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The Case Recommendation System for Reinforcement and Deformation Correction in High-rise Buildings

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Abstract

As the construction industry continues to raise its standards for safety and quality, reinforcement and correction technologies have become increasingly important in the renovation and repair of high-rise building structures. This paper proposes a content-based reinforcement and correction project case recommendation system that automatically recommends the most suitable reinforcement solutions based on data such as the tilt degree and structural type of high-rise buildings, aiming to improve construction efficiency and precision. This paper extracts the features of buildings and reinforcement cases, converting information such as the building's tilt degree and structural type into vectors. The cosine similarity algorithm is then used to calculate the similarity between buildings and reinforcement cases, generating the most suitable recommendation results. The system effectively improves the accuracy of reinforcement plan selection, reduces construction costs, and provides a more efficient decision-support tool for reinforcement and correction projects.

Keywords

Case Recommendation; Reinforcement and Correction; High-Rise Buildings; Content-Based Recommendation.

1. Introduction

In the construction industry, reinforcement and correction of high-rise buildings are key technologies for addressing issues such as building tilt and settlement. With the acceleration of urbanization, particularly the increasing number of old buildings, building tilt has gradually become a significant safety hazard that affects both structural integrity and functionality. Traditional reinforcement and correction methods often rely on manual experience and lack a systematic reference for case selection, resulting in longer project cycles, higher costs, and less stable outcomes[1]. Therefore, it is essential to develop a reinforcement and correction project case recommendation system for high-rise buildings.

2. System Design

2.1. System Requirements Analysis

The goal of the Reinforcement and Correction Project Case Recommendation System is to use reinforcement and correction technology to solve the problem of building tilt in high-rise buildings. The system analyzes the treatment experiences of related previous projects and automatically suggests appropriate engineering cases after surveying the tilt degree of a

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building. After analyzing the system's requirements, including a summary of all modules and functions, the essential system features are as follows：

User Management Module: The system includes functions for user registration, login, and identity authentication. Users can log into the platform using a username and password, with different types of users granted varying levels of permissions. The system supports two user roles: engineers and administrators. Engineers can access the basic functions of the system but can only view and modify their personal information; administrators can manage all user information.

Data Collection and Analysis Module: This module is an important component of the reinforcement and correction project case recommendation system. The system connects to building tilt detection tools to collect data on the tilt degree of buildings, supporting both manual input and automatic sensor readings. The collected tilt data is pre-processed to remove noise and outliers, and then categorized and analyzed based on the building's structural type and tilt degree.

Case Recommendation Module: This module uses parameters such as the building's tilt degree and structural type to calculate the similarity between projects and cases using a content-based recommendation algorithm, generating recommended engineering cases. The algorithm references similar project reinforcement solutions to provide personalized recommendations for the project. Based on the recommendation results, the system generates a list of suitable options. Additionally, the system continuously optimizes the algorithm based on historical data, gradually improving recommendation accuracy and user satisfaction.

Project Management and Tracking Module: This module supports the creation, editing, and deletion of projects, and allows the management of basic project information and progress. Engineers can record the progress of each project within the system and update the project status in real-time. The system also provides visualization features, such as Gantt charts and progress bars, to help users clearly track the project's progress.

Data Analysis and Reporting Module: The system analyzes the reinforcement effectiveness of historical projects, the success rate of projects, etc., and generates visual reports to assist users in making better decisions.

2.2. Data source and preprocessing

In the reinforcement and correction project case recommendation system for high-rise buildings, the data source and preprocessing are crucial. The following outlines the data sources and data processing workflow of the system:

(1)Data sources.

Building Tilt Data: The building tilt data is sourced from building tilt detection tools.

Historical Project Data: This consists of information from earlier studies, which can be used to assess the effectiveness and success rate of the project.

(2)Data preprocessing.

Data Cleaning: Process the raw data to eliminate invalid and unreasonable entries. Feature Extraction: Identify and extract the most relevant features from the dataset to suggest cases effectively.

2.3. Recommendation algorithm design

The content-based recommendation method primarily recommends items based on the features of users and items. The core idea of this method is: if a user likes certain items, the system recommends other items that are similar to those items[2].

The content-based recommendation algorithm in this system is mainly divided into the following steps:

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(1)Feature Extraction: Extract features from the building and reinforcement cases, and convert them into numerical form.

(2)Similarity Calculation: Calculate the similarity between the building and reinforcement cases. Common methods include cosine similarity, Euclidean distance, etc. This system uses the cosine similarity algorithm for similarity calculation.

(3)Generate Recommendation List: Based on the calculated similarity, recommend the most similar reinforcement cases for the building.

In the design of the content-based recommendation algorithm, the core of the algorithm is to calculate the similarity between the building features and reinforcement case features, then construct a similarity matrix. Based on this matrix, the system recommends the reinforcement cases that best meet the building's needs[3].

3. System implementation

3.1. Technical architecture and tool selection

3.1.1. System Architecture

This system mainly consists of the following four modules:

User module: This module provides an interactive interface between users and the system, allowing users to perform basic operations such as logging in and entering data. The system also displays case recommendation results through this module.

Data preprocessing module: This module processes the raw input data of the system, including building tilt data, project progress data, and more. The recommendation module uses the processed data to calculate similarity and other relevant information.

Project management module: This module is used in the project management, which is used to keep track of and record the information about the project, as well as to track the progress made in the process of the project.

Recommendation Module: The system utilizes a content-based recommendation approach to implement the reinforcement case recommendation module. The algorithm applies the cosine similarity method to calculate the similarity between buildings and reinforcement cases, generates a similarity matrix, and ultimately produces a recommendation table based on the matrix.

3.1.2. Technology Overview

The following are the main technologies and tools used in the system:

(1)MySQL: A widely used database known for its simplicity and ease of use, commonly found in various applications.

(2)Spring Boot framework: A framework based on Spring that allows for the rapid creation of Spring applications, automatically configures the environment, and generates some code, streamlining the application development process[4].

(3)Vue Framework: It was easier to get started because of the development of a progressive framework that was intended to create user interfaces with its main library, which is centered on the view layer.

(4)Element UI: A UI component library based on Vue.js, offering a large number of elements to enable the rapid development of user-friendly interfaces.

3.2. Recommended module implementation

In this system, the recommendation module recommends suitable reinforcement cases for users based on building tilt data, historical reinforcement cases, historical project data, etc. The specific process is as follows:

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(1)Prepare Relevant Feature Data: Collect the relevant feature data of buildings and reinforcement cases, including the building's tilt degree, structural type, the tilt degree range applicable to the reinforcement case, the structural types the case is suitable for, and the recommended reinforcement methods.

(2)Feature Transformation: Convert the features of buildings and reinforcement cases into vectors for similarity calculation.

(3)Similarity Calculation: Use the cosine similarity method to calculate the similarity between the building and reinforcement cases. Recommendations are made based on the calculated similarity[5].

(4)Generate Similarity Matrix: Create a similarity matrix and select the top reinforcement cases that are most similar to the target building for recommendation.

4. System Testing and Analysis

The testing method used in this evaluation is black-box testing, with the following objectives for the system test:

(1)To verify whether the recommendation system functions properly.

(2)To test whether the user interface displays correctly and if user operations are simple and intuitive. Additionally, to evaluate whether the system administrator interface functions properly and if the administrative tasks are straightforward, with seamless transitions between pages.

(3)To ensure that all functionalities within the system have been implemented and align with the requirements outlined in the system's analysis.

The results of the system testing indicate that the reinforcement and correction project case recommendation system for high-rise buildings performs well in recommending reinforcement and correction cases and successfully implements all the functionalities specified.

5. Summary

This paper provides a detailed explanation of the design and implementation of the reinforcement and correction project case recommendation system for high-rise buildings, as well as the system's functions and features. The system integrates the current state of case selection in domestic building reinforcement and correction processes, aiming to provide a platform that can reduce construction costs and improve construction efficiency. It is a targeted recommendation system. Based on data such as the building's tilt degree, the system intelligently recommends the required reinforcement cases for the project. The system serves as an efficient case selection platform for engineers in the reinforcement and correction field, and can also serve as a reference for addressing other issues in the construction industry.

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