LOGIC
Journal of Engineering Design and Technology
Vol.22 No.3 November 2022; p. 244 - 252

p-ISSN : 1412-114X
e-ISSN : 2580-5649
http://ojs2.pnb.ac.id/index.php/LOGIC

DESIGN & BUILD BANKNOTE NOMINAL IDENTIFICATION TOOLS FOR VISUAL IMPAIRMENT USING CONVOLUTIONAL NEURAL NETWORK ALGORITHM AND TENSORFLOW WITH ANDROID BASED

Selvia Rossa [1)], Lindawati [2)], Suzanzefi [3)]

[1,2,3)] Jurusan Teknik Elektro, Politeknik Negeri Sriwijaya, Jl. Srijaya Negara, Palembang, Indonesia

Corresponding email [1)] : lindawati@polsri.ac.id

Abstract. The buying and selling transactions that we usually do in our daily lives are difficult for people with visual impairment because it is difficult to distinguish the denomination of rupiah banknotes because of the limitation of sight, so it becomes one of the problems. This research focused on making a voice-based rupiah banknote nominal detection tool, using convolutional neural network algorithms in machine learning as the core of this system. This tool was also equipped with a voice-based android application to monitor the remaining money used when making buying and selling transactions-testing the tool used real test data of 20 images per class, producing an accuracy of 83%, as evidenced by Confusion matrix calculations.

Keywords: CNN, Visual Impairment, Android, Prediction, Confution Matrix

1. INTRODUCTION

Humans nowadays buy and sell transactions to meet their basic requirements. Cash payment instruments are used in this buying and selling transaction procedure to facilitate the transaction process[1].

Most humans can easily do buying and selling transactions because they have a clear vision. It is in contrast to people with visual impairment disabilities who have difficulty making payments using banknotes because it is difficult to distinguish the nominal that will be paid or received after a transaction. To distinguish each nominal banknote, they usually fold the money according to different folds in each nominal of money or ask people around about the nominal money held. How to distinguish nominal money has flaws in terms of memory for people with visual impairment and the honesty of people around them and sellers in buying and selling transactions[2]. In helping people with visual impairment, money is equipped with a blind code as a language code that contains information about the nominal amount of money. Basically, a blind code is included to make it easier for people with visual impairment to recognize and make transactions using money. However, some people with visual impairment still have difficulty recognizing the nominal money. Furthermore, the difference in the type of blind code in each nominal banknote circulating in the community makes it difficult for people with visual impairment to recognize and remember it[3]. Therefore, using digital image processing, a sound-based banknote nominal detection tool is needed to help people living with visual impairment conduct buying and selling transactions.

Digital image processing, in general, is two-dimensional image processing using a computer. In a broader context, image processing refers to two-dimensional processing data. A digital image is an array containing real and complex values presented with a certain series of bits[4]. Introducing nominal banknotes uses digital image processing with applications using machine learning. Machine learning is a computer application and mathematical algorithm that is taken using learning from various data and generating predictions[5]. In this study, we used deep learning, a machine learning development. Deep learning is a method of data learning that aims to create a multilevel representation (abstraction) of data using a layer of processing development in machine learning.

Deep learning is a method of data learning that aims to create a multilevel representation (abstraction) of data using a data processing layer. The important thing generated as material for data representation is not made explicitly by humans but by an algorithm[6]. This study used a convolutional neural network algorithm to detect the nominal banknote.

Algorithms using Convolutional Neural Networks (CNN) are one of the machine learning methods, which is a development of Multi-Layer Perceptron (MLP), designed to process or create data from two dimensions. CNN is also a type of deep learning method because it has a network level and many applications that are carried out at a network level[7].

In previous studies [8] using the Convolutional Neural Network (CNN) method in classifying vehicle types and resulting in an accuracy of 81.94%. The same method used for the systemization of the identification of coins [9] results in 100% accuracy with the identification of 1-3 objects, then the degree of accuracy decreases with an increase in the number of objects.

This study used the Convolutional Neural Network (CNN) algorithm and the Tensorflow framework, a library for expressing machine learning algorithms and executing commands using information about these objects or recognized targets and can distinguish objects from one another[10]. In addition, this rupiah banknote nominal detection tool was also equipped with an android application to monitor finances when buying and selling transactions.

Based on the previous two studies, the author hopes that the convolutional neural network (CNN) algorithm can identify banknotes, to help some people with visual impairment and can monitor finances during buying and selling transactions using android applications, so as to reduce fraud for blind people when making buying and selling transactions.

2. METHODS

In this study, two stages of implementation were carried out, namely the stage of hardware design and software design in recognition and object detection using the Convolutional Neural Network (CNN).

2.1 Research Framework

This research framework is based on figure 1 as a reference for designing and designing hardware and software that produces a system.

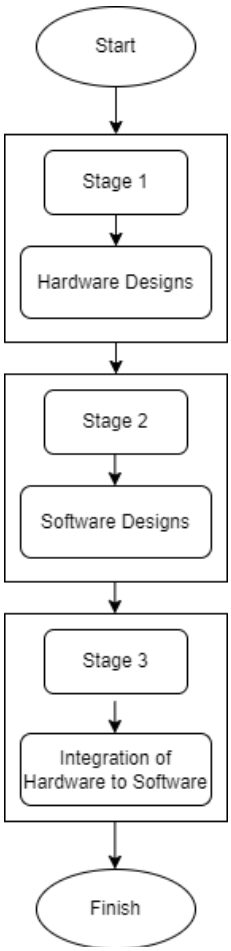


Figure 1. Flow Chart

2.2 Hardware Design

The hardware design used Raspberry Pi 3 model b+ as a microcontroller which is a computer mini device using an SD card for booting and long-term storage[11]. This raspberry pi is connected to other components such as a camera as a medium to detect the nominal money and a power bank as power. In addition, an LED is used to illuminate rupiah banknotes when conducting real test detection, and a button that stores financial history to the server and speakers as an output of the hardware design that mentions the nominal money that matches the money detected.

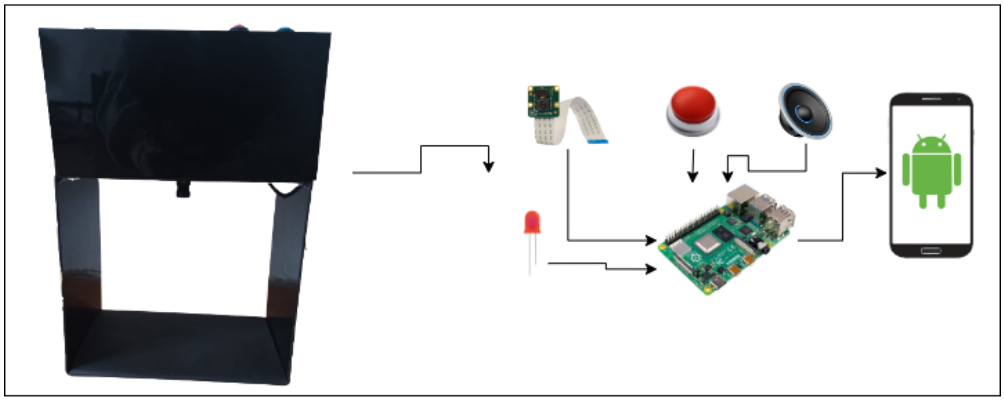


Figure 2. Tool Design and Hardware Circuit Schematic

2.3 Software Design

Software design was the most important thing in this study because it was the core of program processing using Convolutional Neural Network (CNN) algorithms in the detection process[12].

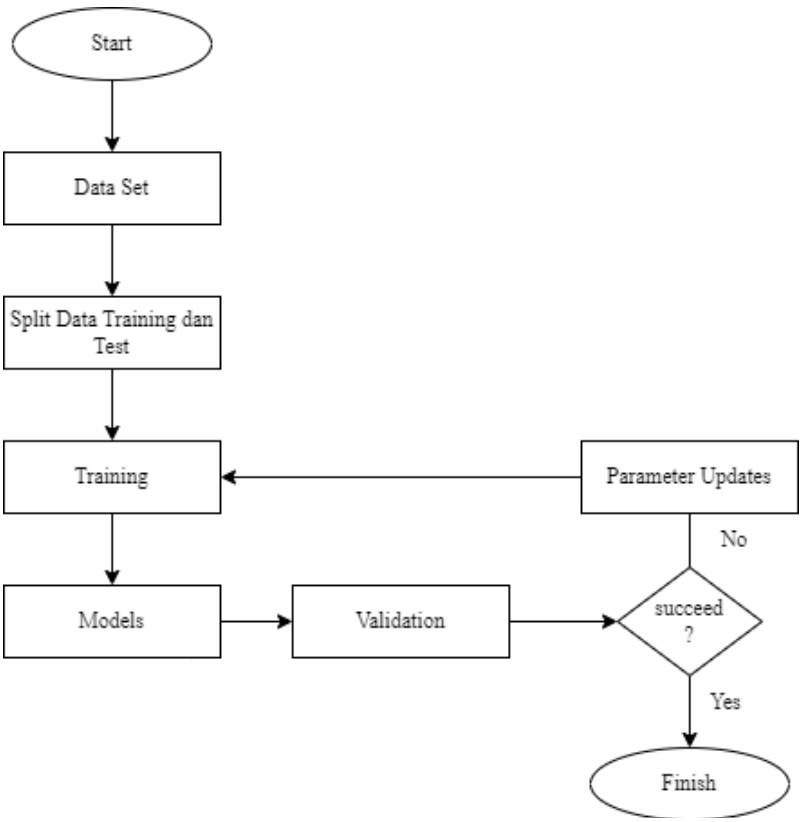


Figure 3. Software Flow Chart

a. Dataset

Dataset collection was carried out by taking pictures through Raspberry Pi cameras from each side of money ranging from 1000, 2000, 5000, 10000, 20000, 50000, and 100000 Indonesian currency, with as many as 40 images of each money.

b. Split Data Training and Testing
This stage first divided the training data and then the test data. Data training is a complete set of data containing classes divided into seven classes to be trained, from which the model can then be grouped into the correct classes. Meanwhile, the testing data contains real data that can be grouped based on a model to determine the system's accuracy. In other words, data training is data that is learned to form a model after learning the patterns and characteristics of a data set that has been collected before. In contrast, data testing is the process of testing a model that has been formed before.
c. Training
At this stage, training in machine learning was machine learning algorithms. The machine learning algorithm changed its parameters to match the data provided during the training process. The training process was needed so that the machine could recognize the characteristics and patterns of an image when going through the training/learning process.
d. Models
After the model was formed, the validation process was carried out, and the learning algorithm tested the image according to the model formed from each class.
e. Validation
The validation stage was carried out to test whether the learning algorithm has succeeded in recognizing the patterns and characteristics of an image. Model validation aims to measure the performance of a model with the ability to classify the data classes being tested. So that the performance of the model is obtained which can help optimize the parameters on the model so that the results obtained are much more accurate.

The software design was also equipped with an android application which is an operating system for Linux-based mobile devices with coverage in the form of operating systems, middleware and applications[13]. Android application for financial monitoring or to find out the remaining money that has been used after making buying and selling transactions. The design of the Android application system can be seen in the following flowchart:

Figure 4. Android Application System Design

2.4 How to Use The Tool
Here's how to use the rupiah banknote nominal detection tool

1. Press the "Power ON" button to turn on the tool.
2. Place the rupiah banknote in the detection place to start predicting how much the money is
3. The speaker will produce sound by mentioning the nominal money according to the predicted money
4. When making a buying and selling transaction, when predicting money in, press button one, while when predicting money out, press button 2. These two buttons are distinguished by braille letters intended for people with visual impairment.
5. After pressing the exit and entry buttons, the data will be stored on the database or server
6. The last process to see the remaining money after a transaction can be monitored using a voice-based android application by stating the amount of money left.

3. RESULTS AND DISCUSSION

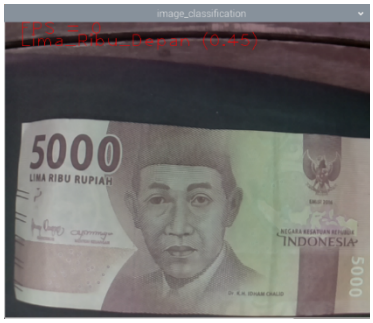
3.1 Design Results

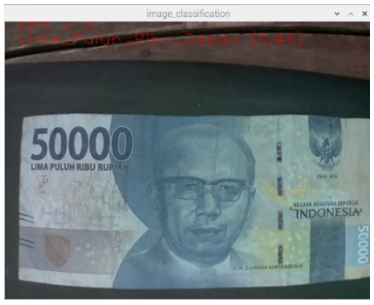
The money nominal detection tool can be used by placing money in the place provided by the tool and can be used to monitor the amount of money used as expenses or entered and stored in the database. The monitoring process can be done through the android application.

3.2 Hardware Build Results

A real test was carried out to find out whether it is true that the tool can predict money according to a predetermined class.

Table 1. Testing of Banknote Nominal Detection Tool

Class	Prediction Results of Banknote Nominal Detection Tool	Descriptions
Seribu		successfully predicted
Dua Ribu		successfully predicted
Lima Ribu		successfully predicted
Sepuluh Ribu		successfully predicted

Class	Prediction Results of Banknote Nominal Detection Tool	Descriptions
Dua Puluh Ribu		successfully predicted
Lima Puluh Ribu		successfully predicted
Seratus Ribu		successfully predicted

In this study, real testing was carried out with data of 20 images per class (nominal money) with the following prediction results:

Table 2, Predicted Results

Class	Correct Prediction Results	Incorrect Prediction Results
Seribu	20	0
Dua Ribu	17	3
Lima Ribu	15	5
Sepuluh Ribu	15	5
Dua Puluh Ribu	14	6
Lima Puluh Ribu	18	2
Seratus Ribu	18	2

3.3 Calculation of Cnn Algorithm Using Confusion Matrix

Based on the results of predictions using real testing on the tool, we can calculate using the confusion matrix by determining several conditions as in the following table:

Table 3. Confution Matrix

Class	TP	FP	FN	TN	Total
Seribu	20	0	0	0	20
Dua Ribu	17	3	0	0	20
Lima Ribu	15	5	0	0	20
Sepuluh Ribu	15	5	0	0	20
Dua Puluh Ribu	14	6	0	0	20
Lima Puluh Ribu	18	2	0	0	20
Seratus Ribu	18	2	0	0	20

1. TP is True Positive, the amount of positive data correctly predicted by the system.
2. TN is True Negative, negative data correctly predicted by the system (in this case, no testing was carried out).
3. FN is False Negative, the amount of negative data predicted to be incorrect by the system (in this case, no testing was carried out).
4. FP is False Positive, the amount of positive data predicted correctly by the system[14].

To calculate the confusion matrix value based on the table, we can calculate each class's precision, recall, and accuracy values and calculate the average of all classes[15].

a. Precision is used to measure the accuracy between the information requested by the user and the answers given by the system. with the equation as follows:

$$\text{Precision} = \frac{TP}{(TP + FP)} x100\%$$

b. Recall is used to measure the success of a system in rediscovering information with the following equation:

$$\text{Recall} = \frac{TP}{(TP + FN)} x100\%$$

c. Acuracy is used to organize a work method. with the equation as follows:

$$\text{Acuracy} = \frac{TP + TN}{(TP + TN + FP + FN)} x100\%$$

Based on the equation above, the calculation results of each class are obtained as shown in the following table:

Table 4. Confution Matrix Results

Class	**Number of Test Data**	**Precision**	**Recall**	**Acuracy**
Seribu	20	100%	100%	100%
Dua Ribu	20	85%	100%	85%
Lima Ribu	20	75%	100%	75%
Sepuluh Ribu	20	75%	100%	75%
Dua Puluh Ribu	20	70%	100%	70%
Lima Puluh Ribu	20	90%	100%	90%
Seratus Ribu	20	90%	100%	90%
Reform Avarage		83%	100%	83%

3.4 Software Build Results

The software design results were in the form of a voice-based application that sends data in accordance with the results of the buying and selling transaction process that has been stored in the database. For example, the android app looks as follows:

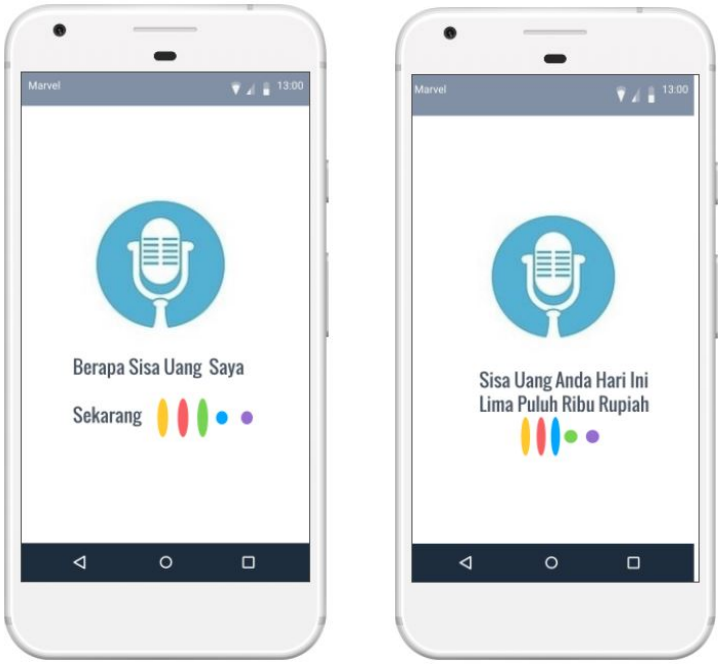


Figure 5. Android App View

4. CONCLUSION

From the research, it can be concluded that the Convolutional Neural Network algorithm can predict the nominal rupiah with an accuracy rate of 83%. In this study, the output or predictions produced are influenced by the datasets used to carry out the training and validation processes in the machine learning process to recognize the patterns and image characteristics of each class.

From this study, it can also be concluded that the money nominal detection tool can predict correctly even with the presentation of errors in predicting as low as 17%. Furthermore, the Android application as support in monitoring money can also be run properly, as evidenced by the amount of money left when making voice-based buying and selling transactions by the application when run. Thus, in its implementation, the process of using the correct tool is required to produce accurate data.

5. REFERENCES

[1] G. K. Putra, "PERANCANGAN ALAT PENDETEKSI NOMINAL UANG UNTUK TUNANETRA MENGGUNAKAN METODEHSVBERBASIS RASPBERRY PI - POLSRI REPOSITORY," *Palembang*, 2020. .

[2] I. A. Khoirunisa, "MONITORING LOKASI KAPAL MENGGUNAKAN GR-AIS DENGAN RASPBEERY PI DAN RTL-SDR," 2020.

[3] P. Komunikasi and D. A. N. Komunikasi, "Blind Code Pada Uang Kertas Rupiah," vol. 5415, 2020.

[4] D. Putra, "Pengolahan Citra Digital - Darma Putra - Google Books," *CV Andi Offset*, 2010. .

[5] A. Roihan, P. A. Sunarya, and A. S. Rafika, "Pemanfaatan Machine Learning dalam Berbagai Bidang: Review paper," *IJCIT (Indonesian J. Comput. Inf. Technol.*, vol. 5, no. 1, pp. 75–82, 2020, doi: 10.31294/ijcit.v5i1.7951.

[6] yaya dan E. I. Heryadi, "Deep Learning: Aplikasinya di Bidang Geospasial - Yaya Heryadi, Edy Irwansyah - Google Books," *PT. Artifisia Wahana Informa Teknoogi*. .

[7] V. M. P. dkk Salawazo, "View of IMPLEMENTASI METODE CONVOLUTIONAL NEURAL NETWORK (CNN) PADA PENEGANALAN OBJEK VIDEO CCTV," *J. Mantik Panusa*, vol. 3, 2019.

[8] A. Tri Nurolan, "Deteksi Dan Klasifikasi Jenis Kendaraan Berbasis Pengolahan Citra Dengan Metode Convolutional Neural Network (Cnn)," *Deteksi Jenis Kendaraan*, 2019.

[9] R. A. Doga, H. F. . Lami, and S. I. Pella, "Sistem Identifikasi Nominal Uang Logam Menggunakan Tensorflow Dan Convolutional Neural Network Berbasis Raspberry Pi," *Semin. Nas. Sains Dan Tek. Fst Undana*, no. June, pp. 503–511, 2019.

[10] D. J. P. Manajang, A. Jacobus, J. T. Elektro, U. Sam, and R. Manado, "Implementasi Framework Tensorflow Object Detection API Dalam Mengklasifikasi Jenis Kendaraan Bermotor," *J. Tek. Inform.*,

vol. 15, no. 3, pp. 171–178, 2020, doi: 10.35793/jti.15.3.2020.29775.

[11] M. A. I. Hakim and Y. H. Putra, "Pemanfaatan Mini Pc Raspberry Pi Sebagai Pengontrol Jarak Jauh Berbasis Web Pada Rumah. Unikom," *Jur. Tek. Komput. Unikom*, no. September 2015, pp. 1–6, 2013, [Online]. Available: https://www.researchgate.net/profile/Yeffry_Handoko_Putra/publication/312040113_PEMANFAATAN_MINI_PC_RASPBERRY_PI_SEBAGAI_PENGONTROL_JARAK_JAUH_BERBASIS_WEB_PADA_RUMAH/links/586bccb308ae6eb871bb6b90/PEMANFAATAN-MINI-PC-RASPBERRY-PI-SEBAGAI-PENGONTROL-JARAK.

[12] C. N. Ihsan, "DoubleClick : Journal of Computer and Information Technology Klasifikasi Data Radar ....(Ihsan) | 115 DoubleClick : Journal of Computer and Information Technology E-ISSN : 2579-5317 116 | Klasifikasi Data Radar ....(Ihsan)," *J. Comput. Inf. Technol.*, vol. 4, no. 2, pp. 115–121, 2021.

[13] N. A. Pratama and C. Hermawan, "Aplikasi Pembelajaran Tes Potensi Akademik Berbasis Android komputer yang dibuat untuk menolong manusia Dalvik Virtual Machine (DVM) adalah Android SDK adalah tools API (Application Examination) yang sudah menjadi standar Pengertian Android Android ad," *Jnteti*, vol. 6, no. 1, pp. 1–6, 2016, [Online]. Available: http://jurnal.unda.ac.id/index.php/Jpdf/article/view/11/13.

[14] B. P. Pratiwi, A. S. Handayani, and S. Sarjana, "Pengukuran Kinerja Sistem Kualitas Udara Dengan Teknologi Wsn Menggunakan Confusion Matrix," *J. Inform. Upgris*, vol. 6, no. 2, pp. 66–75, 2021, doi: 10.26877/jiu.v6i2.6552.

[15] R. K. Dinata, S. Safwandi, N. Hasdyna, and N. Azizah, "Analisis K-Means Clustering pada Data Sepeda Motor," *INFORMAL Informatics J.*, vol. 5, no. 1, p. 10, 2020, doi: 10.19184/isj.v5i1.17071.