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Development of an Offline Android-based Test Paper Checker Application for Northwestern Visayan Colleges

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Abstract: This research introduces an offline Android-based Test Paper Checker application designed to automate and streamline the grading process in institutions like Northwestern Visayan Colleges. Using optical character recognition (OCR) and machine learning, the app accurately digitizes and scores handwritten test responses, improving grading speed and accuracy. Key features include student registration, exam creation, paper scanning, correction key generation, and item analysis for question performance. The app functions offline, ensuring accessibility without internet connectivity. By reducing manual errors and processing times, it supports educators in delivering faster feedback and aligns with UNSDGs Goal 4 (Quality Education) and Goal 9 (Innovation).

Keywords: Automated Grading, Optical Character Recognition (OCR), Item Analysis, Offline Test Paper Checker

1. Introduction

In universities and colleges, administering exams is a fundamental part of assessing students' learning. Traditionally, exams are printed on paper, with students answering various questionnaires using pens. Teachers then manually check each answer sheet, calculating the total score. This process plays a crucial

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role in evaluating students' academic progress, knowledge, understanding, and skills, ultimately preparing them for their future careers. However, the manual grading method, while thorough, is time-consuming and labor-intensive.

Teachers often face significant workloads, with multiple subjects and schedules to manage, leaving little time for rest and relaxation. The manual process of checking papers can drain their energy and reduce overall efficiency. Additionally, it can lead to delays, potential errors in grading, and a lack of real-time feedback, all of which hinder the timely evaluation of students' performance.

To address these challenges, this research introduces an offline Android-based Test Paper Checker application designed to streamline and accelerate the grading process for college students in Northwestern Visayan Colleges. This system offers a faster, more secure, organized, and reliable way to grade exams. By scanning and digitizing printed answer sheets, the application automates the evaluation and grading process, reducing the likelihood of human error while providing prompt and accurate feedback. This innovative solution enhances the efficiency of assessment in educational institutions, allowing teachers to focus more on instruction and less on administrative tasks.

Generally, the objective of the study is to develop an offline Android-based test paper checker application for Northwestern Visayan Colleges. Specifically, the study aims to:

1. Develop a system that provides students with immediate exam results.
2. Enable the application to export a comprehensive list of students and their scores.
3. Ensure the application functions offline for uninterrupted use.
4. Integrate analysis tools to evaluate question performance and assess student understanding.

2. Review of Related Literature

The demand for automated grading systems has risen significantly in the past decade, with various technological solutions being developed to reduce manual effort and improve grading accuracy. Several studies have contributed to this field, emphasizing the role of technologies such as computer vision, Optical Mark Recognition (OMR), and machine learning in automating the grading process.

Ascencio *et al.* [1] presented an Automatic Multiple Choice Test Grader using Computer Vision that uses Python and OpenCV for answer recognition on multiple-choice tests. It demonstrates how contour detection and image processing can significantly speed up the grading process, minimizing human error and increasing accuracy. The findings show that automated grading systems can be more efficient than manual grading, reducing the time required for teachers to check exams.

Largo [2] explored a Bubble Sheet Multiple Choice Mobile Checker using OMR algorithms. The mobile-based solution allows teachers to check bubble-sheet exams offline, providing instant feedback to students. This system is particularly relevant to environments with limited internet access, similar to the goals of the offline Android-based Test Paper Checker application being developed in this study.

Further, Wata and Villaverde [3] introduced a Bubble-Sheet Assessment Checker using Raspberry Pi and computer vision. The system, equipped with edge detection and perspective transformation techniques, achieved a high accuracy rate of 96.8% during testing. The study highlights the importance of low-cost grading systems, reinforcing the potential for such systems in educational institutions where resources are limited.

Alhamad *et al.* [4] conducted a comprehensive review on the significance of Optical Character Recognition (OCR) for handwritten documents, emphasizing its practical value in transforming various document types into analyzable and searchable data. They highlighted that incorporating symmetry as a preprocessing step can enhance the accuracy of recognition algorithms by normalizing input data. Their review, which spanned research articles published between 2019 and the first quarter of 2024, gathered 116 articles using a structured review protocol, presenting key advancements in OCR and identifying areas for further research.

Lastly, Mondal *et al.* [5] (2023) introduced a lightweight Convolutional Neural Network (CNN)-based system, OMRNet, aimed at addressing the limitations of traditional Optical Mark Recognition (OMR) systems, which are often rigid and prone to errors. Unlike conventional OMR systems, OMRNet classifies answer boxes into marked, empty, and crossed-out categories, offering more flexibility in grading [6]. Built on MobileNetV2, OMRNet achieves an average accuracy of 95.96% and can be deployed efficiently using minimal memory through quantization techniques, making it suitable for resource-constrained environments.

3. Methodology

The approach used is Agile methodology, as depicted in Figure 1, which is a dynamic and iterative approach to software development that emphasizes flexibility, collaboration, and continuous improvement.

Figure 1. Agile Method

3.1 Requirements Gathering

In this initial phase, the focus is on understanding the needs and expectations of the users, in this case, the teachers and educational institutions. The researcher gathers specific requirements for the

application, such as the ability to scan and check answer sheets, provide instant results, work offline, and export student data. This phase involves active collaboration with stakeholders to ensure the system addresses the key pain points of manual paper checking and grading.

Key Activities:

1. Identify core features (*e.g.*, automatic grading, real-time result display).
2. Define user stories that describe the desired functionalities from the perspective of the end users.
3. Prioritize features based on their importance to the users and stakeholders.

3.2 Design

In the design phase, the researcher translates the gathered requirements into a blueprint for the application. This includes designing the system architecture, user interface (UI), and workflows for the grading process. Wireframes or prototypes may be created to visualize how the app will function and what it will look like. The design will focus on user-friendly navigation, offline capability, and smooth integration with devices such as mobile phones or tablets.

Key Activities:

1. Create mockups or wireframes for the application's UI.
2. Develop a data model for handling exam results and student lists.
3. Design the system architecture to ensure that the application runs offline and performs efficiently on Android devices.

3.3 Development

In this phase, actual coding begins based on the design and requirements. The development team works in short, iterative sprints, each focusing on building and delivering a specific feature or module of the application. The development will start with critical features like scanning answer sheets, automatic grading, and result calculation. Throughout this phase, the team works closely with the testers to ensure that each module functions as intended before moving on to the next one.

Key Activities:

1. Write and implement code for core features (*e.g.*, image processing for answer sheets, offline functionality).
2. Integrate SMS notifications and result exporting capabilities.
3. Develop algorithms for accurate score calculation and performance evaluation.

3.4 Testing

In this phase, the application will undergo various tests, including unit testing, integration testing, and user acceptance testing. The focus will be on checking the accuracy of results and the system’s ability to work offline. Any bugs or issues are addressed immediately before proceeding to the next phase.

Key Activities:

1. Conduct functionality tests for each feature, such as the scanning and grading process.
2. Test the application's performance in offline mode.
3. Validate that the system provides accurate and instant feedback to students and teachers.

3.5 Deployment

Once testing ensures that the system is stable, the application is deployed in an educational environment for pilot testing. During this phase, the system will be installed on Android devices for real-world use. The deployment phase also involves preparing the necessary documentation, user manuals, and installation guides to assist teachers and administrators in adopting the new system.

Key Activities:

1. Deploy the application for use in educational settings.
2. Ensure all necessary support materials (*e.g.*, user manual) are available for end-users.
3. Monitor the system's real-world performance for any issues.

3.6 Review

In the final phase, feedback is gathered from teachers, administrators, and students who have used the application. This feedback is crucial for identifying areas of improvement and additional features that may enhance the system further. The team reviews the application's performance based on user experience, identifying any bugs or enhancements needed for future sprints. This phase also involves assessing the system's impact on grading efficiency and accuracy compared to manual processes.

Key Activities:

1. Gather user feedback on system functionality, usability, and overall performance.
2. Analyze the system's effectiveness in improving grading speed and reducing errors.
3. Plan future iterations for continuous improvements based on user feedback.

3.7 Performance Evaluation

The equation shown calculates the weighted mean, which is essential for assessing the performance of the offline Android-based Test Paper Checker application in terms of system functionality. The weighted mean provides a more accurate representation of the system's overall performance by considering the significance or frequency of each rating given by the respondents.

The weighted mean is expressed in equation 1.

$$Weighted\ Mean = \frac{\sum(x_i - w_i)}{\sum(w_i)} \quad (1)$$

Equation 1 is applied in the study to evaluate the functionality of specific features of the test paper checker application, such as button operation, scanning accuracy, and data exporting capabilities. By using the weighted mean, the evaluation accounts for how frequently each rating was given, providing

a clearer understanding of how well the system performs across multiple functionalities. The result gives an overall score that determines whether the system is classified as Functional or Not Functional based on user feedback.

In this study, this formula ensures a fair assessment of the system's functionality, allowing for the identification of areas that meet the required standards and those that may need improvement.

4. Results and Discussion

4.1 Test Paper Checker (Optical Character Recognition)

The end product of this implementation approach will be a fully functional offline Android-based Test Paper Checker application designed to streamline the grading process for educators. This system will leverage Optical Character Recognition (OCR) technology to scan and automatically grade test papers, providing teachers with a faster and more efficient way to evaluate student performance. One of its key features is offline functionality, allowing the application to work seamlessly without an internet connection, which is particularly beneficial in areas with limited connectivity.

Teachers will be able to generate immediate results, enabling them to provide quick feedback to students. The system will also allow users to export data such as student results and reports into Excel files, facilitating easy record-keeping and analysis. Security features such as user authentication and data encryption will ensure that only authorized personnel can access sensitive student data, maintaining the confidentiality and integrity of the information.

The application will feature a user-friendly interface that simplifies the management of student lists, exams, answer keys, and results. It will be highly testable and maintainable, ensuring that future updates and enhancements can be easily incorporated based on user feedback. Additionally, the system will offer scalability, providing room for future expansions, such as advanced analytics or Cloud-based functionality.

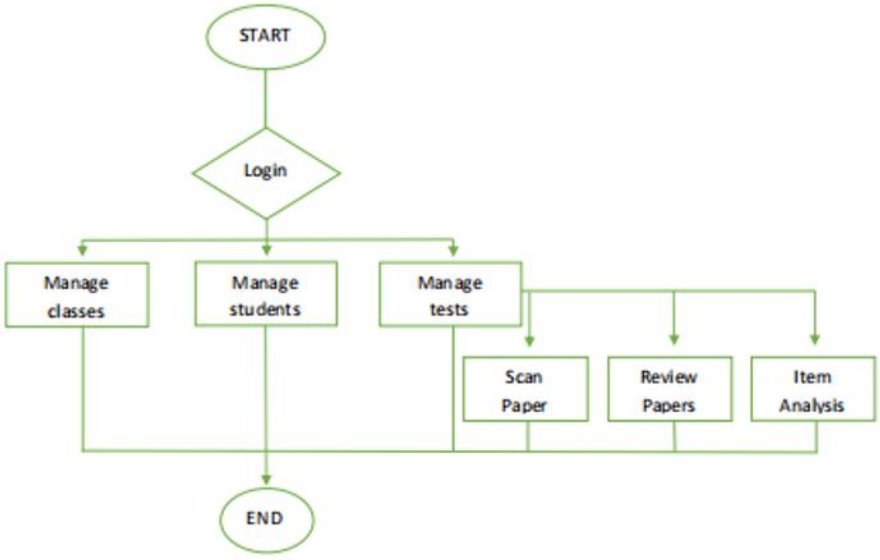

Figure 2. System Flow Diagram

This offline Android-based Test Paper Checker application will save teachers considerable time and effort, reduce human errors, and enhance the accuracy and speed of grading, all while being cost-effective and accessible in various educational settings. The system is tailored to improve the educational process for both teachers and students at Northwestern Visayan Colleges and similar institutions.

Figure 2 depicts the system flow diagram that provides a clear overview of the operations involved in the test paper checking system. It outlines the user's journey from logging in, managing classes and students, to scanning test papers and conducting item analysis. This logical flow ensures that each step in the system is structured and efficient for the user to navigate.

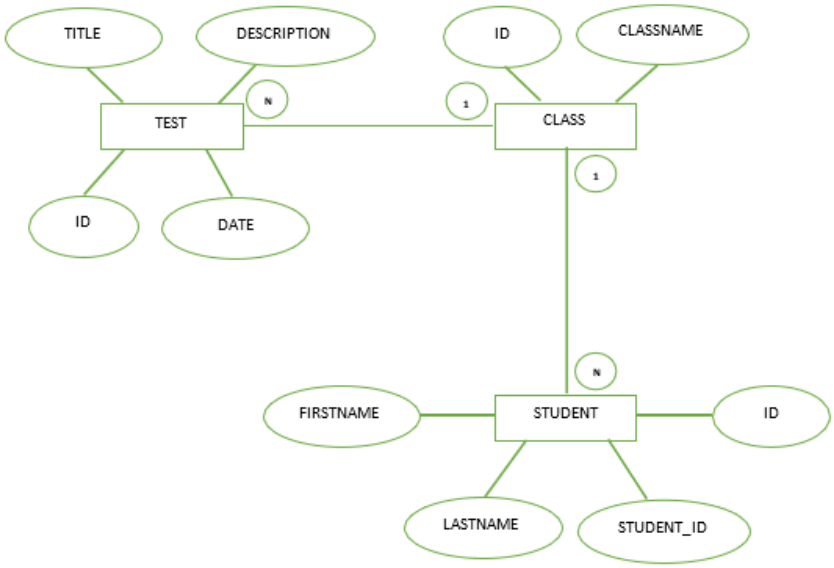

Figure 3. Entity Relationship Diagram (ERD)

Figure 3 depicts the entity relationship diagram (ERD) that visually represents how test records are linked to specific classes and how students are associated with both classes and the tests within those classes. This is useful for structuring databases that track student information, test administration, and class management, ensuring organized and efficient data handling.

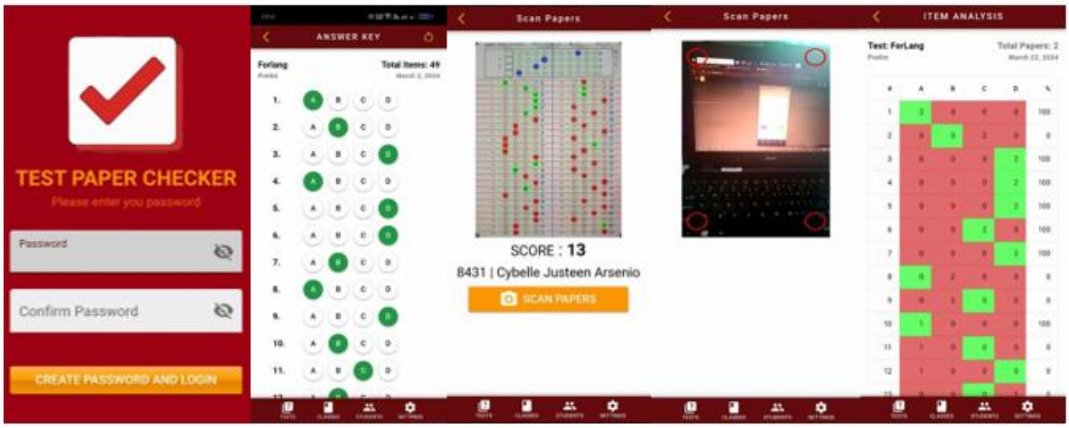

Figure 4. User Interface

Figure 4 depicts the user interface that displays the main features of the user interface, including password-protected login, answer key entry, paper scanning using OCR, and item analysis for student performance. The interface is designed for easy navigation and efficient test management.

4.2 Major Findings

The major findings of this study, as depicted in Table 1, would emphasize the effectiveness of the offline Android-based Test Paper Checker application in improving grading efficiency, accuracy, and user satisfaction. The application not only reduced the workload for teachers but also provided quicker, more reliable feedback for students. The system's offline capabilities, security features, and cost-effectiveness made it an excellent tool for enhancing academic processes at Northwestern Visayan Colleges and potentially other educational institutions. Additionally, the study may have opened doors for future improvements, indicating the potential for wider adoption and continued development of the system.

Table 1. Development of an Offline Android-based Test Paper Checker Application

Major Findings	Results	Weighted Mean	Interpretation
Increased Efficiency in the Grading Process	– 50% reduction in grading time on average – Grading speed: 100 papers/hour	1.97	Functional
Accuracy and Consistency in Grading	– 95% accuracy in detecting and grading answers – 30% reduction in grade discrepancies	2.00	Functional
Offline Functionality	– 100% of respondents confirmed offline functionality	2.00	Functional
Immediate Availability of Results	– 85% of teachers reported sharing test results on the same day – Instant result generation	2.00	Functional
Usability and User Satisfaction	– 95% of respondents found the system easy to use – Quick adoption after 1-hour training	1.97	Acceptable

Security and Data Protection	– 60% found student score security acceptable – Teacher account security needs improvement	1.55	Secured
Flexibility and Adaptability of the System	– 85% of respondents found it adaptable to different exam types – Easy answer key modification	2.00	Functional
Impact on Teachers' Workload	– 75% of teachers reported a 50% reduction in workload due to the system	2.00	Functional
for Future Enhancements	– 70% suggested advanced analytics – 65% requested a cloud-based version	N/A	Identified opportunities for growth

5. Conclusion

The development and implementation of the offline Android-based Test Paper Checker application significantly improved the grading process for educators at Northwestern Visayan Colleges. The system achieved its primary objectives by automating the grading of test papers using Optical Character Recognition (OCR), reducing the time and effort required for manual grading while enhancing accuracy and consistency. Teachers were able to grade test papers more efficiently with a 50% reduction in grading time and provide immediate feedback to students, which was a marked improvement over traditional methods.

The offline functionality of the system proved invaluable, especially in areas with limited internet connectivity, allowing teachers to use the application without interruptions. Additionally, the system was found to be secure, though some improvements to teacher account security were recommended. The flexibility of the application allowed it to adapt to various exam formats, and teachers appreciated the ability to modify answer keys easily.

Usability was another highlight of the system, as teachers quickly adopted the tool with minimal training. The system’s user-friendly interface, coupled with its cost-effectiveness, made it accessible and beneficial to the institution. Furthermore, the reduction in teacher workload due to automation was a significant advantage, allowing educators to focus more on instructional activities and student engagement.

Overall, the study demonstrates that the offline Android-based Test Paper Checker application offers a reliable, efficient, and secure solution for grading tests. While the system has room for future enhancements—such as the integration of advanced analytics and Cloud-based features—it has already proven to be a valuable tool for improving the educational process at Northwestern Visayan Colleges.

The system successfully meets the needs of teachers by providing faster, more accurate grading and enhancing the overall efficiency of the exam evaluation process.

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