OPTICAL CHARACTER RECOGNITION (OCR) APPLICATION FOR IMAGE TO BRAILLE TYPEFACE CONVERSION

MICA SHAINE T. MAGHANOY[1], MARJHUVYN B. LAPIRAS, LPT, MAST[2], BRENT PAUL L. MACASILHIG[3], NAJMAIN KENNETH N. IMBIN[4], MAURICE BON B. NAMION[5]
https://orcid.org/0009-0001-5678-3222[1], https://orcid.org/0000- 0002-6154-3047[2], https://orcid.org/0009-0001-9491-85383, https://orcid.org/0009-0005-5204-13780009-0005-5204-13784, https://orcid.org/0009-0003-3684-1418
micamaghanoy@gmail.com[1], marjhuvyn.lapiras@gmail.com[2], brentpaul7.mcbroom@gmail.com[3], najmainkennethnimbin@gmail.com[4], mauricebonnamion@gmail.com[5]
Mapúa Malayan Colleges Mindanao Davao City, Davao del Sur, Philippines[1-5]

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ABSTRACT

The quantitative research titled "Optical Character Recognition (OCR) Application for Image to Braille Typeface Conversion" focuses on developing an application capable of converting text-containing images into a braille PDF document, ready for printing. This initiative aims to benefit students with visual impairments in the educational environment, offering them a valuable tool for processing educational materials tailored to their specific needs. The project underwent evaluation by 10 experts and 20 co-developers, assessing its functionality, responsiveness, performance, and usability (user satisfaction). Data, collected through Microsoft Forms, were analyzed using the mean score for each category. The results indicated that Product Functionality, Product Responsiveness, and Product Performance all received mean scores corresponding to the interpretation table's "Excellent" category (4.59, 4.52, and 4.51, respectively). Product Usability (User Satisfaction) achieved a mean score of 4.46, categorized as "Good." Overall, the application project received an impressive mean score of 4.52, denoting an "Excellent" rating. This signifies that the application is highly acceptable, effectively fulfilling the intended functions for end users.

Keywords: Optical Character Recognition (OCR), Braille, Typeface Conversion, Text Extraction, Application

INTRODUCTION

Software like Omnipage Ultimate, which can scan paper documents and convert them into Word or PDF documents suitable for e-text or braille, are available to help the visually impaired read printed text. Computer software like this is of great apparency as it incorporates Optical Character Recognition (OCR), which is text recognition for images, into the Braille typeface system. Optical Character Recognition (OCR) is a system that can read text from pictures, like those that are done to printed documents that require its text extracted. To provide some context, Braille is a tactile writing and reading system developed for the blind. According to Salah and Ranjith's (2015) study on issues in converting Malayalam text into Braille, however, there aren't many educational resources for the visually impaired written in

Braille. Similar transliterating window-based systems have been successful in aiding to this need, although the same research notes that they still have some limitations, such as a small database and a scanning issue. While the OneStep Reader application does possess the capability to convert text to speech and text to braille, its limited accessibility arises from the absence of free trials and a cost that falls outside the budgetary reach of the majority of users (Paths to Literacy, 2022). Consequently, this capstone project is directed toward developing a product that prioritizes inclusivity and usability for visually impaired students. The objective is to create an accessible and more affordable alternative, positioning the project as a viable and improved option for the broader user base.

In A Beginner's Guide to Access Technology for Blind Students (2018), the authors, who assessed assistive technology for visually-impaired students on a global scale, quoted the International Braille and Technology Center for the Blind (IBTC) in Maryland. They write those phones, which increasingly resemble computers, are recognized as valid instruments for aiding students with visual impairments. However, it also covered mainstream devices, such as the iPhone, which is regarded in high favor is actually understandably out of reach for certain people due to its high price. When it comes to raw power, though, android phones are on par with the iPhone—just without the same level of accessibility.

On a national initiative, however, the Philippines' Resources for the Blind (RBI) has adopted ABBYY FineReader, a piece of Optical Character Recognition (OCR) software capable of transforming scanned paper documents into editable digital versions that might subsequently be converted to Braille or audio format. Despite its intended use to improve access to braille textbooks, the nature of the software (computer) means that it is not particularly user-friendly for the visually impaired. As a result, RBI must use this software manually to convert these textual pieces to electronic view, and there are more and more pages to convert each year as students' course loads grow more complex (Weisser, 2023). Moreover, it's the slowest process, and it's what's led to problems like errors and low output.

In a similar context, much closer to home, students at SPED schools in Davao City that value an inclusive education have also mandated the use of this technology to convert texts into braille typeface. However, as was reported by SunStar Davao in an article, “PCs for Students” (2019), a similar barrier was the lack of specialized literature for SPED lessons. Yet, it has been claimed that a student from Davao City who is partially deaf, and blind has been given a program that makes computers speak out loud the keys pressed, which could help with typing and, more crucially, note taking. Unfortunately, his school did not offer any elective computer classes because its systems were too outdated for him to make use of.

To address the gaps of conventional systems, the developers are striving to develop a mobile app that can do readable-text extraction from photos and convert them into a braille typeface within a Word Document. Like other similar applications, this one seeks to implement an Optical Character Recognition (OCR) system into an Android-programming language Beta App. Uploading a PDF document, taking a photograph from your phone or in real time through the app will now have the text automatically extracted and converted to Braille using the font based on the USA Computer Code, a system commonly used by embossers. The goal of this project is to create a smartphone app that uses optical character recognition (OCR) to scan readable text and transform it into electronic text or braille transcription using Braille OCR software. This will allow the user to scan words in real time and have them translated into braille typeface on a document, which will be incredibly beneficial to learners who will always have access to their braille files on their phones in a convenient and inexpensive manner which may be brought to print for their personal use.

OBJECTIVES OF THE STUDY

The primary objectives of this research study are twofold. Firstly, the goal is to design and develop a prototype utilizing the Android programming language for a beta Optical Character Recognition (OCR) application. Secondly, the study aims to comprehensively test the Android programming language beta OCR application, focusing on its functionality, responsiveness, and performance. This evaluative process ensures a thorough examination of the application's capabilities. Additionally, the study is dedicated to ensuring an acceptable level of usability for the end-users, emphasizing a user-friendly and effective interface for optimal engagement with the developed OCR application. These objectives collectively guide the course of the research, aiming to achieve a robust, efficient, and user-centric OCR application on the Android platform.

METHODOLOGY

The Developmental Evaluative Quantitative Method Design will be employed over the course of this research project. Patton (2012) describes developmental evaluation (DE) as an organized method of monitoring, analyzing, and providing feedback on a project or program's growth. Accordingly, using this approach, the developers will undergo an iterative and embedded evaluation to promote ongoing product learning and adaptation (Developmental Evaluation, 2021). As such, by using a quantitative data gathering method to pose relevant questions, apply evaluation logic, and compile and give reflective data on the app's status, developers may swiftly evaluate user response to their app. The data will then be utilized to improve the product's internal consistency and efficiency, ensuring that it always adjusts to users' changing needs. Thus, this approach will allow developers to continuously improve the app to provide visually impaired students with their learning resources in a cost-effective and easily accessible manner.

Under the context of this project, the System Development Life Cycle (SDLC) will be carried out utilizing the Waterfall Process. According to Sherman (2015), the Waterfall Process is a formal process in which tasks are broken down sequentially and progressively. In this process, tasks that are assigned first must be accomplished by completing the set criteria given for that particular task before moving up to the next one to ensure the quality state of the product. Using this method will aid in the progress of the project by reducing the likelihood of mistakes and making better use of the available resources (time and money). Although the task should be specified in depth with stringent criteria, the possibility of producing the product effectively and of attracting users will considerably increase.

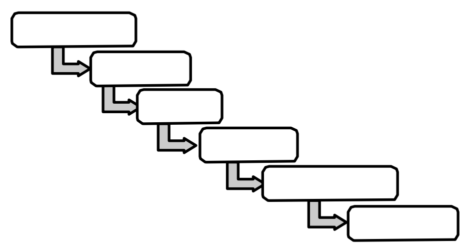

Figure 1. The Waterfall Process Model

The developers who are conducting this study will use a simple random sampling method in selecting the respondents. Using a simple random sampling method, in which each subset of a population's participants has an equal chance of being selected, helps ensure that the data collected is indicative of what would have been found had the entire population been sampled. The developers will require input from two distinct categories of research respondents: Alpha and Beta Testing. The commencement of Alpha

Testing is carried out in the product's field environment, and the following demographics are the target respondents (with a minimum sample size of 30 under this testing method):

1. The Developers
2. The Experts (IT/Software/Computer Professionals)
3. SPED Teachers

Following the completion of Alpha testing, the next phase of testing is known as Beta testing and is focused on gathering feedback from the end-users themselves. Since this is a technology for the visually impaired, the research subjects will be students at the Davao City School of the Blind who are not particularly concerned with auditory details.

To obtain the data that answers the research questions, a questionnaire with three distinct parts: a Demographic Profile section, a FURPS Evaluative Questionnaire section, and a Usability section measuring the extent to which respondents are satisfied with its use, will be used. Moreover, the answers to the questionnaire will then be evaluated and given interpretation using the Likert scale.

FURPS Questionnaire. The FURPS model, as defined by Gekht (2020), will serve as the foundation for the questionnaire, with the goal of ensuring that no aspect of the software product's requirements—or its potential users'—is overlooked. To find out the extent to which the beta OCR app developed in the Android programming language conducted in terms of functionality, responsiveness, performance, and usability.

Likert Scale. The Likert scale, defined by Preedy & Watson (2010) as "a psychometric response scale on which responders specify their level of agreement to a proposition normally in five points," will be integrated into the survey to gather data on the variables. This is a rating scale that ranges from one to five, with one (1) being the lowest possible score (*Very Poor*) and five (5) representing the highest possible score (*Excellent*).

Descriptive Statistics. Trochim (2023) explains, that descriptive statistics allow you to easily describe what persists, what the data shows, or observed quantifiable descriptions in a digestible format. Indicators for the prototype itself can range from very poor to very good, while usability can range from very dissatisfied to very satisfied.

To determine the extent to which the product met its research objectives the mean value calculated from the responses of the users for each indicator will be used to reflect how the sample views each indicator with the descriptive indicators found on the Likert scale.

RESULTS AND DISCUSSION

1. Product Functionality

Table 1
Product Functionality

Items	Mean	Description
Capacity to extract text from photographs and/or printed materials.	4.67	Excellent
Capability to scan documents that are already in PDF format.	4.63	Excellent
Comprehensible braille output file once the text has been extracted.	4.47	Good
Category Mean	4.59	Excellent

Table 1 displays the mean score for each statement used to evaluate the product's functionality. As shown, the highest mean score acquired is of 4.67, referring to the statement, "Capacity to extract text from photographs and/or printed materials." However, the statement "Comprehensible braille output file once the text has been extracted" has the lowest possible acquired mean of 4.47.

In accordance with the data that was acquired, the product's functioning received a mean score of 4.59 on its overall category, which is the descriptive equivalent of excellent. Within this category, it is also feasible to note that two of the three items obtained a descriptive equivalent of excellent, while the other acquired a descriptive equivalent of good. This suggests that the respondents find the application to be highly acceptable in terms of functionality, particularly the ability to extract text from images, scan documents that are already in PDF format, and produce legible braille output.

2. Product Responsiveness

Table 2
Product Responsiveness

Items	Mean	Description
Capable of notifying the user that they have not detected any text.	4.60	Excellent
Capacity to extract every word of the text from the image.	4.40	Good
Accuracy of text conversion from standard typography to braille	4.57	Excellent
Category Mean	**4.52**	**Excellent**

Each statement used for determining a mean score for the product's responsiveness is presented in Table 2 below. The statement, “Capable of notifying the user that they have not detected any text," obtained the highest mean score of 4.6 among all the items. Following " Accuracy of text conversion from standard typography to braille," with a mean of 4.57. To the contrary, the statement, "Capacity to extract each and every word of the text from the image," has the lowest possible mean acquired, a mean score of 4.40.

The aggregated data indicates that the product's responsiveness is the descriptive equivalent of excellent, with a mean score of 4.52. Two of the items in this category obtained the equivalent of an excellent descriptive score, while one of them earned a descriptive equivalent of good. This suggests that users see the application's responsiveness as highly acceptable, particularly in relation to its ability to alert users of errors, its ability to extract word for word from pictures, and the accuracy of text conversion.

3. Product Performance

Table 3
Product Performance

Items	Mean	Description
The speed at which pictures and/or printed documents can be scanned.	4.63	Excellent
The speed at which PDF documents can be scanned	4.33	Good
The speed at which the text extracted is converted to a braille file	4.57	Excellent
The impact of scanning and conversion on the amount of memory (RAM) used.	4.43	Good
Efficacy of the scanning and conversion process	4.57	Excellent
Category Mean	**4.51**	**Excellent**

Table 3 presents each statement that was utilized in the process of determining the mean rating for the performance of the product. Three items under this category refer to the speed at which the application processes its various features. This is the domain where we can also find the highest mean score for the category, which is 4.6. This mean score is associated with the statement, "The speed at which pictures and/or printed documents can be scanned." Furthermore, the lowest possible mean score acquired for this category is 4.3, corresponding to the statement, "The speed at which PDF documents can be scanned."

Earning a mean score of 4.51, the collected data unequivocally indicates that the product's performance aligns with the descriptive rating of "excellent." Within this category, three out of five items achieved an "excellent" rating based on their mean values, while the remaining items secured a rating equivalent to "good." This observation suggests that respondents perceive the application's performance as highly satisfactory across all pertinent dimensions, encompassing processing speed, impact on RAM utilization, and the efficacy of scanning and conversion processes.

4. Product Usability

The mean scores received for the various aspects of a product's usability, as measured by user satisfaction, are summarized in Table 4, which can be found below. The data shows that the statements, "Satisfaction with the processing time" and "Satisfaction with the resulting PDF document," have the highest mean score of 4.50. The value of 4.37, which corresponds to the item titled "Satisfaction for audio feedback," is the category's mean value, which is the lowest possible value.

Table 4
Usability (User Satisfaction)

Items	Mean	Description
Satisfaction for audio feedback	4.37	Good
Satisfaction with the processing time	4.50	Excellent
Satisfaction with the resulting PDF document	4.50	Excellent
Satisfaction with the responsiveness	4.47	Good
Category Mean	**4.46**	**Good**

The data presented above show that the category mean for product usability is 4.46, which corresponds to the descriptive equivalent of good. There are four items in this category, two of which have a descriptive equivalent of excellent and the other two of which have a descriptive equivalent of good. This implies that the application can function in accordance with the specifications set out by the developers, since the respondents have deemed the application's usability to be acceptable.

5. Overall Product Rating

Table 5
Overall Product Rating

Items	Mean	Description
Functionality	4.59	Excellent
Responsiveness	4.52	Excellent
Performance	4.51	Excellent
Usability	4.46	Good
Overall Mean	**4.52**	**Excellent**

The general evaluation of the product is displayed in Table 5. This takes into account the product's functionality, responsiveness, performance, and usability (user satisfaction). This will serve as the foundation through which the application's capabilities and usefulness are evaluated to guarantee conformity with and fulfillment of its intended goals.

The means and descriptive equivalents for the five categories of the research assessment tool used in this study are displayed in the table provided below. Most of the categories, namely functionality, responsiveness, and performance, have a mean score that is consistent with the description "excellent," as seen by the means they obtained. While the mean score for the application's usability was rather close to the good descriptor. This provides strong evidence to support the conclusion that the product is highly acceptable, with a mean score of 4.52.

Considering the foregoing, the image-to-braille (typeface conversion) application serves a purpose and is well-received by the respondents. Thus, the overall data analysis from the research's respondents over alpha testing reveals that the application's functionality, responsiveness, performance, and usability are, as a whole, highly acceptable. As an outcome, it is reasonable to presume that the application will fulfill its function for its intended beneficiaries once it is made available to the public.

CONCLUSIONS

This study indicates that the app's development costs are well-aligned with the goal of creating an affordable application for the potential market. In the alpha testing survey involving 30 respondents, the overall mean strongly supports the application's high acceptability, consistent with the detailed findings in functionality, responsiveness, performance, and usability. The Human Activity Assistive Technology (HAAT) Model (Cook & Hussey, 1995) is invoked to underscore the importance of considering user regular activities in addressing their needs, and the study's positive user satisfaction scores affirm this approach. Additionally, Goodhue and Thompson's (1995) Task-Technology Fit (TTF) Theory substantiates the excellent mean functionality score, affirming the application's effectiveness in achieving its intended purpose. Lastly, the Cognitive Load Theory (Sweller, 1988) underscores the significance of creating instructional materials conducive to optimal learning environments. The application's outstanding average performance mean, encompassing processing speed, RAM utilization, and efficient image-to-braille conversion, aligns seamlessly with this theory and the overall study findings.

RECOMMENDATIONS

Culminating in outlined recommendations for developers and future research, the developers propose the following recommendations:

For visually impaired students, the app's public release offers a transformative tool for accessing braille-formatted educational resources on cellphones, with support from parents, guardians, or teachers. Embracing the app is encouraged for more efficient studying of content not originally adapted to their needs, fostering continuous growth and expanding educational opportunities.

Special Education (SPED) teachers find significant benefit in using the app to convert reading materials into braille, expanding their students' access to information beyond what is currently available. The app is highly recommended for educators, facilitating a broader range of learning resources for visually impaired students.

Parents, recognized as a child's primary educators, are encouraged to use the app for independent learning, engaging children in tactile learning with both standard storybooks and those created or found online to broaden their horizons.

SPED institutions are urged to play a leading role in promoting the app to educators, students, and families, addressing the scarcity of braille-formatted educational resources and fostering the integration of braille in classrooms. This initiative grants visually impaired students increased access to materials traditionally designed for standard learners.

Future developers conducting similar studies are advised to dedicate additional resources to identify efficient features that can be integrated without incurring higher development costs. Conducting beta testing among visually impaired students is recommended to gain valuable insights into the product's effectiveness and enhance the educational experience for visually impaired students.

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AUTHORS’ PROFILE

Mica Shaine Maghanoy is an alumnus of Precious International School of Davao and Mapua Malayan Colleges Mindanao. In 2023, she received her high school diploma from the institution under the academic track, Science, Technology, Engineering, and Mathematics (STEM) with 2nd Honors. Currently, she is moving forward in committing to a career in healthcare by presently being a college student enrolled in a Bachelor of Science in Nursing.

Marjhuvyn B. Lapiras, LPT, MAST, is a graduate of Bachelor of Secondary Education major in Biological Science and Master of Arts in Science Teaching major in Biology at the premier institution of the University of Southeastern Philippines. He is currently pursuing his doctoral degree in Ph.D. in Educational Leadership. He is former Science educator at Holy Cross of Davao College (HCDC), Inc. for five years and was a member of the HCDC Research Council representing the Basic Education Department. The author is currently the Research Cluster Head and Science practitioner at Mapua Malayan Colleges of Mindanao teaching diverse Science courses that includes the spectrum from General Biology, General Physics, Earth and Life Sciences, Physical Sciences, and Capstone Research Project.

Brent Paul L. Macasilhig is a first-year BS Industrial Engineering student from Mapúa Malayan Colleges Mindanao. He graduated his Senior High School taking up Science, Technology, Engineering and Mathematics in the same school with 2nd Honors last school year 2022-2023. He finished his elementary years at Magugpo Pilot Central Elementary School as Valedictorian, school year 2016-2017. He also completed his four-year Junior High School at Tagum City National High School with 2nd Honors. He is also an active member of the Boy Scouts of the Philippines as a Rover Scout

Najmain Kenneth N. Imbin is a first year BS Civil engineering from Mapúa Malayan Colleges Mindanao. He finished his Elementary and Junior High School Years at Christian Colleges of Southeast Asia. He Graduated his Senior High School taking up (STEM) Science, Technology, Engineering and Mathematics in Mapúa Malayan Colleges Mindanao.

Maurice Bon B. Namion is a BS Electronics Engineering student from Mapua Malayan Colleges Mindanao. He graduated from his Senior High School taking up Science, Technology, Engineering and Mathematics in the same school with 2nd Honors and Perfect Attendance last school year 2022-2023. He finished his elementary years at Heartworks Learning Center Inc. with Perfect Attendance in 2016-2017. He also completed his four-year Junior High School at Holy Cross of Mintal Inc., with Honors.

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