

Python Application: Visual Approach of Hopfield Discrete Method for Hiragana Images Recognition

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ABSTRACT

Python is a dynamic object-oriented programming language. Python provides strong support for integration with other programming languages and other tools. Python programming is rarely used in the field of artificial intelligence, especially artificial neural networks. This research focuses on running Python programming to recognize hiragana letters. In learning the character of Hiragana, one can experience difficulties because of the many combinations of vowels that form new letters by different means of reading and meaning. Discrete Hopfield network is a fully connected, that every unit is attached to every other unit. This network has asymmetrical weights. At Hopfield Network, each unit has no relationship with itself. Therefore it is expected that a computer system that can help recognize the Hiragana Images. With this pattern recognition Application of Hiragana Images, it is expected the system can be developed further to recognize the Hiragana Images quickly and precisely.

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1. INTRODUCTION

Python comes with expandable standard libraries that can be easily learned. Many communities out there are developing Python libraries for various purposes. Like PyQt, Python libraries can be used to develop GUI programs [1], [2]. NumPy and SciPy are used to perform vector and matrix operations quickly. PIL or Pillow, Python libraries used for image processing, and much more. With the right libraries, Python can be used to develop a variety of software with different functionality and platforms [2]. Python was developed by Guido van Rossum in 1990 at CWI, Amsterdam as a continuation of the ABC programming language with the last released version 1. 2. Python is currently under development by a group of programmers coordinated by Guido and the Python Software Foundation [1], [2]. Python Software Foundation is a non-profit organization established as intellectual property holder of Python since version 2.1 and thus prevents Python from being owned by commercial companies. Currently, Python distribution has reached version 2.7 and version 3.5.

Artificial Intelligence is one part of computer science that makes machines can do the job as and as well as human beings do [3], [4]. One example of artificial intelligence applications that are quite complicated in the field of AI study is pattern recognition. The problem encountered is how to make the machine able to recognize a picture of characters or handwriting strokes and translate it into the form of a particular pattern of letters or characters. This character recognition function can be developed and implemented in the scanner software to support speed in performing character input or typing the desired character. This character recognition problem is solved by implementing artificial neural networks [5].

Artificial Neural Network (ANN) is an information processing system that mimics, adopts, imitates the performance of the human brain [3]. Artificial network also using to target recognition of marine search

[6]. This artificial network is modelled by the human nervous system with the aim of a system can think and can recognize and make reasoning on input received, for example when someone who can not recognize the meaning of the foreign language that he met, then the computer system that has been embedded Network. Artificial Neural Network (ANN) can recognize the foreign language and directly translate it into a language that the person understands. Lots of utilization obtained from the application of this Artificial Neural Network, such as pattern recognition on images, print letters, handwriting, sound, and others. And then, ANN can be using for prediction like student graduation[7] or compression method with combining wavelet transform and ANN [8].

The Hopfield network is highly dependent on the correlation of the sample data. In the Hopfield network, all neurons are connected. The one neuron outputs and then becomes the input for all the other neurons [9], [10], [5]. Hiragana is one of three ways of writing Japanese and representing syllable designations [11]. Hiragana has 104 letters, and each has a different sound [12], [13]. Of the 104 letters, 46 letters are the necessary letters a-n, 25 letters using teng-teng (") and Maru (o), 33 letters using a small yes-yo combination. In learning the character of Hiragana, one can experience difficulties because of the many combinations of vowels that form new letters by different means of reading and meaning. It is expected that a computer system that can help recognize the character Hiragana. The following of flowchart shows in Figure 1.

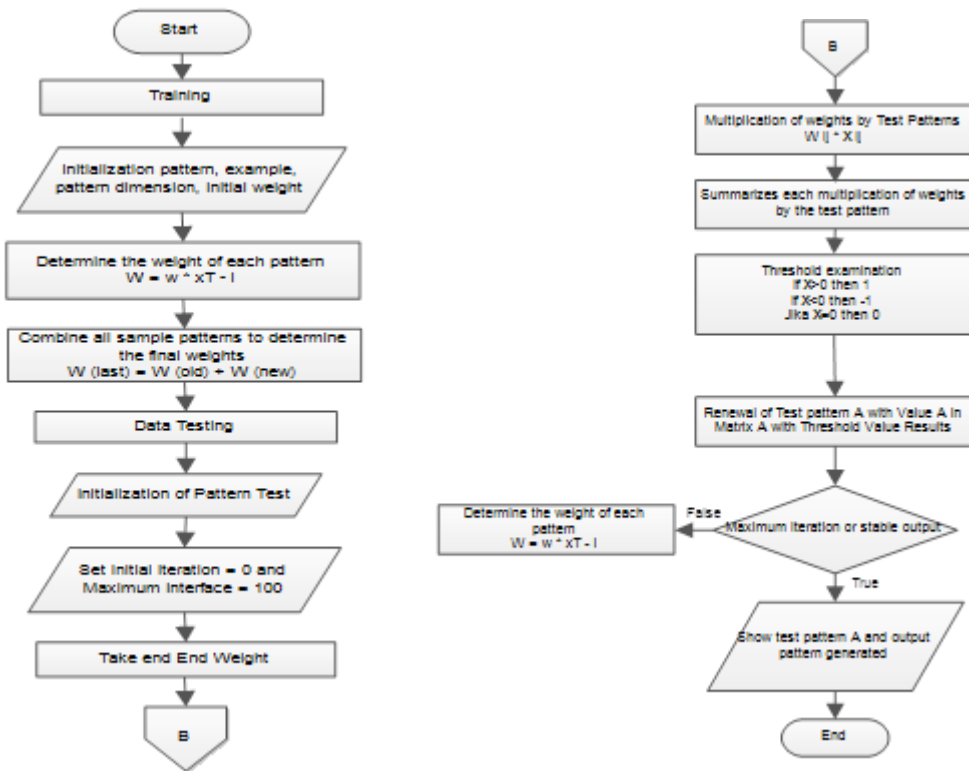


Figure 1. Flowchart of hopfield discrete method

The flowchart in Figure 1 explains how the process of recognizing an image pattern using the Hopfield Discrete method. In the Hopfield network, which is seen as an associative reminder system, the learning process is the process of adding memories of the trained pattern.

$$T_{ji} = \begin{cases} \sum_{p=1}^m P_{j,p} P_{i,p} & \text{If } i \neq j \\ 0 & \text{If } i = j \end{cases} \tag{1}$$

This equation is related to "energy" even though it does not represent the real energy as in the physics system. The energy function of the above equation is an objective function that is minimized by the network. Each condition of the network has a set of energy (convergence). This value is defined:

$$E = -\frac{1}{2} \sum_j \sum_{i \neq j} i T_{ji} U_j U_i \quad (2)$$

A grayscale image is a digital image that has only one channel value on each pixel, in other words, the red part=green=blue. The value is used to indicate the level of intensity. The color of the grayscale image is a gray color with varying degrees from black to white. Grayscale images can be obtained from RGB imagery. Grayscale image intensity value (gray) is calculated from RGB image intensity value using equation.

$$\text{Grayness Value} = 0.2989 * R + 0.5870 * G + 0.1140 * B \quad (3)$$

2. RESULTS AND ANALYSIS

Problem analysis is an activity to observe existing problems to produce a new system or develop an existing system that will be used to solve the problem. The Hopfield Network is an algorithm in artificial neural networks that can be used as recognition of Hiragana character patterns. To be able to read Hiragana character pattern using artificial neural network using Hopfield Network, the first step is analyzing by using image processing. The image processing will transform the original image into a bipolar picture. From these results it can be done the next activity, that is to train the image and then test it on a system to be built. Capabilities using the Hopfield Network are extensive and can identify images with unrestricted pixels, and can determine whether an input (vector input) is recognized or not recognized by the artificial neural network system.

Step 1: Input Preparation

The input preparation used in the Hiragana character recognition system is to prepare the original image as a training pattern and then perform the imaging of the image management into bipolar images of 1 and -1, here are the steps:

- An input image of original Hiragana character with image resolution 120 x 120 pixel.
- Perform edge detection to crop additional background image, then reduce the image resolution to 20 x 20 pixels.
- Convert the image into a polar image with a threshold of 250. which means if the image matrix value is greater than 250 then it is worth 1, and if it is smaller than it is worth -1

Sample image of hiragana character "A" original and result after cropping and sizing (resizing) as shown in Figure 2

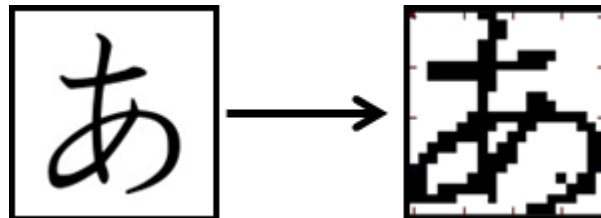


Figure 2. Sample image of hiragana character "A" original and result after cropping and sizing (resizing)

Step 2: Training/Learning Concept

At the training stage, each sample character pattern is entered and introduced into the system. The result of this process is the value of training weight. This weight value will be used to recognize the new character pattern entered in the system testing mode later. The new character pattern is then multiplied by the weights that have stored information from each character pattern of the instance, and the result of the multiplication will form a pattern that will be considered to be a pattern that has a similarity between the pattern of the new character and the character pattern of the example.

For example, the character to be trained to the system is Hiragana's 5 characters with the pattern in following stages. Determine the weight of each hiragana character with the following formula.

$$W = xx^T - I = \begin{bmatrix} 0 & x_1x_2 & \cdots & x_1x_n \\ x_2x_1 & 0 & \cdots & x_2x_n \\ \vdots & \vdots & \ddots & \vdots \\ x_nx_1 & x_nx_2 & \cdots & 0 \end{bmatrix} \quad (4)$$

Step 3: Testing

The testing phase is the stage where the trained network will be tested using a new pattern to see if the new pattern is recognized by the network or not. This test will be performed on Artificial Neural Networks for Hiragana character "A, E, I, U" above by using A character test pattern which has been given noise so that it can not be recognized again as character A. The test process will be done with the following stages:

- a. Create a new test pattern by giving noise to the pattern of example A characters so as to form a new pattern that is partially similar to the example pattern of character A. For ease of testing, the noise delivery is done by changing the matrix value in the pattern of example A with the position of random value as much 200 so as to produce a pattern in accordance within Figure 3.

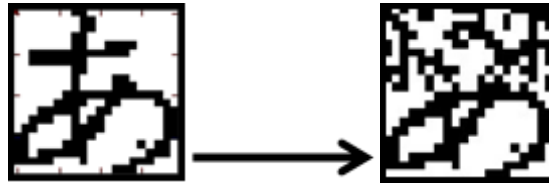

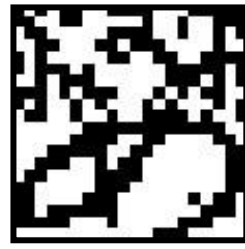


Figure 3. Character test pattern “A” has been given noise

Table 1. Comparison of Bipolar Matrix Pattern Example And Character Test Pattern “A”

Image	Bipolar Matrix
	<pre> 1 1 1 1 1 1 1 1 1 -1 -1 -1 -1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 -1 -1 -1 -1 1 1 -1 -1 -1 -1 1 1 1 1 1 1 1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 1 1 1 1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 -1 -1 1 1 1 1 1 1 1 1 1 1 1 1 1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 1 1 1 -1 -1 -1 -1 -1 1 1 -1 -1 1 1 1 1 -1 -1 1 1 1 1 -1 -1 -1 -1 -1 1 1 -1 -1 1 1 1 1 1 1 -1 -1 1 1 1 -1 -1 -1 1 1 1 -1 1 -1 -1 1 1 1 1 1 1 1 1 -1 1 1 -1 -1 1 1 1 1 1 -1 -1 -1 -1 1 1 1 1 1 1 1 -1 -1 -1 -1 1 1 1 1 1 -1 -1 -1 1 1 1 1 1 1 1 -1 1 -1 -1 1 -1 -1 1 -1 -1 -1 -1 -1 1 1 1 1 1 1 1 1 -1 -1 -1 1 1 -1 -1 -1 -1 -1 1 1 1 -1 1 1 1 1 1 1 -1 -1 -1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 -1 -1 -1 1 1 1 1 1 </pre>
	<pre> -1 1 -1 1 -1 -1 1 1 -1 -1 -1 -1 1 1 1 -1 -1 -1 -1 -1 -1 -1 1 1 -1 -1 1 1 1 1 1 -1 1 1 -1 1 1 -1 -1 -1 -1 1 -1 -1 1 1 1 1 1 -1 -1 -1 -1 1 1 -1 1 1 -1 1 1 -1 1 1 -1 -1 1 1 1 -1 -1 -1 -1 -1 1 1 1 1 -1 1 1 1 1 -1 1 -1 1 1 1 1 1 -1 -1 1 1 -1 -1 1 1 -1 -1 -1 -1 -1 1 -1 -1 -1 1 -1 1 1 1 1 1 1 -1 -1 -1 -1 -1 1 -1 1 1 -1 1 -1 -1 -1 1 1 1 1 1 1 -1 -1 -1 1 -1 1 -1 -1 -1 -1 1 -1 1 -1 -1 1 1 1 -1 1 -1 1 1 1 -1 1 1 1 -1 1 -1 1 1 -1 1 -1 1 1 1 -1 1 -1 1 1 1 -1 1 1 -1 1 1 1 1 1 1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 1 1 1 -1 -1 -1 -1 1 1 -1 -1 1 1 1 1 1 1 -1 -1 1 1 1 -1 -1 -1 1 1 -1 1 -1 -1 1 1 1 1 1 1 1 -1 -1 1 -1 -1 1 1 1 1 -1 -1 -1 -1 1 1 1 1 1 1 1 1 -1 -1 -1 -1 1 1 1 1 1 -1 -1 -1 1 1 1 1 1 1 1 1 1 -1 -1 -1 -1 1 -1 -1 -1 -1 -1 1 1 1 1 1 1 1 -1 -1 -1 1 1 -1 -1 -1 -1 1 1 1 1 -1 1 1 1 1 1 1 1 1 1 -1 -1 1 1 -1 -1 -1 -1 1 1 1 1 1 1 -1 -1 -1 1 1 1 1 -1 -1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 -1 -1 -1 1 1 1 1 1 </pre>

- b. Starting the test by multiplying the weight value of row to i and column j by the value of the test pattern of the column to j ($W [4] [3] * I [3]$), provided that the value of i in $W [i] [3]$ must be in sequence. The multiplication result is then summed for each Calculation/neuron and then given the following threshold values: $f(x) = \{-1, \& x < 0 @ 0, \& x = 0 @ 1, \& x > 0\}$. Updating the T test pattern by matching the value of $A [i] [3]$ to the matrix A with the above calculated value. Renewal of Test Pattern Value as shown in Tabel 2.

Table 2. Renewal of Test Pattern Value

Epoch	Result $W[i][3] * I[3]$	Threshold $W[i][3] * I[3]$	Value of Pattern Test $A[i][3]$	New Value of Pattern Test
1	59.8	1.0	1.0	1.0
2	-6.6	-1.0	-1.0	-1.0
3	98.0	1.0	1.0	1.0
4	63.6	1.0	1.0	1.0
5	81.2	1.0	1.0	1.0
6	190.4	1.0	1.0	1.0
7	-125.4	-1.0	1.0	-1.0
8	-14.2	-1.0	-1.0	-1.0
9	328.8	1.0	1.0	1.0
10	383.0	1.0	1.0	1.0
400	66.2	1.0	1.0	1.0

- c. Using the A test pattern given above, repeat steps 2 and 3 until the output pattern is stable (unchanged) or touch the limit/maximum. The calculation is determined (in this case the maximum count is 100). The following are outputs that appear when the output pattern is stable (unchanged):

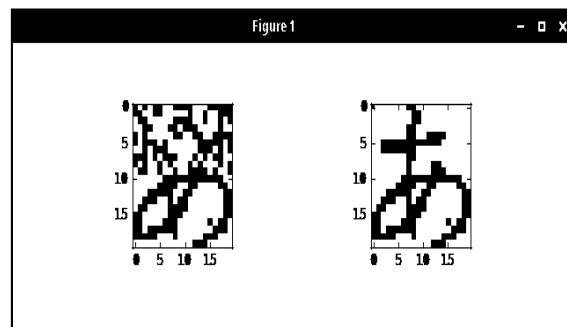


Figure 4. Output results from a test pattern recognized by hopfield network as "A" character hiragana

- d. If the output pattern is the same as the example model, then the test is considered successful, and Hopfield network can recognize hiragana character "A, E, I, U".

3. SIMULATION

Implementation and testing program in hiragana character recognition system requires devices, namely: software and hardware. Implementation is a step used to operate the system to be built. In this chapter will explain how to run the system. Here is a look at Hiragana Character Recognition System. This form is a page to train predetermined images to be tested and recognized by the system. The display of the Training and Testing as shown in Figure 5.



Figure 5. Sample of data training

This test result form is the page to display the test results. The display of the test result form is as follows in Figure 6.

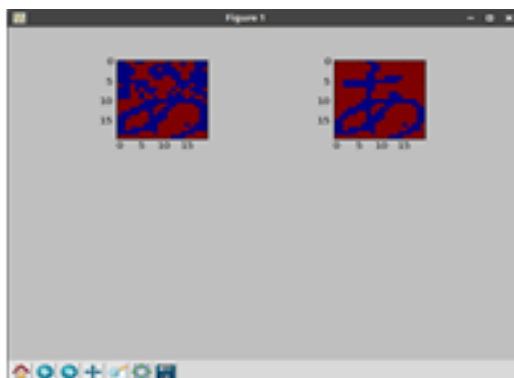


Figure 6. Result

4. CONCLUSION

After the research is done, it can be drawn some conclusions as the conclusion of this research. As for some conclusions obtained from this research are as follows: Character recognition Hiragana can apply an artificial intelligence system that is artificial neural network by using Hopfield Network which later results from testing are picture recognizable or not recognizable. In designing a system that can recognize the character, Hiragana required a system that adopts Hopfield Network that begins with the process of preparation of training patterns. Then performed the process of image processing so as to produce threshold value, then the value will be trained so that in the testing process the value will be compared with the value of the character pattern Hiragana tested, and last will produce a recognizable or unrecognized conclusion.

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