Asian Journal of Multidisciplinary Studies
Vol. 6, No. 1, (2023)
ISSN 2651-6691 (Print)
ISSN 2651-6705 (Online)

E-CHEQUER: A SMART EXAM -CHECKING MACHINE USING IMAGE PROCESSING TECHNIQUE

Ruby Rosa N. Puno, Yuen A. Nicdao, Christian Devan Sen Deinla, Gabriel Hernandez, Milongy Javier, Dhenzel Macalino, Renniel Ocampo, Jobert Santos, Gio Sicat
Don Honorio Ventura State University, Main Campus
Bacolor, Pampanga, Philippines

Article Info:
Received: 11 Aug 2023; Revised: 08 Dec 2023; Accepted: 20 Dec 2023; Available Online: 31 Dec 2023

Abstract *- This study developed an E-Chequer: A Smart Exam-Checking Machine Using Image Processing Technique. The research aims to identify the feasibility and effectiveness of using image processing techniques for automated exam grading among secondary level teachers in public schools. Specifically, it aims to (1) to develop a system that will help secondary-level teachers in terms of functionality, reliability, efficiency, and usability in checking the exams, (2) to identify the significant differences between the conventional way and the designed project in terms of checking exams. (3) to build a machine that will help the secondary level teachers lessen their workload. A great significance of this study is speed and efficiency when it comes to checking, assessment and data analysis of the students' exam papers. A machine can check a large amount of papers in a small amount of time compared to a human teacher. A Developmental Research Method concept was employed with 15 preliminary respondents and 13 evaluators, that includes secondary level teachers and professionals. The data were analyzed using statistical analysis. The device obtained an error rate of 1.33%, a precision of 100%, a recall of 96%, and an F1 score of 97.96%. Moreover, the accuracy of the device, based on the calculated Precision, Recall, and F1 Score, is 96%. The overall rating for the design project is 4.25 out of 5, showing that the respondents AGREE that the device meets the standard features and characteristics for property evaluation and serves the needs of the stakeholders, and so holds value. The device can perform bulk checking, and the scanning rate is only 9 exam papers per minute. Also, it only accepts A5 paper size and is limited to the customized answer sheet and 50 items only. For the volume of the exam paper, it can handle a maximum of 50 exam papers in one go. The contributing factors to paper jams include the quality and condition of the paper used and incorrect loading of the paper tray.*

Keywords – *image processing techniques, smart exam-checking, OMR, e-chequer*

INTRODUCTION

A teacher is a person who educates others, one who teaches or instructs. Almost all places have education, whether developed or not, and a partner in education is a teacher. Teachers have such a great while also physically and mentally taxing job. Being a teacher is a challenging yet rewarding profession. It involves preparing lesson plans, delivering lectures, grading assignments, and providing support to students. International studies show that teachers' work intensification mirrors societal trends toward overwork. Site-based management has led to increased teacher workload. Imposed and centralized system accountability, lack of professional autonomy, relentlessly imposed change, constant media criticism, reduced resources, and moderate pay all relate to teacher stress. The effects of teacher stress include declining job satisfaction, reduced ability to meet students' needs, significant incidences of psychological disorders leading to increased absenteeism, and high levels of claims for stress-related disability. Stress appears to be a factor in teachers leaving the profession in many countries [1].

A survey conducted by the researchers with the Science Department Teachers at Pampanga High School found that all teachers exclusively use the multiple-choice format for their examinations. Multiple-choice exams have numerous advantages, such as the time of correction, scoring efficiency, accuracy, objectivity, and the ability to cover much material efficiently [2]. Scores are also less influenced by guessing compared to true-false items. Multiple-choice items provide the most useful format for comparing performance from class to class and year to year, consistently employing objective correction methods. In the context of high school level education, it is common for teachers to incorporate multiple-choice questions in their periodic exams. These exams serve as a means to assess a student's knowledge and comprehension of the subject matter.

Given class sizes, teaching loads, and a host of other academic responsibilities, many teachers feel as though multiple-choice tests are the only viable option. Their widespread use justifies a regular review of those features that make these tests an effective way to assess learning and ongoing consideration of those features that compromise how much learning they promote.

(Optical Mark Recognition) OMR technology is particularly useful for applications in which large numbers of hand-filled forms need to be processed quickly and with a great degree of accuracy [3]. OMR will be used as the technology of electronically extracting intended data from marked fields, such as square and bubbles fields, on printed forms. Thus, this technology makes a great tool for scanning multiple-exam papers. Based on the study entitled "Automated Grading System for Multiple Choice Examination Using Image Processing", the study used image processing techniques such as thresholding, edge detection, and morphology to extract features from scanned answer sheets [4, 5].

Moreover, to enhance the grading process, we incorporated machine learning into our methodology. As each paper is fed into the machine, a cascade of learning is initiated. Through this iterative process, the system refines its understanding and proficiency in accurately evaluating exam responses. In summary, our study embarks on a journey to explore the potential of image processing techniques and machine learning algorithms for revolutionizing the grading process, addressing the crucial issue of teacher workload [6]. By seamlessly integrating OMR technology, we aim to provide a solution that not only enhances efficiency but also alleviates the burden on educators. The results showed that the proposed system achieved an accuracy rate of 90.5% in grading the exams.

OBJECTIVES OF THE STUDY

Specifically, it ought to answer the following questions:

1. How can the design project help the secondary level teachers in checking the exams in terms of: a. functionality; b. reliability; c. efficiency; d. usability?
2. What are the significant differences between the conventional way and the designed project in terms of checking exams?
3. How can the design project help secondary-level teachers in lessening their workload?

From the stated problem above, here are the research objectives that the researchers ought to achieve:

1. To develop a system that will help secondary-level teachers in terms of functionality, reliability, efficiency, and usability in checking the exams.
2. To identify the significant differences between the conventional way and the designed project in terms of checking exams.
3. To build a machine that will help the secondary level teachers lessen their workload.

This study focused on the problems related to the additional workload for teachers when checking students' exam papers. The researchers specifically address the issue of exam papers because it is a feasible problem that can be solved using technology, unlike other problems that require human reasoning [7]. Moreover, the development of the design project aligns with the researchers' field of study. The respondents for this study are secondary-level teachers, and the researchers do not inquire about other departments as the focus is solely on these teachers. The researchers will not intrude into their personal lives but rather concentrate on the satisfaction derived from using the machine. The goal of the system's development is to assist secondary-level teachers in checking students' exam papers. The system will solely support the paper-checking process and not address other issues.

In terms of the device, it is designed explicitly for multiple-choice exams with a maximum of 50 items. The end user cannot modify the number of exam items or the answer sheet. This means the device is designed to work with the provided answer sheets with a fixed layout for 50 questions. The paper format used for the answer sheets is A5 size. Using a different paper format is not possible. Additionally, the paper thickness should be 20 or 24 substances, as changing the thickness may adversely affect the device's performance. The device also comes with a website that the end users can access through echequer.site.

MATERIALS AND METHOD

The researchers employed a distinct research method to provide adequate solutions to the challenges inherent in the current system.

In developing the project system, the researchers used the Developmental Research Method concepts. This developmental research design strives to solve issues concerning advancing technologies or processes [8]. That said, the design project is applicable. The research objective is clearly not knowledge in the hypothetical sense but with the design knowledge that users can utilize. Developmental research is projected in natural working conditions. This increases the credibility of the research, but it frequently raises methodological quandaries for the researcher. But even so, whether undertaken during the design and development retrospectively, the ideal research applies to actual projects rather than simulated or hypothetical ones. This research method involves several phases, which may be iterative: analysis, design, development, implementation, and evaluation.

Developmental research can be classified into two (2) groups based on the structure and purpose of the study. The researcher's design project falls under the Type II Classification as it aims to be reconstructive and innovative with consideration of various constraints.

Table 1: *Type II of Developmental Research (Richey and Klein, 2005*

Features	Type II
Name as	Reconstructive Studies Model Development and Techniques Development
Emphasis	Study of design development, and evaluation processes, tools, or models
Product	New design development and evaluation procedures and/or models that facilitate the use
Conclusion	Generalized

Under this category, phases and types of participants are identified, shown in Table 2 below.

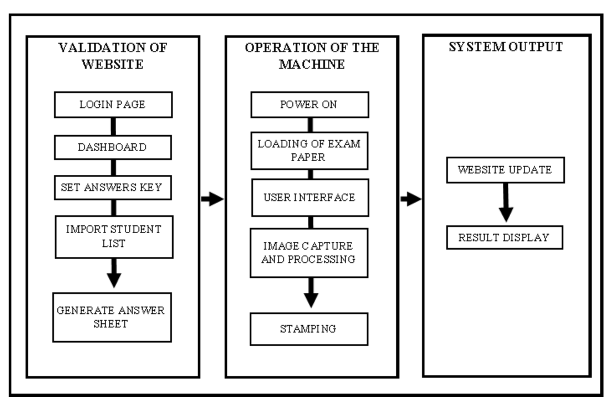
Table 2: *Phases and Types of Participants*

Function/ Phase	Model Development	Model Use	Model Validation
Type of Participant	Designers, Developers, Evaluators, Researchers, and Theorists	Designers, Developers, Evaluators, and Clients.	Designers, Developers, Evaluators, Clients, Learners, Instructors, and Organizations.

For the sampling procedures, this study used a combination of accidental and purposive sampling techniques to acquire and determine the number of respondents. For the accidental sampling procedure, during the pre-survey phase, respondents were selected from a pool of secondary-level teachers in two distinct schools. This approach allowed for a diverse representation, capturing a range of perspectives and experiences from educators in varying educational environments. The selection of respondents during this phase was determined based on their availability and willingness to participate, ensuring a practical and accessible sample. The purposive sampling procedure was implemented during the testing phase of our machine. This targeted approach involved selecting participants based on their specific expertise and experience in exam grading. By focusing on educators who were actively engaged in the assessment process, we aimed to gather insights from professionals with a deep understanding of the challenges and demands associated with manual grading. This deliberate selection ensured that our study captured the nuanced perspectives of those directly impacted by the technology. The researchers will utilize the mentioned sampling techniques to obtain the validity of the acceptability measures of the design project. The researchers conducted data gatherings through the Internet to construct their background information regarding their system. They formulated related questions regarding the design project using Google Forms. The questionnaires comprised related questions that helped the researchers explore and understand the importance of creating the system. After that, the researchers sent the formulated questionnaires to different secondary level public school teachers around Pampanga. The researchers were able to garner information from the participants and were able to identify the problems and processes encountered regarding checking exam papers among their students. Apart from using Google Forms, the researchers also conducted informative face-to-face and online interviews to gain first-hand information to broaden the data gathering.

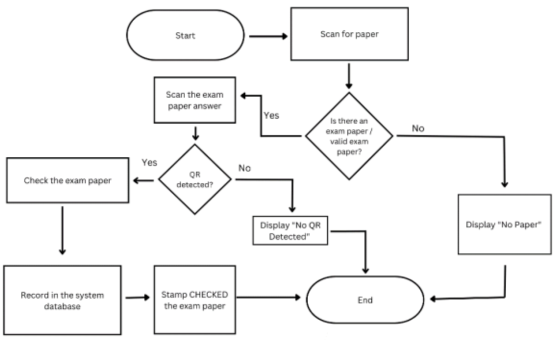
The researchers designed the whole system to fulfill the purpose of the whole system efficiently. The components were determined in this system design. The researchers used Raspberry Pi 4, OpenCV, OMR, Parallel Processing, Ramer–Douglas–Peucker algorithm, Haar Cascade algorithm, and Image Processing Techniques [9]. Figure 1 shows the block diagram of the whole process of how the software and hardware of the device work. The first block shown above is the validation of the website. It begins with the login page, where users enter their credentials. The website then verifies the provided information to authenticate the users. If the credentials are valid, users gain access to the dashboard. The dashboard serves as the central hub for managing exam-related tasks. Within the dashboard, users have the option to import a student list by uploading an Excel file containing student details such as names and IDs. Additionally, users can input their answer sheets from here.

The next block is the Operation of the Machine. The operation of the machine starts with powering it on by connecting it to a power source. Once powered on, the user loads the exam paper into the machine, ensuring proper positioning. The machine features a user interface through which users can interact with it using touchscreen controls. The machine captures an image of the exam paper using a built-in camera or scanning mechanism. The captured image then undergoes several image processing techniques, such as pre-processing, image segmentation, feature extraction, and more, to improve its quality and clarity. Furthermore, the machine may apply stamps or markings on the exam paper for visual feedback or to indicate that the exam paper has been checked.



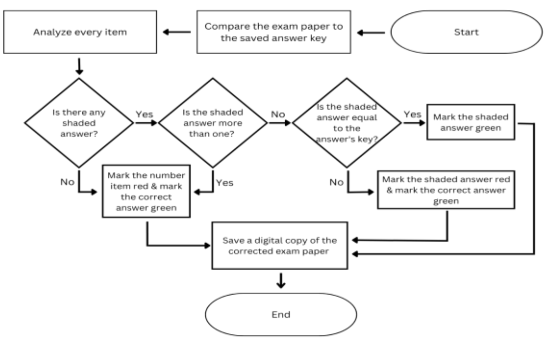
(Fig.1) System Block Diagram

The last block is the System Output. The system output consists of two main sub-blocks. First, the website is updated with relevant information and exam results. This ensures that the website's data, including student details and result records, has been reflected and synchronized with the machine's operations. Second, the machine displays the calculated results to the user. The result display includes the total score with a marking of the wrong and correct answers per item number. The system output gives users real-time access to exam results, facilitating efficient monitoring.



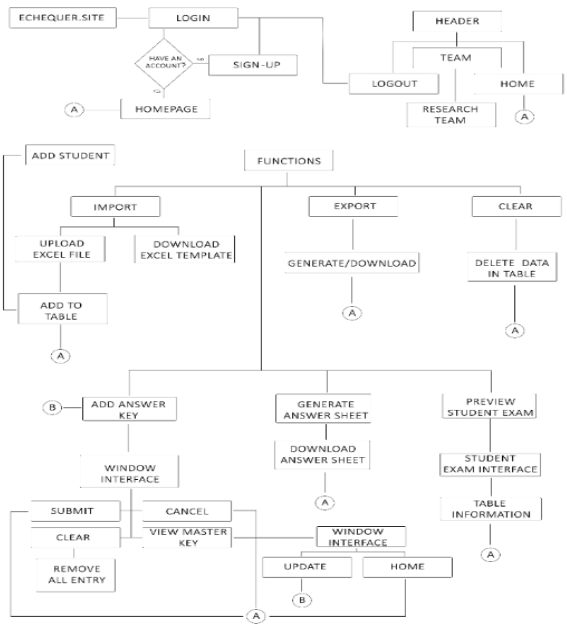
(Fig.2) Overall Machine Process Flowchart

Figure 2 shows the overall process of the system. Initially, the user turns on the device. Once turned on, the system begins to scan the exam papers. If the system detects an invalid exam paper, it displays "No paper" and terminates the process. Otherwise, the system scans the exam paper and attempts to detect the QR code. If the QR code is not detected, the system displays "No QR detected" and the entire device process ends. If the QR code is detected, the system proceeds with the checking process. After the checking process is complete, the system records the obtained data in the database, and the exam paper is stamped with a "CHECKED" mark.



(Fig.3) Overall Process Flowchart

Figure 3 shows the internal process of checking the exam paper. The exam paper will go through several image processing techniques to extract the data and compare it in the saved answer key from the database. Once the exam paper has been processed, the system will save a digital copy of the corrected exam paper with the total score obtained.



(Fig.4) Web Diagram

Figure 4 shows the interconnections of the functions on the website. The user can access the homepage by signing up or logging in to the site. The homepage has eight parts, which are all connected to the homepage where users can access them. They consist of the following functions: the table for the imported data, the add student function, the import, export, clear, add answers key, generate answer sheets, and the preview student exams. These are all accessible to users, and the output is dependent on the user's input.

The proponents conducted several tests on the device to assess its efficiency and determine the error rate of the acquired data. The number of exam sheets used for the testing is based on the calculated mean from the bulk testing, considering several factors that affect the device's accuracy, such as paper and marking quality, lighting conditions, and environmental factors. The researchers also adapted Precision, Recall, and F1 Score evaluation metrics to evaluate the performance in terms of the accuracy of the device in comparison to the manual grading. Below are the following formulas were used:

Error Rate = [(Number of Errors/(Exam Papers x Total (1) Number of Items)] x 100

Precision = TP / (TP + FP)

Recall = TP / (TP + FN)

Asian Journal of Multidisciplinary Studies
Vol. 6, No. 1, (2023)
ISSN 2651-6691 (Print)
ISSN 2651-6705 (Online)

F1 Score = 2 * (Precision * Recall) / (Precision + Recall)

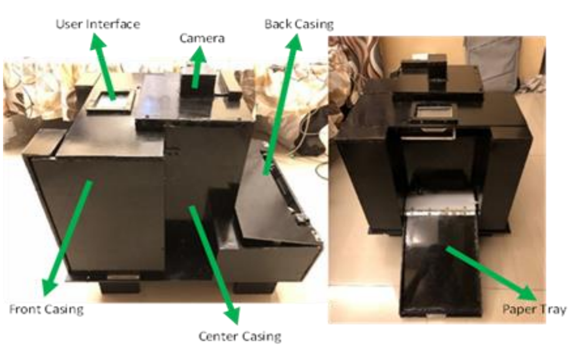
Accuracy = (TP) / (TP + FP + FN)

Precision calculates the proportion of correctly detected marks. According to Formula (2), the precision equals the number of true positives (TP) divided by the sum of true positives (TP) and false positives (FP). Recall measures the proportion of correctly identified marks out of the total marks. According to Formula (3), the recall equals the number of true positives (TP) divided by the sum of true positives (TP) and false negatives (FN). The F1 score is the harmonic mean of precision and recall and can be calculated using the Formula (4) [10].

Ten (10) secondary-level teachers from the Science Department at Pampanga High School completed questionnaires during the evaluation of the E-Chequer: A Smart Exam-Checking Machine Using Image Processing Technique. The questionnaires consist of four (4) criteria on the device's functionality, reliability, efficiency, and usability. To further strengthen the evaluation results, the proponents surveyed three (3) professionals, a Computer, Electronics, and a Mechanical Engineer graduate. The evaluation form answered by the professionals was aligned with the ISO/IEC 25010:2011 evaluation standard [11].

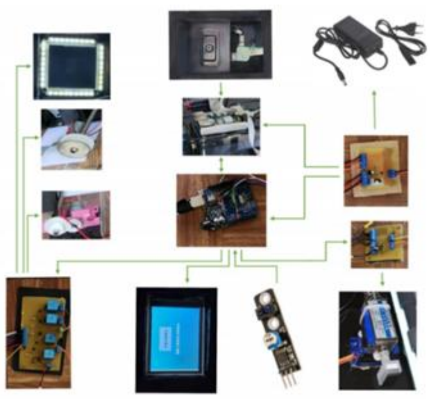
RESULTS AND DISCUSSION

This section consists of the output designs and explains the analysis and interpretation of the study on checking exam papers using Image Processing techniques and its comparison to manual grading. It contains the statistical results computed through error rate and various evaluation metrics, such as Precision, Recall, and F1 Score. Including also the teachers' and professionals' evaluations accumulated through the actual demonstration.



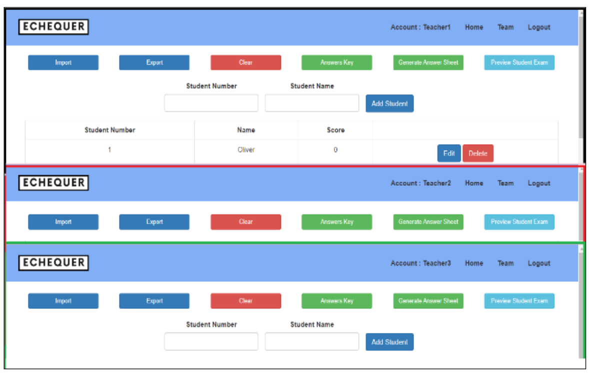
(Fig.5) The Actual Device

Once all of the hardware and software components are combined, the E-Chequer is made: A Smart Exam-Checking Machine Using Image Processing Technique, as shown in Figure 5 above. The developed device has three (3) separate enclosures connected to each other, the paper feeder, camera, and outer roller.



(Fig.6) Design Project Architecture

Figure 6 illustrates the interconnections between each component in the system. Based on the gathered knowledge, the researchers constructed a fiberglass case to serve as the device's frame. The design project involved electronic equipment that operated using a microcomputer. The system employed an ATMEGA2560 and a Raspberry Pi 4 Model B that communicated with each other while relying on a regulated 12-volt power supply that outputs 5 volts. The roller, feeder, stamper, and LCD strip lights were connected to the ATMEGA2560 integrated circuit. The device utilized a 720p/30fps camera linked to the microcomputer. The Infrared line tracking sensor was also connected to the ATMEGA2560 and powered by regulated 5 volts [12, 13, 14, 15].



(Fig.7) Web Interface

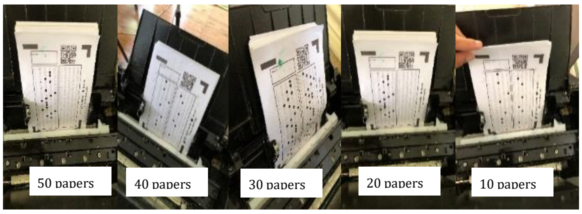
Figure 7 shows the homepage screen of a web application, which consists of three main sections. Firstly, the Home Page comprises eight distinct parts.

The Import button lets users import data from an Excel file into the database. Users can import their student list from an Excel file by clicking the Import button, and the imported data will be displayed in a table on the homepage. The table provides two actions: Users can freely edit or delete each content and manually add a student. Another element on the homepage is the Export button, allowing users to download the table contents, including student number, name, and score, as an Excel file. The homepage also features a Clear button, allowing users to erase the table contents. This function is particularly useful when changing subjects or students for assessment. The Generate Answer Sheet button is another prominent feature, facilitating the extraction of table contents to create a unique QR code for each student. These codes are then transferred to the answer sheet template, which users can download. The answer sheet file includes the QR codes and names of the students in the table. The Add Answer Key button enables users to input the answer key using buttons labeled with ABCD manually. It also provides the functionality to verify the input answers.

Furthermore, the Preview Student Exam button allows users to view checked papers processed by the system. Moving on to the second section, the Team Page allows users to access information about the authors and their curriculum vitae. Lastly, the Logout button redirects users to the Login page when clicked. The website supports the creation of multiple end-user accounts, each having a separate database. The name of the user account is displayed beside the Home tab.

(Fig.8) Testing of the Haar Cascade Algorithm

Figure 8 shows the testing if the image sensor can detect the region of interest on the exam paper that was trained through the Haar Cascade algorithm. Each detected shapes or pattern will be labeled Cascade 1, Cascade 2, Cascade 3, and Cascade 4. The Haar Cascade training test conducted to determine and locate predefined shapes on the exam sheets has yielded remarkably accurate results with an impressively low error rate of only three (3) percent. This level of accuracy is particularly noteworthy when considering factors such as paper quality. Factors like paper creases, texture, and ink smudges can introduce variability and make accurate shape detection more difficult. Despite these potential impediments, the Haar Cascade training test achieved an impressive level of accuracy, demonstrating the effectiveness and robustness of the trained model in handling variations in paper quality.



(Fig.9) Paper Bulk Testing

The device can do bulk checking, and the scanning rate is nine (9) exam papers per minute. To determine the device's efficiency, the proponents performed a test on the device, as shown in Figure 9 above. Each bulk of exam papers underwent three (3) tests to determine the average exam sheets the device could handle with minimal feeding failure and paper jams.

Table 3: *Bulk Testing*

Number of Exam Paper	Number of Paper Jams			Average Number of Paper Jams
	Test 1	Test 2	Test 3	
10	0	0	0	0
20	0	1	0	1
30	2	3	3	3
40	6	4	5	5
50	5	6	6	6
Average Mean				**3**

Table 3 shows the results of the performed testing on the device's efficiency. The test obtained an average mean of three (3) paper jams among the tested bulk samples. The results indicated that as the volume of papers increases, so does the frequency of paper jams. However, some observed variations indicated that factors other than the paper volume alone might influence the occurrence of paper jams. The observed factors contributing to the occurrence of paper jams include the quality and condition of the paper used and incorrect loading of the paper tray.

Asian Journal of Multidisciplinary Studies
Vol. 6, No. 1, (2023)
ISSN 2651-6691 (Print)
ISSN 2651-6705 (Online)

Table 4: *Error Rate*

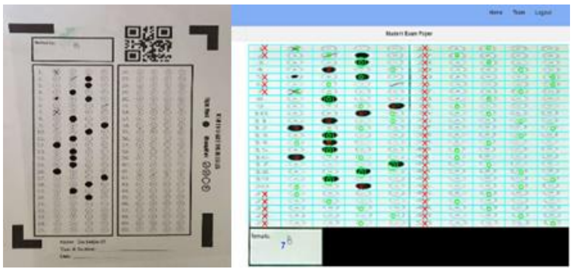
Exam Papers	Total Number of Items per Exam Paper	Number of Errors
30	50	20
Error Rate = [20 / (30 x 50)] x 100 Error Rate = (20 / 1500) x 100 = **1.33%**		

Table 4 shows the device's error rate calculation, based on Formula (1), in checking exam papers. Based on the 30 tested exam papers with 50 questions per paper, the obtained error rate is 1.33%. The number of errors indicates the total number of incorrect answers or misclassified marks across all 30 papers. Thus, on average, 1.33% of the answers or marks were incorrect or misclassified by the device across the tested exam papers.

Table 5: *Precision, Recall, and F1 Score Evaluation*

Number of Exam Papers	30	True Positive (TP)	1440
		False Positive (FP)	0
		False Negative (FN)	60
Precision = 1440 / (1440 + 0) = **1.0**			
Recall = 1440 / (1440 + 60) = **0.96**			
F1 Score = 2 * (1.0 * 0.96) / (1 + 0.96) = **0.9796**			
Accuracy = 1440 / (1440 + 0 + 60) = **0.96**			

Table 5 shows the data and results of the Precision, Recall, and F1 Score evaluation test. Based on the calculated results, the device's precision is 1.0, indicating that out of all the marks identified as correct by the device, 100% were actually correct. The recall is 0.96, indicating that out of all the correct marks in the manual grading, the device identified 96% of them. The F1 score, which combines precision and recall, is 0.9796, providing a single measure that balances both metrics. These metrics mean that the device has achieved a high precision, indicating a high percentage of correctly identified marks out of all marks classified as correct. The accuracy of the device, based on the calculated Precision, Recall, and F1 Score in Formula (5), is 96%. This indicates that the device correctly identified and classified 96% of the total marks on the exam papers, considering both true positive and true negative cases.



(Fig.10) Manual Grading and Device Grading Comparison

Figure 10 shows the comparison of the Manual and Device results in terms of checking and grading exams. One of the primary advantages of the device is its ability to process many papers quickly. In this scenario, the device can check nine (9) papers in a minute, which translates to approximately 540 papers in an hour. Comparatively, manual grading takes between 1 to 5 hours per paper based on the preliminary survey results depending on the exam's complexity and the grader's experience. With an average class size of 45 students, using the automated device can reduce grading time significantly. Using the automated device, grading 45 papers would take approximately five (5) minutes, whereas manual grading could take anywhere from 45 to 225 hours. While efficiency is an important aspect to consider, grading accuracy is paramount in assessing students' performance. Manual grading, although time-consuming, allows teachers to thoroughly evaluate each response, considering context, creativity, and subjective elements. On the other hand, automated exam-checking devices rely on predefined algorithms and answer key matching, which may not accurately grasp student responses' nuances and subtleties. As a result, automated grading might overlook original interpretations or penalize unconventional yet valid answers. Therefore, it is crucial to balance efficiency and accuracy when choosing a grading method.

In addition, automated paper grading offers several advantages over manual grading in education, according to Kumar (2020). Regarding speed and efficiency, automated paper grading systems can process a large volume of papers in a significantly shorter time than manual grading. The developed device can handle a maximum of 50 exam papers, and the scanning rate is 9 papers per minute. This relieves educators of the time-consuming task of manually evaluating each student's paper. Besides, the automated device provides an objective assessment treating all papers equally, unlike manual grading, which subjective factors can influence. Human graders

Asian Journal of Multidisciplinary Studies
Vol. 6, No. 1, (2023)
ISSN 2651-6691 (Print)
ISSN 2651-6705 (Online)

can unintentionally introduce biases into their grading. Developing an automatic checking device eliminates such biases, promoting fairness and equal treatment for all students. Furthermore, automated systems are designed to minimize miscalculation errors, leading to more accurate and reliable grading outcomes.

The device has been designed to deliver reliable and efficient operation in optimal working conditions for two (2) to three (3) hours. This duration allows for effective and uninterrupted exam sheet processing and offers convenience and flexibility to users. However, it was observed that various factors can influence the operating time. Good working conditions, such as optimal temperature, adequate ventilation, and minimal system stress, contribute to the device's capability to operate for the specified duration. However, the operating time may be slightly reduced in more demanding scenarios or under less favorable conditions.

One of the device's limitations is that it accepts exclusively an A5 paper size and is limited to the customized answer sheet and 50 items only. For the volume of the exam paper, it can handle a maximum of 50 exam papers in one go. However, based on observed variations in the performed alpha testing (see Table 6), the frequency of paper jams increases as the volume of papers increases. It also indicated that contributing factors to paper jams include the quality and condition of the paper used and incorrect loading of the paper tray.

Table 6: *Assessment on the Functionality of E-Chequer: A Smart Exam-Checking Machine Using Image Processing Technique*

Assessment on the Study Functionality		
Aspect	E-Chequer: A Smart Exam-Checking Machine Using Image Processing Technique	
	RS	DR
The E-CHEQUER can easily process and mark exam papers.	5	Highly Functional
The E-CHEQUER can accurately calculate the total score for each exam paper.	4.9	Highly Functional
Average Weighted Mean	**4.95**	**Highly Functional**

Table 6 shows the respondent's assessment of the project design's functionality. The computed average weighted mean is 4.95, which indicates that the device is Highly Functional.

Table 7: *Assessment on the Reliability of E-Chequer: A Smart Exam-Checking Machine Using Image Processing Technique*

Assessment on the Study Reliability		
Aspect	E-Chequer: A Smart Exam-Checking Machine Using Image Processing Technique	
	RS	DR
The E-CHEQUER can constantly check and stamp exam papers.	5	Highly Reliable
The E-CHEQUER rarely experiences errors or malfunctions that require manual intervention.	4.9	Highly Reliable
The E-CHEQUER is easy to troubleshoot and fix errors or malfunctions.	4.9	Highly Reliable
Average Weighted Mean	**4.93**	**Highly Reliable**

Table 7 shows the respondent's assessment of the project design's reliability. The computed average weighted mean is 4.93, which indicates that the device is Highly Reliable.

Table 8: *Assessment on the Efficiency of E-Chequer: A Smart Exam-Checking Machine Using Image Processing Technique*

Assessment on the Study Efficiency		
Aspect	E-Chequer: A Smart Exam-Checking Machine Using Image Processing Technique	
	RS	DR
The E-CHEQUER processes exams faster than traditional manual grading methods.	5	Highly Efficient
The E-CHEQUER can handle enough volume of exams efficiently and reliably.	4.9	Highly Efficient
Using E-CHEQUER can save more time compared to traditional grading methods.	5	Highly Efficient
Average Weighted Mean	**4.97**	**Highly Efficient**

Table 8 shows the respondent's assessment of the project design's efficiency. The computed average weighted mean is 4.97, which indicates that the device is Highly Efficient.

Asian Journal of Multidisciplinary Studies
Vol. 6, No. 1, (2023)
ISSN 2651-6691 (Print)
ISSN 2651-6705 (Online)

Table 9: *Assessment on the Usability of E-Chequer: A Smart Exam-Checking Machine Using Image Processing Technique*

Assessment on the Study Usability		
Aspect	E-Chequer: A Smart Exam-Checking Machine Using Image Processing Technique	
	RS	DR
The E-CHEQUER has an intuitive interface and is user-friendly for teachers.	5	Highly Usable
The E-CHEQUER requires minimal guidance as it is easy to learn and use.	5	Highly Usable
The E-CHEQUER can work with the existing tools and resources commonly used by teachers.	4.9	Highly Usable
Average Weighted Mean	**4.97**	**Highly Usable**

Table 9 shows the respondent's assessment of the project design's usability. The computed average weighted mean is 4.97, which indicates that the device is Highly Usable.

Table 10: *Assessment of E-Chequer: A Smart Exam-Checking Machine Using Image* Processing Technique Based on ISO/IEC 25010

E-Chequer: A Smart Exam-Checking Machine Using Image Processing Technique		
Aspect	**Average Rating Scale**	**Average Descriptive Rating**
Functional Stability	4.11	Agree
Performance Efficiency	4.33	Agree
Reliability	4.22	Agree
Usability	4.33	Agree
Overall Average	4.25	Agree

Table 10 shows the assessment of the professional respondents on the overall aspect of the device.

In summary, the overall rating for the design project is 4.25 out of 5. The results show that the respondents AGREE that the device meets the standard features and characteristics for property evaluation and serves the needs of the stakeholders, and so holds value.

CONCLUSION AND RECOMMENDATION

In this paper, the E-Chequer: A Smart Exam-Checking Machine Using Image Processing Technique was developed to automate the process of checking exam papers. The system undergoes specific processes such as paper feeding, scanning, image processing, and stamping to obtain the results from the checked exam paper. The device can handle a considerable number of exam papers. The device keeps working until no more papers or errors are encountered and can provide efficient operation in optimal working conditions for 2 to 3 hours. The website application has eight parts (see Figure 9), accessible to users on different platforms like mobile or desktop. The study results show that the E-Chequer: A Smart Exam-Checking Machine Using Image Processing Technique has achieved its objectives and functional requirements. The device obtained an error rate of 1.33%, a precision of 100%, a recall of 96%, and an F1 score of 97.96%. The accuracy of the device, based on the calculated Precision, Recall, and F1 Score, is 96%.

The teachers find the project design functional, reliable, efficient, and usable. With that being said, the researchers concluded that this device would help automate the process of checking exam papers for students, contributing to a reduction in time and effort compared to the conventional way of checking exam papers.

Although the device can perform bulk checking, the scanning rate is only nine (9) exam papers per minute. Also, it only accepts A5 paper size and is limited to the customized answer sheet and 50 items only. For the volume of the exam paper, it can handle a maximum of 50 exam papers in one go. The contributing factors to paper jams include the quality and condition of the paper used and incorrect loading of the paper tray.

Those researchers who want to carry on or improve the study in the future should consider developing the following features: the device's capability to process more than nine (9) exam sheets at a time. It is also recommended to use a higher RPM DC motor for faster feeding, improve the device's ability to process a faster scanning of the exam papers, and include a feature to stamp the total score on the exam paper automatically. Also, future researchers can consider customizing the software to allow the total question items and types of exams to be adjusted for different exams, implementing an item analysis feature in the software, and a feature to save multiple answer keys, allowing teachers to switch between subjects and check exams more efficiently and quickly. These recommendations can enhance the device's functionality, reliability, efficiency, and usability, providing more flexibility and insights for teachers and students.

REFERENCES

[1] Naylor C. (2014), Teacher Workload and Stress: An International Perspective on Human Costs and Systemic Failure. BCTF Research Report. Retrieved December 15, 2022 from https://eric.ed.gov/?id=ED464028/

[2] Lopes, A. P., Babo, L., Azevedo, J., & Torres, C. (2015). Multiple-Choice Tests - A Tool in the Assessing Knowledge. Retrieved May 11, 2022 from https://core.ac.uk/download/pdf/47136087.pdf

[3] Hasan, et. al. (2015). An Image Processing Oriented Optical Mark Reader Based on Modify Multi-Connect Architecture MMCA.

[4] Ahmad, F., Husain, S., & Shah, M. A. (2018). Automated grading system for multiple choice examination using image processing. Journal of King Saud University-Computer and Information Sciences, 30(4), 459-467.

[5] eLearning Industry. (2023). AI's New Role In Education: Automated Grading. Retrieved from https://elearningindustry.com/artificial-intelligence-new-role-in-education-automated-paper-grading/

[6] Simplilearn (2022). What Is Image Processing? Overview, Applications, Benefits, and Who Should Learn It. Retrieved November 29, 2022 from https://www.simplilearn.com/image-processing-article#:~:text=Benefits%20of%20Image%20Processing&text=It%20helps%20to%

[7] IEU (2019). Why workload remains the biggest issue facing teachers. Retrieved November 29, 2022 from https://www.ieuvictas.org.au/news/why-workload-remains-the-biggest-issue-facing-teachers/

[8] Ibrahim, A. A. (2016). Definition Purpose and Procedure of Developmental Research: An Analytical Review

[9] Rosebrock, A. (2016). Bubble sheet multiple choice scanner and test grader using OMR, Python, and OpenCV. PyImageSearch. Retrieved April 10, 2023 from https://pyimagesearch.com/2016/10/03/bubble-sheet-multiple-choice-scanner-and-test-grader-using-omr-python-and-opencv/

[10] Vakili, M., Ghamsari, M., & Rezaei, M. (2020). Performance Analysis and Comparison of Machine and Deep Learning Algorithms for IoT Data Classification

[11] International Organization for Standardization. (2011). ISO/IEC 25010:2011 Systems and software engineering -- Systems and software Quality Requirements and Evaluation (SQuaRE) -- System and software quality models. Retrieved April 19, 2022 from https://www.iso.org/standard/35733.html

[12] Elec Circuit (2019). 12V to 5V converter step down 3A regulator. Retrieved March 20, 2023 from https://www.eleccircuit.com/12v-to-5v-converter-step-down-3a-regulator/

[13] Elec Circuit (2019). LM350 Adjustable Voltage Regulator. Retrieved March 22, 2023 from https://www.eleccircuit.com/lm350-adjustable-voltage-regulator/

[14] HowToMechatronics (n.d.). Arduino TFT LCD Touch Screen Tutorial. Retrieved March 18, 2023 from https://howtomechatronics.com/tutorials/arduino/arduino-tft-lcd-touch-screen-tutorial/

[15] Synthiam (n.d.). TIP120/TIP122 Transistor Switching Circuit. Retrieved March 31, 2023 from https://synthiam.com/Community/Tutorials/Tip120-Tip122-Transistor-Switching-Circuit-16244/