Optical Character Reader of a Braille Unicode System for the Blind

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ABSTRACT--- This study aspires to innovate braille system by applying the fast coping technological advancement of the world to it. Braille is a code – a system of dots that represents the letters of the alphabet and that visually impaired individuals can use to read independently. As Braille Technology is fast growing, more and more people with visual impairment cannot afford to bought one. Thus, the proponents created a prototype, a portable and a lot cheaper braille device that will help individuals and institutions for their reading challenges. The proponents created a braille display that comes up with a scanner that will scan physical text documents then process it to become an output as a braille cell. It also comes up with a text-to-speech conversion which will become an option for the involved person on what will he or she chooses as an output. This is made possible by Optical Character Recognition (OCR) technology that the proponents used in Raspberry Pi. The OCR is responsible for the image processing that will convert the image captured into a text file. The text file will then be processed again to send signal to the servo motor that is responsible for pushing the braille cells needed. The device also includes motor guide for correct scanning of the physical text documents. The device will perform the task quickly that will surely help visually impaired individuals to easily read reading materials. This system is conducted to provide another solution on problems about reading for blind and visually impaired individuals and to provide cheaper device for them. It will contribute not only to the community involved but also in the technological industry in the Philippines.

Index Terms— braille, optical character recognition, raspberry pi, Braille, Unicode System, Optical Character Reader.

I. INTRODUCTION

Reading is always a challenge for the blind and the visually impaired where they only rely on special books and items that are limited in terms of availability and effectiveness. The blind and visually impaired does not only struggle to read books, articles, or any published materials, physically written papers and signage are just few of those that have little to no use for the blind and visually impaired to use. Their touch is the most important factor for them to read and interact with their surroundings which is why people started to invent electronic devices and applications which communicate with computers and phones in order to provide and help them in using computers and phones, although it is a solution for them to communicate it is only for digital or non-physical means only, this means they are left behind when it comes to physically written, printed or displayed words. Refreshable braille displays are currently available on the market this day. These displays are mostly used in computers to output a text, which means it is only limited to display computerized text. The braille system uses six dots to represent a certain character. Therefore, there will be two (the possible states of the dots, on/off) raise to the power of six (the number of dots) combinations which is equivalent to 64. Therefore, a braille system with 6 dots is capable of displaying 64 different characters. Optical Character Recognition is a technology that is widely used nowadays in various fields. Optical Character Recognition, or OCR, is a technology that enables you to convert different types of documents, such as scanned paper documents, PDF files or images captured by a digital camera into editable and searchable data.

The proponents would like to use this technology to develop a system that will be able to recognize texts from the outside world, and project those texts using a braille display. Blind and visually impaired individual needs to have a proper education just like us. But in our current society, they are rapidly left behind by the rapid growth of education system. Admit it or not, people with disability, especially blind individual can't cope on a normal education system that we have today. It is not because of their thinking capability, it is because it's hard for them to use and apply materials that students use on schools, especially in reading. Maybe there are some who can overcome that obstacle with the help of available Braille devices in the market but, there are many also who are left behind. So the big question is was it enough given that there are many children who are in need of a device that will help them to study? As a solution to that, the proponents want to develop an Optical Character Reader of a Braille Unicode System for the Blind to help them easily read printed materials that will become the first step in making their study patterns easy. It will also serve as the first step in the development of technology in the field of Braille devices and hopefully, the time will come that there are no more visually impaired individual that will be left behind in this society where disability is a disease and education is most important.

II. METHODOLOGY

A. Method of Research

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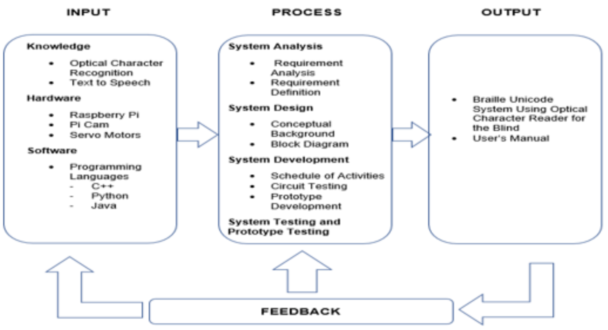

Figure 1 Research Paradigm of the Project proposal

To improve human conditions of visually impaired persons, the proponents used applied and developmental research. As an applied and developmental research study, it focuses to solve practical problems that will improve human conditions rather than to acquire knowledge. It focuses on analysis and solving social and real-life problems and generally conducted on a large-scale basis. It uses some part of the research communities' accumulated theories, knowledge, and methods. It is used to find solutions to everyday problems, and develop innovative technologies, rather than to acquire knowledge for knowledge's sake. Once an applied research has identified a workable solution to a specific problem the focus shifts to development of a specific product that involves refining the solution to produce a substance that will be effective, safe and appealing and can be manufactured in a timely and cost-effective way.

B. Data Gathering Procedure

Permission to conduct the research will be secured by the proponents from the administrator of the ATRIEV where questionnaires will be distributed to the chosen sample of the institution. The questionnaire will be scored, tallied and tabulated. The proponents and instructors of the institution will guide the persons involved for answering the given questionnaires.

III. RESULTS AND DISCUSSION

a. Functionality testing for Optical Character Recognition

Functionality Testing	First Testing	Second Testing	Third Testing	Fourth Testing
• OCR using Raspberry Pi and Pi Cam	Approximate image to text conversion accuracy is 30%	Approximate image to text conversion accuracy is 50%	Approximate image to text conversion accuracy is 60%	Approximate image to text conversion accuracy is 55%
	Fifth Testing	**Sixth Testing**	**Seventh Testing**	**Final Testing**
	Approximate converted image accuracy is 55%	Approximate image to text conversion accuracy is 70%	Approximate image to text conversion accuracy is 80%	Approximate image to text conversion accuracy is 90%

Table 1 shows the functionality of the OCR with a total of 8 testing done. The results are approximately computed based on the factors that are used during the testing period.

Figure 2. Prototype of the Project

Figure 2 shows the prototype of the project that showcases the braille system and the OCR and Camera that will store all the scanned documents. The device uses an 8 megapixels Raspberry Pi Cam that is installed to the Raspberry Pi, this makes it possible for the user to scan physical texts from documents or printed materials, then it will be processed by the Raspberry Pi. The scanned image undergoes Optical Character Recognition whereas the output is a text file containing all the converted data from the image. The Raspberry Pi then reads this text file and converts it to Braille ASCII, this text file is also read by the Raspberry Pi as an output for the text-to-speech

The Raspberry Pi checks the position of every cell of the braille by reading data from the rotary encoders which are attached to the servo motors on each cell, this position is used to determine the rotation needed for the servo motors to rotate to the correct position. The Raspberry Pi will send signals to the PWM Servo driver to rotate the servo motors for the desired angle. A wheel with magnets lined on its outside wall is driven by these servo motors along with the rotary angle sensors, these magnets attract and repel the pistons that serves as the individual dots. A rumble motor then vibrates to provide a haptic feedback to as the user navigates through the device.

As a feedback and error checking the rotary angle sensors are read again to ensure that the correct position is obtained, the rotary angle sensors are connected to a multiplexer that is then connected to the Raspberry Pi.

b. Weighted Mean (WM) and Verbal Interpretation (VI) of Students, Staffs, and IT Practitioner for Optical Character Reader of a Braille Unicode System for the Blind in terms of Accuracy

Accuracy	Students		Staffs		IT Practitioners		Overall	
	WM	VI	WM	VI	WM	VI	WM	
Correct characters are displayed	3.50	G	3.70	G	4.20	G	3.80	G
Converted text is complete	3.60	G	3.50	G	4.20	G	3.77	G
Word/Words are easy to understand	4.20	G	4.10	G	4.50	G	4.26	G
Overall Mean	3.77	G	3.77	G	3.90	G	3.94	G

Legend: Good(G)

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Table 2 shows the respondents result of the assessment. It shows the results of the developed device based on its functionality. Accuracy table shows the evaluation of the "Correct characters are displayed" with the WM of 3.50 for Students which is Good, a WM of 3.70 for the Staffs which is Good and WM of 4.20 for IT Practitioners which is Good too. "Converted text is complete" has a 3.60 WM for students and 3.50 WM for the Staffs and 4.20 WM for IT Practitioners which are both Good. "Words/Words are easy to understand has both 4.20 WM for the Students, 4.10 for Staffs, and 4.50 for IT Practitioners which indicates Good verbal interpretation. This implies that the developed device meets the functionality specification and requirements of the respondents in terms of different criteria made to be said that the device is functional.

c. Weighted Mean (WM) and Verbal Interpretation (VI) of Students and Staffs of ATRIEV, and IT Practitioner for Optical Character Reader of a Braille Unicode System for the Blind in terms of Efficiency

Efficiency	Students		Staffs		IT Practitioners		Overall	
	WM	VI	WM	VI	WM	VI	WM	
How long the device will last on a daily usage	3.90	G	4.00	G	4.10	G	4.00	G
Characters that the device can output at a time	3.80	G	3.80	G	3.80	G	3.80	G
Overall Mean	3.85	G	3.90	G	3.95	G	3.90	G

Legend: Good(G),

Table 3 shows the evaluation of the respondents which are Students and Staffs on Optical Character Reader of a Braille Unicode System for the Blind on the criteria of the Efficiency. It is evaluated using two (2) criteria to assess if the device can efficiently be used by the users specifically the life span of the device and the output rate of it. Efficiency evaluation table shows in terms of how long the device will last on daily basis usage, achieve a 3.90 WM with a VI of Good and 4.00 WM with a VI of Good for the staffs and a WM of 4.10 for IT Practitioners which indicates Good interpretation. Measuring the characters that the device can output at a time produced a WM of 3.80 for both Students and Staffs and IT Practitioners that indicates a Good interpretation.

This implies that students, staffs and the IT Practitioners agreed that the developed device is appropriate to use, effective and efficient based on their needs in their everyday routine and activities.

d. Weighted Mean (WM) and Verbal Interpretation (VI) of Students and Staffs of ATRIEV, and IT Practitioner for Optical Character Reader of a Braille Unicode System for the Blind in terms of Portability

Portability	Students		Staffs		IT Practitioners		Overall	
	WM	VI	WM	VI	WM	VI	WM	
Weight of the device	3.90	G	3.70	G	4.10	G	3.30	F
Overall size of the device	4.60	G	3.30	F	3.70	G	4.10	G
Overall Mean	4.25	G	3.50	G	3.50	G	3.70	G

Legend: Good(G), Fair(F)

Table 4 shows the evaluation of the respondents to Optical Character Reader of a Braille Unicode System for the Blind on the criteria of portability. Portability table shows that the device meets the needs for portability as the weight of the device scores a 3.90 WM that has a Verbal Interpretation of Good for students, a WM of 3.70 that indicates Good interpretation for the staffs and a WM of 3.10 with an interpretation of Fair for the IT Practitioners. The overall size of the device produced a WM of 4.60 which is Very Good, 3.30 which is Fair and 3.70 WM which is Good for staffs, and IT practitioners respectively. Although the results are not that high the overall WM reach a Good interpretation with a WM of 3.70 so we can conclude that the device portability was met.

f. Weighted Mean (WM) and Verbal Interpretation (VI) of Students and Staffs of ATRIEV, and IT Practitioner for Optical Character Reader of a Braille Unicode System for the Blind in terms of Cost-Effectiveness

Cost-Effectiveness	Students		Staffs		IT Practitioners		Overall	
	WM	VI	WM	VI	WM	VI	WM	
Components Cost	4.50	VG	4.70	VG	4.60	VG	4.60	VG
Housing Cost	4.50	VG	4.90	VG	4.40	VG	4.60	VG
Overall Mean	4.50	VG	4.80	VG	4.50	VG	4.60	VG

Legend: Very Good(VG)

Table 5 shows the evaluation of the respondents to Optical Character Reader of a Braille Unicode System for the Blind on the criteria of portability. Cost-effectiveness table shows that the components cost got a WM of 4.50 and a verbal interpretation of Very Good for students, a WM of 4.70 which is Very Good for staffs, and a WM of 4.60 which indicates a Very Good interpretation for IT practitioners This implies that both the students, staffs and the IT practitioners agreed that the developed device is a cost-effective one. This is very important now that as technology arises, its price also gets bigger.

g. Overall Weighted Mean (WM) and Verbal Interpretation (VI) evaluation for Optical Character Reader of a Braille Unicode System for the Blind

Variables	Students		Staffs		IT Practitioners		Overall	
	WM	VI	WM	VI	WM	VI	WM	
Accuracy	3.77	G	3.77	G	3.90	G	3.83	G
Efficiency	3.85	G	3.90	G	3.95	G	3.90	G
Portability	4.25	G	3.50	G	3.70	G	3.80	G
Cost-Effectiveness	4.50	VG	4.80	VG	4.50	VG	4.60	VG
Overall Mean	4.10	G	4.00	G	4.01	G	4.03	G

Legend: Good(G), Very Good(VG)

Table 6 shows that the overall based on the four variables got a WM of 4.10 and a verbal interpretation of Good for students, a WM of 4.00 which is Good for staffs, and a WM of 4.03 which indicates a Good interpretation for IT practitioners This implies that all the type of respondents agreed that the developed device is effective in term of the variables mentioned.

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h. ANOVA

To determine the difference among the evaluation of Students, Staffs and IT Practitioners of ATRIEVs' assessment of the Optical Character Reader of a Braille Unicode System for the Blind, the analysis of variance or ANOVA is applied. The results of the application of the test statistics will be presented, and discussed below:

Table 7 Summary of Evaluation of the Respondents

Variables	Source of Variation	Sum of Squares	df	Mean Square	F	P	Decision
Accuracy	Between Groups	0.252	2	0.126	3.316	0.052	Accepted
	Within Groups	1.013	27	0.038			
	Total	1.265	29	0.164			
Efficiency	Between Groups	0.030	2	0.015	7.5	0.026	Rejected
	Within Groups	0.045	27	0.002			
	Total	0.075	29	0.017			
Portability	Between Groups	0.350	2	0.175	6.481	0.005	Rejected
	Within Groups	0.725	27	0.027			
	Total	1.075	29	0.202			
Cost-Effectiveness	Between Groups	0.120	2	0.060	30	0.000	Rejected
	Within Groups	0.040	27	0.002			
	Total	0.160	29	0.061			

Table 7 shows that the difference in the evaluation in term of accuracy, efficiency, portability and cost-effective of the Optical Character Reader of a Braille Unicode System for the Blind

1. Accuracy

Table 7 shows that there is no difference in the evaluation of the Students, Staffs, and IT Practitioners in Optical Character Reader of a Braille Unicode System for the Blind between groups and within groups using one-way ANOVA. The computed value of P = 0.052 which is greater than the 0.05 level of significance accepts the null hypothesis. The result of the non-rejection of the null hypothesis indicates the equality of evaluation among the three groups of respondents which further proves that the Optical Character Reader of a Braille Unicode System for the Blind meets the specification and requirements of the respondents in terms of Accuracy

2. Efficiency

Table 7 shows that there is a difference in the evaluation of the Students, Staffs, and IT Practitioners in Optical Character Reader of a Braille Unicode System for the Blind between groups and within groups using one-way ANOVA. The computed value of P = 0.026 which is less than the 0.05 level of significance accepts the null hypothesis. The result of the rejection of the null hypothesis indicates the differences of evaluation among the three groups in terms of efficiency since the users are not knowledgeable in terms of technical operation of the device except the IT Practitioners.

3. Portability

Table 7 shows that there is a difference in the evaluation of the Students, Staffs, and IT Practitioners in Optical Character Reader of a Braille Unicode System for the Blind between groups and within groups using one-way ANOVA. The computed value of P = 0.005 which is greater than the 0.05 level of significance accepts the null hypothesis.

The result of the non-rejection of the null hypothesis indicates the equality of evaluation among the three groups of respondents which further proves that the Optical Character Reader of a Braille Unicode System for the Blind meets the specification and requirements of the respondents in terms of Portability.

4. Cost-effectiveness

Table 7 shows that there is a difference in the evaluation of the Students, Staffs, and IT Practitioners in Optical Character Reader of a Braille Unicode System for the Blind between groups and within groups using one-way ANOVA. The computed value of P = 0 which is less than the 0.05 level of significance accepts the null hypothesis. The result of the rejection of the null hypothesis indicates the differences of evaluation among the three groups of respondents which tells that there is a difference in terms of knowledge or experience in cost among the groups of respondents.

IV. CONCLUSIONS

On the account of the foregoing significant findings the following conclusions were made:

1. The stages undertaken in the development of the Optical Character Reader of a Braille Unicode System for the Blind sign the SDLC followed the system engineering procedure with the steps of Defining Requirements to itemize the specification and needs of target client, Iteration of Integration and Testing for the development, coding, designing, and prototyping until customer satisfaction then Deployment to the client and Maintenance. Those steps will help to provide the highest satisfaction of the users.
2. The result of the assessment of Students, Staffs, and IT Practitioners to the accuracy, efficiency, portability, and cost of the Optical Character Reader of a Braille Unicode System for the Blind is Good therefore recommended for implementation.
3. There is a significant difference in the assessment of the Students, Staffs, and IT Practitioners on the Braille Unicode System using Optical Character Reader for the Blind in terms of efficiency, portability and cost-effectiveness while there is no significant difference in terms of accuracy.
4. Based on the problem encountered during the development of the device, the researchers need to consider all the components by making sure that the criteria that need to meet will satisfy the requirements of the device.
5. The problem encountered was solved by adding functionality similar to the functions the beneficiary uses which they recommended as a solution to the problem.

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