Automatic MCQ Grader

1. Introduction

With the growing number of students and increased frequency of assessments, the grading of multiple-choice question (MCQ) exams has become a time-consuming and labor-intensive process, often prone to human error. Particularly in academic settings where large volumes of answer sheets are handled, manual grading can lead to inconsistencies and delays. Automating the grading process can significantly reduce these issues, enabling faster, more accurate assessments.

This project focuses on developing an automated MCQ grading system that leverages image processing techniques to process and analyze answer sheets. The system will accept a directory of scanned or photographed answer sheets along with an answer key in CSV format and will then compare each student's responses to the key, counting the number of correct answers efficiently. The system also supports answer variations (A, B, or C), allowing it to accommodate different answer sets for exams.

Once grading is complete, the system will output results in the form of individual CSV files, as well as a comprehensive summary of all graded sheets. This approach not only streamlines the grading process but also ensures higher consistency and reliability, making it suitable for institutions with large-scale examination requirements. By automating the MCQ grading workflow, this system promises to improve efficiency and reduce the workload on educators, helping them focus more on student performance analysis rather than administrative grading tasks.

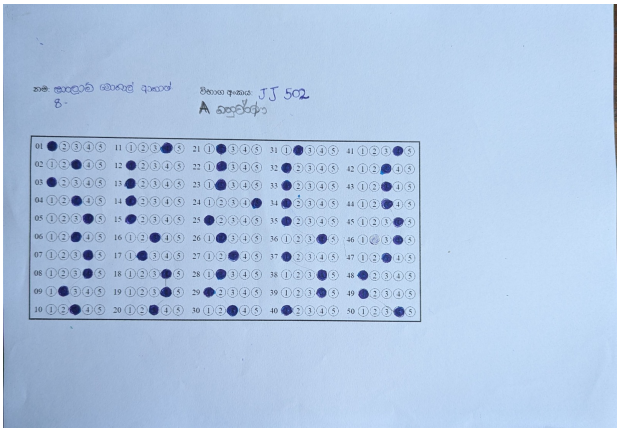

Figure 1: Sample Input Image

2. Our Approach

2.1 Input Stage

The primary input includes a CSV file containing the answer key, which serves as the benchmark for evaluating student responses. Additionally, a directory of scanned or photographed answer scripts is provided, allowing the system to automatically read and analyze each answer sheet within this directory. This input method supports a wide range of image formats, ensuring compatibility with various scanning devices and cameras. Finally, the user specifies an output directory path where the system saves the graded results, including individual CSV files for each answer sheet and an overall summary of the scores.

```
python grade_mcq.py --marking-scheme-path "Data Set\Marking Schemes\
    Marking Schemes\A.csv" --answer-sheet-folder "Data Set\Answer Scripts\
    Answer Scripts\A" --output-folder "Graded\A"
```

A.csv

Data Set > Marking Schemes > Marking Schemes > A.csv > data

```
Question ID,Answer ID,Condition
1,2,-
2,3,-
3,3,-
4,3,-
5,3,-
6,3,-
7,4,-
8,3,-
9,4,-
```

Figure 2: Sample Answers in CSV

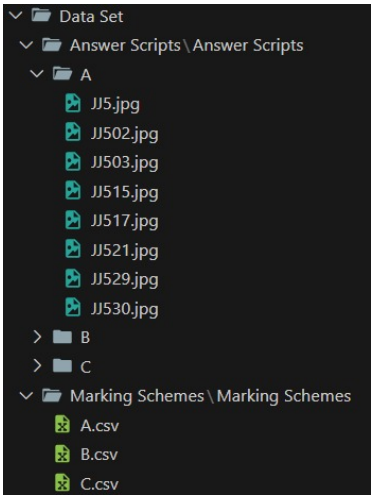

Figure 3: Dataset Directory

2.2 Image Preprocessing

In the image preprocessing stage, each answer sheet image is carefully prepared for analysis through several key steps. Initially, the system loads each image from the provided directory, ensuring that all answer sheets are available for automated grading. Each color image is then converted to grayscale to reduce complexity and highlight the essential features needed for processing. Using the Canny Edge Detector, the system identifies the edges within the image, aiding in detecting the sheet's boundaries and enhancing clarity. Subsequently, the largest contour is identified, which is presumed to be the outline of the answer sheet. A perspective transformation matrix is then applied to warp the image into a standard aspect ratio, aligning it uniformly for accurate analysis. Finally, the image undergoes orientation adjustments, including rotation and flipping, to ensure all answer sheets are correctly aligned before grading. These preprocessing steps are essential for consistent and precise interpretation of the answer sheet data.

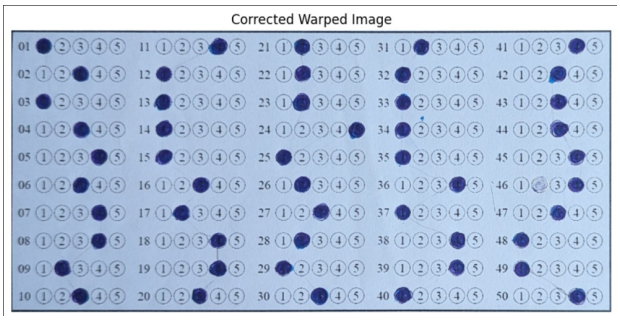

Figure 4: Warped Image

2.3 Making Grid

In the grid-making stage, a structured framework is created on the preprocessed answer sheet image to accurately identify and separate each question for analysis. The system first establishes a grid layout with five columns, each containing ten question slots, to align with the answer sheet format. By defining the top-left and bottom-right corners for each cell within this grid, the system can locate individual question areas

precisely. Using the rectangle function, the grid is visually overlaid on the warped image, allowing each question's location to be clearly marked and accessible for further processing. Once the grid is set, each question box is extracted separately, enabling the system to focus on student responses within each area. This organized grid creation process is essential to isolate each question accurately, allowing for efficient answer detection and grading.

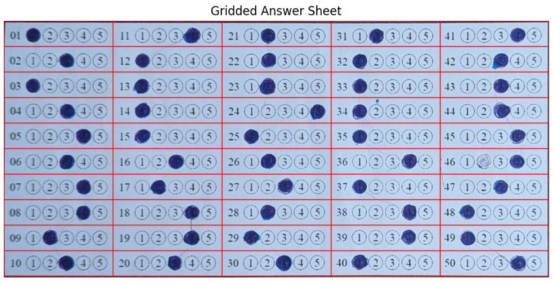

Figure 5: Making Grid

2.4 Detect Coloured Bubbles

In the colored bubble detection stage, each question box undergoes a series of steps to identify the student's selected answer accurately. First, each question box is converted to grayscale, simplifying the image and focusing on the filled bubble areas. Thresholding is then applied to isolate high-contrast regions, making the colored bubbles more detectable. The question box is divided into six sub-boxes: one for the question number and the remaining five for the potential answer options (A to E). The system calculates the filled area percentage in each answer sub-box, identifying the bubble with the highest filled area as the student's answer. This process ensures that each question number is paired with its corresponding detected answer, enabling reliable and efficient grading by accurately capturing student responses.

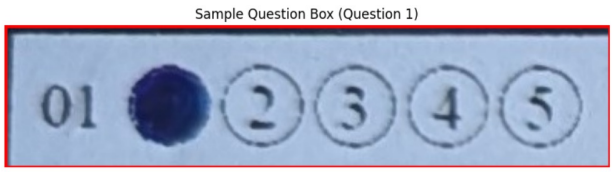

Figure 6: Coloured Bubbles

```
Question 1: Option 1
Question 2: Option 3
Question 3: Option 1
Question 4: Option 3
Question 5: Option 4
Question 6: Option 3
Question 7: Option 4
Question 8: Option 4
Question 9: Option 2
Question 10: Option 3
```

Figure 7: Answers Detected

2.5 Grading and Output Process

In the grading and output process, the system first loads the marking scheme and detected student answers to assess each response. For each question, the correct answer is referenced from the marking scheme based on question number, and specific conditions for grading are checked. The conditions include:

- **Single Answer ('-')**: Only one correct answer is accepted.
- **Any ('Any')**: Any of the specified answers is accepted.
- **All ('All')**: All specified options must be selected to be considered correct.

Each student's response is compared to the marking scheme, and if it meets the required conditions, the grade for that answer is set to "True" (correct); otherwise, it remains "False" (incorrect). The system

then calculates the total score for each student based on the number of correct answers and grading rules provided.

Once grading is complete, the final grade for each student is stored in a CSV file along with the respective answer sheet's file name. A comprehensive summary CSV file is also generated to provide an overview of all graded answer sheets. Both individual results and the summary report are saved to the designated output directory, enhancing user accessibility and enabling efficient grading management.

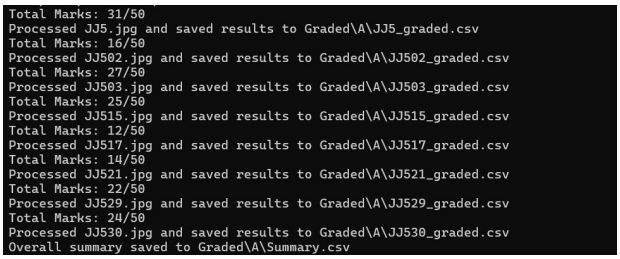

Figure 8: Output