Automatic Method to Grade Multiple Choice Questions Exams

by
Moiz Sajid
i14-0167

Abstract: Multiple Choice Question, or MCQs for brevity, have been used throughout the time because of there simplicity. Simplicity not for the MCQs exam taker but also for the checker for these exams. In this paper, I provide a novel and an efficient approach which can automate the task of checking MCQs exams. The ultimate goal of this approach is to reduce the time that MCQs exams checkers in checking these MCQs exams.

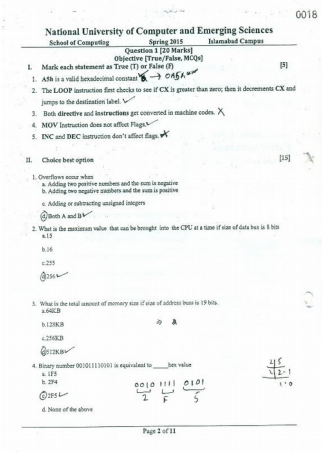
Keywords: Template Matching, Thresholding, Generalized Hough Transform, Multiple Choice Questions

Introduction:

Multiple Choice Questions (MCQs) basically consist of question statements which is then followed by options (mostly four and five). The student's job is to select the best option that answer the question statement. These exams are conducted to test the knowledge of the exam takers. There are two types of tests: firstly, those are conducted on a computer and secondly, those that are conducted in a exam sitting. The main advantages of conducting MCQs exams are that they are easy to administer and check and the results of the MCQs exam for consistent from exam taker to exam taker.

Students at FAST-NU also take MCQs exams in different courses that they study here. Figure 1 shows a sample MCQs exam that the students take. As for the exam paper that is shown in Figure 1, there is no answer sheet. For this exams, students had to mark the best option with a circle or a tick mark. Each question is followed by four options (a, b, c, d) from which the student had to select the best option.

If the student circle or marks more than one options it will be treated as wrong. The paper on which implemented our algorithm had no such question, so this case was totally ignored. If the student left the MCQs options blank, they will also be marker as wrong. Again, we had no such questions in the provided dataset, so this case was also totally ignored.



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Question 1 [20 Marks]
Objective [True/False, MCQs]

I. Mark each statement as True (T) or False (F) [5]

1. Ah is a valid hexadecimal constant
2. The LOOP instruction first checks to see if CX is greater than zero; then it decrements CX and jumps to the destination label.
3. Both directive and instructions get converted in machine codes.
4. MOV Instruction does not affect Flags.
5. INC and DEC instruction don't affect flags.

II. Choice best option [15]

1. Overflows occur when
a. Adding two positive numbers and the sum is negative
b. Adding two negative numbers and the sum is positive
c. Adding or subtracting unsigned integers
d. Both A and B
2. What is the maximum value that can be brought into the CPU at a time if size of data bus is 8 bits
a.15
b.16
c.255
d.256
3. What is the total amount of memory size if size of address bus is 19 bits.
a.64KB
b.128KB
c.256KB
d.512KB
4. Binary number 00101110101 is equivalent to ____hex value
a. 1F5
b. 2F4
c. 1D5
d. None of the above

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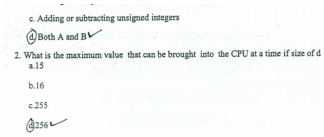
Figure 1



c. Adding or subtracting unsigned integers
d. Both A and B
2. What is the maximum value that can be brought into the CPU at a time if size of d
a.15
b.16
c.255
d.256

Figure 2

Implementation

1. All the images in the dataset are read, and are converted to grayscale images for easy processing.

2. Image are scaled down by a factor of 4 because the provided images have very large dimensions which will make it very inefficient for processing them.

3. Templates of all the question number (from 1 to 15) of size 7 by 7 are extracted from the provided images as show in Figure 3.

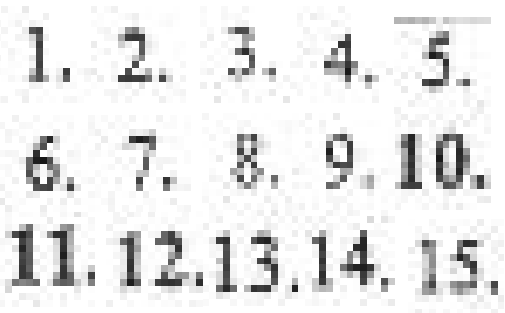


Figure 3

4. Similarly the template for options a,b,c, and d are also extracted from the provided images as shown in Figure .

Figure 4

5. Then, I used template matching with templates that were extracted in Step 3 to find the location of the all the questions from 1 to 15. Theses entries were saved in an array.

6. Using the location entries that were saved in an array, I extracted all the questions and their options as shown in Figure 5. Other details like question statement, options statement were left out.

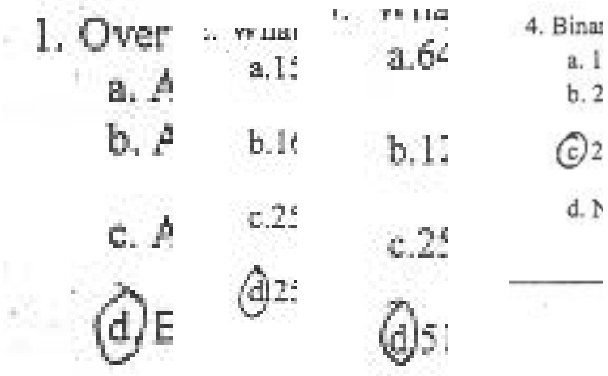


Figure 5

7. Otsu Thresholding was used to binarize the images as shown in Figure 6 before processing them in Generalized Hough Transform.

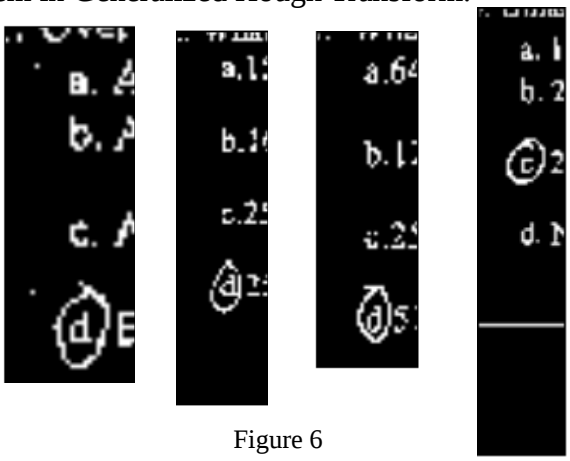


Figure 6

8. Next I used to Generalized Hough Transform to detect the marked circle in the images that were extracted in Step 6. The circle template of size 15 by 15 that I used is shown in Figure 6.

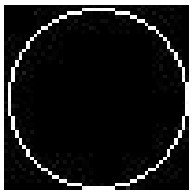


Figure 7

9. Location of the maximum response was recorded which was provided by Generalized Hough Transform. Some accumulator array which were given by Generalized Hough Transform are given below:

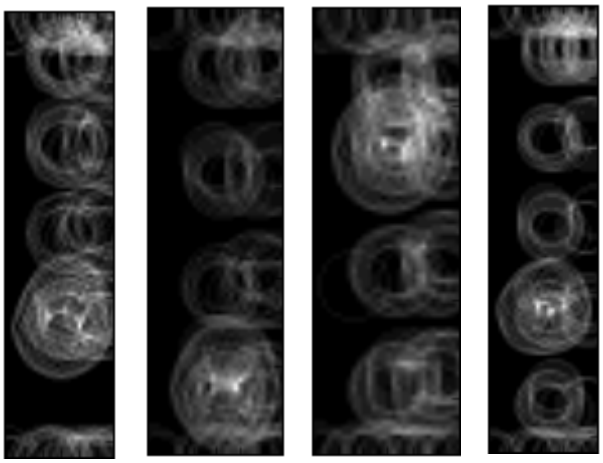


Figure 9

10. 7 by 7 regions of the image, where maximum response was given by applying Generalized Hough Transform, were as extracted as shown in Figure 10.

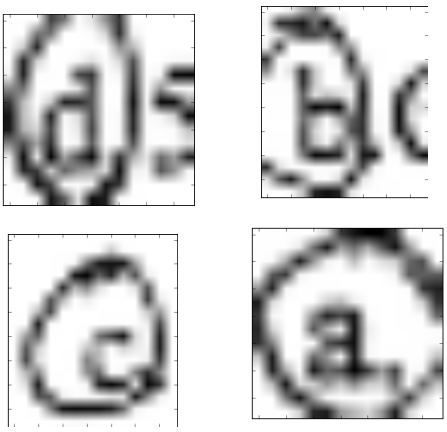


Figure 10

11. The resulting images from Step 10 when then matched with the images that were extracted in Step 4 using Template Matching. The results from the Template Matching are shown below in Figure 11:

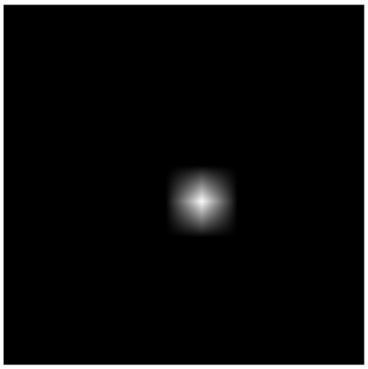


Figure 11

12. Every template for options a, b, c and d showed a response but the option that was actually circled showed maximum response.

Results

My algorithm correctly identified all of the student's responses. It achieved an accuracy of 93.33% on the provided dataset images. Results are displayed below in Figure 12:

```
Question  1  =>  d
Question  2  =>  d
Question  3  =>  d
Question  4  =>  c
Question  5  =>  d
Question  6  =>  b
Question  7  =>  a
Question  8  =>  c
Question  9  =>  b
Question  10  =>  a
Question  11  =>  a
Question  12  =>  d
Question  13  =>  d
Question  14  =>  b
Question  15  =>  b
```

Figure 12

Failure Case

My algorithm worked well for majority of the cases. However, it incorrectly the identified the marked option for Question 5 (shown below in Figure 13). The answer to Question is option "b" but algorithm identified the correct option as option "d".

Figure 13

Further Improvements

Machine Learning could have been used to further improve. I could have trained a classifier but the provided images were very few to train classifier like Support Vector Machine or Neural Network.

Conclusion

In this paper, we looked at a novel approach to automatically check MCQs exams which will be able to reduce the time of exam checkers.

References

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