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Money Identifier: An Android-Based Application For Visually Impaired People Using Object Detection

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ABSTRACT

A normal person can readily recognize and distinguish any banknote, but a visually impaired person finds the task much more difficult as they either have partial or complete vision loss. They face several obstacles when going about their daily lives. They have many issues in terms of monetary transactions as they cannot recognize the currencies due to the similarity of paper texture and size between different categories. To address this problem, the proponents implemented image processing techniques that will assist visually impaired people in detecting and identifying money using object detection. The objective of this application is to make them feel secure and confident in their financial decisions. It will be implemented as an Android-based money detection app. Also, the researchers utilized AGILE and TensorFlow's Convolutional Neural Network algorithm to build a model. They collected multiple images of Philippines notes captured in different light conditions and angles to achieve efficient results in the Money Identifier Application.

Furthermore, the proponents have created a survey questionnaire for blind persons to evaluate the produced application. The Eyessential program can recognize Philippine money with a mean of 4.91, a 98 percent accuracy, and a run time of 3 to 4 seconds. The software is functional, dependable, helpful, efficient, maintainable, and portable based on the results. The developers suggest submitting the Eyessential Android app to Google Play to allow individuals to install the software from anywhere. Also, Google Play services work with Google Assistant, useful for blind people who want to utilize the app. The developers propose adding a flashlight option to make the program more user-friendly. To detect denominations precisely, the developers suggest employing substantial data sets.

Key words : CNN, Eyessential Android-based App, money identifier, Tensorflow

1. INTRODUCTION

A person can quickly identify and distinguish any banknote. However, doing the same activity is significantly more difficult for the visually impaired. They experienced numerous challenges in conducting regular activities and faced many difficulties in terms of monetary transactions. The ability to detect one's own money is essential, and it allows persons who are blind or visually impaired to shop independently, safely, and effectively. While many businesses accept alternative payment methods such as debit cards and bank transfers, in some instances, some companies still prefer cash, especially in the community market and sari-sari stores. However, a visually impaired individual might have difficulty telling each paper bill apart since, for example, all peso bills have the same size and texture. According to Escalona [1], the Filipino banknotes in circulation today do not vary in size and texture. Additionally, people are already going to social media to complain about the new coins. They look almost exactly alike, with just about the same weight that feels just like the same, and sizes that do not vary [2].

Real-time detection and recognition of banknotes have become necessary for everyone, including the blind and visually impaired, because money is crucial in our daily lives and is required for any commercial transaction. According to [3], people with visual impairment encounter particular problems transacting with currency notes in their quest for independent living. They could not identify the different denominations and found that people cheated them sometimes.

People with visual impairments are unable to distinguish the currencies due to the similarity of paper texture and size. For that reason, the Money Identifier Application will assist visually impaired people in detecting and identifying money. Furthermore, it will contribute to the convenient life of these people and will help them with their monetary transactions. Visually impaired people can scan the note and notify the user how much the money note is worth. The mobile application for money identifier that recognizes Philippine peso currency will help elderly and visually impaired people make payments and receive changes in their daily lives.

The researchers interviewed to know the experience of visually impaired people when it comes to identifying the currency of money. The respondent said they recognize the difference between coins based on their sizes. To know the difference, they will observe and feel their dimensions; if one coin is bigger than the other, it may be five or ten pesos.

Meanwhile, when it comes to paper bills, they ask their companion to know their currency since it is hard for them to identify. In addition, other visually impaired people use a unique wallet that has separate compartments for each denomination. However, it can be difficult for blind people to sort through many denominations, and this technique is ineffective when people need to carry many currencies simultaneously. Moreover, given the circumstances that visually impaired people are experiencing when it comes to identifying the currency of money, the researchers realized that the application of money identification for visually impaired people is a great idea to help them know the accurate value of money.

Since this application will be targeting visually impaired people, it brings several possible challenges. The user may be oblivious of the surrounding circumstances, such as lighting, contrast, saturation, and whether or not the currency note is visible in front of the phone screen. The application should be adaptable to images the target user is likely to scan. For a visually impaired person, using the application should be simple. Once the application is open, they can scan the money, and it will tell the user how much the money is worth. This application will use the text-to-speech concept to read the value of money to the user through the audio output. As a result, the problem requires innovative strategies to consistently and effectively recognize the currency note in various situations. Furthermore, this will be developed as an Android application.

1.1 Problem Statement

The study is designed to develop a money classifier entitled Money Identifier: An Android Based Application for Visually Impaired People using Object Detection to contribute to the convenient life of these people, especially those who are having difficulty with monetary transactions. Consequently, the project seeks to answer the following questions:

- How to assist visually impaired people in recognizing the accurate value or amount of money with the help of image processing techniques?
- How do they obtain accurate results in natural lighting?
- How to develop an Android money identifier application with a simple Graphic User Interface (GUI)?
- How to evaluate the proposed application based on the ISO 9126-1 criterion?

1.2 Literature Review

Money, according to Park [4], is a critical factor in people's lives. Rakoczy [5] also said that humans require money to pay for all of the necessities of life, such as housing, food, medical costs, and a good education. Money is required to purchase the commodities and services that you require to survive; so, knowledge of personal finance is crucial.

Robredo [6] undertook an extensive study and discovered that, according to the August 1, 2015 Census [7], the Philippines has a total population of 100,981,437 people. The 2010 Census [8], on the other hand, shows that approximately 16 per thousand persons in the country have disabilities, accounting for 1.57 percent of the population. In the Philippines, there are around 500,000 blind or visually impaired people, most of whom are impoverished and illiterate.

Tom [9] writes in his article that blind or visually impaired people must be able to distinguish their currencies swiftly and safely while paying and receiving change. In the U.S., all bills are the same size. Blind people can't tell denominations apart. Banknote sizes are different in several countries, such as India, Australia, and Malaysia, making money identification easier. Blind people may measure and identify money with a money identity card. When a currency is lined up with the card, tactile markings determine which bill to use. However, the blind individual needs help to determine money's value. Another way is blind people can fold money for specific denominations. However, they may have trouble sorting through many denominations while carrying multiple currencies. Tom said that identifying money varies by necessity and currency, and each choice has pros and cons. If people could distinguish banknotes by touch, life would be easier, improving and securing cash identification.

Pocket Money Brailler and iBill Talking Money Identifier, both mentioned in [10], as well as the LookTel Money Reader, are two instruments that can recognize money. By pressing the tabs on the corners of the banknotes, the Pocket Money Brailler allows the user to label $1-$100 bills with braille for identification. The battery-operated iBill Talking Money Identifier can tell you what cash you're dealing with. It recognizes all current US paper currencies and speaks denominations in a female voice. With only two buttons, it's easy to operate. While the LookTel Money Reader [11] is an essential and straightforward mobile assistant. When you are out shopping, use the app to double-check your money or make sure you are getting the correct change back. It can be used to quickly and efficiently sort money while maintaining confidence and independence. LookTel Money Reader

instantly recognizes currency and speaks the denomination, allowing those with visual impairments or blindness to quickly and effortlessly identify and count bills. When you point your iOS device's camera at a bill, the app will tell you about the denomination in real-time. The LookTel Money Reader supports twenty-one (21) currencies.

Based on PressReader [12], BSP governor Benjamin Diokno announced peso bill adjustments in July 2019. Diokno claimed that the new peso bills would be the first to allow blind people to distinguish between denominations, as current paper currency has the same size, shape, and feel, which makes blind Filipinos can't count or recognize money without help. The new peso bill will have tactile markers for the elderly and visually impaired, said Diokno. It's part of BSP's effort to expand Filipinos' access to high-quality financial services. This announcement made the blind and visually challenged thrilled as they would be able to identify peso bills apart by touch. However, Ghosh's article [13] claimed that the visually challenged, who rely on touch, are confused by the new money in circulation. Visually impaired people detect letters by their length, width, and tactile characteristics, which requires practice. Ghosh said adding marks to the new denomination won't help unless the visually handicapped know. Few blind educated people know this, so the government should raise public awareness.

1.2 Related Studies

Everyone, especially those who are blind or visually challenged, needs real-time detection and recognition of banknotes. According to Joshi et al. [14], it is pretty simple for an ordinary person to perceive and recognize any banknote, but it is challenging for a visually impaired individual. Therefore, for that purpose, they proposed a YOLO-v3 CNN model based on a banknote detection and recognition system, which is fast and accurate. According to the test results, the suggested YOLO-v3 model-based technique exhibits detection and recognition accuracy of 95.71 percent and 100 percent, respectively.

One of the primary issues that persons with visual difficulties encounter, according to [15], is the inability to distinguish paper currency. Therefore they proposed a simple Egyptian currency recognition system. The system has been written in MATLAB and OpenCV libraries under the Android platform. Under the MATLAB system, the system's accuracy reached 89 percent. Singh et al. [16] also developed the same application that enables visually impaired people to recognize the value of money using a mobile phone. The app uses a visual Bag of Words (BoW) based method for recognition. The technique used enables robust recognition in a cluttered environment. They deployed their system on paper banknotes of Indian National Rupees and reported a 96.7 percent success rate with the SIFT descriptor.

Yousry et al. [17] have proposed a mobile-based currency recognition system for the blind and visually impaired using the Oriented FAST and rotated BRIEF (ORB) algorithm. The goal is to provide a quick and effective replacement for Local Scale-Invariant Features (SIFT). A smartphone application is developed to identify partially visible currencies, folded, wrinkled, or even worn by usage. The result is converted to speech utilizing sound from the system, which tells the value of the currency through the mobile speaker without the need for human intervention. Similarly, [18] presented software that uses the device's camera to capture frames at regular intervals. When a bill or card is inserted into the camera viewport, the program scans the image and determines the denomination, which it then conveys audibly and in real time. The deployed system has a hit rate of 97.5 percent with high or medium environmental illumination and 97.91 percent if none.

[19] introduced a mobile system for currency recognition that recognizes Indian currency in different views and scales. Using the scale-invariant feature transform (SIFT) algorithm, they applied an automatic mobile recognition system using a smartphone on the dataset using the scale-invariant feature transform (SIFT) algorithm. They claimed that the SIFT algorithm outperforms the current HOG in performance and recall value. [20] proposed a money identification system that employs the SIFT algorithm. The proposed money identification system is highly efficient, quick to detect currency, and can count or add up the total amount detected. The proposed system recognizes seven different types of Indian currency. The proposed system can be deployed in real-time scenarios with a 93 percent accuracy rate and a running time of 0.73 seconds.

[21] have proposed a real-time Bangladeshi currency detection system for visually impaired persons. It uses image processing techniques to assist visually challenged persons in successfully recognizing banknotes. The researchers claim that Bangladesh's newest banknotes contain blind embossing or blind dots, which might help identify the bill's value by touching. As embossing fades in long-term used notes, determining the correct value of the banknote may be difficult. The implemented system can recognize Bangladeshi banknotes from various angles and scales and identify rumpled, deteriorated, or worn money. The descriptor of an individual input scene is matched with numerous training images of the same category to improve the determination of currency recognition. The researchers have deployed the system into a mobile application for real-time recognition.

In a study entitled "A Currency Recognition App for Visually Impaired People", the researchers use computer vision techniques for currency detection that operate on a low-cost smartphone. Because the appliance runs on the smartphone, there is no requirement for a local server. They analyze the performance of a group of images captured in various natural environments, which report an accuracy of 95.6 percent on 2438 images [22].

2. EXPERIMENTAL DETAILS

This money identifier application helps visually impaired people in recognizing and detecting money. Thus, the application is simple to use, accessible, and economical. To use the application, once the application is open on their smartphone, they can scan the money, and it will tell the user how much it is worth. This application will read the value of money to the user through the audio output. There will be incidents where the user may be completely unaware of the environment, including lighting, contrast, saturation, and whether or not the money note is visible in front of the phone screen. To solve these challenges, this application should be able to adapt and handle a wide variety of photographs that the target user is likely to scan. The algorithm extracts currency features that match the original currency features and presents

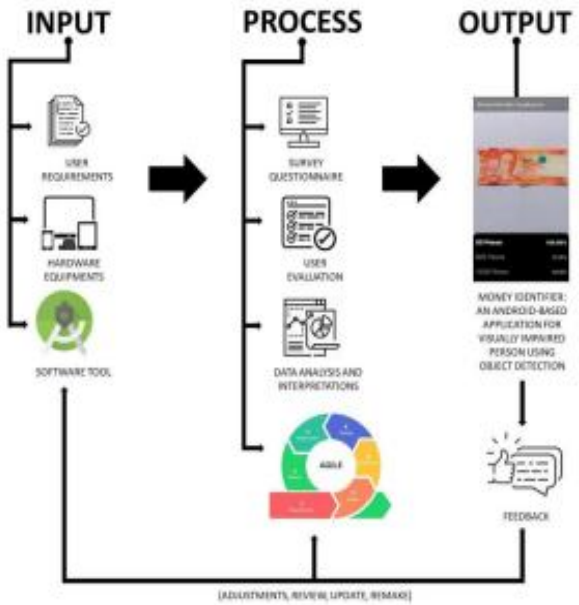

Figure 1: Conceptual Framework

the result quickly and accurately. As a result, the problem requires the development of innovative ways of recognizing the currency note in a variety of situations.

Conceptual Framework

Figure 1 depicts the conceptual framework and research processes of the study. Application inputs are provided. Since the user and programming requirements are the foundation and key resources for the application, the developers must be informed of both. The review of related studies and systems is also essential because it will guide application developers. Software and hardware requirements must also be met to design a visually impaired application. The Agile Life Cycle Model will be used for application development. The developers will utilize this technique to help them work efficiently as they review requirements, plans, and results. A visually challenged individual can place their money in front of the app's camera to hear how much it's worth. It is not necessary to keep scanning until the application recognizes the money. The study's outcome is an Android-Based Application for Visually Impaired People Using Object Detection.

2.1 Application Development

For application development, the proponents will employ the Agile Life Cycle Model [23]. The Agile Life Cycle Model includes six (6) processes: requirements gathering, design, development, testing, deployment, and review. It will help improve quality by detecting faults early in the production process. As the requirements, plans, and results are continually examined, the developers will use this technique to encourage and assist them in working efficiently at each point. As a result, teams can ensure that their target users are satisfied with the quality of their work.

Figure 2: Money Identifier Application Prototype

2.1.1. Requirements Gathering

Requirements gathering involves studying and documenting the project's actual needs. Any software development project needs it, and it's vital because it sets clear goals for everyone. It will assist developers in comprehending visually impaired people's financial demands.

Brainstorming encourages independent thought to address a commercial or technological problem. Each person provides views immediately and discusses every complex issue. Developers examine whether research information and resources are available to complete the project.

During planning, project proponents define the exact tasks and resources needed. They have decided what type of application will help the visually impaired and what features and functionality they will need to make the Money Identifier application more accessible and usable to them. The developers have also planned which software to use. The proponents also interviewed ten (10) visually impaired individuals to determine the system's functional requirements. All user preferences are acquired.

Document analysis was also used and involved three phases. First, developers identify adequate and relevant study materials. The second stage is the review, where they go over the material and highlight key topics. Wrap-up is the final stage. In this stage, developers grouped their notes and software needs.

2.1.2. Design

The design phase is a mechanism to transform user requirements into some suitable form, which helps the programmer in software coding and implementation. Once

the condition has been identified, the researcher will convert all the specifications into an interactive design known as prototyping and wireframing. When it comes to this, Adobe XD will be used. This software allows developers to create a precise detail of a Money Identifier Application in terms of its features and functionality that will help to visualize the possible outcome. On the other hand, Adobe Photoshop will be applied for the logo and different patterns needed for the Money Identifier Application.

Figure 2 illustrates the appearance of the money identifier application. Once the app is open, it requires no input from the user, which will be easily accessible to the visually impaired.

The application's design is straightforward, with the logo and app's name prominently displayed at the top. The middle screen displays the scanned image, and at the bottom of the screen shows the result of the scanned money. Aside from the display output, the user will also receive an audio output that tells them how much the money is worth since the target users are those with visual impairment.

2.1.3. Development

By collecting Philippine coins and bills, developers will establish datasets. Developers will use the Oppo F7's camera, which runs Android Q or version 10, to capture photos of Philippine banknotes for the Money Identifier App. CNN, a well-known system for image identification, will be employed to construct the current research. The project's proponents will use a Teachable Machine to train photos of Philippine money to detect accurate currencies. The developers will ensure that the detection accuracy falls from 80% to 100%.

Moreover, the project's developers will use Android Studio and Java. The Money Identifier application will use Java to implement picture classification and item identification. In contrast, Android Studio will be used to create the design, functionality, and user interface. These include monetary scanning, identification, and audio based on teachable machine-trained datasets. The Money Identifier App will be developed on an Acer Aspire E15 laptop with a 2.40GHz Intel Core i3-7100U CPU and 12GB RAM.

2.1.4. Testing

The application must be evaluated to prove that it can aid visually impaired persons. The proponents prepared a survey questionnaire for people with visual impairment. The proponents produced a rating scale questionnaire where target respondents rate the given questions from 1 to 5, 5 being the

highest or outstanding, that they agreed to the question, and one being the lowest or they disagreed that it needs improvement. The survey questionnaire is also based on ISO 9126-1 quality standard since it measures application quality. This standard includes functionality, reliability, usability, efficiency, maintainability, and portability.

Eighty-seven (87) visually impaired people in District One (1) of Manila, Philippines, were tested. Proponents utilize stratified random selection because they aim to reach a certain subset. The Eyessential application focuses on a particular population attribute, namely those with visual impairment, best suited to answer the survey questions.

2.1.5. Deployment

The system should be deployed in this phase: install, configure, and enable the program to a particular URL on a server. Once deployed, the URL or app becomes public. With the help of mentors and lecturers, the product will be launched on Google Play, so visually challenged individuals can use it. It will also allow the researcher to receive valuable input and suggestions for future project maintenance and improvements.

2.1.6. Review

Customers review products and services, and its purpose is to show the product, customer success, and marketing teams how to improve. Analyzing user feedback can help developers better grasp what visually impaired individuals need and want. Using the informative data, developers may improve their services by quickly and efficiently resolving issues that individuals with visual impairment face, resulting in a great user experience and a focus on their needs.

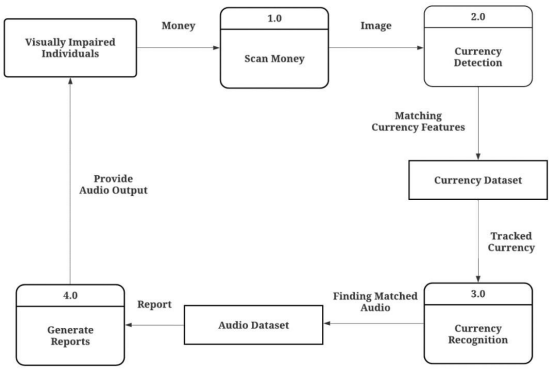

Figure 3: Data Flow Diagram of Money Identifier App

3. EYESSENTIAL ALGORITHM

The data flow diagram of the Money Identifier Application, as shown in Figure 3, shows the app's general procedure. These procedures involve information such as scanning the visually impaired person's money. The machine then matches the image to the monetary dataset. After that, the software will track matched audio in the audio dataset and speak it to the user. It displays how the system reacts to the user and manages recognized data. It will also track the matching audio in the dataset and shout it out loudly for the user to hear.

Figure 4 displays Eyessential's flowchart, a diagrammatic depiction of a solution model for a specific problem. The money must fit within the Android phone screen to be scanned. If the user did not place the money correctly, there would be a voice prompt error. Otherwise, the system will pre-process the scanned image to increase image quality and reduce noise. The program would find it easy to compare the scanned image to the currency datasets in this situation. When the software finds a match, the denomination of the currency detected will be displayed, including its equivalent

accuracy. The user will also hear the audio format results corresponding to the correct banknotes.

Figure 5 is the schematic of the Money Identifier Application's high-level control flow diagram for visually challenged users. A control flow diagram can help you grasp the complexities of a process. It indicates where control begins and ends in specific situations, as well as where it may branch off in another way. The challenge is exacerbated by the fact that the intended audience is visually impaired. The user is entirely unaware of the condition of the surrounding environment, including other items, lighting, contrast, and whether the bill is in the camera's field of vision. The system should be capable of handling a wide variety of images that the target user is likely to take. When the Money Identifier program is unable to read the currency of the money, the user must continue scanning until the detected currency of the money is heard. For someone who is blind, using the app should be simple and intuitive. It should feature a bespoke camera that requires no user interaction once engaged. In brief, the problem needs the creation of novel modules capable of reliably, robustly, and efficiently recognizing bills in a range of situations.

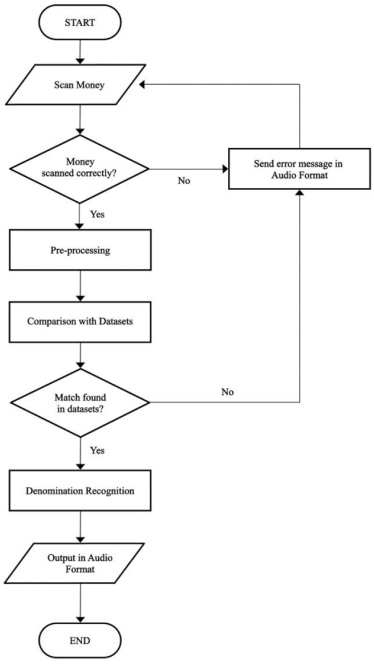

Figure 4: Flowchart of the Money Identifier App

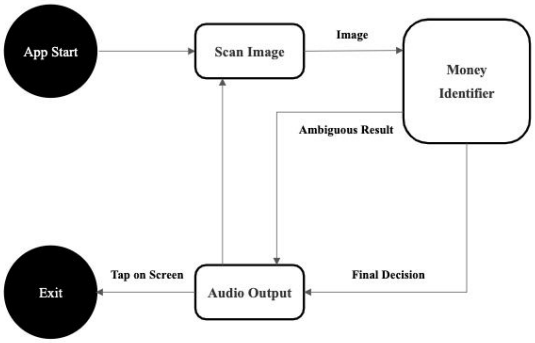

Figure 5: Control Flow Diagram of Money Identifier App

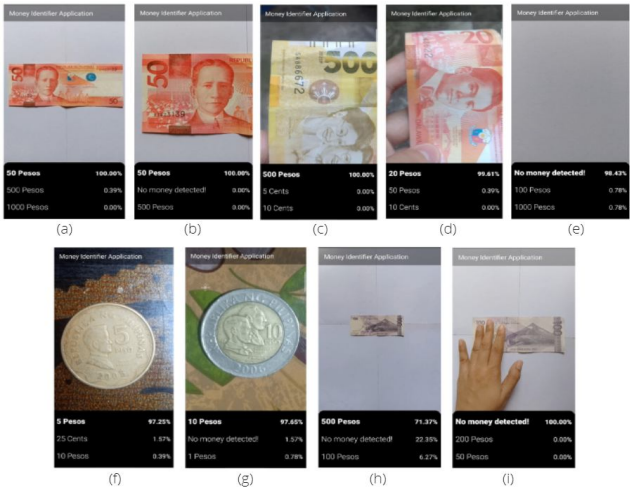

Figure 6: Generated Sample Money Identification (a)-(g) Accurate Results (h)-(i) Failure cases

4. RESULTS AND DISCUSSION

4.1 Philippine Banknote Recognition

The developers have created a simple Graphical User Interface (GUI) application. The interaction between the visually impaired person and the application is simple and user-friendly. Once the Android application is launched, it requires no input from the user, making it easily accessible to visually impaired people. The application's design is simple, with the name clearly displayed at the top.

Numerous tests have been carried out with bills held at various distances and positions relative to the device's camera as shown in Figure 6. The figure shows the equivalent percentage rate in terms of its accuracy. They demonstrate that solid results are frequently reported if the bill spans at least 40% of the total area of the camera or if the bill is at a distance of no more than 1 foot or 1 arm's length from the camera. Figures 6a to 6g show that the Eyessential money identifier application gives accurate results or value when users scanned their money. Furthermore, at least half of the bill should be seen in the camera for correct recognition. Users should scan the money in a natural lighting environment to obtain an accurate result from the money identifier application. The figures were scanned in a place with natural lighting. The developers were able to report a recognition accuracy of seventy to ninety-nine percent (80-99%) on the dataset of Philippine currency, specifically the twenty (20), fifty (50), one hundred (100), two hundred (200), five hundred (500), and one thousand (1000) pesos paper bills along with the ten (10) peso coins to five (5) centavos.

Figures 6h and 6i are examples of wrong recognition. Color, due to its sensitivity to illumination and fading, cannot be used as a trustworthy feature in this situation. As a result, such positions frequently produce incorrect/ambiguous outcomes. When various denominations of money are not in the camera's view, the result is guaranteed to be uncertain.

4.2 Evaluation based on ISO 9126-1 criterion

A survey of 87 visually challenged was conducted, fifty-four (54) of them with hazy vision, whereas twenty-eight (28) were elderly people, and five (5) people were utterly blind. The ISO 9126-1 questions were created to test if the app makes life easier for people with visual impairments by assisting them in identifying the currency of the money. It allowed proponents to discern between responses from people who had visual problems and those who did not. Because all of the questions revolve around how the created application can help them, the proponent discerns that only visually impaired people's responses should be assessed to produce reliable results. Furthermore, frequency counts were applied to the data collected by a questionnaire. In other words, the replies of the subjects to each particular question were put up to get the maximum frequency of occurrence or the number of times a specific response occurs. These quantifiable responses to the questions are provided in a weighted mean format.

4.2.1. Functionality

Functionality refers to the application's usefulness or efficiency. The app received 4.95, 4.95, 4.93, 4.79, and 4.90 mean scores for criteria 1 to 5, respectively, as shown in Table

Table 1: User Evaluation Summary

CRITERIA	GENERAL WEIGHTED MEAN	INTERPRETATION
1. Functionality	**4.9**	**Excellent**
Completeness of the application.	4.95	Excellent
The application performs the tasks assigned.	4.95	Excellent
The application produces expected results or output.	4.93	Excellent
The application is compatible with different versions of android phones. (Version 4.4 to 11)	4.79	Excellent
The application is equipped with acceptable security measures.	4.9	Excellent
2. Reliability	**4.92**	**Excellent**
The application can handle errors (Fault tolerance).	4.9	Excellent
The application meets the existing reliability	4.95	Excellent
3. Usability	**4.95**	**Excellent**
The application has a simple yet an attractive User Interface.	4.97	Excellent
The application can be learnt easily by the users.	4.94	Excellent
The application can be operated with minimal effort.	4.94	Excellent
The application can be understood easily by the target users.	4.97	Excellent
4. Efficiency	**4.9**	**Excellent**
The application behaves a timely manner (Time Behavior).	4.91	Excellent
The application gives output quickly.	4.9	Excellent
The application utilizes resources efficiently.	4.89	Excellent
5. Maintainability	**4.89**	**Excellent**
The application can be modified easily.	4.8	Excellent
The application continues to function even if changes are made.	4.92	Excellent
The application can be tested easily.	4.95	Excellent
6. Portability	**4.92**	**Excellent**
The application can be adapted easily.	4.91	Excellent
The application can be installed easily.	4.93	Excellent
The application can replace the traditional way of identifying money.	4.93	Excellent

1. Overall, the weighted mean is 4.90, which is equivalent to Excellent. Respondents say the developed app has all the needed functions.

4.2.2. Reliability

The application's reliability is measured by how well it performs its primary purpose without failure under specific conditions over a set period. The first criteria obtained a weighted mean of 4.90 in the survey, as shown in Table 1. Therefore, the verbal interpretation is excellent, telling that the application can handle errors. While the second statement gets a 4.95 weighted mean, which means that the application meets the existing reliability standards. Moreover, most participants agreed that the application's capability to maintain its service provision under defined conditions for defined periods with a verbal interpretation of excellent and a weighted mean of 4.92.

4.2.3. Usability

Usability refers to the quality of the visually impaired people's experience when engaging with the Eyessential money identifier application. The first criteria under Usability got a weighted mean of 4.97, which corresponds to Excellent, as shown in Table 1. While the weighted mean for the second, third and fourth criteria were 4.94, 4.94, and 4.97, respectively. According to the respondents, the application's user interface is simple but appealing and straightforward to understand for the target users. They can use the application with minimal effort and agree that it is simple to understand. Overall, many users expressed satisfaction when engaging with the app. With an average mean of 4.95, most respondents assessed the developed application as excellent in terms of Usability.

Figure 7: The General Weighted Mean of the Overall Criteria

4.2.4. Efficiency

The ability to execute a task with the least amount of time and effort is known as efficiency. Most of the respondents are satisfied with how well the application provides the required performance relative to the number of resources used, with an average mean of 4.90 (excellent).

The amount of storage the application consumes is only 73MB, which is the average amount of storage since an AI application requires a massive amount of data. And the application takes only seconds to respond, and it also gives a quick output. One more thing that the respondents like is that the application does not require an internet connection to use the application. From the data shown in Table 1, under Efficiency, proponents conclude that Eyessential is efficient.

4.2.5. Maintainability

Maintainability refers to the application's continuous improvement, such as learning from the past to increase one's ability to maintain systems or improving system reliability based on maintenance experience. The weighted mean of the

first criteria in Table 5's Maintainability section was 4.80, 4.92 for the second, and 4.95 for the third. The majority of respondents feel that updating the program is simple. According to them, the program continues to function even when changes are made. They also like how quickly the application can be tested. Likewise, the findings revealed that many respondents are pleased with the ease with which the application may be maintained. The calculated average was 4.89, with an interpretation of excellent.

4.2.6. Portability

Portability refers to the application's capacity to function correctly on a different platform. A weighted mean of 4.91 for the first criteria in Table 1 under the Portability section was obtained in the survey, and both the second and third criteria have a 4.93 weighted mean. The general weighted mean of Eyessential's Portability was 4.92. As a result, the respondents agreed that the application is easy to customize and install, and that it can be migrated from one environment to another. Furthermore, most respondents agreed that the application can be used to replace the traditional method of recognizing Philippine money. The respondents are satisfied with how the application can replace the conventional way of identifying the money by letting someone assist them.

5. CONCLUSION

The proponents surveyed the target users and investigated the developed application using the six ISO 9126-1 criterion. Functionality, reliability, usability, efficiency, maintainability, and portability are only a few of the requirements, and it includes all specific needs specified by the end-user. Furthermore, visually impaired people in District One of Manila were asked to assess the app based on their experiences, with five (5) being the best and one (1) being the worst. After reviewing the respondents' responses, the proponents assessed that the system met all of the survey's criteria, as evidenced, all of the results for each category have an excellent rating, as seen in Figure 7. In addition, depending on the outcomes, the program is functional, dependable, helpful, efficient, maintainable, and portable, among other features. The program is suitable for usage, according to the researchers, based on the results of their survey.

For future works, the researchers will add an automatic money counter to assist persons in determining the total amount of money scanned. The developers will also put a flashlight feature in the application as this component helps capture visible images. They will also create larger datasets to accurately identify money notes with different colors, hues, and textures. Furthermore, the researchers will upload the Eyessential to Google Play Store with the improvements indicated above. Since this platform offers streamlined services, visually impaired people will be able to download or install the application. Users may utilize Google Assistant to open applications by executing simple voice commands rather than tapping on the screen.

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