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Currency Nominal Detection With Tempalate Matching Method To Help Turnanetra

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Abstract: This research aims to design and implement a currency nominal detection system using the template matching method, how accurate and effective the template matching method is in detecting currency nominal from various lighting conditions and viewpoints and how to detect currency nominal through web-based applications. This research uses descriptive quantitative research with the R&D (Research and Development) approach method. Data collection methods in this research are literature study and observation. The system development method in this research is planning, data collection, needs analysis, system design and system testing. The results showed that the way the application works is that users can use a laptop camera or directly select an image of Rupiah money to detect its nominal value. The application of currency nominal detection with the template matching method to help the visually impaired in this study was built using Visual Studio Code software using the Python programming language. User interface is the appearance of the programme that can be seen, heard or perceived by the user and the commands or mechanisms used by the user to control operations and enter data. It can be concluded that an application has been produced that is built using Visual Studio Code software with the Python programming language to be used in the nominal detection process of rupiah currency banknotes using the template matching method effectively and accurately used and the nominal detection process of rupiah currency banknotes can be done through a webcam or by selecting images of money contained in laptop storage.

Keyword: Currency Detection, Template Matching, Visually Impaired.

INTRODUCTION

A blind person is one who is unable to function normally with his or her vision, unable to see (totally blind), and can only see light (low vision). Reports that Indonesia is among the top four of the five countries with the highest number of blind people. China, India, Pakistan, and the United States rank last; data from the Indonesian Ministry of Health's Data and Information Centre (2018) shows that 0.49% of the world's 7.33 billion population are visually impaired, and 0.55% of them are women. (Fatimah et al., 2021).

Visually impaired is a general term used for the condition of a person who has a disturbance or obstacle in their sense of vision. Based on the level of impairment, blindness is divided into two categories: total blind and low vision. (Siahaan et al., 2020).

Money is a payment medium to facilitate the process of buying and selling or exchanging goods. In Indonesia itself, the existence of money is very helpful in the process of buying and selling transactions, because in the past the buying and selling process still used the exchange or barter method. Bank Indonesia is the only institution authorised to issue, revoke and circulate money in Indonesia, this has been regulated in Article 11 of Law No.7 in 2011.

Each currency has a different value which is useful for determining the value of goods and services being traded. There are two types of currency: cash deposits and current accounts. Currency is money in the form of metal and paper. While current accounts are digital currencies such as ATMs. Money is one of the transaction tools used by the community, there are two types of money, namely foreign exchange and current accounts. Money that is used directly for the exchange process is currency.

There are two types of money: coins and banknotes. Banknotes are money made of paper and are legal tender. According to Law No. 23/1999 on Bank Indonesia, paper money means money in the form of sheets made of paper or other materials in the form of paper. Rupiah banknotes are banknotes or state currency in Indonesia. The rupee note itself comes in many denominations, including 1000, 2000, 5000, 10000, 20000, 50000, 10000. Each fraction has different characteristics (Alfita et al., 2022).

Of the total population in Indonesia, 1.5% are visually impaired. If in 2019 the total population of Indonesia is 250 million, then there are currently at least 3.750 million visually impaired people in the country, both blind and partially sighted. (Ramadani & Mukhaiyar, 2022).

Identifying currency amounts is an important daily activity, especially in financial transactions. For the visually impaired, this difficulty can lead to dependence on others and potentially reduce their independence. While there are several solutions such as banknotes with tactile features or voice recognition applications, many of these solutions have limitations in terms of practicality and accuracy. One potential method to overcome this problem is the use of computer vision technology, specifically the template matching method.

Template matching is a technique in digital image processing that is used to find specific parts of an image that match a given template. This method can be used to detect and recognise patterns in images, including patterns on banknotes.

By applying the template matching method, a system can be developed that is able to detect and recognise currency nominal automatically. This system can be integrated with computer devices, so that the visually impaired can use it easily in various situations. The system is expected to provide a more accurate, faster, and practical solution compared to other existing methods.

This research aims to design and implement a currency nominal detection system using template matching method to help the visually impaired. With this system, it is hoped that the visually impaired can be more independent in their daily transactions and activities, and improve their overall quality of life.

Template matching has advantages and disadvantages. The advantages are that this method is easy to write into the programme language and easy to prepare the reference data. While the disadvantage is that it requires a lot of reference data or database to get optimal results. (Rahman & Sahira, 2020).

The government's efforts in handling the visually impaired can be realised in the aspect of education as stipulated in Article 15 of Law Number 1 Year 2003 concerning the National Education System, the type of education for children with special needs is special

education.People who are blind from birth and cannot see are different from people who are blind from birth who do not feel happy. According to Article 15 of Law No 1 of 2003 on the National Education System, special education is one type of education that can be provided to children with special needs. Thus, the government's efforts to overcome blindness can be done in the field of education.

This limitation relates to the field of view and accuracy of vision when using the Snellen card. The symbols on the Snellen chart must be clearly visible from 20 feet away, and visually impaired people have vision that does not exceed 20/200, which means they can only see at a distance of 20 feet, while normal vision is at a distance of 200 feet. There are about 3.5 million visually impaired people in Indonesia today. About 1.3 billion people worldwide have some type of visual impairment, including distance vision impairment, 188.5 million have mild visual impairment, 217 million have moderate to severe visual impairment, and 36 million are blind, according to the World Health Organisation. (Aulia, 2024).

According to RG Thomas, money is something that is available and generally accepted in contemporary economies as a means of payment for buying goods, services, and other wealth, as well as a means of paying debts. Money is defined by Mulyani as a merchandise or tool that has many functions, one of which is as a medium of exchange. Mankiw considers money as an asset that can be used for trading.

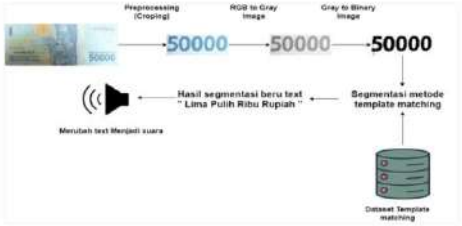
After reading some definitions about money, the author can say that money is a common medium of exchange used by society to measure value, exchange, and payment for purchased goods and services. In addition, money can also be used as a tool to accumulate wealth.

Machine learning is a paradigm shift in the way we programme and interact with computers. Computers are typically programmed with rules and step-by-step instructions. ML has a broad and profound impact. It has changed the way we use technology, from speech recognition to providing product recommendations. It is an invaluable tool in various fields, such as scientific research and industrial automation, due to the ability to learn from data and improve performance over time. (Prihandoko, 2024).

Source: (Azindha et al., 2023)

Figure 1 Data set Architecture

The data architecture of the system is depicted in Figure 1. The figure above shows the process of creating a dataset that will be used as training data for the currency nominal detection system. The image processing process starts with the banknote image data as input, then the clipping process to get the desired part, converting the RGB image to grey scale, and then converting the grey scale image to binary. After that, the required image data is stored in the dataset. (Azindha et al., 2023).



Source: (Azindha et al., 2023)

Figure 2 System Architecture

Figure 2 shows the system architecture. The figure above shows the process when the system is running. After inputting the banknote image into voice, the model matching method is used with the generated dataset. Next, the text segmentation results are configured with the speaker system. (Azindha et al., 2023).

In general, an image is a representation, likeness, or imitation of an object. Images as the output of a data recording system can be optical in the form of photographs, analogue in the form of video signals such as images on television monitors or digital in nature that can be directly stored on a storage medium. (Syahputra, 2019).

RGB is a colour scheme rule consisting of 3 colours, namely red, green, blue, which are processed using various techniques to get a variety of colours. Processing RGB images into grey images is one sample of image processing with point operations. In processing RGB into grey by calculating the average RGB intensity of each pixel that makes up the image. (Kirana, 2021).

A grey image represents more colours than a binary image because it falls between the minimum and maximum values. The number of possible values and their maximum values depend on the number of bits used. A grey image has an image format called the grey scale. (Ikromina & Ujianto, 2019). In general, the colours used are black as the minimum colour and white as the minimum, so the colour between the two is grey. (Fadjeri, Saputra, Adri Ariyanto, & Kurniatin, 2022).

Python is an object-oriented programming language on par with other programming languages such as Perl, Ruby, Scheme, and Java. The first version of Python was object-oriented and had a module system. It can also perform exceptions, functions, and core data types such as list, dict, and str (Abdiansyah, 2022).

A website is a collection of pages that contain various text, data, images, and video information, both statically and dynamically. Before proceeding, it is important to understand the definition of the web. Web programming, also known as web programming in Indonesian, consists of two words: "web" and "programming", which means the process of creating a programme or application. In addition, "web" can be defined as a computer network or also referred to as "website", which contains websites that have various features.Based on the above theory, it can be concluded that the web is a system that allows searching for information and displaying content such as text, images, multimedia, and others on the internet network. (Harani, 2022).

This research is related to previous relevant research, namely by brother Supangkat with the research title "Comparison of the combination of Template Matching Method and Feature Matching Algorithm on Indian Currency Recognition" (Supangkat et al., 2021). Furthermore, by Azindha's brother with the research title "Banknote detection system for blind people with Template Feature Matcing Method" (Azindha et al., 2023). Furthermore, by Tamara's sister with the research title "Detection of banknote authenticity based on Gray Level Co-Occurrence Matrix (GLCM) Features using k-Nearest Neighbor". (Tamara et al., 2022).

Based on the description above, the researcher wants to study more deeply by formulating, namely how to design and implement a currency nominal detection system using the template matching method, how accurate and effective the template matching method is in detecting currency nominal from various lighting conditions and viewing angles and how to detect currency nominal through web-based applications.

METHOD

This research also uses a descriptive quantitative method, which shows variables in real terms and is supported by numerical data. The method used in this research is Template

Matching with correlation development method. The selection of this research is based on research objectives supported by numerical data.

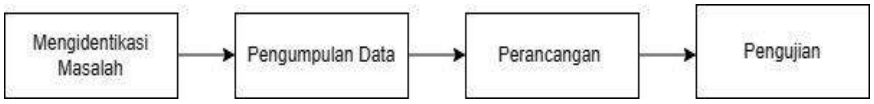


Figure 3 Stages of the Research Framework

Problem identification is the process of recognising to determine a condition, state or issue that requires research, analysis or resolution. This process is one of the first stages in planning research or solving a particular problem. This process includes observing, analysing, and evaluating the situation at hand to determine what needs to be researched or improved.

Data collection techniques are interviews and literature studies. In this study, interview is one of the data collection methods used, which aims to evaluate the impact of template matching for currency recognition. Literature study aims to gain a deeper understanding of each issue through reviewing every written source, which includes various perspectives of existing experts, such as in books and journals, among others, and assists in data collection when studying each subject.

This research generally aims to develop a web-based application that can be used to detect currency nominal using the Template Matching method. The research method used in this research is the Research and Development (R & D) method. The research and development method is a research method used to produce certain products, and test the effectiveness of these products in detecting currency using the Template Matching method to facilitate the visually impaired in detecting the nominal currency. The steps in development using Research and Development (R & D) in this study are as follows:

Figure 4 Steps of R&D Research

Based on Figure 4 Research Framework, the stages carried out in the research will be described as follows:

1. Planning

   The system to be built in this research is used to detect the nominal currency using the Template Matching method and then analyse the detection results provided by the system to be built.
2. Data Collection
   a. Literature Study, by studying references and literature related to the material in journal writing. The references used are generally about how to prepare journals at the State Islamic University of North Sumatra and also journals about literature studies used in writing theses.

b. Observation, which is the collection of currency image data that will be used as training data by directly conducting the image acquisition process of the Rupiah currency.

3. Needs Analysis

In the application design process the things needed are a computer or laptop hardware, as well as Visual Studio Code software to design a web-based system. Other needs are in the form of image data obtained by acquiring images of rupiah currency directly.

4. System Design

The system design that will be made in this study uses UML so that all design stages can be described properly to produce a web-based system to be used in the process of detecting the nominal rupiah currency using the Template Matching method.

5. System Testing

At this stage, the combination of modules that have been made and this test is carried out to find out whether the application made is in accordance with the previously designed design and there are still errors or not. Testing is done in the form of trying to test the resulting system by inputting the image of the rupiah currency to see if the resulting system can perform the appropriate detection to display the nominal money from the image that has been inputted in the testing process.

The plan in this research is a flowchart of planning in Preprocesing Image in the form of cutting image dimensions (x, y), transforming RGB images into grayscale images, transforming grayscale images into binary images using thresholding methods, thickening or expanding pixel values using thresholding methods, and then converting text results into sound.

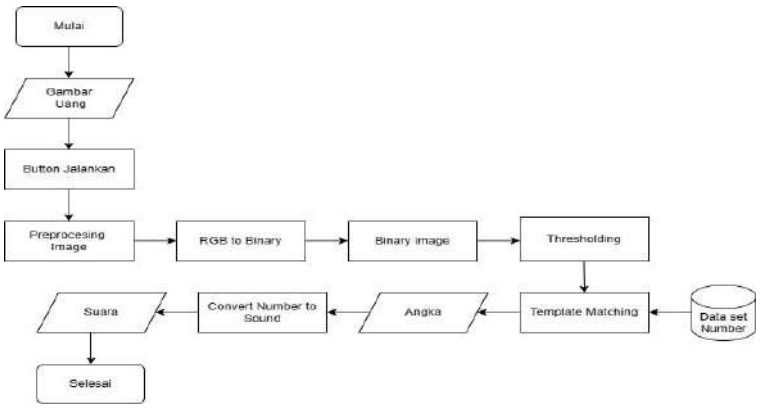


Figure 5 Flowchart of Template Matching

The flowchart of the template matching method above is as follows:

1. Input money data or money images
2. Already run enter the image preprocessing stage
3. Perform image preprocessing process by cutting image dimensions (x, y)
4. Convert RGB image into grayscale image
5. Transforming the grayscale image into a binary image.
6. Perform thickening using thresholding
7. Performing the template matching method process by comparing the input data against the data set.
8. After the process is complete, the system will display the numbers in the form of sound and then finish.

RESULTS AND DISCUSSION

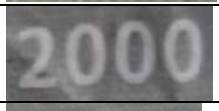
Planning

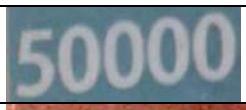
In this research, an application will be built to assist the blind in detecting the nominal value of currency with the implementation of the template matching method. Where the way the application works is that users can use a laptop camera or directly select an image of Rupiah money to detect its nominal value. Furthermore, the application will display the results in the form of sound based on the nominal successfully detected by the application resulting from the template matching process between the dataset used and the image inputted by the application user.

Data Collection

In this research, a dataset is used as a reference in the process of using the template matching method. The dataset used is the nominal value of each rupiah banknote consisting of denominations of 1000, 2000, 5000, 10,000, 20,000, 50,000 and 100,000. The dataset used can be seen in table 1 as follows:

Table 1 Template Matching Dataset

No.	Money Nominal	Template Image	No.	Money Nominal	Template Image
1	1000		19	10.000	
2	1000		20	10.000	
3	1000		21	20.000	
4	1000		22	20.000	
5	1000		23	20.000	
6	2000		24	20.000	
7	2000		25	20.000	
8	2000		26	50.000	
9	2000		27	50.000	
10	2000		28	50.000	
11	5000		29	50.000	

12	5000		30	50.000	
13	5000		31	100.000	
14	5000		32	100.000	
15	5000		33	100.000	
16	10.000		34	100.000	
17	10.000		35	100.000	
18	10.000				

Needs Analysis

At the time of the research, researchers needed several tools and materials in conducting research to support building a nominal rupiah currency detection system using the template matching method and completing the research conducted. The materials used in this research are messages in the form of images used as templates and images that will be used in the process of testing the system to be built in this study. While the tools used in this research in the form of hardware and software as follows:

Hardware

The hardware specifications used in making this system are as follows:

1. Laptop: Core i3 processor
2. Hard disc: 500 GB
3. RAM: 4 GB
4. Mouse

Software

The software used in making this system is required as follows:

1. Windows Operating System
2. Visual Studio Code
3. Web Browser (Chrome, Firefox, and others)
4. Python Debugger

System Design

The Currency Nominal Detection Application with the Template Matching Method to Help the Blind in this study was built using Visual Studio Code software using the Python programming language. The user interface is the appearance of the programme that can be seen, heard or perceived by the user and the commands or mechanisms used by the user to control operations and enter data. The following is the interface design of the application that will be built in this study:

1. Webcam Detection Flowchart

The flowchart describing the currency nominal detection process through a webcam on a laptop displays the steps that the user must take in using the application to perform the detection process. The webcam detection flowchart can be seen in Figure 6.

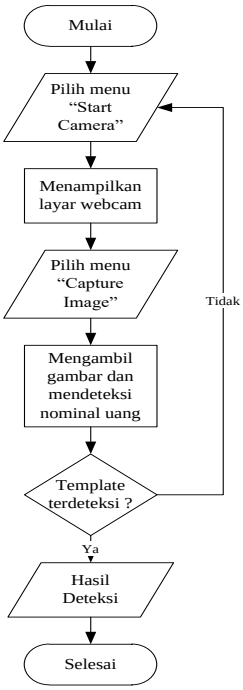


Figure 6 Flowchart of Detection Through Webcam

2. Flowchart of Detection Through Image Selection

The flowchart describing the currency nominal detection process through the image selection process in the storage directory contained in the laptop displays the stages that must be performed by the user in using the application to perform the detection process. The flowchart of detection through image selection can be seen in Figure 7.

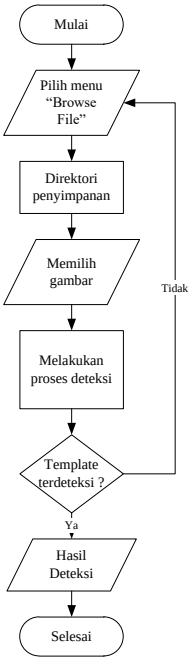


Figure 7 Flowchart of Detection Through Image Selection

3. Application Design

On the application page there is a "Start Camera" menu button that serves to open the webcam, the "Stop Camera" menu button that serves to close the webcam, the "Capture Image" menu button to take pictures from the webcam to be processed in detecting the nominal currency and the "Browse File" menu button to select images contained in the laptop storage directory. The application design can be seen in Figure 8.

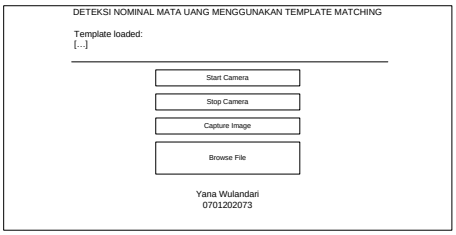


Figure 8 Home Page Design

System Testing

This research has produced an application built using Visual Studio Code software using the Python programming language to be used in detecting the nominal value of rupiah paper currency using the template matching method. This application can then be used as a medium to assist the visually impaired in the process of detecting the nominal currency they have.

The following are the results of testing the application when run directly through Visual Studio Code software. Testing is done in the form of running the application and trying the currency detection process through a webcam and also through laptop storage. The results of testing the application are as follows:

1. Application Display

The following is a display of the application that has been produced in this study which can be used in the process of detecting the nominal rupiah currency using the template matching method. The application display can be seen in Figure 9 as follows

Figure 9 Application View

2. Display of the Detection Process Using a Webcam

The display of the application process in detecting the nominal rupiah currency using a webcam located on a laptop can be seen in Figure 10.

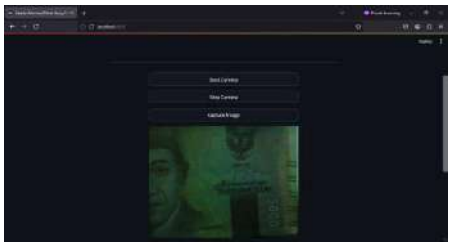


Figure 10 Display of the Detection Process Using a Webcam

3. Display of Detection Process Using Files From Storage

The display of the application process in detecting the nominal rupiah currency using images contained in laptop storage can be seen in Figure 11.

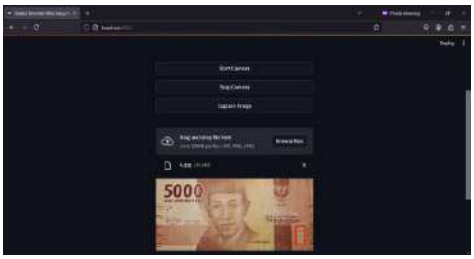


Figure 11 Display of the Detection Process Using Files from Storage

Example of Template Matching Calculation

This calculation example will be explained based on the processes in template matching, using the SAD (sum of absolute differences) formula, namely finding the lowest number of differences from the sum, by carrying out calculations one by one to get absolute results. In the calculation example, we will calculate the value in number 1 between matrix A (number template) and matrix B (written numbers), the results are taken to provide a conclusion stating that matrix A and matrix B are the same by finding the lowest difference value between Matic A. with matrix B.

Given matrix A (number pattern 0-9) and matrix B (written numbers), prove that matrix A and matrix B have the same value by using the template matching method. The manual process of the template matching method is as follows:

1. Matrix pattern A is a template that will be used as a matching dataset for the input data, as seen in Figure 12.

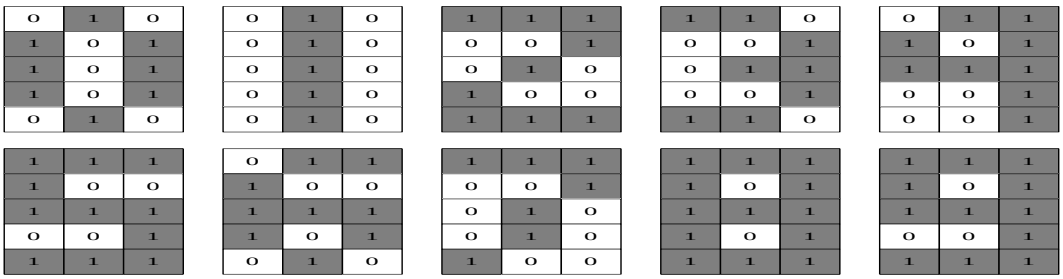


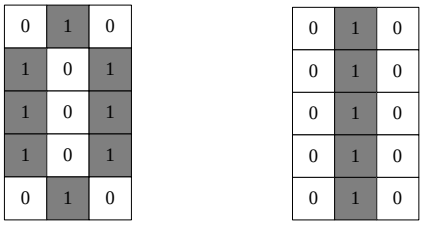
Figure 12 Matrix Pattern A

2. The matrix pattern B that is input and the similarity will be searched for based on the dataset template contained in the matrix pattern A is as follows:

0	1	0
0	1	0
0	1	0
0	1	0
0	1	0

Figure 13 Matrix Pattern B

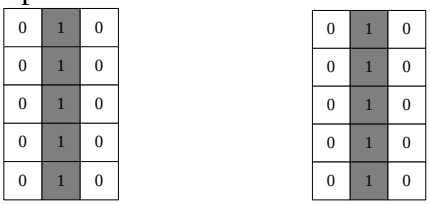
3. Calculation process for the template matching method: To find out the lowest difference value, a calculation is carried out by comparing the template dataset one by one with the input value: Matrix pattern A is number 0 with matrix pattern B being number 1



The first step is calculating the pixels in x, and y coordinates in matrix A (pattern 0) with matrix B (number 1). The number of calculations between matrix A (pattern 0) and matrix B (number 1), namely: **(0 - 0)2 + (1 - 1)2 + (0 - 0)2 + (1 - 0)2 + (0 - 1)2 + (1 - 0)2 + (1 - 0)2 + (0 - 1)2 + (1 - 0)2 +(1 - 0)2 + (0 - 1)2 + (1 - 0) 2+ (0 - 0)2 + (1 - 1)2 + (0 − 0)2** = 9

The second step calculates the pixels in x, and y coordinates in matrix A (pattern 1) with matrix B (number 1).

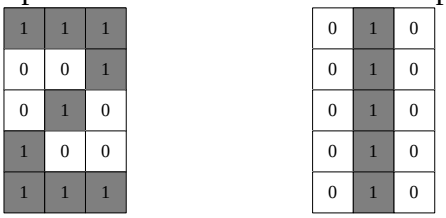
Matrix pattern A is number 1 with matrix pattern B being number 1



The number of calculations between matrix A (pattern 1) and matrix B (number 1), namely: **(0 - 0)2 + (1 - 1)2 + (0 - 0)2 + (0 - 0)2 + (1 - 1)2 + (0 - 0)2 + (0 - 0)2 + (1 - 1)2 + (0 - 0)2 + (0 - 0)2 + (1 - 1)2 + (0 - 0)2 + (0 - 0)2 + (1 - 1)2 + (0 - 0)2** = 0

The third step is to calculate the pixels in x, and y coordinates in matrix A (pattern 2) with matrix B (number 1).

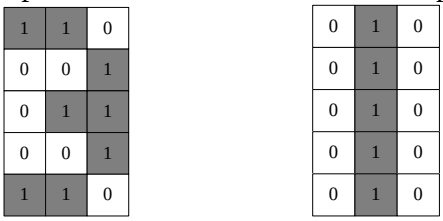
Matrix pattern A number 2 with matrix pattern B number 1



The number of calculations between matrix A (pattern 2) and matrix B (number 1), namely: () **2 + (1 − 1)2 + (0 − 0)2 + (1 − 0)2 + (1 − 1)2 + (1 − 0)2 + (0 − 0)2 + (0 − 1) 2 + (0 − 0)2** = 7

The fourth step is calculating pixels in x, and y coordinates in matrix A (pattern 3) with matrix B (number 1).

Matrix pattern A number 3 with matrix pattern B number 1



The number of calculations between matrix A (pattern 3) and matrix B (number 1), namely: **(1 − 0)2 + (1 − 1)2 + (0 − 0)2 + (0 − 0)2 + (0 − 1)2 + (1 − 0)2 + (0 − 0)2 + (1 − 1)2 + (1 − 0)2 + (0 − 0)2 + (0 − 1)2 + (0 − 0)2 + (1 − 0)2 + (1 − 1)2 + (0 − 0)2** = 7

The fifth step calculates the pixels in x, and y coordinates in matrix A (pattern 4) with matrix B (number 1).

Matrix pattern A number 4 with matrix pattern B number 1

0	1	1
1	0	1
1	1	1
0	0	1
0	0	1

0	1	0
0	1	0
0	1	0
0	1	0
0	1	0

The number of calculations between matrix A (pattern 4) and matrix B (number 1), namely: **(0 − 0)2 + (1 − 1)2 + (1 − 0)2 + (1 − 0)2 + (0 − 1)2+ (1 − 0)2 + (1 − 0)2 + (1 − 1)2 + (1 − 0)2 + (0 − 0)2 + (0 − 1)2 + (1 − 0)2 + (0 − 0)2 + (0 − 1)2 + (1 − 0)2** = 10

The sixth step calculates the pixels in x, and y coordinates in matrix A (pattern 5) with matrix B (number 1).

Matrix pattern A number 5 with matrix pattern B number 1

1	1	1
1	0	0
1	1	1
0	0	1
1	1	1

0	1	0
0	1	0
0	1	0
0	1	0
0	1	0

The number of calculations between matrix A (pattern 5) and matrix B (number 1), namely: () **2** + (**1 - 1**) **2** + (**1 - 0**) **2** + (**0 - 0**) **2** + (**0 - 1**) **2** + (**1 - 0**) **2** + (**1 - 0**) **2** + (**1 - 1 1**) **2** + (**1 − 0**)**2** = 10

The seventh point counts the pixels in x, and y coordinates in matrix A (pattern 6) with matrix B (number 1).

Matrix pattern A number 6 with matrix pattern B number 1

0	1	1
1	0	0
1	1	1
1	0	1
0	1	0

0	1	0
0	1	0
0	1	0
0	1	0
0	1	0

The number of calculations between matrix A (pattern 6) and matrix B (number 1), namely () **2** + (**1** − **1**)**2** + (**1** − **0**)**2** + (**1** − **0**)**2** + (**0** − **1**)**2** + (**1** − **0**)**2** + (**0** − **0**)**2** + (**1** − **1**) **2** + (**0** − **0**)**2** = 8

Point length counts pixels in x, and y coordinates in matrix A (pattern 7) with matrix B (number 1).

Matrix pattern A number 7 with matrix pattern B number 1

1	1	1
0	0	1
0	1	0
0	1	0
1	0	0

0	1	0
0	1	0
0	1	0
0	1	0
0	1	0

The number of calculations between matrix A (pattern 7) and matrix B (number 1), namely: $(1-0)2 + (1-1)2 + (1-0)2 + (0-0)2 + (0-1)2 + (1-0)2 + (0-0)2 + (1-1)2 + (0-0)2 + (0-0)2 + (1-1)2 + (0-0)2 + (1-0)2 + (0-1)2 + (0-0)2 = 6$

The ninth step calculates the pixels in x, and y coordinates in matrix A (pattern 8) with matrix B (number 1).

Matrix pattern A number 7 with matrix pattern B number 1

1	1	1
1	0	1
1	1	1
1	0	1
1	1	1

0	1	0
0	1	0
0	1	0
0	1	0
0	1	0

The number of calculations between matrix A (pattern 8) and matrix B (number 1), namely: $(1-0)2 + (1-1)2 + (1-0)2 + (1-0)2 + (0-1)2 + (0-1)2 + (1-0)2 + (1-1)2 + (1-0)2 + (1-0)2 + (0-1)2 + (1-0)2 + (1-0)2 + (1-1)2 + (1-0)2 = 12$

The tenth step calculates the pixels in x, and y coordinates in matrix A (pattern 9) with matrix B (number 1).

Matrix pattern A number 9 with matrix pattern B number 1

1	1	1
1	0	1
1	1	1
0	0	1
1	1	1

0	1	0
0	1	0
0	1	0
0	1	0
0	1	0

The number of calculations between matrix A (pattern 9) and matrix B (number 1), namely: $(1-0)2 + (1-1)2 + (1-0)2 + (1-0)2 + (0-1)2 + (1-0)2 + (1-0)2 + (1-1)2 + (1-0)2 + (0-0)2 + (0-1)2 + (1-0)2 + (1-0)2 + (1-1)2 + (1-0)2 = 11$

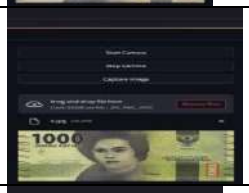
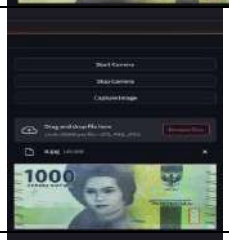
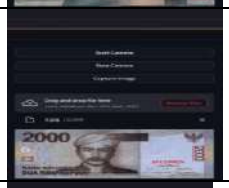
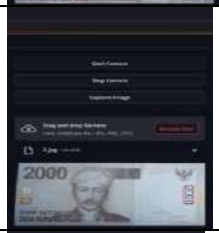
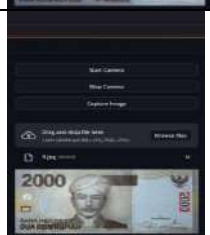
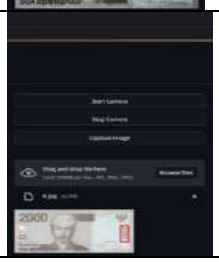
The result of the calculation between pattern 0 and number 1 is 9, pattern 1 with number 1 is 0, pattern 2 with number 1 is 7, pattern 3 with number 1 is 7, pattern 4 with number 1 is 10, pattern 5 with number 1 is 10, pattern 6 with the number 1 is 8, pattern 7 with the number 1 is 6, pattern 8 with the number 1 is 12 and pattern 9 with the number 1 is 11. From the calculation process carried out there is the lowest error value of 0, namely in template 1. So, based on the dataset used as a template, it can be seen that template 1 and number 1 are the same.

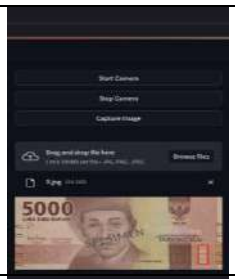
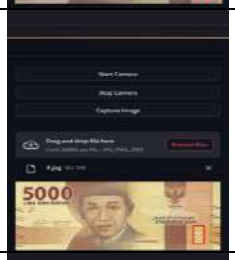
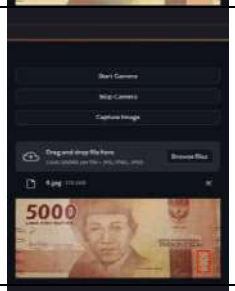
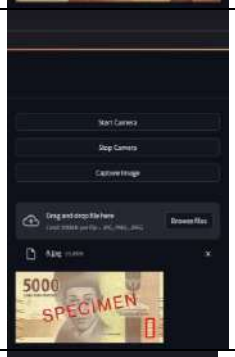
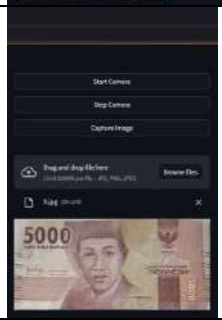
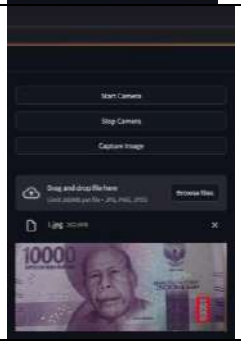
Application Testing Results

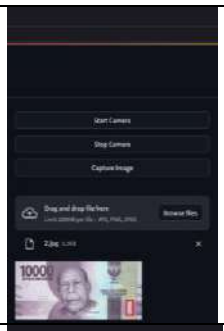
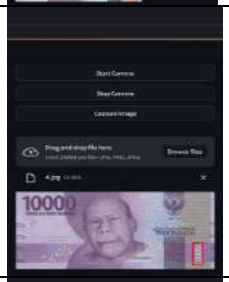
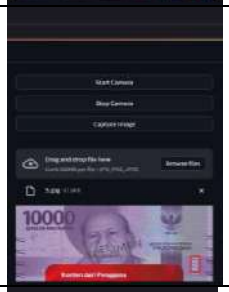
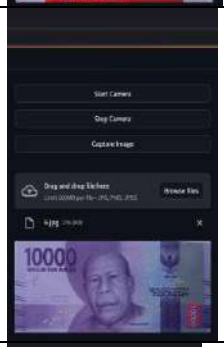
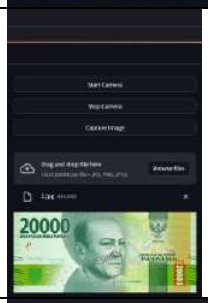
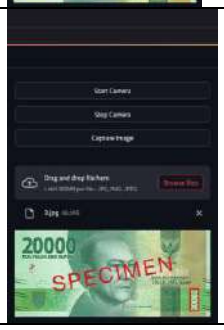
At this stage, testing is carried out using a nominal currency detection process using each denomination of 1000, 2000, 5000, 10,000, 20,000, 50,000, and 100,000. The results of application testing in the process of detecting nominal currency using the template matching method can be seen in Table 2.

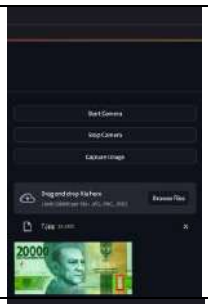
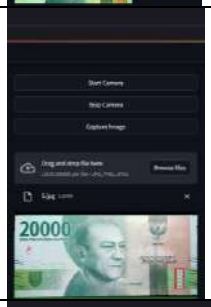
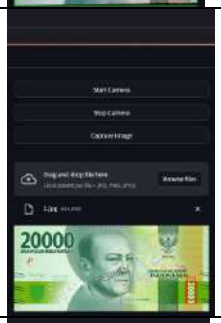
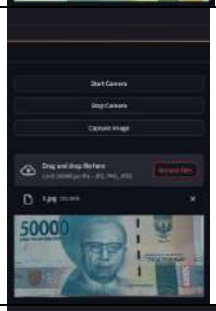
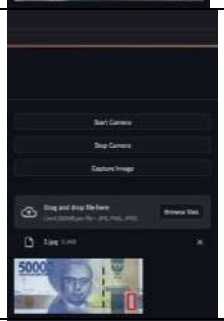
Table 2. Application Testing Results

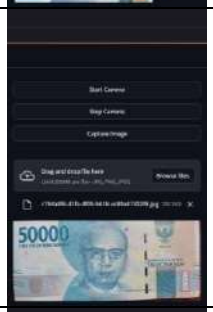
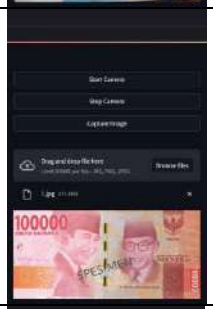
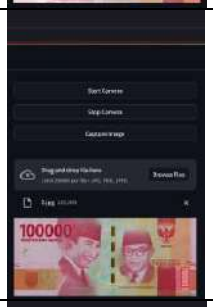
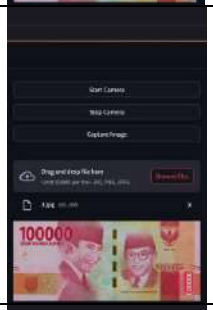
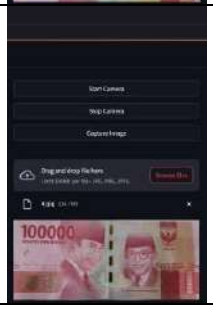
No.	Nominal Money	Test result	App View
1	1000	1000 nominal money detected	

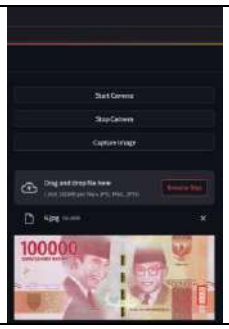
2	1000	1000 nominal money detected	
3	1000	1000 nominal money detected	
4	1000	1000 nominal money detected	
5	1000	1000 nominal money detected	
6	2000	2000 nominal money detected	
7	2000	2000 nominal money detected	
8	2000	2000 nominal money detected	
9	2000	2000 nominal money detected	
10	2000	2000 nominal money detected	

11	5000	5000 nominal money detected	
12	5000	5000 nominal money detected	
13	5000	5000 nominal money detected	
14	5000	5000 nominal money detected	
15	5000	5000 nominal money detected	
16	10.000	10.000 nominal money detected	

17	10.000	10.000 nominal money detected	
18	10.000	10.000 nominal money detected	
19	10.000	10.000 nominal money detected	
20	10.000	10.000 nominal money detected	
21	20.000	20.000 nominal money detected	
22	20.000	20.000 nominal money detected	

23	20.000	20.000 nominal money detected	
24	20.000	20.000 nominal money detected	
25	20.000	20.000 nominal money detected	
26	50.000	50.000 nominal money detected	
27	50.000	50.000 nominal money detected	
28	50.000	50.000 nominal money detected	

29	50.000	50.000 nominal money detected	
30	50.000	50.000 nominal money detected	
31	100.000	100.000 nominal money detected	
32	100.000	100.000 nominal money detected	
33	100.000	100.000 nominal money detected	
34	100.000	100.000 nominal money detected	

35	100.000	100.000 nominal money detected	

CONCLUSION

In this research, an application has been produced that was built using Visual Studio Code software with the Python programming language to be used in the nominal detection process of rupiah banknotes using the template matching method. The dataset used consists of banknote denominations with denominations of 1000, 2000, 5000, 10,000, 20,000, 50,000 and 100,000.

The process of detecting the nominal value of rupiah banknotes can be done via webcam or by selecting an image of the money on the laptop storage. The application will match the tested image with the template dataset that has been prepared in the application. If suitable data is found in the template dataset, the application will display the detected denomination and will play a sound of the detected nominal amount to assist the visually impaired in the process of detecting the currency denomination.

It is hoped that more datasets will be added to provide optimal results in the money nominal detection process. It is hoped that you will use an external webcam to produce better images in detecting nominal amounts of money.

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