Research on Computer Assisted Intelligent Emission System of High-rise Building Based on BIM Technology and Wireless Automatic Monitoring

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Abstract. In response to the needs of low-carbon design and carbon emission measurement of public buildings, we use advanced information tools, building information model BIM technology to solve these problems, and from the perspective of strategic development, we will establish a set of home improvement design systems based on BIM technology for unification Three-dimensional home improvement design. The system includes analysis of thermal performance of high-rise building decoration and building light environment, and proposes optimization countermeasures for low-carbon design.

Keywords: BMI technology, high-rise building decoration, intelligence, carbon emission measurement system.

1. Introduction
In 2009, the "Building and Climate Change" report released by the United Nations Environment Program showed that the energy consumption of the construction industry accounts for 40% of the energy consumption of various industries in the world, and the construction industry emits 1/3 of the world's greenhouse gases. With the completion of the national "Twelfth Five-Year Plan" and the beginning of the "Thirteenth Five-Year Plan", the pace of new urbanization has been further accelerated. China's planned buildings have rapidly increased, and the consumption of building materials has also increased significantly. This will inevitably lead to an increase in the country's resource consumption and greenhouse gas emissions [1]. In the entire life cycle of a building, the operating phase of a building is the phase with the most carbon emissions. How to reduce carbon emissions in the operating phase is a key link in building energy conservation and emission reduction. At present, there are no home improvement design tools in the home decoration industry that can realize the linkage between the flat, vertical, and cross-sectional graphics and the three-dimensional model at the same time. As a result, the partial changes in the drawings of the home decoration design need to be redrawn and rendered. This problem has become the main reason for home improvement designers to improve work efficiency and the rapid development of home improvement companies. At the same time, the home improvement industry also includes drawing design, home improvement materials purchase, construction project management and supervision and other links. The workload in the whole chain is very large. Among them, the budget is opaque, the construction period is delayed, the quotation is not clear, and the materials are substandard. Waiting to become a pain point in the
development of the home improvement industry. Therefore, this article takes a villa building as the research object and constructs a set of home improvement design software based on the current development of the home improvement design industry [2]. By using the functions and advantages of the building information model to perform a BIM-based energy-saving analysis on the model before and after the design improvement, it proves the feasibility of the BIM technology in the study of carbon emissions during the building operation stage.

2. System design and main function design

2.1. The overall design of the system
This article uses BIM technology as hardware support, integrates it into the overall service of home improvement design, uses it as a data carrier to build a three-dimensional decoration design software system centered on BIM technology. In this design, it is expanded by two levels: (1) Soft decoration design. (2) Hard-mounted design. The latter needs to achieve functional requirements including: wall and room layout drawing, water, and electricity design, etc.; the former mainly refers to the placement of a series of products, such as sofas, curtains, etc. Figure 1 shows the main architecture of the system.

Based on clarifying the main functional requirements, the software tool can complete several functions such as modelling drawing, product combination, and two-dimensional view switching. Among them, modelling drawing uses visualization as the main method to achieve the stitching of various graphics patterns. The purpose of tailoring includes the design of house types, water and electricity, skirting, etc.; product portfolio refers to the induction of models stored in the product library to the design platform, and the use of coordinate systems to realize the process of drag and drop based on the model. Complete the corresponding combination. In addition, the system also needs to have the precise measurement function of the design plan, and the realization of this function needs to be supported by two architectures: First, build a complete enterprise list quota, material library and other various databases [3]. The information data and the design software complete the relevant integration to facilitate the establishment of an effective association between the basic product information and the basic library; second, for a series of product lists involved in the design plan, including the corresponding customized dosages to be accurately summarized and integrated.
2.2. System physical topology design
This system is a B/S+C/S architecture application system deployed on the WEB server and the client respectively. The system is divided into two relationship levels, namely the corporate headquarters, each branch, and the store client. The enterprise headquarters deploy the B/S centralized management platform, that is, the BIM design management platform, which includes the management of workflow, authority management, knowledge management, building material product library, construction process library, standard specification, and design plan library. The store client deploys a C/S architecture three-dimensional home improvement design system. Mobile terminal deployment of mobile terminal applications, including process approval, mobile application display, browse and view solutions. The home improvement design system based on BIM technology is deployed in the group headquarters. The network resources include: application servers, database servers, storage servers, firewalls, switches, routers, and personal computers. All subordinate branches, subsidiaries and other units access the group network through the Internet network to complete the maintenance and management of the design system [4]. The headquarters firewall effectively guarantees the security of business data when the headquarters and branch users access the server. The specific physical topology is shown in Figure 2.

![System physical topology](image)

Figure 2. System physical topology

3. Smart carbon emission management

3.1. Calculate the comprehensive carbon emission coefficient of sub-projects
The sub-projects in the construction phase mainly include three parts: labour, materials, and machinery. Comprehensively considering the number of the three parts, their respective carbon emission coefficients, the recycling rate of building materials and the repair rate of building components, the calculation formula for the comprehensive carbon emission coefficient of sub-projects can be established as:
\[
C_i = \left[\Sigma pC_{per} + \Sigma qC_{mat} (1 - \mu) + \Sigma rC_{mach}\right] (1 + \eta)
\]  

(1)

In the formula, \(C_i\) is the comprehensive carbon emission coefficient of a certain sub-project; \(p, q, r\) are the number of labours, material, and machinery in various unit projects respectively; \(C_{per}, C_{mat}, C_{mach}\) is the carbon emission coefficient of various labour, material, and machinery respectively; \(\mu\) is the material recovery rate; \(\eta\) is the repair rate of building components.

### 3.2. Calculating the comprehensive carbon emission coefficient of the measure project

The "National Uniform Cost Rates for Construction Machinery per shift" stipulates the energy consumption of construction machinery, including gasoline, diesel, coal, electricity, water, firewood, etc., combined with the energy carbon emission coefficient and calculates the comprehensive carbon emission coefficient of the project accordingly [5]. The formula for calculating the comprehensive carbon emission coefficient of the establishment of the measure project is:

\[
C_j = \Sigma pC_{per} + \Sigma qC_{mat} (1 - \mu) + \Sigma rC_{mach}
\]  

(2)

In the formula, \(C_j\) is the comprehensive carbon emission coefficient of a certain measure project; \(p, q, r\) are the quantity of labour, material, and machinery in various unit projects respectively; \(C_{per}, C_{mat}, C_{mach}\) is the carbon emission coefficient of various labour, material, and machinery respectively. The carbon emissions of buildings in the operation stage mainly measure the carbon emissions of construction equipment and the carbon sink of green spaces.

#### 3.2.1. Electricity carbon emission factor.

According to the average carbon dioxide emission data of China's regional power grid unit power supply provided in the "Provincial Greenhouse Gas Inventory Compilation Guidelines", this study takes the average carbon emission coefficient of unit power supply in Central China to be 0.801kg/kWh.

#### 3.2.2. Carbon emissions of air-conditioning systems.

According to the air conditioning load simulation data in the BIM model of the sample building, the building HVAC system is selected as an energy-saving inverter air conditioner, with a cooling energy efficiency ratio of 3.6 and a heating energy efficiency ratio of 3.3. The annual power consumption of the sample building is 351,734 kWh.

#### 3.2.3. Carbon emission of lighting system.

Architectural lighting load density refers to the lighting load density of office buildings in "Data of Commonly Used Electrical Appliances in Architectural Design" (04DX101-1), which is 10W/m², a total of 10000m², the need factor is 0.5, the power factor is 0.9, and the electricity load is 45kW. According to the analysis of the architectural light environment, the natural lighting conditions of the sample buildings are relatively good [6]. Calculated based on the need for artificial lighting for 125 days per year and 10 hours of electricity consumption per day, the annual electricity consumption of architectural lighting is 56250kWh.

#### 3.2.4. Greenbelt carbon sink.

The greening rate of the sample building design plan is 30%, the green area is 900m², and the plant species are mainly shrubs. Taking the carbon dioxide absorption coefficient as 0.212kg/m², the annual carbon sink of the sample building is 190.8kg.

### 4. System test analysis

Before using BIM technology to analyse the building's thermal environment, it is necessary to export the building model in Revit to a gbxml file, and then import the exported gbxml file into Ecotect Analysis, and perform monthly air conditioning energy consumption analysis on the model. As shown
in Figure 3, it is the architectural analysis model after the Revit architectural model is imported into Ecotect Analysis.

![Ecotect Analysis Ecotec model](image)

**Figure 3.** Ecotect Analysis Ecotec model

In this paper, three sets of simulation analysis are carried out on the indoor thermal environment of the building from the angle of glass material and building orientation. They are the building’s due south orientation and single-layer ordinary glass, due south orientation and double-layer Low-E glass, and south-west 7.5° And a single layer of ordinary glass. After adding the relevant building information parameters of the model and setting up the air-conditioning system, perform the monthly heating and cooling simulation of the building throughout the year, and you can get the monthly air-conditioning energy consumption of the building throughout the year as shown in Figure 4-6 (gray means heating for each month Power consumption, black is cooling power consumption for each month). Table 1 shows the specific numerical values of 3 sets of simulated annual building energy consumption. It can be seen from Table 1 that in terms of energy consumption in the indoor thermal environment of a building, the choice of glass material has a greater impact than the orientation of the building.

| Project | South facing and single-layer ordinary glass | South facing and double Low-E glass | 7.5° west by south and single layer of ordinary glass |
|---------|---------------------------------------------|---------------------------------|-----------------------------------------------------|
| Heating load/kW·h | 14816 | 13826 | 14,855 |
| Cooling load/kW·h | 2987 | 3068 | 2720 |
| Total/kW·h | 17,803 | 16,894 | 17575 |

During the 50-year operation period, the use of double-layer Low-E glass has reduced carbon emissions by 140t, accounting for about 4.7% of the initial plan; with the best orientation of the building, the building has reduced carbon emissions by 40t, accounting for about 1.4% of the initial plan. By comparing the above data, the selection of glass material reduces carbon emissions by 100t more than the orientation of the building, and the effect of energy saving and emission reduction is obvious. Therefore, in the building energy-saving design stage, when the building orientation meets local regulations, more consideration should be given to the role of building materials in reducing...
carbon emissions, to effectively reduce the carbon emissions of buildings throughout the life cycle of the building.

5. Conclusion
BIM technology has a powerful visualization function. In the design of energy saving and emission reduction, it has stronger operability than traditional energy saving design. The selected materials can be changed arbitrarily in the model, and the results of the new plan can be quickly simulated to select the least carbon emissions program. The implementation of this system has been successfully launched in the D company, which has indeed improved the designer’s work efficiency. At the same time, the company has accumulated design resources through the system and improved the management level. However, the current system modules need to be further developed during the use process. Meet the needs of enterprise business development and management.

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