	42.5	32.4	Modern facade, clearly defined functional zones
Historical and cultural community	1995	182 households	58.7	44.1	Preserving the traditional street and alley structure
Medium-density mixed-use communities	2008	195 households	49.2	37.6	Mixed residential and commercial layout

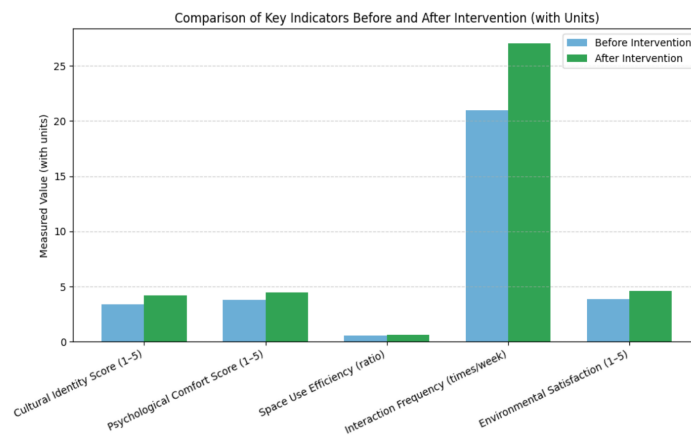
**FIGURE 1.** Model validation metrics and numerical changes

Figure 1 shows that cultural semantic optimization significantly improved residents' emotional identification with and willingness to use the space. The increase in cultural identification indicates that the cultural hierarchy system established by SSE coding successfully constructed a psychological connection between language and space; the increase in psychological comfort reflects the moderating effect of light and color matching strategies and word meaning matching on perceptual balance; the simultaneous increase in space utilization efficiency and interaction frequency indicates that cultural spaces have the potential to promote social communication. The differences before and after the experiment were statistically significant ($p < 0.01$), indicating that the model optimization results have statistical reliability.

C. DATA ANALYSIS AND MODEL VALIDATION RESULTS

Following the intervention in cultural semantic optimization, all indicators showed significant positive changes.

The cultural identity score increased from 3.4 to 4.2, a 23.6% increase, indicating that after undergoing semantic spatial reconstruction, residents were more likely to identify cultural information and form a sense of belonging through environmental elements. Psychological comfort rose from 3.8 to 4.5, demonstrating that the matching relationship between lighting, color, and form factors in the environment and cultural semantics improved the balance of spatial perception, resulting in a positive effect of the living environment on emotional regulation. Space utilization efficiency increased from 0.55 to 0.65, a 18.2% increase. Combined with trajectory data analysis, this shows that residents spent more time in areas richer in cultural information, and their activity trajectories shifted from unidirectional flow to cyclical interaction, allowing for more efficient use of space resources. Interaction frequency increased by 28.6%, reflecting that cultural space design promoted group communication and social cohesion; environmental

satisfaction rose from 3.9 to 4.6, indicating that culturally embedded design not only optimized the visual experience but also enhanced psychological security and social identity. Comprehensive analysis shows that the integration of the SSE and RBPM models effectively establishes a positive mapping relationship between cultural semantics and residential behavior, transforming cultural space design from aesthetic expression into a measurable psychological and behavioral improvement mechanism.

V. CONCLUSION

Incorporating Chinese cultural semantics into urban housing planning serves to interlace psychological resonance with the physical environment, hereby positively directing the spatial experience toward the residents' well-being. This semantic integration transforms the residential landscape into a finely spun cultural fabric where the threads of tradition and modern life are tightly bound to support the mental and emotional security of the inhabitants. By means of the joint implementation of the SSE and the RBPM models, the cultural symbols are transformed into the calculable and verifiable design parameters and the traditional culture is moved a step further, to the logical entrenchment on the structural and the perceptual levels. Spatial design is no longer functional but cultural image based to create two-way feedback between the living experience and the environment. The cultural semantics intervention does not only enhance the emotional recognizability and communicative qualities of living spaces but also rebuilds the psychological relationship between individuals, culture and architecture, in a subtle way, which realizes a compound manifestation of the social and spiritual characters of the space. Such approach gives a scientific direction on the subsequent cultural renewal and behavioral environment optimization of the urban housing so that the designs can have the potential of quantifiable evaluation and continued improvement. The importance of this study is to confirm that culture expression is not merely the manifestation of visual signs but also of a spatialization of the emotional memory and mental rationality. This study establishes a generalizable data model that functions as a precision-engineered loom for Chinese residential design, facilitating the seamless interlacing of architectural structures, cultural semantics, and the tactile richness of human experience. By providing this methodological framework, it ensures the comprehensive growth of a living cultural fabric where the threads of tradition and modern life are woven into a resilient and meaningful domestic environment.

AUTHOR CONTRIBUTIONS

Conceptualization – Geng Wang and Gangqiang Li; methodology – Geng Wang and Gangqiang Li; investigation – Geng Wang and Gangqiang Li; writing-original draft preparation – Geng Wang and Gangqiang Li. All authors have read and agreed to the published version of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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HUMAN RESEARCH SUBJECTS

This study was approved by the Ethics Committee of Huanghuai University, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form. The model input data, after.

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