Design and Development of Next-Gen Exam Management Suite Using Spring Boot Application

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Abstract—This paper aimed at offering an outlook on the Spring Boot structure as well as establishing varied approaches to the management of examinations. Moreover, the article indicates the design idea and primary functional modules of Next-Gen Exam Management Suite which is developed on the base of Spring Boot. Testing scheduling, user login, computerised marking, detailed result generation, examinee control, random question generation, result control and system control are all part of the exam management suite. In order to enhance the characteristics of maintainability, scalability, and usability, the underlying technology utilized in this work is Spring Boot framework, and the structure of the network layers is divided into three layers based on the B/S (Browser/Server) structure.

Keywords—MVC framework; exam system; paper constructing algorithm; database design

I. INTRODUCTION

There is increasing trend to develop a paperless examination system since the computer and network technology is rapidly advancing . There are several benefits of such systems, such as the decrease in the costs of labor and materials, the ability to afford and provide accurate and fair assessment of students' academic performance, and a significantly increased exam effectiveness. Important features like automated question generator, randomly generated test sheets, automated grading and "paperless exams" This technology also enhances the teachers' productivity by grading exams. To reduce the amount of stress and the amount of effort placed on the organization of questions, teachers may also command the system to quickly select an adequate number of questions from the test bank depending on the kind and the quantity of tests needed.

II. THE MVCFRAMEWORK

The Next-Gen Exam Management Suite makes use of the Spring Boot in the architecture. It is easy to add up new features on the applications since Spring Boot has a modular approach to developing applications. This is because of its specific characteristics of separating task, simple testing, and support for test-driven development, and so on; accordingly, Spring Boot framework has been swiftly applied to the construction of large-scale and highly expansible Web projects. In order to reduce coupling between modules, the fundamental idea is to split processes into three relatively separate pieces that can cooperate: triad of the controller, the view, and the model [2]. A easily extensible design and disperse of the application are the consequence of this division. Thus, indeed, when developing web apps, Spring Boot has many advantages. Hence, distributed ACID-qualified transactions are particularly appropriate for government platforms and other multi-user, expandable, maintainable systems[3].

The MVC framework is composed of three parts, as shown in Figure 1. The model is the logical abstraction of problem-related data. The view is the user interface and the controller is the link to associate the model with the view.

III. THE COMMON PAPER CONSTRUCTING ALGORITHM [4]

3.1 The random paper constructing algorithm

The random paper constructing algorithm in the first step checks and identifies the test question control parameters based on actual requirements. One is randomly selected from the test bank in compliance with the set parameters to save it in the test paper table as a plausible test question. This is done until the respective test questions scores correspond to the predetermined scores in order to complete the paper constructing. An algorithm of constructing random papers can be described as follows: It is rather simple and does not pose any difficulties when applied. This approach is useful when there are relatively few control parameters that can be created on paper. The success rate of paper building will decrease with the addition of requirements.

3.2 The fuzzy paper constructing algorithm

The random paper constructing algorithm first verifies and extracts test question control parameters in accordance with actual demands. It then chooses a passable test question at random from the test bank in accordance with parameters to save it in the test paper tableThis

process is repeated until all test question scores match the predetermined scores in order to finish paper constructing. The algorithm for creating random papers is straightforward and easy to implement.constructing parameters. A computer applies the method of "eliminating matrix" and gradually selects satisfactory test questionnaires from the test bank at random until the paper constructing parameter matrix basically turns into the zero matrix, so as to complete the paper combination process. Relative the random algorithm, the fuzzy paper constructing algorithm is relatively complicated, so it is more difficult to achieve this algorithm. This approach works well when there are fewer paper-constructing control parameters. The success rate of paper building will decrease with the addition of requirements.

3.3 The backtracking heuristic algorithm

The backtracking heuristic algorithm is the improved random paper constructing algorithm. After the random algorithm selects a test question, the selective basis and status data of this test question are saved. If the next test question fails to be selected, data information saved in previous question selection will be
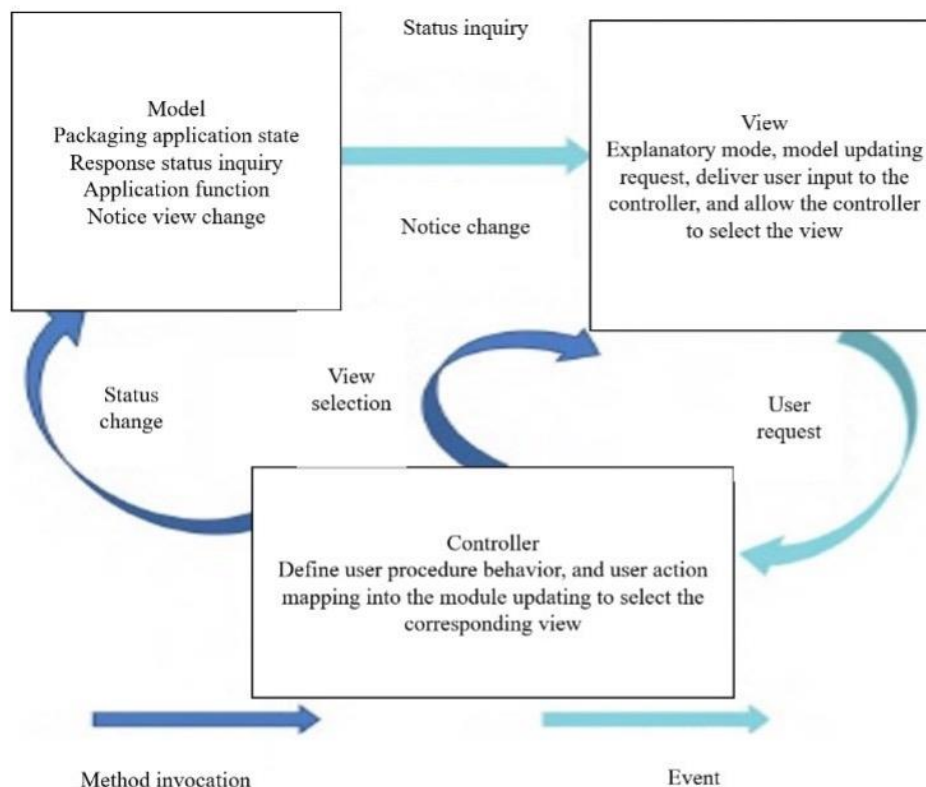

Figure 1 MVC Framework Function Diagram

withdrawn. Then, according to the corresponding algorithm, the updated parameters are used for selecting test questions. Repeated backtracking is conducted until paper constructing succeeds. The paper constructing success rate of this algorithm is relatively high but it occupies more system resources and consumes long time.

3.4 Genetic algorithm

The search algorithm known as the Genetic Algorithm (GA) is based on the "survival of the fittest" hypothesis of species heredity in the "theory of evolution." This algorithm maps "search space" into "genetic space." Put otherwise, every potential resolution is encoded into a vector known as a "chromosome" or "individual." Each "chromosome" makes into a group or colony. Additionally, each chromosome is examined to provide a moderate value consistent with corresponding evaluation results, in accordance with the scheduled "target function." The process begins by generating a random number of chromosomes and calculating their fitness. Certain genetic processes, like as selection, variation, and hybridization, are carried out on these chromosomes according to their fitness. Then, chromosomes that perform poorly or have lower fitness are eliminated, but chromosomes that better fitness remain in order to establish a new colony. The new members of the group are descended from the excellent throwbacks of the preceding generation and inherit its excellent properties.hence when compared to the previous generation, they are clearly superior. "GA" integrates itself repeatedly and moves toward the better answer over time, until it reaches a predetermined programmed optimal index.

IV. SYSTEM FUNCTIONS

The MVC framework and SQL Server 2021 are used in the design of the online exam system. As shown in the system function module diagram (Figure 2), the system integrates a number of essential features [5], such as test database management, examinee management, teacher management for paper inspection, random paper generation, exam administration, paper inspection management, statistical queries, exam paper backup, score management, and overall system management.
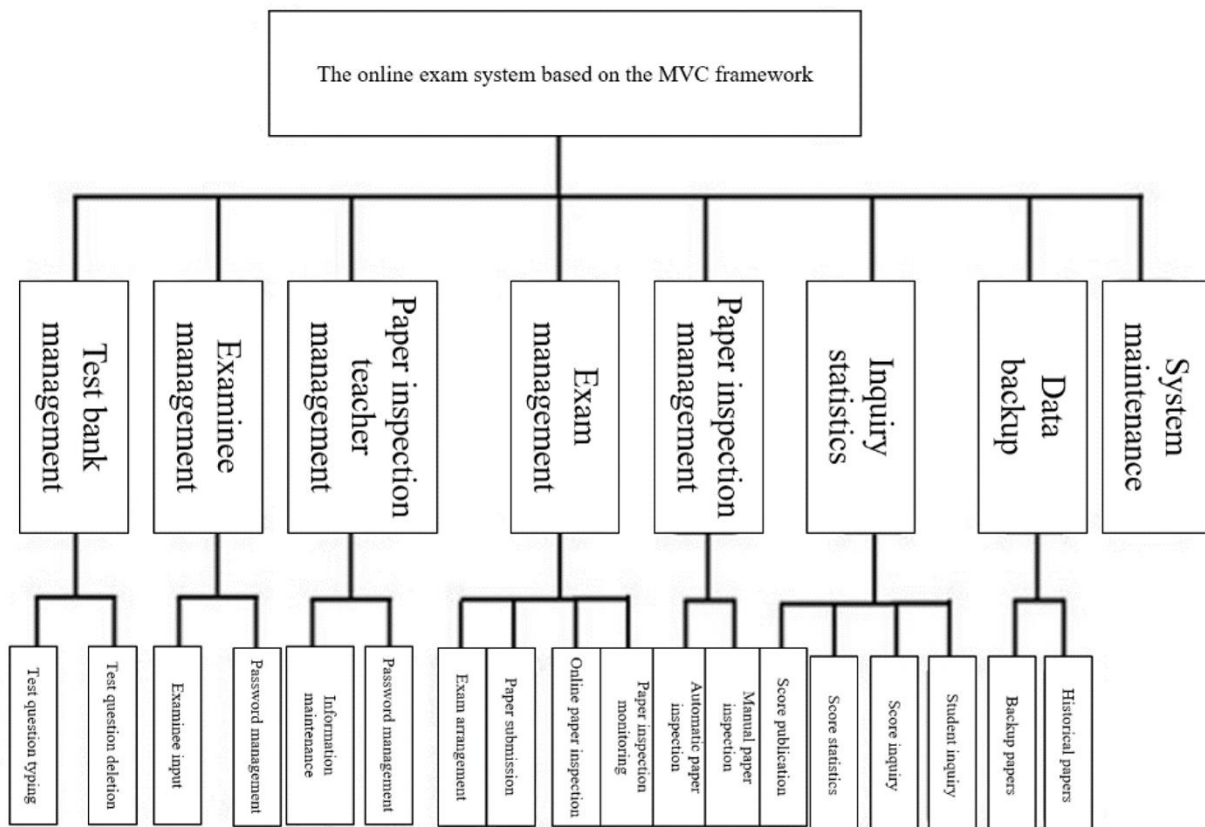
The online exam system creates papers at

Figure 2 System Function Module Diagram

random during use based on the administrator-established criteria. In accordance with the specifications for the test paper arrangement, the system automatically displays the test questions. Examinees enter their user name and password and connect in to the exam system to take the exam. Test questions will be automatically read and evaluated by the backdrop. Corresponding scores will be awarded at the conclusion of the example once it has been entered into the system. The background administrator has the ability to add, edit, and remove test questions as well as information about examinees and teachers involved in paper inspections. The administrator can manage paper inspections, create papers automatically, compile scores, publish scores, ask students about their papers, etc.

V. SYSTEM DESIGN

This subsystem is capable of performing three different tasks related to test questions: formatting keys that include the telecom, typewriting keys like the space bar, the enter key, the backspace and delete buttons. In the process of entering the questions into the test, test question attributes are defined in order to construct the content of test questions. Some of them are gap filling, essay, multiple choice, true or false, and single choice questions. It is good when the content difficulty level is moderate, the points covered are numerous, and the sample is representative and fair when it comes to the scores distribution. These test questions are then stored in the database as background details. So that faulty typed test questions may be detected, typed test questions are questioned and changed. All test questions that do not conform to the codes are immediately changed. However, it should also be noted that the test bank information should be updated very frequently as there are constant improvements in social developments and educational reforms – to delete wrong test questions.

1) Test base management subsystem

2) The examinee management subsystem

The examinee management subsystem can input examinee information and modify exam passwords of examinees.

3) The paper inspection teacher management subsystem

The paper inspection teacher management subsystem can input paper inspection teacher information in batch and modify login passwords of paper inspection teachers.

4) The exam management subsystem

The exam management subsystem can set up exam time, teachers' paper inspection time, test bank question selection, self-question selection exam, set up examinees to attend an exam, and own the exam function and students' repeated exercise functions.

5) The paper inspection management subsystem

The paper inspection management subsystem can realize automatic paper inspection for objective questions and manual paper inspection for subjective questions, set up paper inspection teachers, and allocate papers.

6) The inquiry statistics subsystem

The inquiry statistics subsystem can realize score statistics of examinees, score publication, students' paper inquiry, and students' score inquiry.

7) The data backup subsystem

The data backup subsystem conducts the data backup for students' papers after finishing the exam, completing paper inspection, and publishing the score, so that it is convenient for paper checking in later period.

8) The data maintenance subsystem

The data maintenance subsystem can set up basic system information and database configuration information.

5.2 The database design

The database design is a critical component of the online exam system. To create a suitable and highly effective database, we must connect the functional requirements of the online exam system with pertinent theoretical understanding of the database. The following specifications should be met by the database design: Data integrity, consistency, and independence are guaranteed; good reliability and security are included; transplantable and elastic features are included; the database can be classified into the leading relational mode according to the aforementioned design requirements:

User (User id, password, user role, authority, name, unit and photo)

Administrator (Administrator id, password, and authority)

Test question bank (Test question id, test question type, test question content, test question answer, adding time, difficulty level, and test question symbol);

Course (Course id, course name, score, and course type);

Student's answer sheet (Student number id, test question id, examinees' answer, and remark);

Test paper (Test paper id, course id, teacher id, test question id, array, paper construction form, the volume of questions, exam class, and exam time);

Evaluation system(Class name, student number id, name, the first question score, the second question score, the third question score, the fourth questions core, and the fifth question score, total score, and paper inspection teacher id).

5.3 Paper constructing technology

On the grounds of analyzing the common paper constructing algorithm, we finally select the random paper constructing algorithm but we improve the random paper constructing algorithm and use the random ranking function of SQL SERVER on inquiry results[6].

Result recording is ranked at random. 20 records are returned at random. RAND function is achieved via the SELECT sentence but the RAND function is only generated once in inquiry, thus each line gets the same value. NEWID function is used in ORDER BY sub-sentence to rank the result with the code as follows:

SELECT *

FROM Northwind. Orders
ORDER BY NEWID()
SELECT TOP 20 *

FROM Northwind. Orders

ORDER BY NEWID()

With such a method, it is convenient for us to extract questions from the test bank and generate papers rapidly, ensuring paper fairness and randomness.

5.4 Paper inspection technology

In the system, we can set up objective questions (i.e. single choice questions, multiple choices, true or false questions, and gap filling) and subjective questions (i.e. essay questions). For objective questions, we can apply the automatic paper inspection function in the system which can read the paper answers of questions, gain standard test question answers from the test bank to score examinees' exam, and fill the examinees' score for saving or score inquiry. For subjective questions, in order to ensure paper inspection correctness, we still apply artificial paper inspection. However, with the development of artificial intelligence, the future system upgrading can apply the automatic paper inspection technology.

VI. CONCLUSION

This paper describes the architecture of an online exam system built on the MVC framework. To accomplish a number of tasks, including paper construction, exam, analysis, and feedback, the entire system can be divided into multiple sections, including test bank management, examinee management, paper inspection teacher management, random paper generation, exam management, paper inspection management, inquiry statistics, paper inspection backup, score management, and system management. The three-layer network application system based on the browser and the MVC framework are both used by the system. The client makes advantage of the Web platform, increases the system's simplicity of use and maintenance, and quickens its processing speed.

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