IEESE International Journal of Science and Technology (IJSTE), Vol. 3 No. 1, March 2014, 13-20
ISSN : 2252-5297

Identification of Nominal Value and Authenticity of Rupiah Using Support Vector Machine

Bagus Asriel Aziz Ainun Ni'am, Muhammad Faisal, Yunifa Miftachul Arif

Department of Informatics, Faculty of Science and Technology,
Islamic State University of Maulana Malik Ibrahim, Ministry of religions,
Malang, East Java 65144
Indonesia

Abstract. This study was conducted to create a software that can recognize the value nominal rupiah and its authenticity through image processing by using Support Vector Machine (SVM). The pattern of each rupiah has unique characteristics that distinguish each other, either as a number, the number of zeros and its invisible ink. The difference pattern of the rupiah pieces of money that is the characteristic which will be taken as the data for determining the nominal value and authenticity of the rupiah.
Image processing money obtained from two sources, namely the image appears (visible image) derived from 300 dpi scanner, and the image of the invisible images that uses ultraviolet light (UV).
The identification process is carried out in this study has a two-stage identification. The first stage is the identification of the nominal value of the rupiah and the second stage is the identification of genuine rupiah. Identification is done by taking the nominal value of a particular pattern of on the scanning results rupiah. The pattern here is the form taken by the nominal rate of the respective pieces of money of dollars. Authenticity identification is done by taking pattern of formed from the UV.
The total amount of data is as much as 95 sets, of which 60 of them are used in the training process and the remaining 35 sets are used in the testing process. The simulation results showed the software is able to recognize the nominal value and authenticity of the currency by the level of accuracy of 100% (using gaussian) and 99% (using polynomial). Based on these results it can be concluded that the identification of the nominal value and authenticity of rupiah using SVM with Gaussian kernel can be used appropriately and accurately.

Keyword: *image processing, identification, rupiah, support vector machine.*

1. Introduction

Automation technology enables human activities in everyday life. Process automation will help the work that is done repeatedly with precise accuracy in a fast time. This will be very helpful in the public service. Automation mechanism has been implemented in many developed countries ranging from the sale of cigarettes, soft drinks, mass transit tickets even to deposit cash [1].

Identification of the nominal value and the authenticity of paper money are necessary because in the last three years the number of counterfeit paper money is increasing. During the period of 2010, there were 31 cases of counterfeiting dollars, involving 42 suspects and evidence 1,519 counterfeit bills. The next year will increase to 36 cases with 36 suspects and 3,467 counterfeit bills as evidence. Until September 2012, cases of fraud increased almost 3-fold. There were 87 cases with 97 suspects and 61 943 pieces of counterfeit money. In fact, until July 2012, Bank Indonesia found 50 134 pieces of counterfeit notes [2].

The introduction of the nominal value is based on a series of pattern / drawing on paper money through the process of image recognition. Research on Face detection and authenticity of banknotes has been done before, such as by using LVQ Neural Network [3], using backpropagation [4], with Fuzzy Logic [5], with Backpropagation Neural Networks [1] and the Hidden Markov Model [6].

This study has made the nominal recognition system and the authenticity of paper money using Support Vector Machine (SVM). SVM is one method a lot of attention as a state of the art in the classification.

2. Materials and Methods

2.1. Support Vector Machine (SVM)

Support Vector Machine (SVM) is a learning system that uses the hypothesis space in the form of linear functions in a high dimension feature space, trained with a learning algorithm based on optimization theory to implement the learning bias from statistic learning theory [7] .
The SVM underlying theory itself has evolved since the 1960s, but was introduced by Vapnik, Boser and Guyon in 1992 and since then SVM are growing rapidly. SVM is one technique that is relatively new compared to other techniques, but has a more performance either in various application fields such as bioinformatics, handwriting recognition, text classification, etc. [7].

The pattern of each paper money has unique characteristics that distinguish them from one another, either as a number, the number of zeros, and drawing his invisible ink. This typical pattern of a reference within the framework of the SVM system to distinguish the nominal value and the authenticity of banknotes.

The pattern of each paper money has unique characteristics that distinguish them from one another, either as a number, the number of zeros, and drawing his invisible ink. This typical pattern of a reference within the framework of the SVM system to distinguish the nominal value and the authenticity of banknotes.

2.2. Banknotes Rupiah

As for the paper money that will be recognized in this study is the money with fractional Rp5.000,00, Rp10,000.00, Rp20.000,00, Rp50.000,00 and 100,000.00 on the theme of banknotes, not the national hero photo. Selection is based on the presence of the security thread and invisible ink. For more details can be seen in Figure 1, which shows a visual overview paper money, which will be identified in this study.

Figure 1. Input Data Banknotes Rupiah

The authenticity of money can be identified by characteristics which are both on the materials used, design, and color of each denomination of money, also the money printing techniques. In determining the characteristics of money embraced the principle that the greater the nominal value of money, the more safety element of the money that is safe from counterfeiting efforts. Invisible ink can be seen in Figure 2.

Figure 2. Invisible Ink Used As A Determinant of Authenticity Banknotes Rupiah

To design and create a program that can identify the nominal value and authenticity of banknotes rupiah using Support Vector Machine method, computer hardware specifications used are as follows:

1. Processor Intel® Core ™ 2 Duo CPU T6600 2.20GHz
2. VGA NVIDIA GeForce 9300M GS
3. RAM 4 GB
4. Hard Drive 320 GB
5. The device monitors the output LED 14 "

2.3. Method

The design process of the system to identify the nominal value and the authenticity of paper money. This design is used to determine what processes exist in the system.

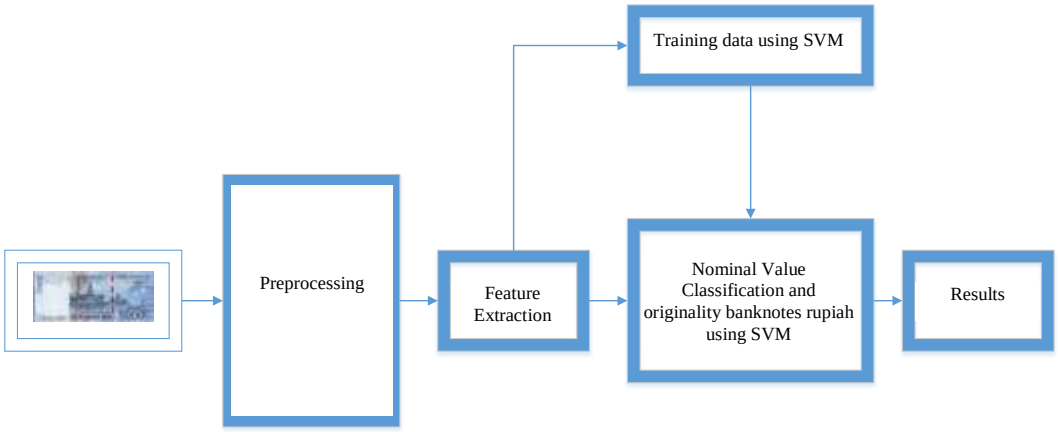

Figure 3 Block Diagram Identification Process nominal value and authenticity Banknotes Rupiah

Figure 3 shows the flow of the identification process outlined in this study. Here's a description of the block diagram :

i. Taking the image of paper money from the drive the computer to be loaded in the application. Training process using the input of n images as training data, while the testing process using only one input.
ii. Preprocessing the image preparation process before having identified several steps that will be described in the following discussion.
   Preprocessing performed consists of two stages. The first stage is in the image of paper money scanning results include the following cuts on the face image, RGB image to grayscale conversion and uniformity of image intensity, eliminating background and detecting nominal pattern and filling gaps in the pattern of nominal money. While the second stage is for the image of paper money are the result of UV irradiation will be cutting the image on the invisible ink only. This phase will be discussed in more detail in the design process of the system.
   Once the preprocessing is complete, the next process is the extraction of features. Features taken derived from the analysis of texture entropy value, the value of contrast, the correlation value, energy value and the value of paper money homogeneity for image scanning results to images of banknotes while UV irradiation results will be taken on average pixel values of R, G and B.
   Digital image of paper money that has been processed in feature extraction process will be done on the training data and data testing.
iii. Classification using SVM is a process for identifying the nominal value and the authenticity of paper money.

The identification results are shown two types of classification is based on the nominal value and the authenticity of paper money.

Data used in this study consist of a set of images of 95 images for a nominal value of paper money which consists of 60 images for training data and 35 images of test data. As for the authenticity of paper money as much as 150 images of 100 images for training data and 50 images of test data. For training and testing image is obtained in two stages as follows:

Stage 1.

Retrieving data using a scanner with a resolution of 300 dpi. The results of scanning an image with a digital RGB jpeg format image size vary between 1636 x 736 pixels up to 1780 x 768 pixels. The results of scanning paper money can be seen in Figure 3.

Figure 3. Scanning Results Money Rp10,000.00 and Rp50.000,00

Stage 2.

The second data retrieval is to use a digital camera that captures the results of UV radiation on the banknotes with a distance of 20 cm. Configuration of the tools used in data collection can be seen in Figure 4.

Figure 4. The image retrieval tool UV irradiation results

Invisible image retrieval is done in the dark using only the UV light exposure, thus making the data on the simulation conditions can approximate the actual conditions on ATVM machine.

For example, the results of data collection with UV irradiation can be seen in Figure 5.

Figure 5. Results of Content UV Money Rp10,000.00 and Rp50.000,00

After the feature extraction is completed, Next process is identified by Support Vector Machine, The result will be obtained in the form of a nominal value and authenticity of the image of paper money.

3. Results

This test consists of two phases. The first stage is the identification of the nominal value of the test paper money. The test starts with the training of the 60 pieces of training data. Then be tested using 35 different test data and make comparisons with the identification manually. Table 1 shows the test data and test results identifying the nominal value of paper money.

Table 1. Results of Test Identification Nominal Value Banknotes Rupiah

No	Name File	Manual Identification	Comp System Identification
1	1.000_06	Rp1.000,00	Unidentified Monetary Object
2	1.000_07	Rp1.000,00	Unidentified Monetary Object
3	1.000_08	Rp1.000,00	Unidentified Monetary Object
4	1.000_09	Rp1.000,00	Unidentified Monetary Object
5	1.000_10	Rp1.000,00	Unidentified Monetary Object
6	2.000_06	Rp2.000,00	Unidentified Monetary Object
7	2.000_07	Rp2.000,00	Unidentified Monetary Object
8	2.000_08	Rp2.000,00	Unidentified Monetary Object
9	2.000_09	Rp2.000,00	Unidentified Monetary Object
10	2.000_10	Rp2.000,00	Unidentified Monetary Object
11	5.000_11	Rp5.000,00	Rp5.000,00
12	5.000_12	Rp5.000,00	Rp5.000,00
13	5.000_13	Rp5.000,00	Rp5.000,00
14	5.000_14	Rp5.000,00	Rp5.000,00
15	5.000_15	Rp5.000,00	Rp5.000,00
16	10.000_11	Rp10.000,00	Rp10.000,00
17	10.000_12	Rp10.000,00	Rp10.000,00
18	10.000_13	Rp10.000,00	Rp10.000,00
19	10.000_14	Rp10.000,00	Rp10.000,00
20	10.000_15	Rp10.000,00	Rp10.000,00
21	20.000_11	Rp20.000,00	Rp20.000,00
22	20.000_12	Rp20.000,00	Rp20.000,00
23	20.000_13	Rp20.000,00	Rp20.000,00
24	20.000_14	Rp20.000,00	Rp20.000,00
25	20.000_15	Rp20.000,00	Rp20.000,00
26	50.000_11	Rp50.000,00	Rp50.000,00
27	50.000_12	Rp50.000,00	Rp50.000,00
28	50.000_13	Rp50.000,00	Rp50.000,00
29	50.000_14	Rp50.000,00	Rp50.000,00
30	50.000_15	Rp50.000,00	Rp50.000,00
31	100.000_11	Rp.100.000,00	Rp.100.000,00

32	100.000_12	Rp.100.000,00	Rp.100.000,00
33	100.000_13	Rp.100.000,00	Rp.100.000,00
34	100.000_14	Rp.100.000,00	Rp.100.000,00
35	100.000_15	Rp.100.000,00	Rp.100.000,00

Table 1 shows a comparison between the results of the identification of the nominal value of paper money manually with the results of identification using the application. From the test results of the 35 data showed all of the data identified correctly. To calculate the percentage of the effectiveness of the system using the f-measure:

$$\text{precision} = \frac{\text{TP}}{\text{TP} + \text{FP}}$$

$$\text{recall} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

$$\text{F} - \text{Measure} = 2 \cdot \frac{\text{precision} \cdot \text{recall}}{\text{precision} + \text{recall}}$$

Where,

a. TP (True Positive) is pointing to the number of samples nominal value and authenticity of the image of paper money are manually identified true and correct by the application.
b. FP (False Positive) is pointing to the number of samples nominal value and authenticity of the image of paper money are manually identified incorrectly and correctly by the application.
c. FN (False Negative) is pointing at amount of samples nominal value and authenticity of paper money which identified one manually and one by the application.

TP (True Positive) = 35
FP (False Positive) = 0
FN (False Negative) = 0
Following the calculation of the value of the effectiveness of the program.

$$\text{precision} = \frac{35}{35 + 0} = 1 \quad \text{recall} = \frac{35}{35 + 0} = 1$$

$$\text{F} - \text{Measure} = 2 \cdot \frac{1 \cdot 1}{1 + 1} = 1$$

The value of the F-Measure, the percentage of the system's accuracy in identifying the nominal value of paper money of 100%.

The second step is testing the authenticity of paper money. The test starts with the training of the 100 pieces of training data. Then be tested using 50 different test data and make comparisons with the identification manually. Here are the test data and test results identifying the authenticity of paper money.

Table 2. Results of Test Identification Authenticity Banknotes Rupiah

No	Name File	Manual Identification	Comp System Identification
1	5.000_Genuine_11	Genuine	Genuine
2	5.000_Genuine_12	Genuine	Genuine
3	5.000_Genuine_13	Genuine	Genuine
4	5.000_Genuine_14	Genuine	Genuine
5	5.000_Genuine_15	Genuine	Genuine
6	10.000_Genuine_11	Not Genuine	Not Genuine
7	10.000_Genuine_12	Not Genuine	Not Genuine
8	10.000_Genuine_13	Not Genuine	Not Genuine
9	10.000_Genuine_14	Not Genuine	Not Genuine
10	10.000_Genuine_15	Not Genuine	Not Genuine

11	20.000_Genuine_11	Genuine	Genuine
12	20.000_Genuine_12	Genuine	Genuine
13	20.000_Genuine_13	Genuine	Genuine
14	20.000_Genuine_14	Genuine	Genuine
15	20.000_Genuine_15	Genuine	Genuine
16	50.000_Genuine_11	Not Genuine	Not Genuine
17	50.000_Genuine_12	Not Genuine	Not Genuine
18	50.000_Genuine_13	Not Genuine	Not Genuine
19	50.000_Genuine_14	Not Genuine	Not Genuine
20	50.000_Genuine_15	Not Genuine	Not Genuine
21	100.000_Genuine_11	Genuine	Genuine
22	100.000_Genuine_12	Genuine	Genuine
23	100.000_Genuine_13	Genuine	Genuine
24	100.000_Genuine_14	Genuine	Genuine
25	100.000_Genuine_15	Genuine	Genuine
26	5.000_NotGenuine_11	Not Genuine	Not Genuine
27	5.000_NotGenuine_12	Not Genuine	Not Genuine
28	5.000_NotGenuine_13	Not Genuine	Not Genuine
29	5.000_NotGenuine_14	Not Genuine	Not Genuine
30	5.000_NotGenuine_15	Not Genuine	Not Genuine
31	10.000_NotGenuine_11	Genuine	Genuine
32	10.000_NotGenuine_12	Genuine	Genuine
33	10.000_NotGenuine_13	Genuine	Genuine
34	10.000_NotGenuine_14	Genuine	Genuine
35	10.000_NotGenuine_15	Genuine	Genuine
36	20.000_NotGenuine_11	Not Genuine	Not Genuine
37	20.000_NotGenuine_12	Not Genuine	Not Genuine
38	20.000_NotGenuine_13	Not Genuine	Not Genuine
39	20.000_NotGenuine_14	Not Genuine	Not Genuine
40	20.000_NotGenuine_15	Not Genuine	Not Genuine
41	50.000_NotGenuine_11	Genuine	Genuine
42	50.000_NotGenuine_12	Genuine	Genuine
43	50.000_NotGenuine_13	Genuine	Genuine
44	50.000_NotGenuine_14	Genuine	Genuine
45	50.000_NotGenuine_15	Genuine	Genuine
46	100.000_NotGenuine_11	Not Genuine	Not Genuine
47	100.000_NotGenuine_12	Not Genuine	Not Genuine
48	100.000_NotGenuine_13	Not Genuine	Not Genuine
49	100.000_NotGenuine_14	Not Genuine	Not Genuine
50	100.000_NotGenuine_15	Not Genuine	Not Genuine

Table 2 shows a comparison between the results of the identification of the authenticity of paper money manually by using the software identification results. From the test results of the 50 data showed all of the data identified correctly.
From the above data can be detailed,
TP (True Positive) = 50
FP (False Positive) = 0
FN (False Negative) = 0

Following the calculation of the value of the effectiveness of the program.

$$\text{precision} = \frac{35}{35+0} = 1 \quad \text{recall} = \frac{35}{35+0} = 1$$

$$\text{F} - \text{Measure} = 2 \cdot \frac{1 \cdot 1}{1+1} = 1$$

The value of the F-Measure above, the percentage of the system's accuracy in identifying the authenticity of paper money of 100%.

4. Conclusion

Based on the analysis of the test results that the application has been made, it can be concluded that the method of Support Vector Machine can be applied to identify the nominal value and the authenticity of paper money and the application can identify the nominal value and the authenticity of paper money with a percentage of 100% effectiveness of the system.

References

[1] Wicaksono D, DawudGede. 2008. Perangkat Lunak Identifikasi Nilai Nominal dan KeGenuinean Uang Kertas Rupiah menggunakan JaringanSaraf Tiruan Backpropagation. Electrical Engineering, Technic Faculty, Indonesia University.
[2] Agita Sukma Listyanti. 2012. Tiga Tahun Terakhir, Pemalsuan Uang Rupiah Meningkat, http://ekonomibisnis.suarasurabaya.net, October 18th, 2012.
[3] Sigeru Omatu, Toshihisa Kosa, et.al. 2003. Classification of Italian Liras Using the LVQ Method, IEEE 599-8531.
[4] Kharisma, G., & Khalilullah, A. S. (2011). Identifikasi Uang Kertas Menggunakan Metode Backpropagasi Pada Sistem Internet-Telepon Umum. EEPIS Final Project.
[5] Hendra Heriawan, 2007. Pengenalan Mata Uang Rupiah Menggunakan Logika Fuzzy, Electrical Engineering, Technic Faculty, Indonesia University.
[6] Anindito Nur Rahmandana, 2012. Perangkat Lunak Identifikasi Nilai Nominal Dan KeGenuinean Mata Uang Kertas Rupiah Dengan Proses Image Recognition Menggunakan Hidden Markov Model, Faculty of Electrical and Communication, Institute Technology Telkom.
[7] Cristianini, N., & Shawe-Taylor, J. (2000). An introduction to support vector machines and other kernel-based learning methods. Cambridge university press.