

# TEAM RED

# PAPER BILL

# COLOR DETECTOR

## Project Description

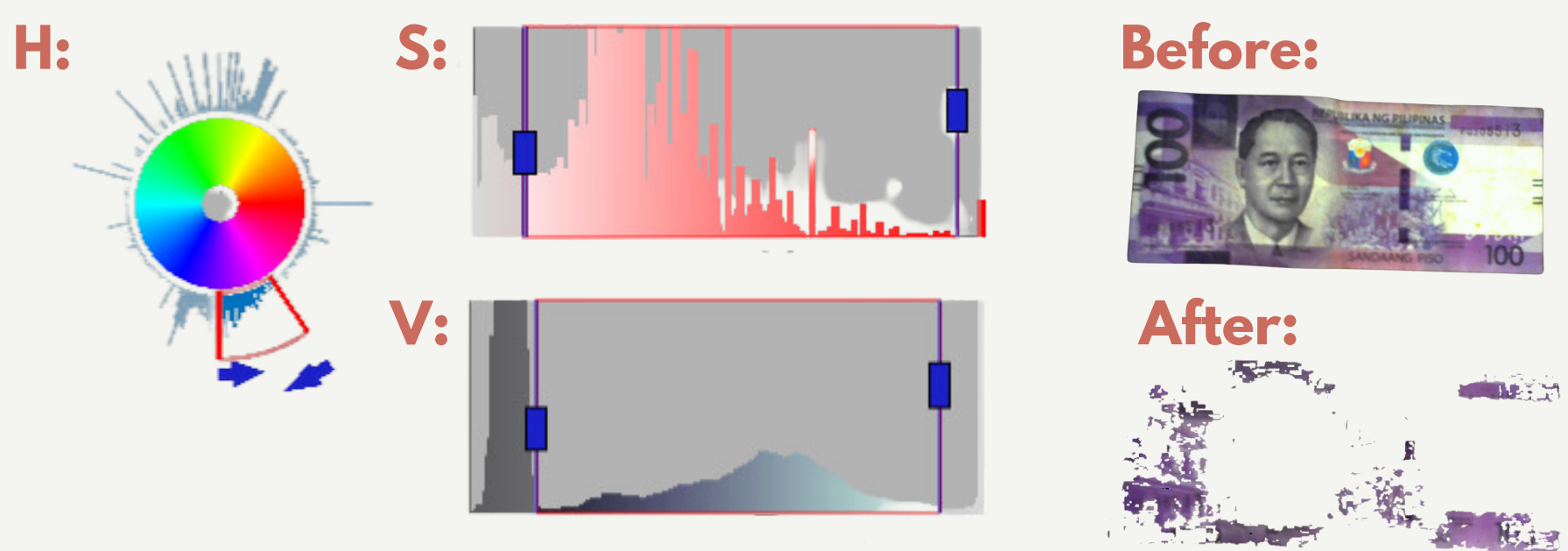
Visually-impaired people are prone to scams involving money. To alleviate this problem, the researchers created a program that can analyze the value of a paper bill based on its color. The said program utilizes the HSV color spectrum in its algorithm to output the paper bill's value.



## Program Flow

- 1.The user takes a picture of their paper bill
- 2.The program takes the RGB values of the picture and determines its HSV spectrum
- 3.The program determines the pixel numbers of each color
- 4.The most dominant pixel color is determined
- 5.The value of the paper bill is outputted based on the dominant pixel color

## Example HSV Thresholding



## HSV Color Thresholding

Using the Color Thresholder application that is already integrated in MATLAB, the researchers uploaded different pictures of the Philippine paper bills and their HSV color space is adjusted so that only that specific color shade will be detected.

## Integrating with the Code

The set values of the HSV spectrum are exported into a function and the specific code for the thresholds is inserted into the main color-detecting code. The program then uses these thresholds to determine the dominant pixel color.



# Paper Bill Color Detector

The researchers have developed a tool to aid individuals with visual impairment in handling and receiving money, aiming to improve their daily lives and overall quality of life. Currently, there is a lack of available tools or applications to assist visually impaired individuals with paper money, leaving them vulnerable to fraudulent activities. Scammers often target people with disabilities, including those with visual impairment, which makes this tool a valuable solution to address this issue. The said tool is a prototype program for detecting paper bills using the concepts of color segmentation.

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## 01 Introduction

The researchers have developed a tool to aid individuals with visual impairment in handling and receiving money, aiming to improve their daily lives and overall quality of life. Currently, there is a lack of available tools or applications to assist visually impaired individuals with paper money, leaving them vulnerable to fraudulent activities. Scammers often target people with disabilities, including those with visual impairment, which makes this tool a valuable solution to address this issue.

## 02 Objective

- To develop a software that recognizes and identifies Philippine currency quickly and accurately
- To integrate text-to-speech feature
- To optimize the application so that it can run on different

## 03 Methodology

For this project, the researchers will be utilizing image processing concepts available in MATLAB. The objective of the project is to provide aid to visually-impaired individuals by processing the image of a paper bill. The main concepts involved in the project are RGB, HSV, and programming loops. Although these concepts are relatively new to the researchers, they conducted research on MATLAB programming which provided valuable insight for the project. The project was able to operate properly with the help of MathWorks and the MATLAB community. The mentioned concepts were all implemented with some necessary modifications made to further optimize its functionality.

### References:

"Currency recognition for the visually impaired people," IEEE Xplore. [Online]. Available: <https://ieeexplore.ieee.org/document/9753373>.

JeefriAMoka and JeefriAMoka, "Image classification with HSV Color Model Processing," Data Science Central, 16-Oct-2017. [Online]. Available: <https://www.datasciencecentral.com/image-classification-with-hsv-color-model-processing/>.

## 04 Data Gathered

### INITIALIZATION

The researchers utilized pre-existing images of Philippine banknotes and loaded them into MATLAB's Color Thresholder program. The HSV feature was then utilized to perform color segmentation, where the hue, saturation, and value (intensity) were adjusted to isolate the specific colors that distinguish a particular paper bill. For example, the colors of a Php 20 bill were separated to retain only the eye-visible orange tint. The HSV values obtained from this color-segmented image were converted into code by the researchers to determine threshold values. These code-derived values will be used in subsequent stages of the project.

### INPUT

The webcam integrated into MATLAB will be used to capture the input. To enable this functionality, the researchers downloaded and installed the Image Acquisition Toolbox and MATLAB Support Package for USB Webcams, which were necessary add-ons for the program. The RGB values of the captured image will be extracted and then converted to HSV for precise color segmentation. The hue, saturation, and value (intensity) of the image will be isolated for further comparison.

### COMPARISON

The HSV values of the image are compared against the defined threshold for each bill using a combination of a for-loop function and if-else statements. In the first if-else statement, each HSV value is checked against the predetermined threshold values for each bill, thanks to the for loop function. The second if statement determines if all the HSV values match the threshold values and if so, the image is labeled with the corresponding color for that bill. Once the for loop completes, another if statement is used to compare the recorded colors and determine the dominant color for each bill, which indicates its monetary value.

### OUTPUT

The application will produce the output by using MATLAB's text-to-speech feature after processing the image of the paper bill and giving it a monetary value. As a result, the results can be spoken out, which is very helpful for people with visual impairment.

### References:

L. Lang, N. F. Gazcón, and M. Larrea, "An open source solution for money bill recognition for the visually impaired user using smartphones," CIC Digital - Home, 01-Oct-2018. [Online]. Available: <https://digital.cic.gba.gob.ar/handle/11746/8991>.

R. Madsen, "Color models and color spaces," Color models and color spaces - Programming Design Systems. [Online]. Available: <https://programmingdesignsystems.com/color/color-models-and-color-spaces/index.html>.

## 05 Analysis

When the image of the paper bill is captured, the software was able to isolate the dominant color of the bill. Visual adjustments are made to the hue, saturation, and value (intensity) to achieve this. Once modified, this will be regarded as the HSV value threshold for identifying a paper banknote. The threshold will now be quantified and converted into code by exporting this graphic as a function.

Using MATLAB's image acquisition, the inputted image was scanned using the function imread. The HSV values are analyzed after the RGB values are converted using the function rgb2hsv. After the conversion, the program will now run through each pixel of the image and compare every pixel to the set threshold. If the pixels scanned correspond to a color, it increments to a specific color pixel counter.

The program will output the amount of the paper bill depending on the color scanned. If the color corresponds to a color green, then it will output the amount Php 200 bill. The final output will be the text-to-speech output of the value of the scanned paper bill. For example, if it is a Php 200 bill, the program will say "The image you have scanned is two hundred Philippine pesos"

During experimentation, the researchers identified flaws in the program's ability to accurately identify bills due to the changing color of the light source and inaccuracies in the capturing device. These factors resulted in the program mistaking bills for other currencies. To address these issues, the capturing device settings were calibrated to improve color accuracy, and a black background was used to avoid errors in color detection caused by the bill's background color. But overall, the software is a success and is effective in scanning the paper bills.

## 06 Conclusion

The researchers were able to develop a program that helps visually-impaired individuals handle or receive Philippine currency by utilizing digital image processing and integrating RGB and HSV concepts into the MATLAB code, enabling the program to identify and inform the user of the value of the bill. To further enhance the project, it is recommended to acquire a better quality capturing device for more accurate color detection and to have more advanced knowledge of digital image processing and MATLAB functions to minimize errors, even with numerous variabilities. Additionally, the researchers aim to expand the program's capabilities to identify the values of coins and other currencies.