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Research on the Design Strategy of Multi-scene Light Environment Mode in Aging Space

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Abstract:

Under the background of the aging of the current social population and the gradual normalization of home-based care for the elderly, the light environment used in the existing space for the elderly is mostly homogeneous and does not adapt to diversified scenes. Traditional lighting is difficult to meet the physiological visual or behavioral characteristics of the elderly. Various special needs. Most of the existing research on the light environment for the elderly in China focuses on the analysis of a single space, and the angle is relatively scattered. There is still a lack of overall design ideas or practical solutions from multiple scenarios. In this paper, multi-scene matching and low intervention are discussed as the basic ideas. Combined with literature, investigation, human factors and model induction and analysis, the residential, community and pension places are taken as three types of key points to construct a dynamic classification framework of light environment, and then a lightweight and less interference design optimization scheme is proposed. The research makes a complete supplement to the systematic light environment suitable for the elderly, and also provides a theoretical and practical reference for the transformation of the existing space and living conditions for the elderly.

Keywords:

Aging Space, Multi-scene, Light Environment, Mode Design, Low Intervention Design, Human Settlement Environment

1. Introduction

Under the dual background of deep population aging and urban stock space renewal, the improvement of light environment quality suitable for aging is the focus of human settlements optimization [1]. At present, China still basically adopts general lighting design labeling for residential, community and old-age places suitable for the elderly. Static lighting design is difficult to adapt to the physiological vision decline, work and rest habits, psychological resistance to transformation and other needs of the elderly. Most of the existing research focuses on a single factor in space or a local intelligent scheme, and lacks the light environment design logic and low-interference strategy method that takes the whole life situation into account. There are problems such as fragmentation of research, lack of scenes, and disconnection between theory and practice. Through the analysis of the current situation and the analysis of human needs,

this paper combs the light environment model suitable for the elderly in multiple scenarios, constructs the dynamic light environment model system, and puts forward the targeted landing design strategy, so as to provide theoretical support for the refinement of the light environment suitable for the elderly.

2. Analysis of the Current Situation of Aging Space Light Environment and Multi-Scenario Requirements

2.1. The existing common problems of light environment suitable for the elderly

At present, the light environment of suitable aging space in China basically has structural defects, and most of the projects involved have no matching degree or fineness. The lighting method itself is fixed and monotonous. Most suitable spaces for the elderly set the illumination and color temperature of the whole day as constant static values, regardless of the light needs of the elderly at various stages of daytime action, night walking, doing meticulous things or rest, resulting in daytime too dark, nighttime strong light or unnatural conversion of light and shade [2]. At this stage, the transformation of the aging light environment is mainly based on the explicit means, and the overall design is completed with additional lamps, high-brightness logos, and rigid lights, resulting in visual clutter and style imbalance. It also forms an impression of over-endowment, which is easy to induce psychological resistance of the elderly. The current intelligent lighting is not good enough for aging applications. Its control logic is complex, the light and shadow transition is rigid, the induction intensity is too high or insufficient, and it cannot adapt to the simple, stable and normal use habits of the elderly. Moreover, the existing lighting design lacks the thinking of stratification according to the scene, and does not set the lighting standard according to the actual function or behavior. The traffic, reading and rehabilitation items share a single parameter. The proposed scheme cannot take into account the multiple needs of safety, convenience and recuperation, and lacks complete guidance.

2.2. Multi-scene system division and differentiated requirements

Starting from the all-weather activities and related spatial functions of the elderly, this paper makes three basic divisions of home life, community public and old-age care for the aging space. The crowd, behavior or function involved in each scene are significantly different, so it corresponds to different light environment adaptation needs.

Home life is a basic situation that the elderly use the most. It involves getting up and sitting, writing and reading, doing housework, walking at night, resting and sleeping. During the day, fine movements should be clearly and comfortably lit. At night, light should be handled in a soft way to ensure traffic safety [3]. At the same time, the light transition during sleep should be properly arranged, so there is a high requirement for the adaptability of the light environment. All kinds of public spaces in the community are mostly outdoor or public areas in buildings. Their functions can be summarized as walking access, social contact, sedentary recuperation, and lighter rehabilitation. They should be based on uniform lighting, clear path and overall safety. Minimize shadow blind spots and brightness contrast, try to avoid falling due to visual confusion, and do not make the public atmosphere too tense or depressed [4]. The old-age care institutions are designed according to professional standards. They are designed for self-care or partially disabled elderly with cognitive difficulties. The activities include rehabilitation exercises, emotional regulation, life help, and night

care. It is necessary to ensure basic visual safety, use light to regulate somatosensory rhythm and psychological state, and achieve the convenience of long-term care. There are stricter requirements for the timing, stability and low stimulation of light and shadow [5].

3. Low Intervention Design Strategy for Aging Light Environment Based on Multi-Scenario Requirements

This section should present your findings objectively, explaining them largely, concisely, precisely in the text. You should show how your results contribute to the scientific knowledge in academic community clearly and logically. Results and Discussion may be divided by subheadings, concluding equations, figures, tables, etc.

3.1. General principles of multi-scene light environment design

Based on the physiological and psychological characteristics of the elderly, this paper proposes five basic construction principles to provide a basis for the design of multi-scene light environment models in view of the shortcomings of the existing light environment and the realistic constraints of the transformation of stock space.

First, the principle of security adaptation. Taking visual and action safety as the primary consideration, we strictly control glare, stroboscopic, light-dark transition and local darkness, so that lighting meets the physiological conditions required for visual degradation in the elderly and reduces falls or visual fatigue. Second, the principle of behavior matching. Starting from the scene function and the behavior of the elderly group, the lighting form, light and shadow parameters and atmosphere are accurately matched with the specific behavior, so as to avoid the indiscriminate and homogeneous lighting treatment of each region. Third, the principle of low intervention. The lighting equipment should be hidden, and its layout should be embedded and integrated, so as not to destroy the original and deterministic space scene atmosphere. Fourth, the principle of temporal dynamics. The dynamic changes of light and shadow are arranged according to day and night, sunlight and human body state, and the biological rhythm is included in the scope of lighting design[6]. Fifth, the principle of spatial integration. In the built space, it takes into account the needs of function, aesthetics and economy, so as to achieve light weight, low cost and low interference, so that the three can be coordinated and unified.

3.2. Spatial implicit integration design strategy

Spatial implicit integration is the core strategy of low-intervention aging light environment design. The use of integrated approach and inconspicuous design does not require dramatic transformation of space or lighting as an isolated element to deal with, but to the two-phase coordination and coexistence. In the background of home life, lamp belt, wall embedded light, cabinet lighting or ground soft light belt should be used as lighting elements, so that the light source used is not exposed to the building structure or soft outfit, and can meet the visual needs of living, reading and walking at night respectively. As far as the public part of the community is concerned, the overall linear soft light design is made for the passage points such as footpaths, stairs, exits and corners, without too strong or too weak light and shade areas, so that the road lighting is smooth and the light sense is soft [7]. It is a suitable arrangement for the elderly to walk slowly and have weak vision, which can improve the safety of passage in public areas. According to the actual needs of the pension institutions, the

light intensity is adjusted by using the time law, so that the light source has high uniformity, high color rendering, no shadow, no eye-catching feeling. With the block lighting scheme, the care, road and rest are included in the comfort category to meet the practical requirements of long-term care.

3.3. Scene light and shadow parameter adaptation strategy

Aiming at the problems of homogenization of traditional lighting parameters for the elderly, wide universal range and insufficient scene matching, the idea of light and shadow parameter adaptation based on scene is introduced, and the layered and feasible parameter standards are determined according to the characteristics of the three types of scenes for the elderly mentioned above. Avoid treating the whole house illumination or the color temperature of the whole year as a fixed value, and should be based on the actual needs of the scene functions of home operations, community traffic, and convalescent institutions, and do differentiated numerical settings for illumination, color temperature, color rendering index, and lighting uniformity. The home scene focuses on high color rendering and moderate illumination to meet the needs of fine visual action [8]; community public areas should ensure uniform lighting and low light-dark contrast to make walking and activities safer. Pension institutions focus on timing color temperature adjustable,low blue light,weak stimulation parameters, to adapt to the elderly biological rhythm regulation and long-term care needs [9]. Through the precise adaptation of scene parameters, the problem of disconnection between general lighting and elderly behavior is solved technically, and the characteristics of light, spatial use and behavior mode are deeply coupled, which provides a quantitative analysis basis for the design of multi-scene light environment mode.

3.4. Intelligent non-inductive dimming control strategy

The control strategy based on intelligent non-inductive dimming aims at lightweight, fully automatic and low operating burden, which makes up for the shortcomings of traditional intelligent lighting, such as too complicated, unsmooth switching and dependence on manual work, and realizes dynamic timing lighting in three types of scenarios [10].

Relying on photosensitive sensing, human body induction and timing preset, the home space realizes the smooth transition switching of different light states of daytime living, fine operation, nighttime rising, sleep and rest, without the need for manual operation by the elderly. The public space of the community is combined with the natural light sensor to automatically adjust the lighting output of the trail and the activity area according to the day and night, the cloudy and sunny ; the old-age care institutions rely on timing regulation to achieve rhythmic lighting, improve the vitality of the light environment during the day, lower the overall illumination at night, and meet the basic lighting of nursing inspections [11].

The system uses gradient dimming logic instead of hard jump, reduces the threshold of use, and achieves the effect of intelligent technology without sensing service and adaptive adaptation of light environment.

3.5. Optimization strategy of psychological atmosphere for the elderly

The aging light environment not only needs to meet the physiological and visual needs, but also needs to take into account the emotional and psychological demands of the elderly group. This strategy runs through three types of aging scenes.

The home scene maintains the soft light and shadow of life, abandons the lights with too much warning, and maintains the familiar and relaxed atmosphere of family space [12]; the community public scene creates a comfortable environment for neighborhood social interaction with diffuse soft light to avoid exaggeration. The old-age care institutions weaken the medical and institutional lighting experience, and eliminate the psychological pressure brought by the institutional space with mild and uniform light and shadow [13].

The design avoids the use of high-contrast warning lights, excessively bright colors or mechanical functions to create discomfort, and avoids the formation of deliberate labels for the elderly [14]. Relying on high-uniformity diffuse lighting and traceless light and shadow transition, it creates a familiar and safe space experience, alleviates the elderly's rejection of aging, strengthens the sense of space belonging, and realizes the dual optimization of physiological adaptation and psychological experience.

4. Conclusions

In order to solve the problems of homogenization of light environment, insufficient scene adaptation, and psychological exclusion of the elderly caused by explicit layout, this paper sorts out the existing problems and differentiated light requirements of three types of scenes in home, community and pension institutions, and establishes five overall design principles of multi-scene light environment. A set of low-intervention design strategies are constructed from the dimensions of spatial implicit integration, scene-based light and shadow parameter adaptation, intelligent non-sensory dimming control, and elderly psychological atmosphere optimization. The application interpretation is carried out in combination with different spatial characteristics, taking into account the design of new space suitable for the elderly and the lightweight update of stock space, so as to make up for the existing research that emphasizes general parameters and ignores scene differences. The short board of emphasizing hardware technology and neglecting psychological experience can provide reference for the fine construction of the light environment suitable for the elderly. This study is mainly aimed at the general space suitable for the elderly, which has not yet covered the needs of special elderly groups such as severe disability and severe cognitive impairment, and the fineness of scene matching can be improved. In the future, we can combine rhythm monitoring and perception technology to further improve the design rules of light environment for special groups, and promote the development of light environment suitable for the elderly to the direction of people-oriented refinement [15].

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this article.

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