THE DESIGN AND IMPLEMENTATION OF ANSWER SHEET GENERATION AND REVIEW ANALYSIS SYSTEM BASED ON C++

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Abstract Through the research and design of the algorithm of the answer sheet template generation and the answer sheet recognition algorithm, this paper dynamically sets the basic information of the answer sheet template and the objective title information and generates the answer sheet template in the form of a Word document, and reads the physical answer sheet in the form of a picture. The image recognition obtains the content of the answer sheet, and compares the recognition result with the set answer information to obtain the test result and the situation. The aim is to make teaching technology, reduce the labor cost of marking, improve the accuracy and efficiency of the analysis of the examination, and reduce the workload of teachers. The main algorithm of this system is based on C++. At the same time, the Qt framework is used for interface design. The QAxObject library and QAxWidget library are used to edit the Word document. The MySQL database is used to store the answer sheet template related data, and the OpenCV computer vision library is used to answer the physical answer sheet.

Keywords: C++; answer sheet generation and recognition; Qt interfacial design; QAxObject library and QAxWidget library operate Word document; OpenCV image processing.

1. INTRODUCTION

The online scoring system means a modern computer system that combines electronic scanning technology and computer network technology to achieve automatic scoring of objective questions and online scoring of subjective questions. Here, for the automatic recognition of objective questions on answer sheets, this project takes the answer sheet model of Guilin University of Technology as an example. Through the study on automatic generation of answer sheet templates and review algorithms, this paper designs a kind of software that can generate answer sheets based on user requirements and provide scoring and analysis of examinations. At the same time, the cost and software requirements for the equipment are minimized. For instance, ordinary A4 paper is applicable for answer sheet printing.

2. SYSTEM OUTLINE DESIGN

2.1. System Function Design

The system functions are as follows:

1) The user can customize the basic information of the answer sheet. According to the number of knowledge points, questions and question options entered by the user, a corresponding number of controls like text boxes are generated for the user to define the knowledge points and answers.

2) According to the above data set by the user, answer sheet templates with the corresponding information and question amount are generated in the form of Word documents for users to print.

3) It is possible to display all the answer sheet templates created by the user, and provide an entry for operations like "batch recognition", "export", "delete" on the answer sheet template.

4) It can realize batch recognition of physical answer sheets, take photos of the answer sheets to be identified separately, and then import them into the program for recognition and record the answer sheet recognition results.

5) It can implement the answer sheet template export function, so that users can repeatedly export answer sheets.

6) It can implement function of deleting answer sheet template, so that the user can delete the unnecessary answer sheet template at any time.

7) It can compare the recognition result of the physical answer sheet with the user-defined answer data and make judgment, output the score of each physical answer sheet, the correct rate of each question, and the scoring rate of each knowledge point.

2.2. Standard Answer Sheet Template Design

Figure 1. Standard answer sheet template

Table can guarantee alignment of the rows and columns. Therefore, table is used as a carrier of the answer sheet contents (Figure 1).

3. COMPARISON ON QUESTION SELECTION SOLUTIONS

3.1. System GUI Design Framework Qt

In the system GUI design, a critical point is to dynamically add controls, which requires good flexibility of the GUI design framework. Qt framework is suitable for GUI design of this system.

3.2. System GUI Design Framework Qt

In this system, the primary purpose of noise reduction is to enable more obvious contrast between anchor points, filling points and the background, so that the image binarization effect is better. Here, we directly provide the comparison of image binarization after noise reduction using mean filtering, median filtering and Gaussian filtering. The comparison is shown in Figure 2:
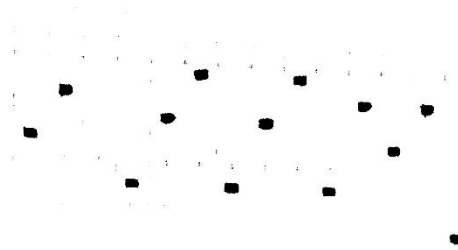
a) Image binarization without noise reduction
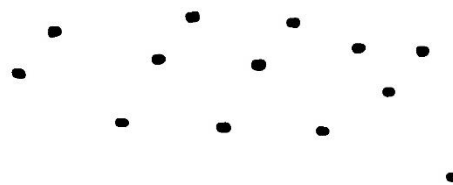
b) Image binarization after mean filtering
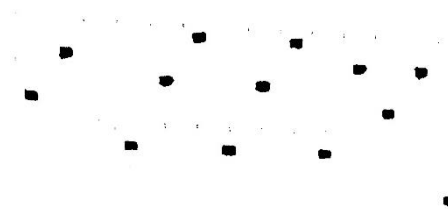
c) Image binarization after median filtering
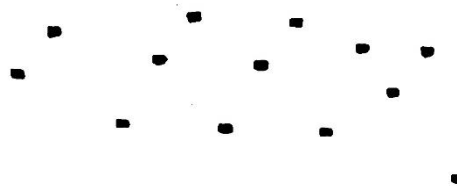
d) Image binarization after Gaussian filtering

Figure 2. Local effect comparison of binary images after noise reduction

As can be seen from the comparison in Figure 2, Gaussian filtering effect is obviously better.

3.3. Algorithm for Finding Answer Sheet Positioning Anchor Point

In the design of standard answer sheet template of this system, the anchor point for overall positioning is a circle in a fixed size.

3.3.1. Template Matching

This system adopts correlation matching for matching, and the results obtained are shown in Figure 3:
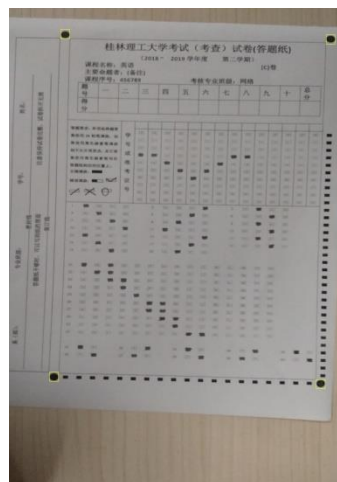
a) Test graph 1
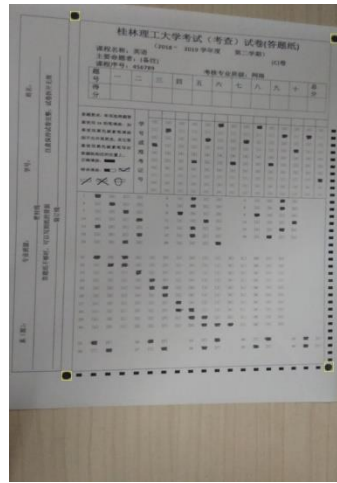
b) Test graph 2

Figure 3. Template matching effect

We can see from Figure 3 that under the premise of designing positioning anchor points for the answer sheet template of this system by inserting pictures, template matching has a high accuracy and is suitable for finding answer sheet anchor points in the system.

4. DETAILED DESIGN AND IMPLEMENTATION

4.1. Design and implementation of the main system interface

4.1.1. Create Answer Sheet Template Interface

1) "Answer Sheet Information" column is mainly for entry of the basic answer sheet information. Where, the student ID length limitation requires entry of non-zero integer only. The interface is shown in Figure 4:

2) In the "Knowledge Points Classification" column, enter the number of knowledge points and click OK to dynamically generate the corresponding controls. Where, one can only enter non-negative integers, as shown in Figure 5:
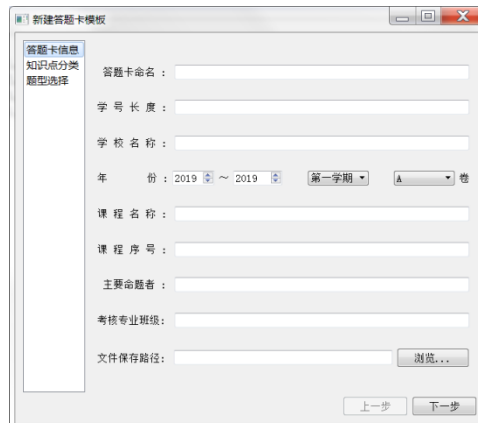
Figure 4. Answer sheet information interface
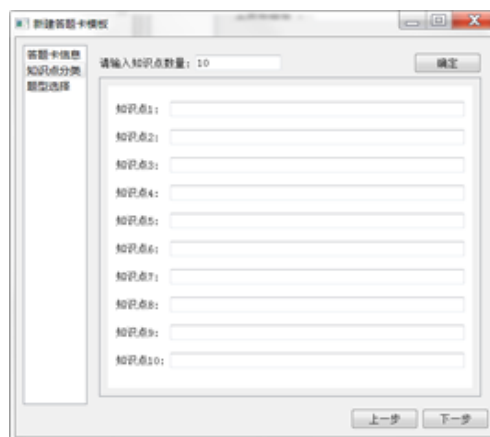
Figure 5. Knowledge point classification interface

3) In the "question type selection" column, click OK after entering data to dynamically generate question answer selection boxes, etc., Where, the number of questions and options requires entry of non-negative integers only, and score for small questions requires entry of non-negative numbers only.

4.1.2. Saved Answer Sheet Template Interface

The saved answer sheet interface is mainly composed of three parts. One is a ListView control that displays a list of answer sheet templates. One is a Menu control for popping up the corresponding operation after selecting the answer sheet template and clicking the right mouse button. The third is a TabWidget control that displays the answer sheet recognition results.

4.2. Design and implementation of answer sheet template generation

Before the system generates a new answer sheet template, all the information to be entered when creating the answer sheet template should be filled in as required, so that then the content can be written into the answer sheet to generate the corresponding answer sheet template.

4.2.1. Judgment of Question Number Overflow

Determine whether the number of questions exceeds the limit, that is, whether the number of questions is within the number range of the answer sheet template.

4.2.2. Using the QAxWidget Class to Insert Content into a Word Document

QAxWidget class can be viewed as a QWidget that encapsulates ActiveX control.

4.2.3. Algorithm for Inserting Question Option Rules in Word Documents

Algorithm for inserting question option rules in Word document is to add text insertion operation based on question number overflow judgment algorithm. In simple terms, it is to calculate n questions to be inserted in each line, insert the question number and question options in each line in order, and then continue with insertion in another line.

The algorithm logic of the processing rules for each question type is roughly the same, with a slight difference: the text inserted in the judgment question is 'T' or 'F'.

4.3. Design and Implementation of Answer Sheet Recognition

The way of answer sheet recognition is to import the actual answer sheet as a photo. Through a series of image processing such as converting grayscale images, noise reduction, template matching, perspective transformation, region projection, expansion corrosion, threshold judgment, etc., recognition result of the answer sheet is obtained, which is then compared with the standard answer data for result analysis.

4.3.1. Template Matching Algorithm

We need to find the coordinates of 4 overall positioning anchor points from the answer sheet picture for subsequent perspective transformation operations, and only the coordinate of the point with the highest matching degree can be obtained via template matching. According to the design rules of the answer sheet template, when the answer sheet is divided into four equal-sized areas of upper left, lower left, upper right and lower right, there must be only one black dot on each area. By separate template matching of the four areas, the coordinates of the four overall positioning anchor points can be obtained.

4.3.2. Perspective Transformation

Perspective transformation is to project a picture to a new viewing plane, also known as projective mapping.

OpenCV provides getPerspectiveTransform function and warpPerspective function for perspective transformation. getPerspectiveTransform calculates the perspective transformation matrix according to the coordinates of the four overall positioning anchor points in the standard answer sheet template and the four coordinates obtained by previous template matching. warpPerspective performs perspective transformation of the picture according to the resulting perspective transformation matrix.

4.3.3. Region Projection Calculation

The positioning of student ID and answer options is to determine x and y of the coordinates by the black rectangle at the bottom and the far right of the answer.

The idea of projection calculation is to count the number of non-zero pixels in each row or column in the area, and then determine the starting coordinates of each black rectangle continuously by judging the threshold and area.

4.3.4. Compare Threshold to Determine Whether to Fill

After a series of image processing and acquisition of anchor point coordinates as described above, the area where the option is located can be found and whether to fill or not can be judged. Student ID information and answer information need to be obtained from the answer sheet, and the image after perspective transformation should be binarized before making a judgment.

By image expansion and corrosion, further noise reduction is possible to highlight the target area.

The overall answer sheet recognition effect is shown in Figure 6 (with traversal flow mark):
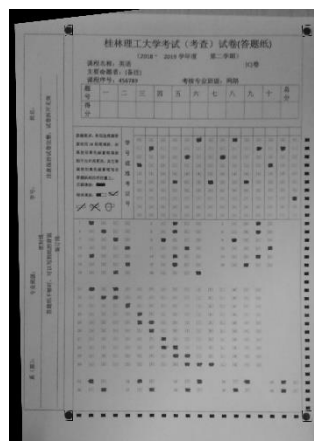
a) The answer sheet after perspective transformation
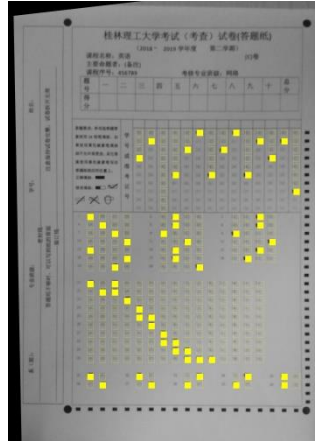
b) Answer sheet recognition effect

Figure 6. Answer sheet recognition effect

The yellow unfilled rectangle in Figure 6 b) shows the flow of the entire algorithm traversal. The figure shows that the program is completely executed according to the algorithm design above.

5. SYSTEM TESTS

5.1. Answer Sheet Template Generation Test

1) When creating the answer sheet template, all entries should be filled. If there is null entry or illegal entry, the system will pop up the corresponding prompt.

2) In the answer sheet template generation, the key data that will affect the question ordering include the number of single choice questions, the number of multiple-choice questions and the number of judgment questions.

5.2. Answer Sheet Recognition Test

After the answer sheet recognition is completed, the analysis result will be given. One can verify whether the result is correct based on the set data.
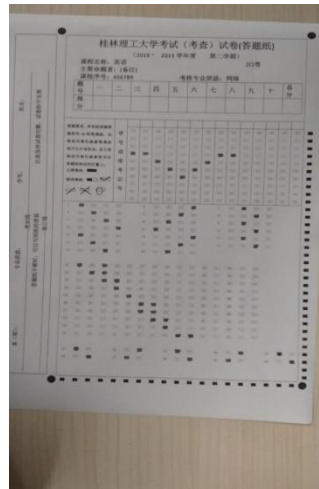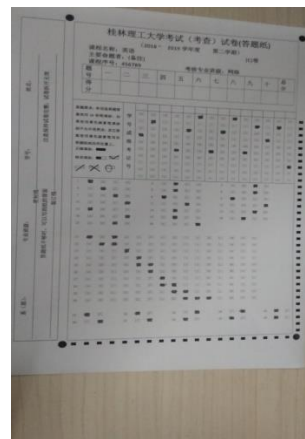
Figure 7. Physical Answer Sheet 1

Figure 8. Physical Answer Sheet 2

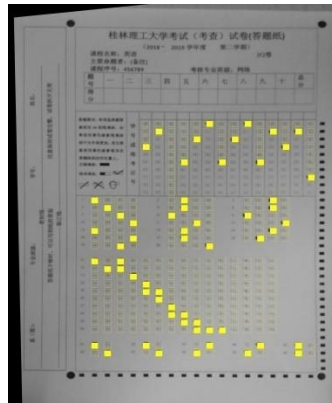**Figure 9. Recognition effect of physical answer sheet 1**

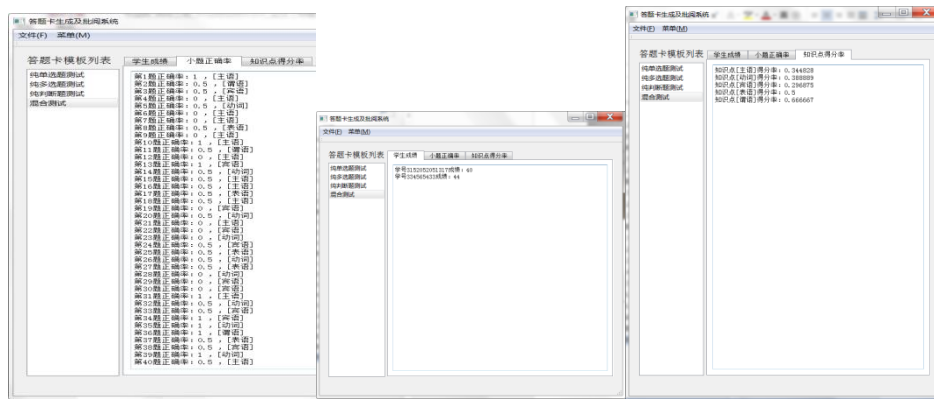**Figure 10. Recognition effect of physical answer sheet 2**

Figure 11. Answer sheet recognition and analysis results

It can be seen (Figure 7-11) that the corresponding data in the data table of the test answer sheet is completely consistent, and the recognition of the filling area in the recognition process is also quite accurate.

6. CONCLUSION

Based on the research and design of the answer card template generation algorithm and answer card recognition algorithm, the basic information and objective title information of the answer card template are dynamically set, and the answer card template is generated in the form of Word. Document and read the physical answer sheet as a picture. Image recognition obtains the content of the answer sheet, and compares the recognition result with the set answer information to obtain the test result and situation. The purpose is to make teaching technology, reduce the labor cost of marking, improve the accuracy and efficiency of examination analysis, and reduce the workload of teachers. The main algorithm of the system is based on C ++. At the same time, the Qt framework is used for interface design. QAxObject library and QAxWidget library are used to edit Word documents. The

MySQL database is used to store data about answer card templates, and the OpenCV computer vision library is used to answer physical answer cards.

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