

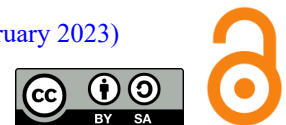
# A Novel Approach for Exam E-assessment Utilizing Image Processing

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## Abstract

There is a brand-new feature called Exam (Infinity Exam) that supports paper-based exams and speeds up the entire process while maintaining all of their beneficial qualities and minimizing their drawbacks, notably in higher education. The method is very different from those employed in the earlier 10+ years, which were implemented in a way that prevented them from replicating and supplanting the conventional paper-based examination format. The article's core relies on the image processing flow, which is the most crucial component of the software.

Multiple Choice Questions (MCQ) have been a more common method of testing someone's knowledge over time. The use of multiple choice questions in exams is becoming more widespread in the education sector (including in schools and colleges). It is employed even when conducting interviews. The current scenario involves either manually correcting the test or using OMR technology. Having OMR at all times in real time is rather challenging, and manually correcting it takes a lot of effort and could result in a mistake. We address this issue by applying a digital image processing technique in our proposed system to correct the response using multiple-choice questions written in Python. Here, we are processing data using Open-Source Computer Vision Library (OpenCV).

**Keywords:** E-assessment, Computer-based Assessment, Computer-assisted Assessment, Computer-aided Assessment, Examination, Exam, Image Processing

## 1. Introduction

Nowadays, there is an increasing demand for digitally storing paper-based information. This issue also affects education, but it doesn't always receive enough attention. However, by appropriately utilizing contemporary technology, many areas of the educational process might be made significantly more straightforward, straightforward, faster, more comfortable, and (partially) automatable.

In the majority of its disciplines, educational institutions continue to use traditional methods of instruction and testing. Although the digitalization of education received some attention in the past and started to gain ground since then. It is not the primary function of the e-learning systems, but there are computer-based assessment techniques that go along with it. Therefore, when it comes to courses that call for examinations to be conducted in this manner, the traditional examination models are typically used. Since it is the primary topic of this article, the paper-based examination method will now be

explained. The term "e-assessment" refers to electronic assessment, in which exam papers filled out by students are marked using software after the test has been finished.

A type of objective evaluation known as a multiple choice question (MCQ) asks respondents to choose just the right responses from a list of options. When a respondent must select amongst a variety of candidates, parties, or policies, the multiple-choice format is most typically employed in educational exams, market research, and elections. Image processing is used to quickly and easily correct the MCQs. It takes a lot of work to get rid of the obstacles in multi-choice assessment correction. To fix the answer sheet that was copied using a photo and supplied by the user, we are employing an array format in this. The fundamental idea is to retrieve an answer and a picture that has been cast in the user's shadow.

## 2. Related Work

### Classifications of Related Systems

The following basic functions of the system provide the basis for the primary classification:

- A. Computerized testing and evaluation methods
- B. Computerized evaluation systems

The previous group of systems obviously offer a wider answer, and it even appears better and simpler to complete the process this way, but this is not always the case, and in most cases, it is not even worthwhile. Despite the fact that it appears that the majority of the relevant work over the past ten or more years has discussed these kinds of systems, since they represent the true direction of computer-based education, These systems' assessment functions are now so useless that they can only accurately mimic their paper-based counterparts in certain circumstances (like multiple-choice exams). Such systems, for instance, were desired in the USA because they were seen to be the true future of computer-based education today.

Since both of the aforementioned categories of systems are also assessment systems with what is known as "intelligence of evaluation", they can both be seen from a different perspective. Following is the classification determined by evaluation's intelligence:

- **Manual Evaluation:** Human resources perform a manual examination of the solutions.
- **Quasi-automatic Evaluation:** Where the system can grade the majority of solutions automatically while leaving a minor portion to be graded by the instructor.
- **Automatic Evaluation:** allowing the system to assess each response.

### A. Computerized Testing and Evaluation Methods

As was already indicated, this class of problem-solving approaches makes up the majority of the linked work, but just one of these is featured below. Below are the explanation and a summary of the highlighted system. The so-called eMax <sup>[2]-[5]</sup> system, which was also developed at the John von Neumann Faculty of Informatics at Obuda University, offers nearly automatic evaluation for brief text responses and unique math assignments. There is a needed syntax for the math jobs that must be followed in order to guarantee the highest possible efficiency of the evaluation algorithms, but the text can be any input from a keyboard. Due to this restriction, many pupils were unable to adequately adjust to the system's workings.

## B. Computer-based Evaluation Systems

There are several works pertaining to this category of evaluation systems as well, although not all of them are finished works or merely use this method to tackle a certain problem. Only one of these is emphasized below, as it was previously, although there is no particular relationship to it this time. It was simply one of the nicer ones discovered during the investigation. The article that will be discussed already reveals its methodology in its title, "Blended e-assessment: Migrating classical exams to the digital world". The reader is assured of the work's purpose because it is nearly identical to mine. It makes a compelling case for the value and significance of such software, including showcasing the finished product, and also lists several

## 3. Methodology

Exams is a manual evaluation computer-based assessment system that includes the following features:

- Login options and user interfaces for teachers and students.
- Exams can be added to or changed, as can teachers and students.
- The creation of customized exam forms and all of their elements, such as QR codes.
- Uploading scanned exam images, processing these files automatically, and getting them ready for instructor correction.
- Automatically creating tests using the provided QR codes if one is not already in the system, and classifying the processed photos according to exams and students.
- An interface for teachers to correct exams.
- With the aid of a teacher's correction, the results of each individual exam paper are automatically generated. Additionally, summarized final results are computed, and various statistics are available for public viewing.

Figure 1 depicts the workflow of the proposed methodology.

### A. The System Model

The computer-based evaluation method known as E-evaluation has the qualities listed below:

Figure 1 depicts the most significant and often utilized job flow. After logging in as a teacher, the user can generate test papers in a few simple steps. During this process, all pertinent information about the exam will be logged, and utilizing this information, the user can produce unique exam papers that the teacher can print and distribute to the students. It is advised to utilize a document feeder to scan the exam papers once the students have finished filling them out because it will speed up the procedure significantly. A minimum standard for scanned image quality exists.

### B. The Special Exam Sheets used by the System

Every paper includes some important details regarding the exam that was administered and the person who took the exam on the paper in question. All of this is depicted in the heading of the paper, which also has six cells for the students to enter their identification codes and a QR code with all the exam details. Additionally, if there are distinct groups of papers, this is indicated in the QR code as well, but since teachers are not required to scan every single one of these, it is shown as a large Latin letter next to the QR code. There are various numbers of assignments on each paper, and they are all divided from one another by horizontal lines.

Figure 1: Users Functional Model Image

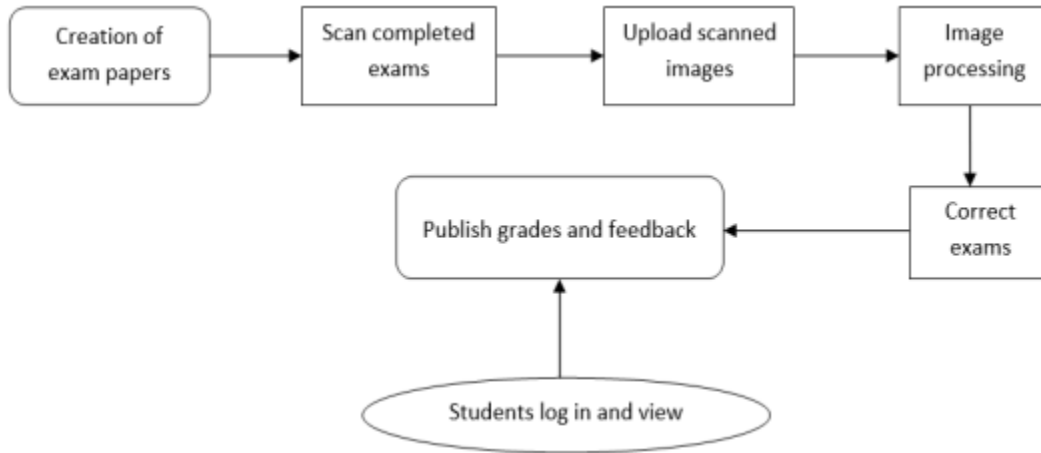
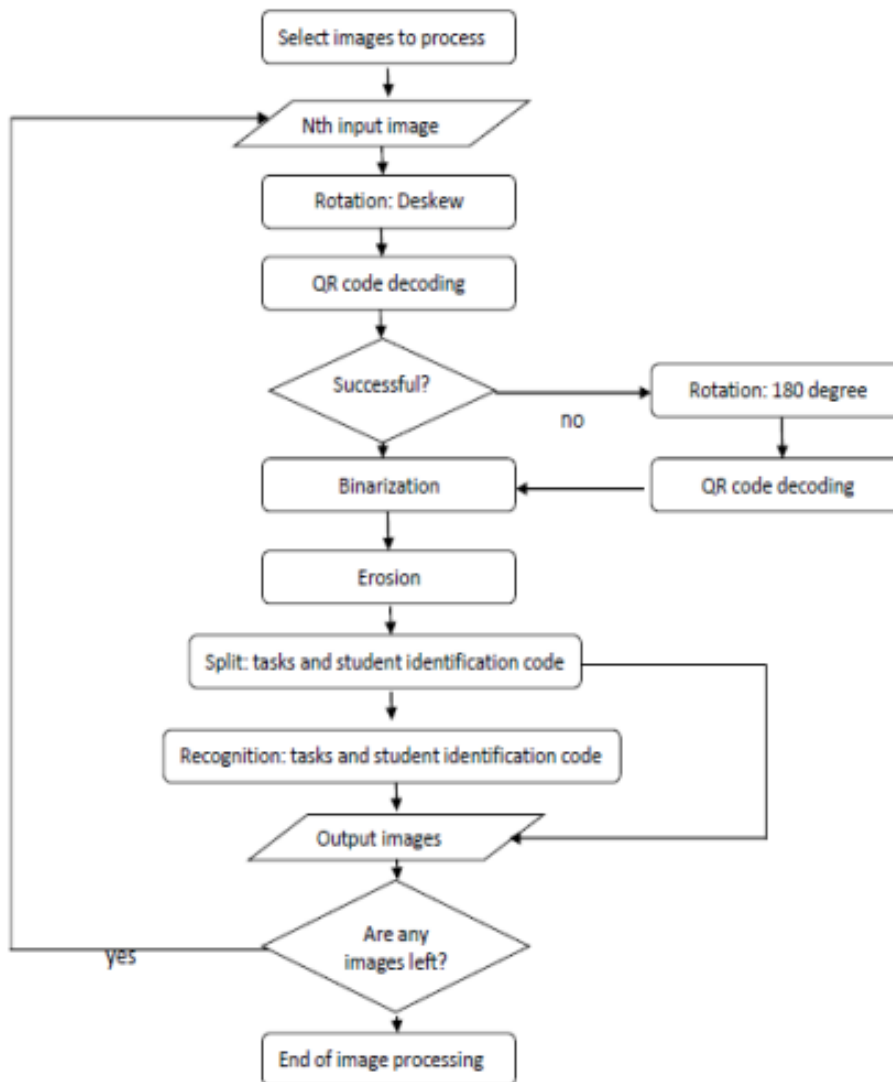


Figure 2: The Main Steps of the Image Processing Flow



There is a vertical line present which makes a margin on the paper and to which the number and letter of the given task is stuck. Each paper has a footer which contains essential information about how to use the paper accordingly during an exam. There are also extra papers because it is not alright to limit the size of a given answer. These extra papers are looking almost the same as the one we have seen, but it

does not contain any task numbers and letters those must be filled out by the students and the QR code is universal, so the extra papers are not bound to a specific exam, these papers can be used at any time and then the system will sort out to which exam the extra answers belong to.

### **Essential Techniques and Algorithms for Image Processing**

The user can upload the chosen images to the system after selecting them, at which point image processing starts and loops until all of the specified images have been processed and are prepared for correction. Figure 2 depicts the essential steps of the image processing flow.

The orientation of the image must first be adjusted to the standard orientation, which is when the paper is upright with the header on top. Deskew will be done first because it is simpler. Using the Hough transformation, which provides an angle that specifies the orientation of the provided picture, it is possible to quickly and efficiently rotate the orientation. The paper might not yet be in reference orientation, but if it is, the algorithms will attempt to decode the QR code there since it should be at the top left corner. It must be turned again because the decoding can only succeed when the paper is in reference orientation.

A fictitious phase called picture erosion will occur as a prelude to the splitting. Even though the white backdrop on the test photographs was intended to be the white foreground by the algorithm, erosion had to be done instead of dilatation. In any case, the purpose of doing this is to make the horizontal lines on the image thicker and easier for the splitting algorithms in the following phase to recognize. Given that it is merely a faux step, the output photos won't be impacted in any manner.

Following this, the chores start to separate, and the horizontal and even vertical lines are discovered, allowing the tasks' numbers and letters to be found alongside the jobs themselves. The images are divided into as many pieces as are required in accordance with the exam sheet's hierarchical structure. The recognition step should next follow utilizing the data from the split photos, but it has not yet been implemented because it involves some handwriting OCR <sup>[13], [14]</sup>, which is difficult to achieve. As a result, this step of the process is omitted and is instead completed manually. Following completion of this process, the output photos are prepared for correction of the given picture, but if there are still files that need to be analyzed, the cycle keeps going until there are none left, at which point the examinations can begin to be corrected.

### **Modules**

The modules come in fours. Both users must complete the registration and login processes in order to access. There are two users: user (Student) and admin (Faculty).

### **Management of Students**

These pupils are not enrolled immediately. Faculty are uploading student data in bulk, including information like name, student id, class, and so on. Faculty will manually issue student IDs to students. Students can log in to obtain the details by providing their username and student ID as their password. The information can be changed, not the instructors, but the pupils.

### **Using Image Processing for Evaluation**

The Faculty will post photos of the students' answer papers. With the use of digital image processing, the photographs can be analyzed. It can be done with the aid of the OpenCV library for Python.

## About Image Processing

The process of converting an image into a digital format and carrying out specific procedures to extract some usable information from it is known as image processing. When implementing specific specified signal processing techniques, the image processing system typically interprets all images as 2-D signals.

## Image Processing Techniques

Image processing can be divided into five categories:

1. Finding objects that are hidden in the image via visualization.
2. Identifying or detecting items in the image.
3. Sharpening and restoration: From the original, produce an improved image.
4. Measure the numerous patterns surrounding the objects in the image to identify patterns.
5. Search and browse through photos in a sizable library of digital photos that are comparable to the source photo.

## Components of Image Processing

### Computer

An image processing system uses a general-purpose computer, which could be anything from a PC to a supercomputer. To achieve a given level of performance, purpose-built computers are occasionally used in specialized applications.

### Hardware for Specialized Image Processing

It consists of the digitizer and hardware that can do fundamental operations, such as an Arithmetic Logic Unit (ALU), which can process complete images while simultaneously performing arithmetic and logical calculations.

### Massive Storing

The ability is crucial for apps that use image processing. The following are the three primary types of digital storage for applications involving image processing: There are two types of online storage for quick recall and one type of short-term storage. storage for archives, which has infrequent access.

### Camera Sensors

It makes reference to perception. Incoming light is captured by the image sensor, which then converts it into an electrical signal, measures it, and outputs the result to supporting electronics. It is made up of a two-dimensional arrangement of light-sensitive elements that change photons into electrons. Equipment like digital cameras use image sensors like CCD and CMOS to capture images. When collecting digital photos, image sensors frequently require two components. The first is a real device (sensor) that can identify the energy released by the thing we want to turn into an image of. The output of a physical sensing device is converted into digital form by a digitizer, which is the second component.

### Image Display

The images are displayed.

### Software

The image processing software is made up of specialized modules that perform certain tasks.

## Hard-copy Equipment

A few examples of the devices used to record images are laser printers, film cameras, heat-sensitive equipment, inkjet printers, and digital technology including optical and CD-ROM discs.

## Networking

It is a requirement to transmit visual data across a networked computer. Since image processing applications demand enormous volumes of data, bandwidth is the most crucial component of picture transmission.

## Result Analysis

Math functions are used to manage the output from the aforementioned module and incorporate the data into calculations. Gets the overall grade point average of the class, which can then be calculated and shown to users.

## Graph Analysis

The values acquired from the result analysis section are used to examine the graph, which may then be seen graphically. Such as a funnel chart, pie chart, and pyramid chart.

Figure: Use Case Diagram: Faculty

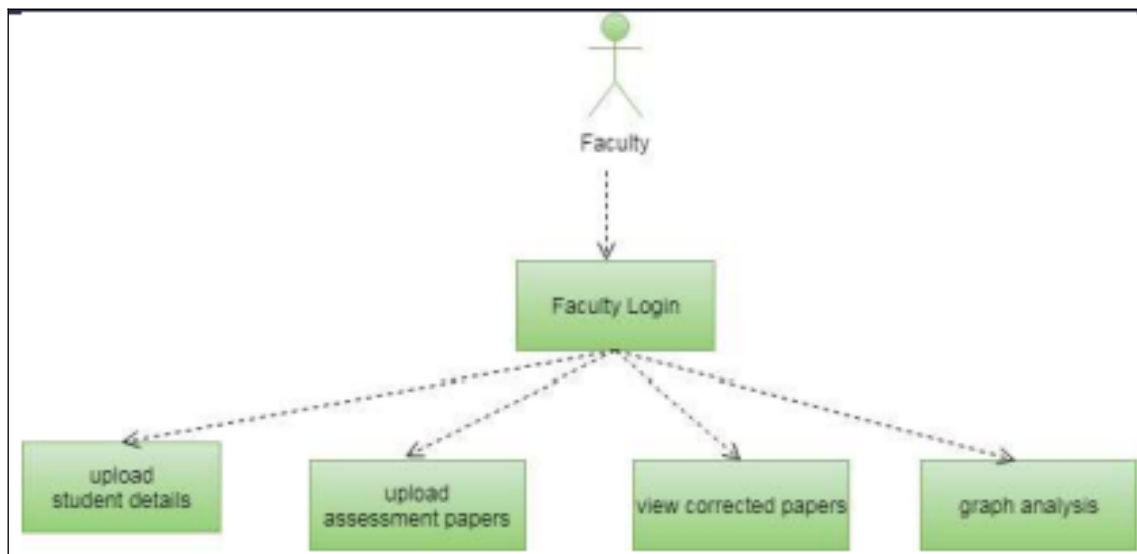
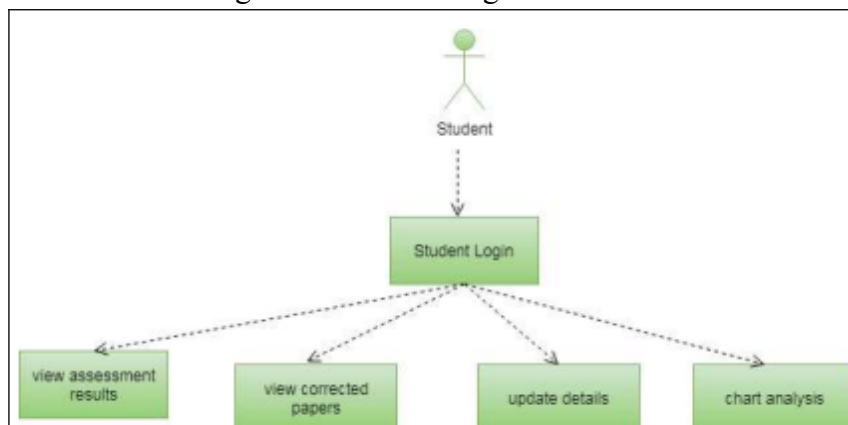


Figure: Use Case Diagram: Student





#### 4. Results and Discussion

The testing of the image processing was done on 66 pieces of exams which had 2 sides each and was filled out by students according to the instructions and this way they did not sabotage the capability of the algorithms. The error rate of the algorithms was (in every case) 0%, which means that every picture got split into the pieces it was meant to be and thus no information was lost during the processing. For the results see Table 1 below.

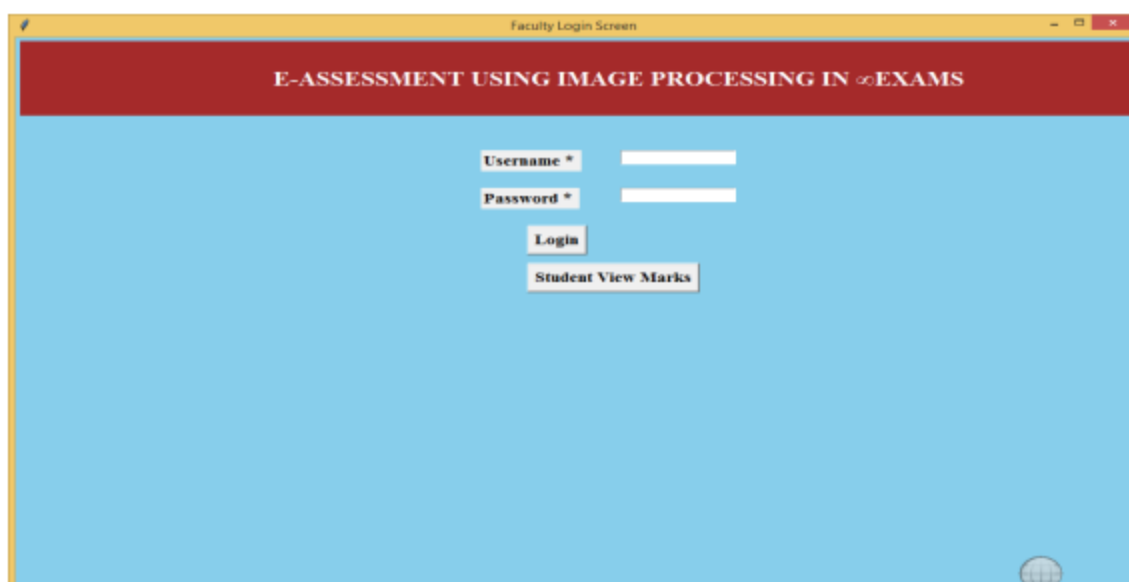
It can also be said that the spared storage space was more than 80% using the binarization and other sparing techniques.

Table 1: Testing of the Image Processing on 132 Pictures at Once

Type of test	Full runtime	Error rate
Best case scenario1	00h 02m 22s	0%
Average case scenario2	00h 11m 11s	0%
Worst case scenario3	00h 19m 00s	0%

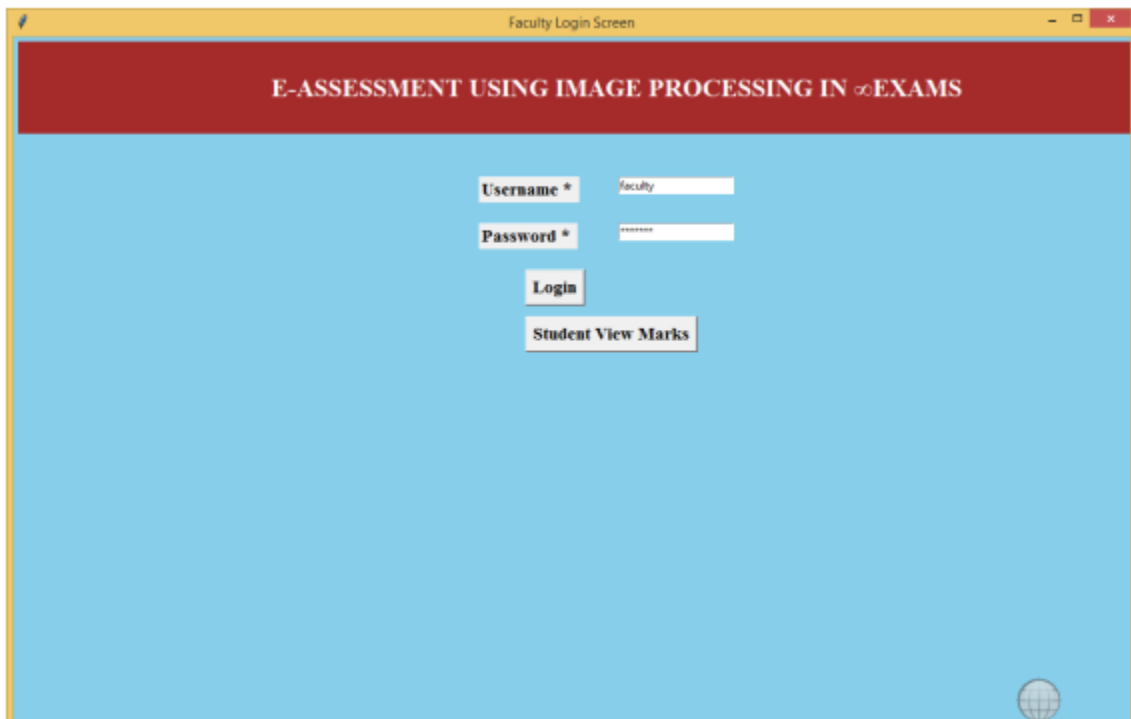
1. Every image you provide is oriented pretty similarly to the reference image.
2. Only half of the supplied photos are oriented correctly; the other half are upside down.
3. All of the input images are reversed.

The system's ability to function properly depends on the picture processing, which has improved significantly over time but is still far from perfect. Many new features could be added to it to make it even better, faster, and more accurate. However, despite the fact that, as was already mentioned, it never failed, it is not yet ready to not fail in unique circumstances where students attempt to undermine its effectiveness. As a result, this will be the main focus of future work on the image processing portion of the system.

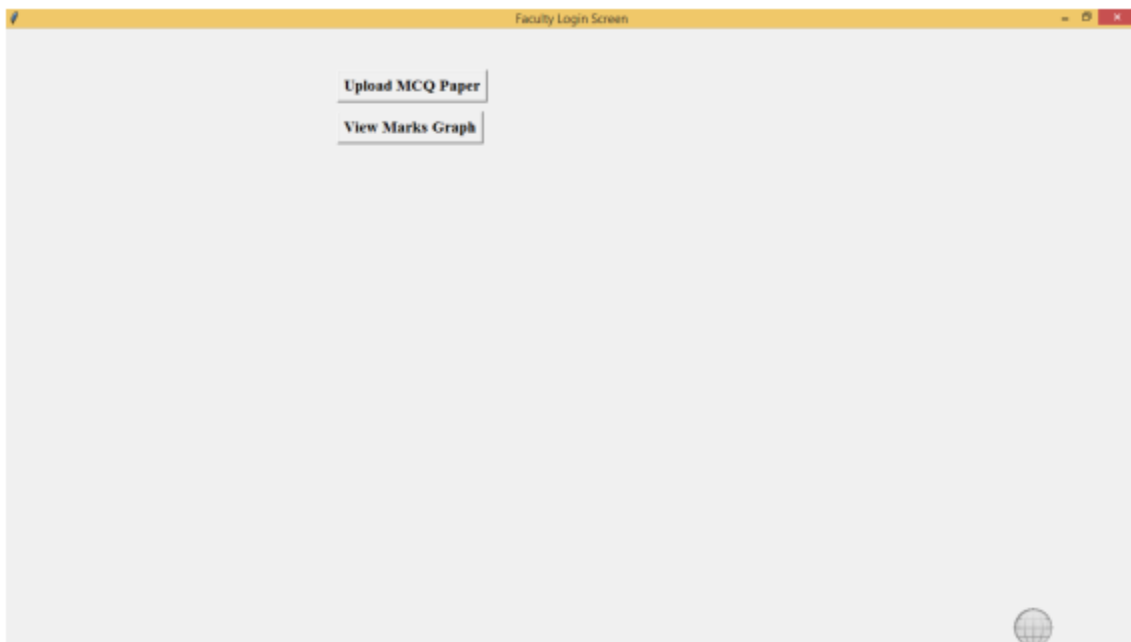


Enter "faculty" as the username and "faculty" as the password on the above screen to log in. The next screen will appear.

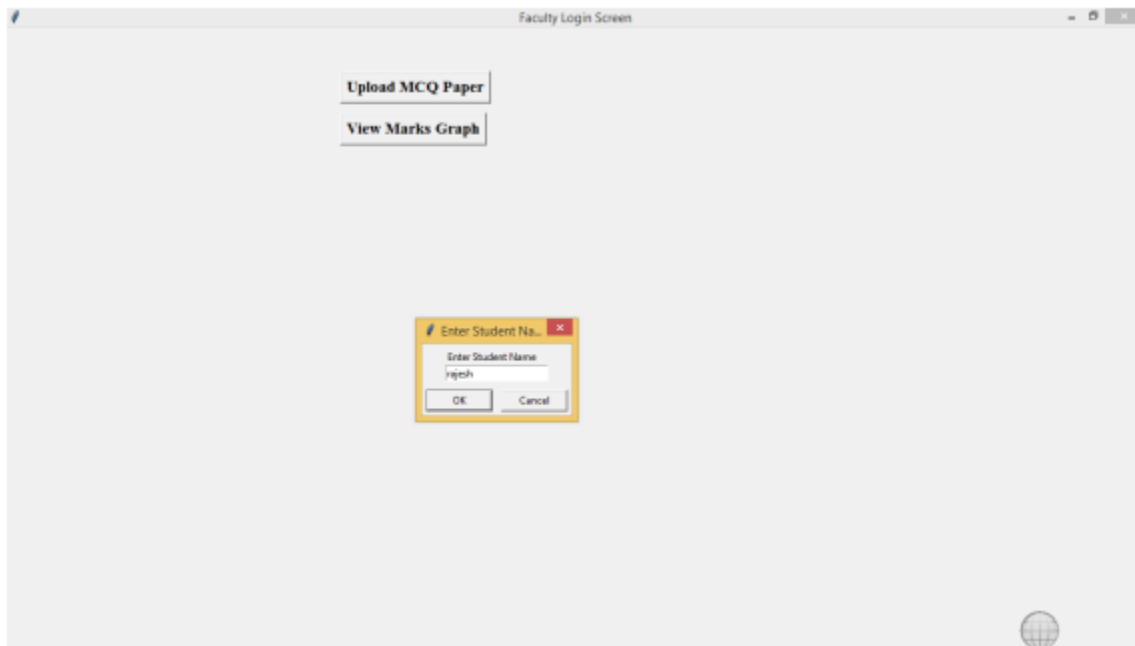




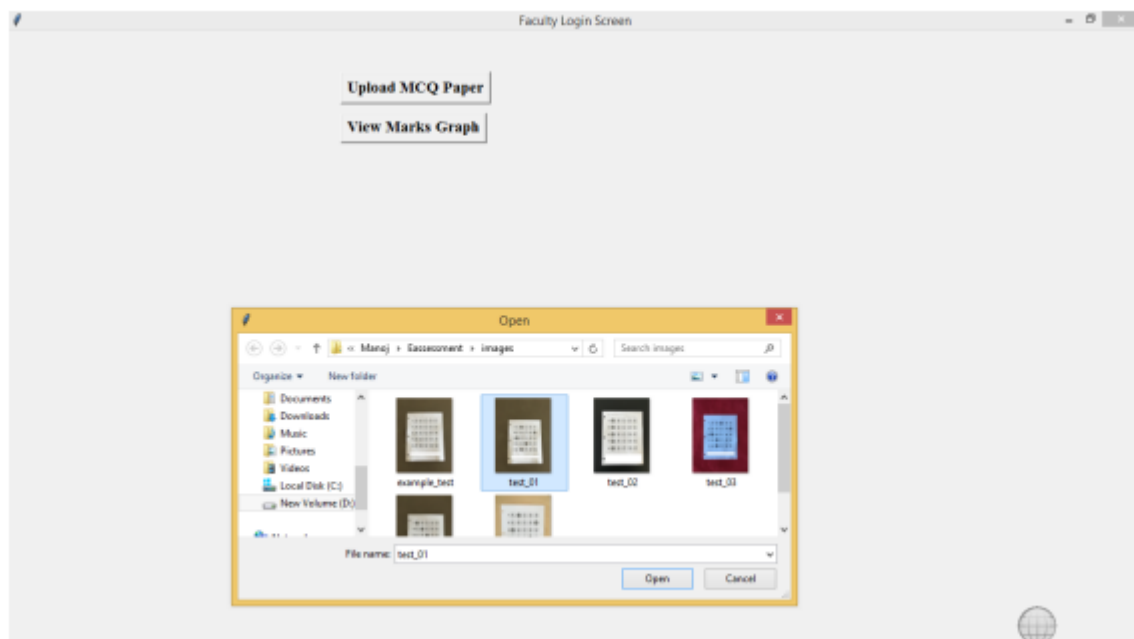
### Faculty Login Details



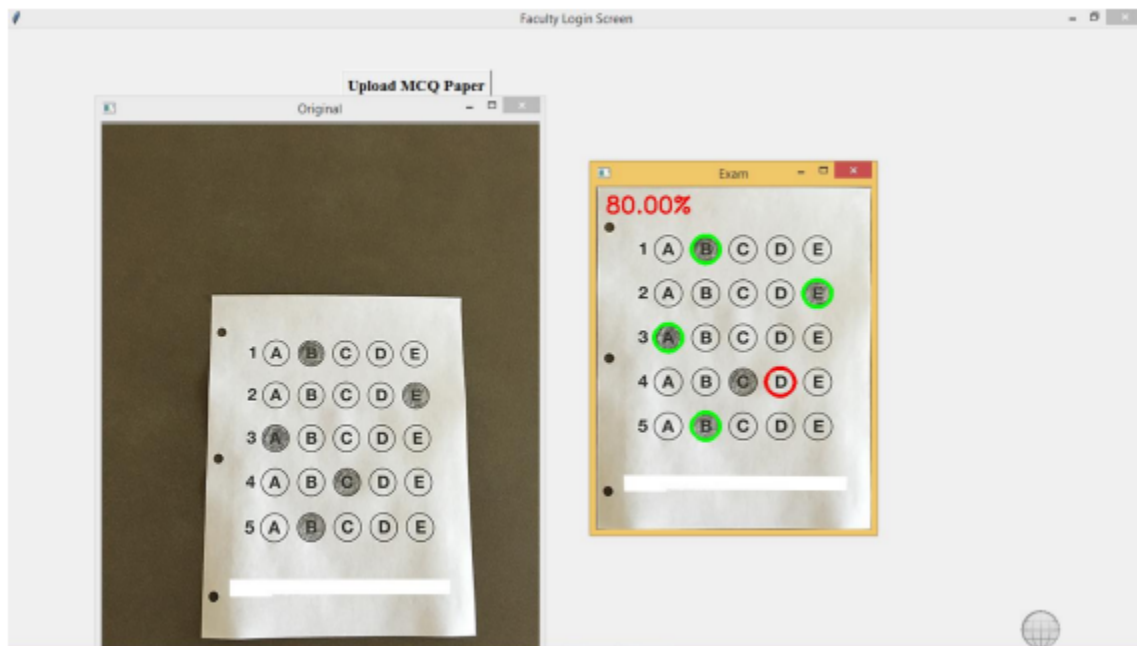
Click "Upload MCQ Paper" in the screen above, enter the student's name, then upload the question images.



In above screen click 'OK' button to upload image.



In above screen, select one image, now click open to process that image.



On the screen above, we can see the students' responses on the left side, and the corrected response on the right side, which is highlighted in red. The same is true for the number of photographs we can upload. The left side of the paper must contain three dot symbols, and each image must have five questions.

## 5. Conclusion and Future Scope

The so-called "Exams" software system that is presented is in alpha, which indicates that some of the previously envisioned capabilities have been built and are usable. Users of the software can create exam sheets, read and amend the database, upload photos, and correct exams using the desktop application. The structure that has already been put in place offers a nice preview of how the entire system will be put together. The software can only be used in offline mode at this time.

More than 100 exam sheets filled out by students specifically for this purpose were used to assess the system's functionality. The system's image processing component appears to be quick enough to process even a large number of photographs at once without experiencing any errors, therefore the results are satisfactory.

There is no question that the Exams software system has a lot of room for growth in the future. By grasping this chance when it is finished and released, it may contribute significantly to the revolution of digitalization in education.

The future of the revolution in the digitalization of education may be significantly influenced by the further development of the Exams software system. The main method of assessment in the present situation is the MCQ Test rectification. The MCQ Test format has a unique technique of conducting exams and correcting answers, which is quite challenging.

Image processing and the Django Framework are used in the suggested solution to address the issue and resolve it. Both of these methods were really helpful for resolving the issues in the MCQ Test Correction. It has its own drawbacks that will be resolved in the future, but in the present situation, it is a

better answer than the alternatives. In the future, this application will be able to offer a wide range of services.

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