

AUTOMATED KNOWLEDGE TESTING SYSTEM

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In this paper, we present a new approach to conducting and revising written examinations in the form of single- and multiple-choice tests. The approach is implemented as an automated knowledge testing system that consists of two parts: a test sheet generation system, represented with a web-based application, and an automatic test-grading system in the form of a mobile app, that uses computer vision technology to scan the test sheet and mark the correct and answers.

Keywords: knowledge testing, mobile application, web-service, computer vision, image processing.

With the technological growth, the education system has become noticeably deficient. Therefore, the necessity arises for frequent and qualitative students' knowledge examination. Usually, it takes a big amount of time for lecturers to compose tests with enough variants to avoid cheating and enough questions to get the full picture of the knowledge level. Then all of the test sheets have to be checked manually. Therefore, many lecturers follow one of few paths: either they make fewer variants of tests or they examine their students with lower frequency than needed. Both of those methods lead to the degradation of "student-lecturer" communication. In addition, because of human factor, mistakes during test grading can take place. This whole process not only reduces education quality, but more than that, it takes a big amount of lecturers' time that can be spent on other, potentially more useful activities.

To combat that issue we have developed an automated testing system that not only takes care of test sheet creation, but also allows the teacher to automatically grade the test sheets simply using the camera of his smartphone.

Described information system accelerates and reduces labor costs for tests making and tests revising. In addition, it also increases the variety of tests and knowledge control quality.

Its usage can be found in any educational institution from primary schools to universities. That, obviously, will raise education quality and provide impartiality when tests are revised.

The proposed approach to knowledge testing implemented in our system can be summarized with the following series of steps:

1. The teacher provides the systems with a number of questions and answers;
2. The system creates a number of test variants using random permutations of the possible questions and outputs them in a special page format;
3. The teacher gets the printed out tests set and passes them out to the students;
4. After the tests are filled out by the students, the teacher grades them using the app on his mobile device and gets results for every revised test.

The proposed system consists of two parts: online service for test generation and mobile app for test checking.

The test generation system is implemented in the form of a single-page web-application using NodeJS. When the user is authorized as a teacher, the system asks him to provide it with a list of possible questions and a number of answer options for each question, while also specifying the correct answer or answers. The system will then use the question pool to compose and generate the desired number of test sheet variants with the specified number of question in each variant. Every test sheet variant has its own sequence of questions and answers, composed using a random permutation of the possible items in the question pool. Therefore, every test variant has a unique sequence of questions with the answers also placed in a random order, to make cheating more difficult.

The outline of the test form is shown on figure 1. Every test form includes two SIFT [1] markers in the top right and bottom left corners (1) and a list of questions with corresponding QR-codes (2), which store information for question checking. Answer options for every question are located directly below the QR codes (3) and must be marked by the students by filling the corresponding box.

The QR codes corresponding to every question on the test sheet contain the information about the

question, such as the ID of the question, the correct answer as well as a link to the question on the test generation web-application.

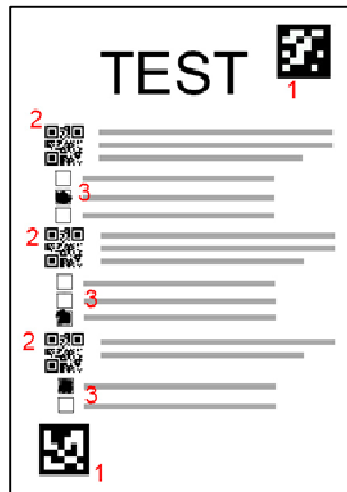


Fig. 1. Outline of the test form

The test grading system is implemented in the form of a mobile application for both Android and iOS. The teacher can check the filled out test sheets using the mobile app by taking a picture of the test form and running the test-grading procedure in the mobile app. The test grading procedure consists of two major steps: the preprocessing step and the actual grading step.

First we perform noise reduction as well as color and brightness correction. After that, the system finds the area of interest on the page, in which the QR-codes and answers are located, based on the corner markers. The SIFT algorithm is used to detect the markers, and then the area on the image, determined by the positions and orientations of the markers, is cropped from the picture. The information about the orientation of the SIFT markers is used to determine the rotation of the test sheet as well as the angle from which the picture was taken. We then use affine transformations to rotate and undistort the picture.

On the second step, every QR-code is segmented from the picture, after which they are decoded using Google API. Since the position of every QR-code (and every corresponding question) is known, the answers can be found by segmenting the answer boxes under every question, sorting them by vertical position and finding which boxes are filled, based on the mean color. This, along with the data from the QR-codes, allows us to determine, what answer was given by the student to which question, and to mark the test sheet accordingly.

For the purpose of image processing the OpenCV library [2] is used.

Our automated knowledge testing system allows the teachers to reduce the time and effort necessary for the creation of high-quality test sheets, as well as their grading. In addition, it also increases the variety of tests and the knowledge control quality.

SOURCES

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Система автоматической оценки знаний

В данной работе представлена система автоматической оценки знаний, которая основана на новом подходе к составлению тестов их проверке. Предложенная система состоит из двух составных частей: подсистемы автоматизированной генерации тестовых вариантов в виде веб-приложения, и системы автоматической проверки и оценки тестов в виде мобильного приложения, использующего методы компьютерного зрения для сканирования тестового бланка.

Ключевые слова: оценка знаний, мобильное приложение, веб-сервис, компьютерное зрение, обработка изображений