DOI: http://dx.doi.org/10.26483/ijarcs.v14i3.6997

Volume 14, No. 3, May-June 2023

ISSN No. 0976-5697

International Journal of Advanced Research in Computer Science

RESEARCH PAPER

Available Online at www.ijarcs.info

AI-WEAR: SMART TEXT READER FOR BLIND/VISUALLY IMPAIRED STUDENTS USING RASPBERRY PI WITH AUDIO-VISUAL CALL AND GOOGLE ASSISTANCE

Allen A. Llorca, MSIT
MSIT, College of Computer Studies
Laguna State Polytechnic University Laguna,
Santa Cruz, Laguna, Philippines

Mia V. Villarica, DIT
College of Computer Studies
Laguna State Polytechnic University Laguna,
Santa Cruz, Laguna, Philippines

Harrold M. Gueta, MSIT
MSIT, College of Computer Studies
Laguna State Polytechnic University Laguna,
Santa Cruz, Laguna, Philippines

Mark Angelo T. Mercado, MSIT
College of Computer Studies
Laguna State Polytechnic University Laguna,
Santa Cruz, Laguna, Philippines

Abstract: The goal of this research is to create a prototype referred to as AI-WEAR: Smart Text Reader for Blind or Visually Impaired Students, which utilizes Raspberry Pi equipped with Audio-Visual Call and Google Assistance. The prototype incorporates various functionalities including text-to-speech capability for reading, Google assistance for online support, and video streaming through Jitsi Meet, enabling students to interact with their teachers. The device offers two modes of control: voice commands and user-friendly buttons with Braille letters engraved on them. OCR (Optical Character Recognition) and Text-to-Speech are integrated into the system. Synthesis techniques on the Raspberry Pi platform. By utilizing OCR, the device scans and extracts text, which is then converted into audio output through a headset. Additionally, the device employs GSM/GPRS technology to access the internet via cellular data when Wi-Fi connectivity is unavailable. The researcher employed the Long-Short Term Memory and Image processing algorithms in this project, and extensive testing and maintenance have been conducted, resulting in favourable evaluation outcomes. The prototype has successfully met the desires of the ISO/IEC 25010 standard. Although some adjustments may be necessary, this proposed device has significant potential to provide visually impaired individuals with innovative learning opportunities, especially in distance education settings. Furthermore, a cost-comparative analysis for future mass production of this assistive prototype tool for blind and visually impaired has been conducted.

Keywords: Wearable text reader, Assistive technology, Text-to-speech device, Accessibility device, Blind and visually impaired aid, Portable text reader, Optical character recognition (OCR) device, Voice output device, Wearable assistive device

INTRODUCTION

The World Health Organization (2019) estimates that there are around 9 million blind and visually impaired individuals in Southeast Asia, including ASEAN countries. Despite this high number, assistive technologies are not widely available in the region, causing significant barriers for blind/visually impaired students to access education. The lack of appropriate assistive technologies poses significant challenges for blind and visually impaired students in ASEAN to access education. By using assistive tools, these students can access educational materials, communicate effectively with teachers and peers, and independently perform various tasks. Providing assistive technologies is also essential in enhancing the quality of education for these students and ensuring equal opportunities for their success. Limited assistive technologies in the Philippines remain a constraint for visually impaired students' right to education. Although the government and non-government institutions support Special Education (SPED) Centers, a steady decline in enrolment persists nationwide. Worsen by the COVID-19 pandemic, learners with visual impairment struggle to obtain an inclusive and high-quality education. Today, their main challenge is the inability to read digital text information since Braille is limited to 2 printed materials. Although advanced assistive devices exist, the costs are prohibitive and lack features that enable communication between the students and teachers in virtual learning. Until now, their access to low-cost and innovative reading tools is insufficient for interactive education. Thus, it is critical to address this issue to comprehend and develop solutions, providing the needs of visually impaired students while meeting the new demands of the evolving education system. UNICEF Philippines survey (2021) found that students with disabilities are mainly concerned about access to education and lack of assistive technologies during the pandemic. The objective of the study was to design an assistive device that is affordable, effective, and easy to use, which could enhance the learning experience of students who were blind or visually impaired. The researcher aimed to develop an AI-WEAR: Smart Text Reader for Blind/Visually Impaired Students that uses Raspberry Pi, Audio-Visual Call, and Google Assistance. The study involved visually impaired students from a few selected basic Education DepEd schools in Laguna and collaborated with the National Council on Disability Affairs, a government agency responsible for managing disability-related policies and initiatives across public and private organizations. This device had text recognition for reading, real-time video streaming for online help, Google assistance for online information, and a user-friendly button for the controller where the braille letters engrave. This assistive device could elevate both teaching and learning methods in special education while contributing to the importance of technological advancement today.

A. Research Objectives

The objective of this research was to assess the effectiveness of AI-WEAR: Smart Text Reader for Blind/Visually Impaired Students using Raspberry Pi with Audio-Visual Call and Google Assistance in empowering

© 2020-2023, IJARCS All Rights Reserved

visually impaired students to independently access the digital world, thereby improving their learning status. The study involved blind/visually impaired students from selected DepEd schools in Laguna and collaborated with the National Council on Disability Affairs, a national government agency responsible for coordinating disability-related policies and activities across public and private organizations. The researcher wanted to accomplish the following goals:

- To design and develop a wearable Raspberry Pi device that incorporates text-to-speech (TTS) technology and camera to assist blind/visually impaired students in reading their learning materials.
- To design and construct an advanced educational assistance device for blind/visually impaired students. The device should utilize a camera to capture text, which was then be processed by:
    - Google Tesseract OCR to convert it into machine-readable text.
    - OpenCV was used for image preprocessing to enhance the quality of the captured text. The device should also feature
    - Google Assistant for voice control, providing an accessible learning experience for visually impaired students.
- To develop a system that maintains the accuracy of the data dictated by the system to the user with advanced features such as text recognition, text-to-speech.
- To test and evaluate the prototype using the ISO 25010 as an evaluation tool for assessing the following attributes: Functionality, Reliability, Portability, Usability, Performance Efficiency, Security, Compatibility, and Maintainability.
- To use cost comparative analysis, the device must offer superior educational aid compared to other assistive devices available for the blind/visually impaired in the market.

II. METHODOLOGY

A. *Research Design*

The researcher opted to use prototype model and experimental research design. Experimental research can be conducted in prototype model development to test the effectiveness and functionality of a prototype. In this context, prototype development is an iterative process that involves creating a preliminary version of a product or system to test and evaluate its features and functionalities. Experimental research can be used to test the prototype model in various ways, such as: Testing the functionality: Experimental research can be used to test the functionality of the prototype model by manipulating one or more variables and measuring their effects on the prototype's performance. Identifying design flaws: Experimental research can also be used to identify design flaws in the prototype model by testing it in various scenarios and observing its performance. Improving user experience: Experimental research can be used to improve the user experience of the prototype model by testing it with potential users and obtaining feedback on its usability and ease of use. Overall, experimental research can be a valuable tool for improving the effectiveness and functionality of a prototype model by identifying design flaws, testing its performance, and improving the user experience.

B. *Applied Concepts and Techniques*

The Speech Language Processing is a field within computer science that deals with the automatic analysis and synthesis of speech and language. It encompasses technologies such as speech recognition, natural language understanding, and text-tospeech synthesis. The components of SLP include signal processing, acoustic modeling, language modeling, and dialog systems. The application areas of SLP are varied and include automatic speech recognition, text-to-speech synthesis, and machine translation. Despite advancements in SLP, there are still challenges that need to be addressed. Nonetheless, the field has made significant strides in recent years. The purpose of managing a human-computer system dialog in speech language 57 processing is to enable the computer system to properly interpret and respond to spoken input from a human user. The ultimate goal of managing a human-computer system dialog in speech language processing is to enable seamless communication between the user and the computer system. This can be achieved through a variety of techniques, including the use of machine learning, natural language processing, and dialogue management. The Application Programming Interface (API) is a set of programming instructions and standards used to access information and services from a software application. In Speech language processing, API can be used to access speech recognition and voice synthesis systems, natural language processing services, and other related technologies. API can also be used to access language databases, such as dictionaries and encyclopedias. API can help developers create more efficient and powerful applications by providing access to a wide range of services and data. Image processing can be used to recognize speech from images, extract text from images. This includes operations such as resizing, cropping, filtering, color correction, image recognition, and object detection. An online assistant for visually impaired people can provide a range of services, including providing access to information, support with communication, helping with navigation and providing activities and entertainment. It can also provide personalized guidance and assistance tailored to the individual's needs, making it easier and more enjoyable for the visually impaired to access the internet. Digital Voice assistants are becoming increasingly popular for people with visual impairments. These digital assistants provide audio feedback, allowing users to interact with their devices without having to look at a screen.

Algorithm

Algorithm analysis is a process of examining and evaluating the performance of an algorithm in terms of its efficiency and effectiveness. Image processing libraries like OpenCV and Tesseract OCR are often used in algorithm analysis to improve the accuracy and speed of image recognition and text extraction. OpenCV provides computer vision and image manipulation functionalities, while Tesseract OCR employs the Long Short-term Memory (LSTM) algorithm to

© 2020-2023, IJARCS All Rights Reserved

extract text from images. The LSTM algorithm helps Tesseract OCR to support sequence processing, enabling it to keep relevant information and discard irrelevant information in every single cell, leading to more efficient and accurate text extraction from images.

- Image Processing Libraries The system operates image processing, such as OpenCV and Tesseract OCR libraries which make the text to speech processing efficient. OpenCV provides computer vision and functionalities which generally not provided by other libraries such as filtering, opening, manipulating images. Tesseract OCR provides extraction of text from images that automatically pre-process images using binarization to make it easier time decipher images.
- Long Short-term Memory (LSTM) Algorithm Tesseract used Long Short-term Memory (LSTM) algorithm in which supports sequence processing when extracting text. This kept the relevant information and all the irrelevant information gets discarded in every single cell

C. *Data Collection Methods*

The researcher used three (3) methods in collecting data as Interviews, Internet Research, and Surveys/Questionnaire.

Interview

The researcher wrote a letter to Calamba Integrated School (CIS), which provides SPED classes with a program for visually impaired students. After conducting an interview both in person and online, the researcher was able to pinpoint a number of the students' needs in relation to the prototype's developed system integration. Both the teachers and the students discussed the difficulties they had with the online classes. The researcher was able to determine the features and order of importance in creating the prototype with system integration based on the needs and desires of the students and teachers when it comes to design prototypes. The researcher then sent a letter of communication to the Council on Disability Affairs (NCDA) asking for a list of schools offering programs for visually impaired students in order to conduct a more thorough evaluation. The NCDA gave the researcher the go-ahead to contact DepEd Laguna for particular schools.

Internet Research

The researcher leveraged the abundant information available on the internet to gather data on the requirements of visually impaired students. This information was crucial in designing and building a prototype with the Application Programming Interface (API). The internet was extensively used to research and identify the possible functions and features of the desired output application for the study. The researcher collected ideas, concepts, information, 60 and processes from existing software and applications related to the study. Due to the vast amount of information available, the researcher carefully selected and filtered the data to extract relevant information for the study. The gathered information aided in formulating new ideas and concepts for the development process of the AI-WEAR: Smart Text Reader for Blind/Visually Impaired Students using Raspberry Pi with Audio-Visual Call and Google Assistance, which were integrated with existing ones. Additionally, the internet served as a valuable resource for the researcher to learn programming skills, such as Python programming and API integration, as well as raspberry pi microcomputer configuration and termination. It also provided guidance on how to apply Cost Benefits Analysis and Prototype Model in the research process.

Surveys/Questionnaires

After the prototype was created, survey evaluations were given out, and the respondents responded. Based on requirements adopted the ISO 25010 acceptability for Functionality, Reliability, Portability, Usability, Performance Efficiency, Security, Compatibility, and Maintainability (John Estdale & Elli Georgiadou, 2018) the researcher conducts an evaluation

D. *Development Methodology*

According to Daniel Galin (2018), prototypes should be developed, with a focus on functionality, usability, and performance. He emphasizes that prototypes should not be viewed as throw away artefacts, but rather as valuable deliverables that can help improve the quality of the final software product.

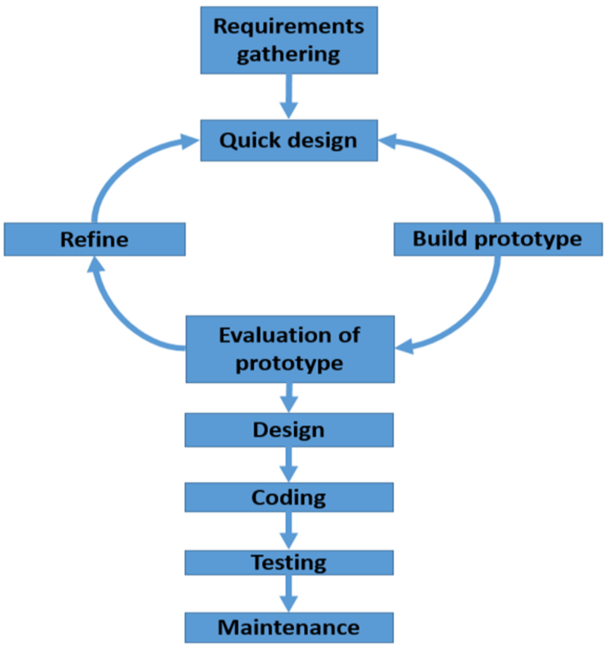

Figure 1. Prototype Model

Overall, perspective on prototype models in software development emphasizes their role in understanding user requirements, validating design decisions, and involving stakeholders in the development process. His approach aligns with the iterative and incremental nature of modern software development methodologies and highlights the importance of prototyping as a valuable technique for improving software quality.

© 2020-2023, IJARCS All Rights Reserved

Requirement gathering

This phase includes an outline of the problem area and an analysis of the system's requirements. The researcher determines and examine the target functions of the system. They provide a requirement specification that discusses all the necessities to establish the project.
Blind/Visually impaired students struggle to learn independently in distant modalities as their resources are limited to the Braille system and audio-visual aid. They remain underprivileged in adopting the digital world. In that case, their learning might not be efficient in today's distant learning since they cannot access online information and lack interaction with their teachers.

Quick Design

In this phase, researcher adopt the paper prototype is one of the earliest forms of prototyping you can use—it's a prototype created using pen and paper. Paper prototyping allows you to create multiple versions of your design and quickly validate them with your users (Nick Babich, 2021). The researcher has chosen to utilize paper prototyping as a cost-effective and convenient means of exploring and evaluating concepts.

Build prototype

The system block diagram is provided to emphasize the role of hardware requirements in the prototyping. In figure 4, the main components of the system are represented by blocks while arrows signify their connections. These connected blocks are crucial in the development of the system.

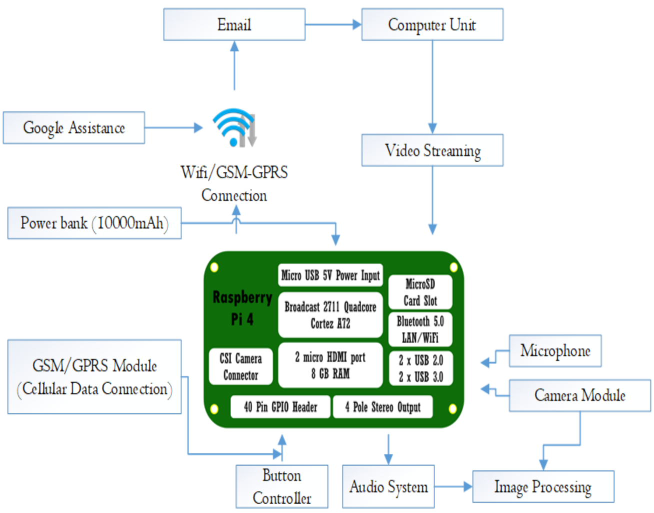

Figure 2. System Block Diagram

Evaluation of prototype

The researcher used the ISO/IEC 25010 (International Organization for Standardization/International Electrotechnical Commission) as the basis to examine and evaluate the system's performance. ISO/ IEC 25010 is an international standard software quality model designed to assess and ensure the effectiveness of software systems. It included eight main quality characteristics: functionality suitability, 68 reliability, portability, usability, performance efficiency, security, compatibility, and maintainability.

Refine and Validation

The researcher utilized a survey questionnaire based on ISO (International Organization for Standardization) / IEE (International Electrotechnical Commission) 25010 to evaluate the system's overall performance. The researcher discussed each phase of ISO/IEE 25010 to relate the questionnaire to their study. This kind of method is enough to gather information about the assessment of Smart Text Reader using Raspberry Pi with Audio-Visual Call and Google assistance. Moreover, the researcher established the validity of the questionnaire by presenting it to the thesis adviser, professors, and college dean that are experts in the field

System Architecture

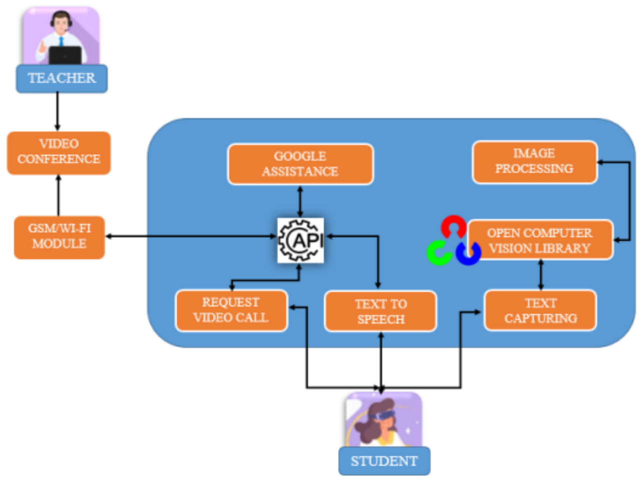

Figure 3. System Architecture of the System

The figure 3 above showed the system architecture of the study. The study had two categories: (1) teacher and (2) student to operate the system. The arrows provided the direction where the system connected to each functionality. The module served as the main component of software and hardware enabling system operation. The data processed from the input module such as the camera, microphone, and GSM/GPRS for the internet connectivity. In this study, every hardware module designated to its process in the system. Teacher functionality depended on internet availability once the video call button Jitsi meet provided video chat to their teacher for video conferencing. Text recognition produced a text-to-speech output using the output module such as speaker/earphone. The system accessibility required an image processing library such as OpenCV and Tesseract OCR, used for output accuracy. Google assistant provided the necessary online information of the user, and at the same time, the study aimed to improve the learning status of visually impaired students by providing them access to the digital world. AI Wear Smart Text Reader Wearable Device had a text recognition system, real-time video streaming for online help, Google assistant for online information, and a user-friendly button for the controller where the braille letters engraved. Proper relation and integration of the variables led to satisfaction

© 2020-2023, IJARCS All Rights Reserved

Use Case Diagram

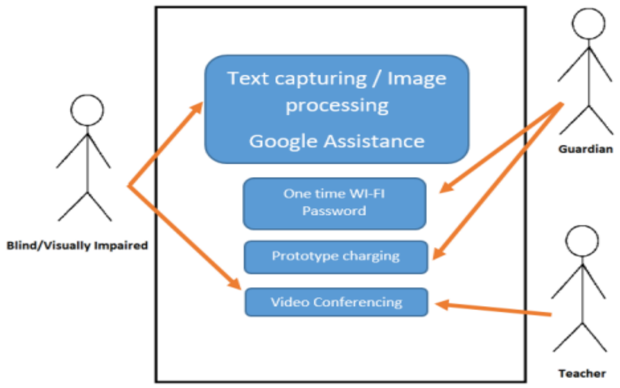

Figure 4. Use Case Diagram of the System

The Blind/Visually Impaired were major users of the prototype that accessed text capturing and image processing, utilized Google assistance for online assistance, and requested video conferencing with teachers. Guardian assisted the blind or visually impaired in charging and connecting the device to the internet for the prototype's online features. Teacher accepted emails initiated by students from the prototype, copied the code, and pasted it onto the website for video conferencing and online classes.

Data Flow Diagrams

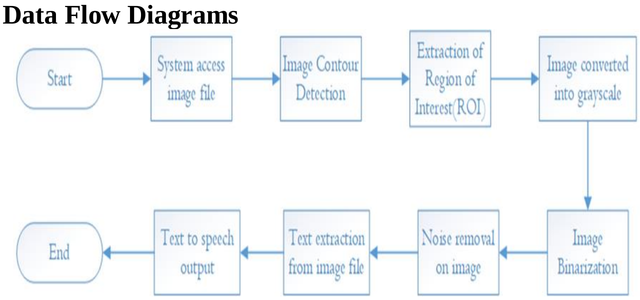

Figure 5. Data Flow Diagram of the System

The diagram above depicts the system's image processing, which converts the camera-captured image into speech. Initially, the system locates the image directory and reads it with OpenCV. When the existence of the file is validated, it performs pre-processing. The system will detect the image contour as it contains excessive background noise for the Tesseract to recognize. Moreover, if the image surpasses the file parameter, the system will automatically perform Region of Interest Extraction (ROI). ROI defines the borders of an object under consideration.

System Flowchart

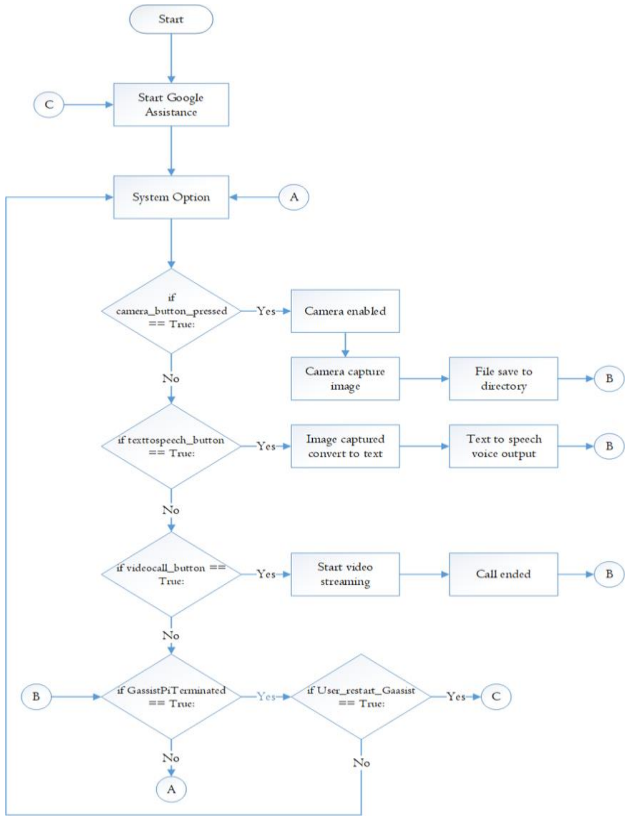

Figure 6. System Flowchart

As shown in the figure, the system operates initially with Google assistance. Using the controller button, the user can access the different features of the system by manually pressing it. Visually impaired can detect what button to press based on the Braille letters engraved on the buttons. The camera button enables the system to capture and save the image file. The text-to-speech button processes the captured image into text then converts it into voice output. It also allows the user to replay the text in the current image captured by the system. As for the video conference button, the system delivers video streaming through Jitsi Meet.

However, the system cannot run the programs simultaneously; it requires finishing the first executable program before selecting others. Based on the user's needs, once a button is pressed, the system executes that program and processes each output needed. Once the system finishes executing the user's request, the program will test the system if the Google assistance is terminated, it will allow the user to start it again. Whereas if the user does not want to use Google assistance, the system will return to the choices button. Google assistance will be temporarily unavailable until the user starts it again.

Analysis and Design

The gathered data was carefully examined to see how it could be utilized to address the issue raised in the previous stage during the analysis and design process. The process of conception was started, which required finding and choosing the right algorithms and methodologies to apply to the system.

© 2020-2023, IJARCS All Rights Reserved

Design and Coding

In this phase, researcher demonstrated a concrete layout based on the determined functionalities and components of the prototype device. It highlights the system's coding and development plan. This phase also defines an overall system architecture and the system design.

Testing Phase

In this phase, each unit of the system combined to produce the final product. The compatibility of the components was examined and evaluated according to the specified as an individual module of the system successfully operates, this was coordinated functionalities. Also, the system was tested according to its overall capability. Into the system. Processes and components underlying in Text-to-speech, Google assistance, and video-conference features of the system were integrated into the device. Other requirements were also administered. Upon developing the system, the compatibility of the functions and components was tested. Modification and adjustment were done to make the system operate simultaneously; the system undergone testing until it successfully embodies the target outcome of the study

Maintenance Phase

At this point, the system is operational and readily available for administration and testing. The system was implemented to the visually impaired students for purpose evaluation that concerns the improvement of their learning status. Respondents tested the system's overall performance according to functionality suitability, reliability, portability, usability, performance efficiency, security, compatibility, and maintainability. Moreover, this stage includes methods and recommendations to maintain the system's productivity.

E. Data Model Generation

The figure 7 shows the thresholding and binarization of the captured image of Pi camera using OpenCV image processing. Bounding box served as the pre-processing image marking which for the Region of Interest (ROI) extraction. It changed the pixels of an image to make the image easier to analyze and that was used by the system to find easily the image contour or edges for ROI (Region of Interest) extraction.

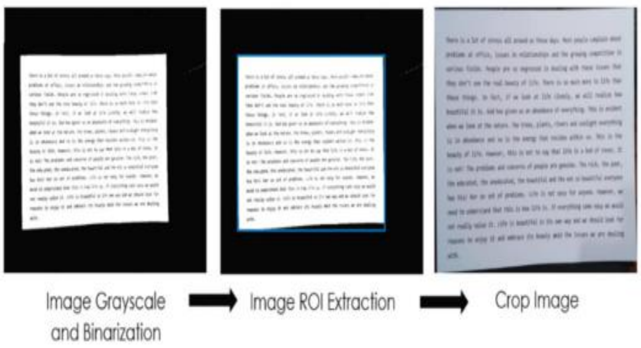

Figure 7. ROI Extraction

Results and Discussion

RESEARCH OBJECTIVE 1: To design and develop a wearable Raspberry Pi device that incorporates text-to-speech (TTS) technology and camera to assist blind/visually impaired students in reading their learning materials.

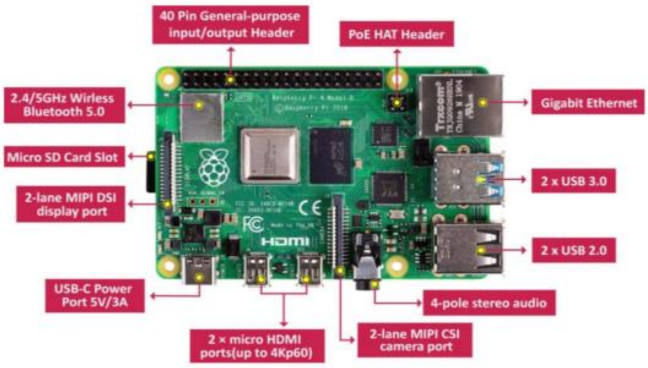

Figure 9. Raspberry pi embedded with text to speech.

The system ran mainly on python scripts. Consisting of the main script, which held the initialization code that setups the system; a camera script to capture an image and automatically save it to the directory; a video conference script for sending emails based on the registered address; a text to speech script which processes the conversion of image to extracted and 70 output through the speaker; and a configure script containing the essential setup values used by the main script.

RESEARCH OBJECTIVE 2: To design and construct an advanced educational assistance device for blind/visually impaired students. The device should utilize a camera to capture text, which was then be processed by:

- Google Tesseract OCR to convert it into machine-readable text.

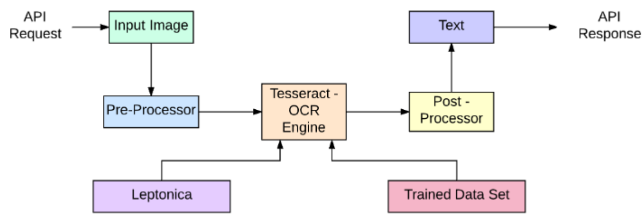

Figure 10. OCR Process flow

- OpenCV was used for image preprocessing to enhance the quality of the captured text. The device should also feature

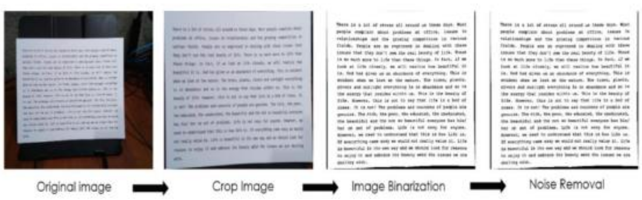

Figure 11: Image Pre-Processing

The figure 8 shows the pre-processing of the image after the extraction of ROI. After converting the image into grayscale

© 2020-2023, IJARCS All Rights Reserved

and applying the thresholding it converted the image into binarize image. Once the system receives the binarize image it removed the noise from the image before the text extraction through dilation and erosion. The dilation procedure looked for similar pixels that overlap between the structuring element and the binary picture. If there is an overlap, the pixels under the structural element's center position was set to 1 or black. In contrast, erosion is the process that determines whether or not there is a complete overlap with the structural element. If there is no complete overlapping, the center pixel indicated by the structural element's center was set to white or 0.

- Google Assistant for voice control, providing an accessible learning experience for visually impaired students.

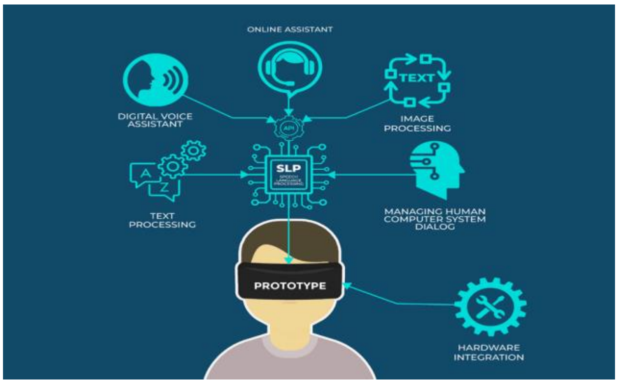

Figure 12: Framework used by the developed system

The figure 12 shows the Speech Language Processing theoretical framework based on the study conducted by Dan Jurafsky and James H. Martin (2020). In the realm of Speech Language Processing (SLP), the Text processing component involves analyzing written and spoken language to extract meaningful information. This can be achieved through the use of text summarization algorithms, which identify important points within a document, and text classification algorithms, which categorize documents into various groups. These tasks are crucial for effective SLP.

RESEARCH OBJECTIVE 3: To develop a system that maintains the accuracy of the data dictated by the system to the user with advanced features such as text recognition, text-to-speech.

The data from accuracy testing of prototype thru the use of Pi camera module. It helped the researcher in proving that this study would help in dictating the text in front of the user.

The figure 13 depicts the distance during the trials when capturing image including the height of the table and chair. This may vary depends on the height of the user. The distance of the camera from the text to capture is based on the specification of camera. The angle used is the standard reading position in which the perspective view of the camera can capture. The concluded distance and angle are result from the sample images captured.

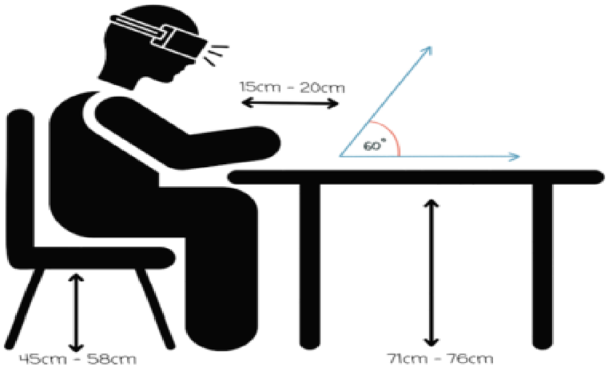

Figure 13: Image Capturing Distance

Table 1: Average Font Accuracy Test

Font	Font Size	Average Accuracy Rate/ Word	Average Accuracy Rate/ Character	Average text extraction process in sec(s)
Times New Roman	12	76.36%	94.00%	5.34
Arial	12	76.45%	93.46%	4.63
Consolas	12	90.28%	97.68%	4.68
Courier New	12	90.89%	98.01%	5.44
Calibri (Body)	12	73.41%	92.84%	4.16
Font	**Font Size**	**Average Accuracy Rate/ Word**	**Average Accuracy Rate/ Character**	**Average text extraction process in sec(s)**
Times New Roman	13	82.90%	95.69%	5.34
Arial	13	80.00%	95.50%	4.71
Consolas	13	93.64%	95.50%	4.88
Courier New	13	94.63%	98.81%	5.84
Calibri (Body)	13	82.10%	96.42%	4.38
Font	**Font Size**	**Average Accuracy Rate/ Word**	**Average Accuracy Rate/ Character**	**Average text extraction process in sec(s)**
Times New Roman	14	95.05%	98.71%	4.36
Arial	14	95.19%	98.81%	5.54
Consolas	14	96.50%	99.12%	5.65
Courier New	14	96.87%	99.28%	6.44
Calibri (Body)	14	93.46%	98.50%	5.08

Table 1 shows the average percent error of the ten (10) trials in every font size with the overall total of (two hundred fifty) 250 trials that have made to test the accuracy rate of the text detection feature of the system. All the sample text

© 2020-2023, IJARCS All Rights Reserved

captured during the accuracy test is in the exact format of double-spacing with varying font sizes.

• Times New Roman: The scale of 12 font of Times New Roman a member of serif types font shows 76.36% average accuracy rate while character accuracy rate shows 94%. This results to 5.34secs average total time duration of text extraction process from the image.

• Arial: The scale of 12 font of Arial a member of sans serif types font shows 76.45% average accuracy rate while character accuracy rate shows 93.46%. This results to 4.63secs average total time duration of text extraction process from the image.

• Consolas: The scale of 12 font of Consolas a member of monospaced types font shows 90.28% average accuracy rate while character accuracy rate shows 97.68%. This results to 4.68secs average total time duration of text extraction process from the image.

• Courier New: The scale of 12 font of Courier New a member of serif types font shows 90.89% average accuracy rate while character accuracy rate shows 98.01%. This results to 5.44secs average total time duration of text extraction process from the image.

• Calibri: The scale of 12 font of Calibri a member of sans serif types font shows 73.41% average accuracy rate while character accuracy rate shows 92.84%. This results to 4.16secs average total time duration of text extraction process from the image.

• Times New Roman: The scale of 13 font of Times New Roman a member of serif types font shows 82.90% average accuracy rate while character accuracy rate shows 95.69%. This results to 5.34secs average total time duration of text extraction process from the image.

• Arial: The scale of 13 font of Arial a member of sans serif types font shows 80% average accuracy rate while character accuracy rate shows 95.50%. This results to 4.71secs average total time duration of text extraction process from the image.

• Consolas: The scale of 13 font of Consolas a member of monospaced types font shows 93.64% average accuracy rate while character accuracy rate shows 98.50%. This results to 4.88secs average total time duration of text extraction process from the image.

• Courier New: The scale of 13 font of Courier New a member of serif types font shows 94.63% average accuracy rate while character accuracy rate shows 98.81%. This results to 5.84secs average total time duration of text extraction process from the image.

• Calibri: The scale of 13 font of Calibri a member of sans serif types font shows 82.10% average accuracy rate while character accuracy rate shows 96.42%. This results to 4.38secs average total time duration of text extraction process from the image.

• Times New Roman: The scale of 14 font of Times New Roman a member of serif types font shows 95.05% average accuracy rate while character accuracy rate shows 98.71%. This results to 4.36secs average total time duration of text extraction process from the image.

• Arial: The scale of 14 font of Arial a member of sans serif types font shows 95.19% average accuracy rate while character accuracy rate shows 98.81%. This results to 5.54secs average total time duration of text extraction process from the image.

• Consolas: The scale of 14 font of Consolas a member of monospaced types font shows 96.50% average accuracy rate while character accuracy rate shows 99.12%. This results to 5.65secs average total time duration of text extraction process from the image.

• Courier New: The scale of 14 font of Courier New a member of serif types font shows 96.87% average accuracy rate while character accuracy rate shows 99.28%. This results to 6.44secs average total time duration of text extraction process from the image.

• Calibri: The scale of 14 font of Calibri a member of sans serif types font shows 93.46% average accuracy rate while character accuracy rate shows 98.50%. This results to 5.08secs average total time duration of text extraction process from the image.

• Times New Roman: The scale of 15 font of Times New Roman a member of serif types font shows 97.94% average accuracy rate while character accuracy rate shows 99.41%. This results to 4.18secs average total time duration of text extraction process from the image.

• Arial: The scale of 15 font of Arial a member of sans serif types font shows 97.48% average accuracy rate while character accuracy rate shows 99.36%. This results to 5.70secs average total time duration of text extraction process from the image.

The data gathered for the accuracy test is based on the system captured and its font’s characteristics. Times New Roman font is short descenders to allow tight lines pacing and a relatively condensed appearance. Arial font is the overall treatment of curves is softer and fuller than in most industrial style sans serif faces. Consolas font characters have the same width and also include hanging or lining numerals; slashed, dotted and normal zeros; and alternative shapes for a number of lowercase letters. Courier new font has the higher line space than other fonts it is where the punctuation marks were reworked to make the dots and commas heavier. Calibri font has subtle rounded stems and corners, which are visible at larger sizes, create a warm and soft character.

The accuracy rate shows a high percentage in Courier New which is a monospaced type. It shows an average of 99.44% accuracy rate in word and 99.83% in character. The lowest accuracy shows in Calibri font which average of 98.46% in word and 99.68% in character. In contrast with the average text extraction, Courier New shows a high text extraction process in the average of 7.24 seconds and the lowest text extraction is the Times New Roman with an average of 4.11 seconds. The text extraction process also affects the temperature of the system. The higher the temperature of the system the lower response rate. The percentage error may vary depends on the image quality, position and angle to capture.

RESEARCH OBJECTIVE 4: How does the prototype of the educational assistance device perform in terms of functionality and meet the standards outlined in the ISO 25010 evaluation tool?

© 2020-2023, IJARCS All Rights Reserved

Table 2: Summary of the Result of the Evaluation Procedure

Particulars	Weighted mean	Interpretation
Functionality Suitability	4.34	Outstanding/Extremely Satisfied
System Reliability	4.37	Outstanding/Extremely Satisfied
Portability	4.28	Outstanding/Extremely Satisfied
Usability	4.47	Outstanding/Extremely Satisfied
Performance Efficiency	4.29	Outstanding/Extremely Satisfied
Security	4.62	Outstanding/Extremely Satisfied
Compatibility	4.44	Outstanding/Extremely Satisfied
Maintainability	4.48	Outstanding/Extremely Satisfied
Group Mean	**4.41**	Outstanding/Extremely Satisfied

Legend: *4.20 -5.00 Outstanding- Extremely Satisfied (ES) 3.40 – 4.19 Very Satisfactory -Very Satisfied (VS) 2.60 – 3.39 Satisfactory Satisfied (S) 1.80 – 2.59 Unsatisfactory Dissatisfied (D) 1.00 – 1.79 Poor - Very Dissatisfied (VD)*

The AI-WEAR: Smart Text Reader for Blind/Visually Impaired Students using Raspberry Pi with Audio-Visual Call and Google Assistance has gone through several 123 trials to determine the system's functionality suitability, reliability, portability, usability, performance efficiency, security, compatibility, and maintainability. According to the results, the system obtained a total mean of 4.41, marked as "Extremely Satisfied/Outstanding". This signifies that both professionals and clients were highly satisfied with the system's characteristics. Moreover, it passed on the standard rating level of ISO/IEC 25010. Although evaluators stated that the system requires additional improvements, they also commended its usability and compatibility. This remark indicates that the system performed effectively and achieved its goals. Evaluating the prototype helped the researcher to further understand how the study answered the problems being discussed before and during the research period. Also, the researcher identified whether the goals and objectives were met and achieved. With the help also of the evaluation procedure, possible improvement and recommendation were raised and identified.

RESEARCH OBJECTIVE 5: To use cost comparative analysis, the device must offer superior educational aid compared to other assistive devices available for the blind/visually impaired in the market

Cost-Comparative Analysis Results

The researcher itemized the necessary materials and tools for constructing a prototype, and conducted a comparative analysis to estimate production costs by comparing it with existing products. This type of analysis involves evaluating and comparing the expenses, economic, environmental and health and safety associated with different options, with the goal of determining which option is the most cost-effective or offers the best value. Essentially, it involves scrutinizing and contrasting the prices of various choices to determine the most economical or advantageous one.

Table 3: Hardware materials billing

Hardware Materials:

Bill of materials

List of Materials	Qty	Price	Amount
Raspberry Pi 4B 8GB RAM	1	6360	6360
Raspberry Pi Switch Type C	1	237	237
Microphone module	1	89	89
Headset	1	600	600
Rpi Camera	1	1600	1600
USB Camera	1	210	210
GSM/GPRS Module	1	600	600
Tactile Switch	5	40	200
Jumper Wires	20	20	400
Resistors	4	20	80
LED	4	40	160
USB Extension	2	172	344
Prototype Casing	1	3500	3500
10,000mAh Rechargeable battery	1	615	615
AUX male to female adapter	1	115	115
			15,110

Economic

The total cost of the project depends on the hardware and software tools being used. Software: Operating system installed on the microcontroller and programming which cost nothing. The website system features of AI-Wear Php 259/month for web hosting and domain. Product Comparison

1. KISA Phone - Php 23,398
2. Orcam Read - Php 109,450
3. OrCam MyEye 2.0 - Php 247,500
4. "SMART" GLASSES FOR THE BLIND - Php 61,090
5. AI-WEAR: Smart Text Reader for Blind/Visually Impaired Students using Raspberry Pi with Audio-Visual Call and Google Assistance - Php 15,110

From the given list, the KISA Phone is the most affordable option at Php 23,398. It is followed by the AI-WEAR: Smart Text Reader for Blind/Visually Impaired Students using Raspberry Pi with Audio-Visual Call and Google Assistance at Php 15,110 is the device development cost, and if it is going to deploy in the market, it costs ₱18,132 with a mark-up average of 200%. On the higher end of the price range, the OrCam MyEye 2.0 is the most expensive option at Php 247,500, followed by the Orcam Read at Php 109,450 and "SMART" GLASSES FOR THE BLIND at Php 61,090.

Environmental

The system itself does not affect environmental concerns. The device is constructed using PLA plastic for 3D printing filaments. PLA is biodegradable under commercial composting conditions and degrades within twelve weeks, making it an environmentally preferable alternative to conventional plastics, which may take decades to decompose and produce microplastics. Additionally, the system utilizes Lithium Polymer batteries. Since lithium-ion batteries contain fewer harmful elements than traditional batteries that may include toxic metals like lead or cadmium, they are generally regarded as non-hazardous waste. However, improper disposal can degrade the soil and contaminate air and water.

© 2020-2023, IJARCS All Rights Reserved

III. SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The objective of the study was to create a prototype for system integration called "AI-WEAR: Smart Text Reader for Blind/Visually Impaired Students using Raspberry Pi with Audio-Visual Call and Google Assistance" that would aid blind and visually impaired students. The prototype was designed to be user-friendly and portable so that it could be taken anywhere as long as there was an internet connection.

The prototype's features included an assistive tool that interacted with Google Assistance, used image processing to read text and translate it into human language, and had a long-lasting battery for prolonged online classes. To create the prototype, the researcher conducted interviews with blind and visually impaired students to gather specifications. The researcher utilized a prototyping model for quick prototyping and system development and reached out to the Education DepEd schools in Laguna and the National Council on Disability Affairs for prototype testing.

Lastly, The AI-WEAR prototype underwent several trials to assess its functionality, suitability, reliability, portability, usability, performance efficiency, security, compatibility, and maintainability. The system received a mean score of 4.38, indicating a high level of satisfaction among professionals and clients. It also met the standard rating level of ISO/IEC 25010. While evaluators suggested that the system could benefit from further improvements, they praised its usability and compatibility, which suggests that it performed well and achieved its goals.

Conclusions

There are several issues concerning education, particularly for students with special needs. One of these is the inability of the visually impaired to access quality learning opportunities. Since the establishment of traditional education, visually impaired students have faced significant challenges, affecting their self-esteem. Furthermore, the transition to distance learning has amplified their problems requiring them to navigate the digital world. Hence, this calls for attention and innovative solution.

The aforementioned issues were resolved with the introduction of AI-WEAR: Smart Text Reader for Blind/Visually Impaired Students using Raspberry Pi with Audio-Visual Call and Google Assistance. The Smart Text Reader system, which incorporates Jitsi Meet and Google Assistance API, is intended to provide a high-quality education for visually impaired students. Compared to the existing learning materials or gadgets for visually impaired students, such as the braille system, this device assists them in reading, learning, enjoying online, and interacting with people at a distance. Thus, it increased their confidence in acquiring independent learning, allowing them to keep up with today's technologically demanding society.

The innovation in this study involves multiple trials and maintenance, which significantly impact the assessment results of the system. The device produces an average 99.44% accuracy rate in font 16 of Courier New which proves its reliability for the information dictated by the system. In contrast, it includes some factors to maintain its accuracy, such as proper lighting and distance of the camera in the text image. With all the system features, the device can run up to 10 hours of usage. Additionally, the test for getting the command using voice speech proves that the system is reliable. This helped the user efficiently run the device and command the system for the information the user wants. Therefore, the innovation of assistive devices in the form of Text Reader Glasses significantly impacts the current situation of blind/visually impaired students and non-students. It caters to their needs to access learning opportunities by providing features and functions intended to upgrade their educational method.

Recommendations

Upon the development of AI-WEAR: Smart Text Reader for Blind/Visually Impaired Students using Raspberry Pi with Audio-Visual Call and Google Assistance the researcher highly recommends the following:

1. Improve the casing for the weight and size of the device
2. Improve camera features
    2.1 HD Lens for more detailed image quality
    2.2 Wide Lens for a wide range of image
3. Use notification if the camera has the right angle and distance to capture.
4. Increase the number of word capabilities for text detection.
5. Increase the number of font styles it can recognize.
6. Adding detection of mathematical equation.
7. Use other voice synthesizers for much clearer results in both English and Filipino language.
8. Use other technology rather than GSM Module for cellular data connection.
9. Adding features such as Braille system reader, object and bills detection.
10. Incorporating a white LED lens into the prototype can enhance its capability to capture images of the processing.

IV. ACKNOWLEDGMENT

The following individuals received the researcher's sincere gratitude and acknowledgement for their assistance in making this study effective: first and foremost, the All-Powerful GOD, who gave him courage and understanding because, apart from Him, the researcher would not have been able to endure all the adversities on their path;

Dr. Mario R. Briones, the University President of Laguna State Polytechnic University, for his leadership and support to steer the University to greater heights.

Mrs. Reynalen C. Justo, the Associate Dean of College of Computer Studies – Sta. Cruz Campus, for steadfast support;

Mr. Mark P. Bernardino, for his expertise and for giving ideas about the study;

Mr. Edward S. Flores, for his expertise and for giving ideas about the study;

© 2020-2023, IJARCS All Rights Reserved

Dr. Mia V. Villarica, the head of the Research Implementing Unit and thesis adviser for the support in the study and for her untiring assistance, help, guidance, pieces of advice, and support for the improvement of the study;

Mr. Victor A. Estalilla Jr., for his expertise and for being their statistician;

Ms. Ma. Cezanne D. Dimaculangan, for patiently checking the grammar of the manuscript;

The researcher's instructors, classmates, and friends for being good friends in trials, and for the encouragement and help which led them to accomplish the study; and finally, the researcher's spouse, **Mrs. Rishel C. Llorca**, and parents, **Mrs. Florencia Atienza** and **Consuelo Canicon**.

REFERENCES

[1] Ahwini, G. et al., (2018). An Intelligent Virtual Assistant Using Raspberry Pi. International Journal of Current Engineering and Scientific Research (IJCESR). 5 (4).

[2] Alon, A. et al., (2020). eyeball-PH: A Machine Vision of Assistive Philippine Bill Recognition Device for Visually Impaired. 11th IEEE Control and System Graduate Research Colloquium (ICSGRC). 312-317. DOI: 10.1109/ICSGRC49013.2020.9232557.

[3] Alvarez et al., (2019). Tactica: An Android-Based Low-Cost Assistive Tactile Device on Basic Braille Notation Reading for Visually Impaired Students in SPED Centers with IoT Technology. Journal of Communications. DOI:10.12720/jcm.14.7.593-600.

[4] Asfar, A. & Asfar, A. (2020). How To Using Online Meeting on Jitsi Meet Application. Researchgate. DOI:10.13140/RG.2.2.28536.80644

[5] Baharampour, S. (2018). Student's Body Dimensions in Relation to Classroom Furniture. Health Promotion Perspectives, 2018, 3(2), 165-174.

[6] Bhui, N. et al. (2021). Design of an Automatic Reader for the Visually Impaired Using Raspberry Pi. Proceedings of the International Conference on Paradigms of Computing, Communication and Data Sciences. 175-188. DOI: 10.1007/978-981-15-7533-4_14.

[7] Correia, A. et al., (2020). Evaluating videoconferencing systems for the quality of the educational experience, Distance Education. DOI:10.1080/01587919.2020.1821607.

[8] De La Cruz, A. et al., (2019). Optical Character Reader of a Braille Unicode System for the Blind. International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, 8(1).

[9] Dhod, R. et al., (2016). Low-Cost GPS and GSM Based Navigational Aid for Visually Impaired People. Springer Science+Business Media New York.

[10] Gombas J. & Csakvari, J. (2021). Experiences of individuals with blindness or visual impairment during the COVID-19 pandemic lockdown in Hungary. British Journal of Visual Impairment.1–11.DOI:10.1177/0264619621990695.

[11] Inciong, T. & Quijano, S. (2018). Inclusion of Children with Disabilities: The Philippines Experience. Asia Pacific Journal of Education. 24(2):173-191 DOI: 10.1080/02188791.2004.10600208

[12] Khattar, S. et al., (2019). Smart Home With Virtual Assistant Using Raspberry Pi. 9th International Conference on Cloud Computing, Data Science & Engineering.

[13] Faruque J., Vekerdy Z., Hasan Y., Islam K., Young B,. Ahmed M., Monir M., Shovon S., Kakon J., & Kundu, P. (2020) Monitoring of land use and land cover changes by using remote sensing and GIS techniques at human-induced mangrove forests areas in Bangladesh

[14] Khormi, A. et al. (2020). A Study on the Accuracy of OCR Engines for Source Code Transcription from Programming Screencasts. 17th International Conference on Mining Software Repositories.

[15] Malipot, M. (2020, July 3). DepEd addresses challenges in special education under 'new normal'. Manila Bulletin.

[16] Miah, R. & Hussain, S. (2018). A Unique Smart EyeGlass for Visually Impaired People. International Conference on Advancement in Electrical and Electronic Engineering. 22-24

[17] Pandey, K. (2018). Comparative Study of Adjustment of Visually Impaired Students Universal Journal of Educational Research 6(11):25622571 DOI:10.13189/ujer.2018.061121.

[18] Pascual, R. (2018). Development and Evaluation of a Scanned Filipino Text-to-Speech Device as a Reading Aid for the Blind and Visually Impaired. 14th National Natural Language Processing Research Symposium, Philippines.

[19] Pradeep, S. et al., (2018). IoT Based Public Bus Boarding Aid for the Visually Impaired. Asian Journal of Convergence in Technology. 4 (1).

[20] Qamar, L. (2020). Impact of COVID-19 Pandemic on Visually Impaired People with Public Media Alliance and Accessibility to Persons with Disability in India. International Journal of Policy Sciences and Law. 1(4).

[21] Raspberry Pi Trading Ltd (2019). Automatic video processing based on IoT using Raspberry Pi. Raspberry Pi Foundation.

[22] Sarkar, S. et al. (2021). Smart Reader for Visually Impaired Using Raspberry Pi. IOP Conference Series Materials Science and Engineering 1132(1):012032 DOI:10.1088/1757-899X/1132/1/012032.

[23] Suitter, J. (2018). Accuracy of Optical Character Recognition Software Google Tesseract. Thinking Matters Symposium Archive. 46.

[24] Sultan, R. & Hoque, M. ABYS (Always By Your Side): A Virtual Assistant for Visually Impaired Persons. International Conference on Computer and Information Technology (ICCIT), 18-20.

[25] Vashistha, P. et al., (2019). Raspberry Pi-based voice-operated personal assistant (Neobot). Proceedings of the Third International Conference on Electronics Communication and Aerospace Technology.

[26] Velmurugan, D. et al. (2018). A Smart Reader for Visually Impaired People Using Raspberry PI. International Journal of Engineering Science and Computing. 6(3). DOI 10.4010/2016.699.
Zacharias, E. et al. (2020). Image Processing Based Scene-Text Detection and Recognition with Tesseract. International Journal of Engineering & Technology. 7(2).

[27] Hyo Geun Choi, E. et al. (2018). Visual impairment and risk of depression: A longitudinal follow-up study using a national sample cohort. International Journal of Science and Technology. Publishing Online. 8:2083 | DOI: 10.1038/s41598-018-20374-5

[28] Daniel Jurafsky, E. et al. (2023). Speech and Language Processing. International Journal of Computer Science & Technology.

© 2020-2023, IJARCS All Rights Reserved