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Application of Ship Identification Number Recognition based on Hopfield Neural Network

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Abstract

In recent years, artificial intelligence is hot, applied in various fields and industries, and has greatly promoted the development of various industries. This paper is based on the Hopfield neural network application to derive the application of ship identification number identification. Hopfield neural network is a recursive combination of storage and binary systems, and ultimately ensures that the network tends to a stable state of single-layer structure by reducing the energy characteristics of recursion. In this paper, the letters and numbers of the ship identification number are designed in the standard matrix, noise (fixed or random noise) interference is added in the later stage, and the noise matrix is processed to identify the fuzzy ship identification number under different noise intensity. The final conclusion of this paper is that under a certain range of noise intensity interference, Hopfield neural network can still identify the letters and numbers of the ship identification number more accurately. The system has strong anti-interference ability and certain practical application value.However, when the noise intensity exceeds a certain range, it is difficult for the system to identify the ship identification number accurately and effectively.

Keywords

Hopfield Neural Network; Ship Identification Number; Letter Recognition; Digital Recognition; Noise Intensity.

1. Introduction

In recent years, with the rise of artificial intelligence, it has brought impacts and changes to all industries, shipping industry is also the first to bear the brunt.In order to keep up with the development and change of The Times and make the shipping industry keep up with the development of The Times, it is necessary to introduce artificial intelligence into the shipping industry and upgrade and change it according to the characteristics and needs of the shipping industry so as to achieve the purpose of applying it to the shipping industry.In this paper, from the perspective of the development of shipping industry, the Hopfield neural network is combined with ships to identify the ship identification number. The traditional artificial identification is transformed and upgraded, and the fuzzy ship identification number is identified through artificial intelligence, so as to improve the identification efficiency and accuracy.

2. Ship's identification number

The ship identification number refers to the unique code used to identify the ship. Each ship has only one corresponding ship identification number [19]. The ship identification number should be applied for, obtained, kept and placed in accordance with the ship identification number management regulations.

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2.1 The purpose of the ship identification numberThe purpose of the ship identification number

The purpose of issuing ship identification numbers is to be used for the identification and classification of ships, so as to strengthen the management of all kinds of ships, protect the water environment and maintain the safety of water traffic [19]. Due to the complexity and variety of the original and current ship codes and coding systems, there are mainly ship registration number, ship inspection registration number, ship call sign, IMO number, ship MMSI, ship hull number, etc. Now the ship identification number is introduced to enable a ship to have a code that can uniquely and permanently identify all ships, and once obtained, it cannot be granted to other ships [19].

2.2 The composition of the ship identification number

The domestic ship identification number is composed of the English letter CN and 11 Arabic numerals. CN stands for China, the first four digits of 11 Arabic numerals indicate the year in which the ship's keel was placed, digits 5 to 10 are random numbers, and digit 11 is the check code [19].

The International Ship Identification Number is composed of the English letter IMO and seven Arabic numerals. IMO stands for the International Maritime Organization. The first six digits of seven Arabic numerals are sequence numbers, and the seventh digit is check code [19].

Check code calculation: whether it is domestic or international check code calculation is 6 random numbers multiplied by 7, 6, 5, 4, 3, 2, the sum of all the products to take the single digit is the check code. For example IMO9295244: (9 x 7) + (2 x 6) + (9 x 5) + (5 x 4) + (2 * 3) + (4 x 2) = 154, 4 to check code.

2.3 Position of ship identification number

The ship identification number shall be permanently marked aft or midship above the deepest approved load line on the port or starboard side, visible on the front of the ship's superstructure, and visible on the port or starboard side of the ship's superstructure.

The permanent mark of the ship identification number on the hull shall be in Song style. For ships with a length of 20 meters or more, the height of the ship identification number character shall be 10 centimeters, and for ships with a length of less than 20 meters, the height of the character shall be 5 centimeters [19].

3. Ship identification number recognition based on neural network

3.1 Basic overview of Hopfield neural network

Hopfield neural network is a kind of recursive neural network structure, the first by the American physicist J.J Hopfield proposed in 1982, the network has strong associative memory function, can in the case of a certain noise figures of the circumstance such as fuzzy or incomplete accurately identified, thus is widely used in image and information recognition, signal data processing and voice data processing, and pattern classification, data query, etc. [20].

According to whether the output of the neural network is discrete or continuous, Hopfield neural network can be divided into the following two types [5]:

(1) Discrete Hopfield network (DHNN), mainly used for associative memory and recognition;

(2) Continuous Hopfield network (CHNN) is mainly used to solve optimization problems.

Among them, the discrete Hopfield Network (DHNN) is the neural network prototype used in this paper, and the ship identification number is extracted and recognized with the help of the discrete neural network.

3.2 Discrete Hopfield Neural Network Network Structure

The network first proposed by DHNN is a single-layer neural network with binary output, and the output values of neurons can only be 1 and -1, which respectively represent that neurons are in two

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different states of activation and inhibition [10]. The numeric and alphanumeric matrix outputs used in this article are of the same type, with 1 and -1 representing different output states.

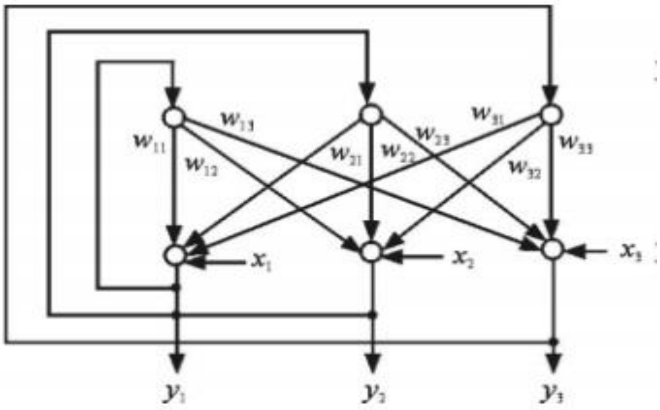

Fig. 1 Structure diagram of discrete Hopfield neural network

Fig. 1 is the structure diagram of the discrete Hopfield neural network, which is assumed to be composed of three neurons. Layer 0 is only the one-way input of this small neural network, because this layer is not an actual neuron, so it has no calculation function.

The first layer is the neuron, so it performs the summation of the product of the input information and the weight coefficient, and generates the output information after processing by the nonlinear function f.F is a simple threshold function. If the output of the neuron is greater than the threshold θ, then the output of the neuron is 1.less than the threshold θ, the neuron output value is -1. The following is the calculation formula of the binary neuron [10]:

$$\mu_j = \sum_i w_{ij} y_i + x_j \tag{1}$$

In Equation (1), is the external input, and has

$$\begin{aligned} y_j &= 1, \mu_j \geq \theta_j \\ y_j &= -1, \mu_j < \theta_j \end{aligned} \tag{2}$$

When the output layer is n neurons, the output at time t is n-dimensional vector, then:

$$Y(t) = [y_1(t), y_2(t),\ldots y_n(t)]^T \tag{3}$$

Because $y_i(t)$ (i= 1,2,3... ,n) can be 1 or -1, so the n-dimensional vector Y(t) has a 2n state, that is, the network has 2n states. Considering the general node state of DHNN, denote the JTH neuron, that is, the state of node j at time t, then the state of the node at the next time (t + 1) can be obtained:

$$y_j(t+1) = f\left[\mu_j(t)\right] = 1, \mu_j \geq \theta_{j,}\ \ or - 1, \mu_j < \theta_j \tag{4}$$

$$\mu_j = \sum_i w_{ij} y_j + x_j - \theta_j \tag{5}$$

If wij equal to 0 at i = j, it means that the output of a neuron will not be fed back to its input. At this time, DHNN is called a non-self-feedback network. If it is not equal to 0 when i = j, it means that the output of a neuron will be fed back to its input end. In this case, DHNN is called a self-feedback network [10].

4. Vessel identification number recognition based on Hopfield neural network

4.1 Overview of Digital Recognition

In daily living, often with noise character (mainly for the Numbers and letters) to identify problems, such as the transportation system in auto car number and license plate, ship the above identification number, etc., because in the process of daily use of the car and ship subjected to protect against the

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natural environment and cause need to identify the character of fuzzy lost or damaged, making it difficult to recognize. So how to extract complete, effective and practical information from these incomplete characters has become a more difficult problem.

As one of the important parts of character recognition, numbers and letters have very high application value in many aspects.

At present, the methods used in character recognition are mainly divided into neural network recognition, probability and statistics recognition and fuzzy recognition, etc. [5]. Conventional digital identification method under the condition of the strong noise interference can't very well to effective accurate recognition of Numbers and letters, and discrete Hopfield neural network itself has the function of associative memory is very suitable for to the recognition of Numbers and letters and other characters, and the recognition effect is good, can obtain a satisfactory result, under the certain interference, the effect of the recognition and speed quickly, has the strong practical space.

In reading domestic and international papers in this field, the author found that most of the Hopfield neural network character recognition is used for the recognition of car license plate number, and the character recognition of ships is rarely used or even not mentioned. Therefore, the author would like to have an in-depth understanding of whether this field can be extended to the use of the shipping industry, which is also a bold attempt of the author, but the effect of identification is very satisfactory.

4.2 Neural network model

4.2.1. Design idea of neural network:

The neural network model in this paper is composed of 15 steady states with 0~9 and 5 letters, and each steady state is represented by a 10*10 matrix (i.e., the binary value neural network mentioned above, with numbers 1 and -1 to represent the activation and inhibition effects of neurons). 10 Arabic numerals and 5 letters needed by the author (capital letters C, N, I, M, O) can be intuitively described by the matrix above, that is, the matrix is divided into 10*10 units, the unit with the number track is represented by 1, and the blank part is represented by -1, as shown in Figure 2 and Figure 3.

Networks for the 15 steady-state and 10 Numbers (dot) and five letters (dot) has the function of associative memory when there is noise (the author separately using two input noise and fixed noise matrix and random noise matrix) of the digital dot matrix input to the network, the network output can get the most close to the goal of the vector (that is, the steady-state standard identification figure 15), so as to correctly identify the effect of the characters [8].

-1	1	1	1	1	1	1	1	1	-1
-1	1	1	1	1	1	1	1	1	-1
-1	1	1	-1	-1	-1	-1	1	1	-1
-1	1	1	-1	-1	-1	-1	1	1	-1
-1	1	1	-1	-1	-1	-1	1	1	-1
-1	1	1	-1	-1	-1	-1	1	1	-1
-1	1	1	-1	-1	-1	-1	1	1	-1
-1	1	1	-1	-1	-1	-1	1	1	-1
-1	1	1	1	1	1	1	1	1	-1
-1	1	1	1	1	1	1	1	1	-1

Fig. 2 The standard lattice of the number 0

-1	1	1	1	1	1	1	1	1	-1
-1	1	1	1	1	1	1	1	1	-1
-1	1	1	-1	-1	-1	-1	-1	-1	-1
-1	1	1	-1	-1	-1	-1	-1	-1	-1
-1	1	1	-1	-1	-1	-1	-1	-1	-1
-1	1	1	-1	-1	-1	-1	-1	-1	-1
-1	1	1	-1	-1	-1	-1	-1	-1	-1
-1	1	1	-1	-1	-1	-1	-1	-1	-1
-1	1	1	1	1	1	1	1	1	-1
-1	1	1	1	1	1	1	1	1	-1

Fig. 3 Standard lattice of the letter C

4.2.2. Design steps of neural network:

Figure 4 is the idea diagram of the design process of the neural network model in this paper.

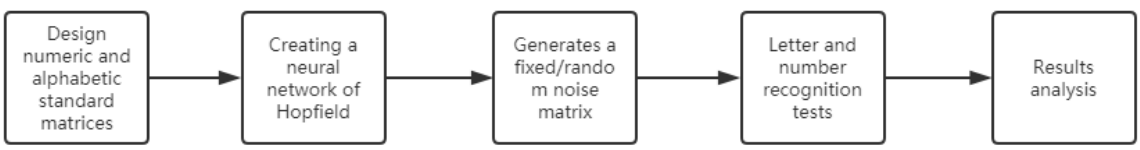

Fig. 4 Flowchart of Hopfield network design

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4.3 The realization of neural network

According to the design process in Figure 4, MATLAB software was used to write, debug and run the algorithm.

4.3.1 Input and output design

The main input matrices in this paper are letters and numbers. Some of the standard matrices of numbers and letters have been shown in Figure 2 and Figure 3 (other numbers and letters are similar). The following figure is part of the code that compiles the above letters and numbers in Matlab.

```
zero=load('zero.txt');
one=load('one.txt');
two=load('two.txt');
three=load('three.txt');
four=load('four.txt');
five=load('five.txt');
six=load('six.txt');
seven=load('seven.txt');
eight=load('eight.txt');
nine=load('nine.txt');
C=load('C.txt');
N=load('N.txt');
I=load('I.txt');
M=load('M.txt');
O=load('O.txt');

T=[zero(:),one(:),two(:),three(:),four(:),five(:),six(:),...
    seven(:),eight(:),nine(:),C(:),N(:),I(:),M(:),O(:)];
```

Fig. 5 The input graph of the standard matrix

Then, the target vector can be trained and output into a graph. Figure 6 is the realization result of the standard dot matrix output of numbers and letters. You can see the numbers and letters very clearly.

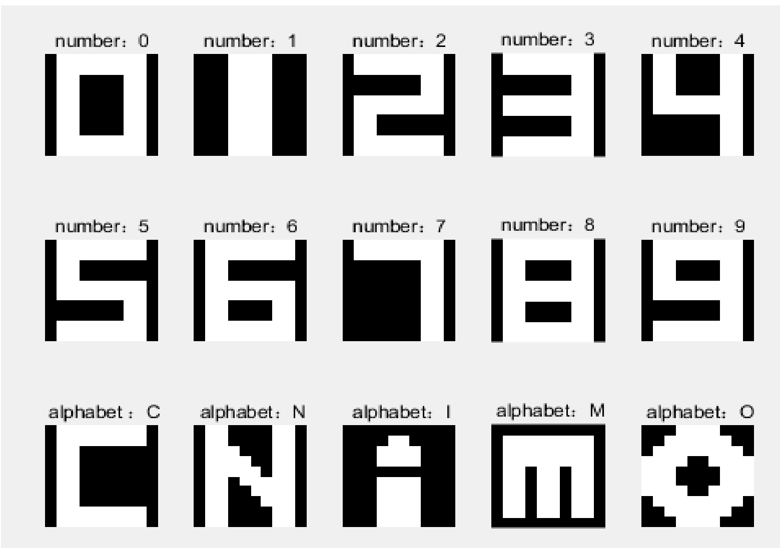

Fig. 6 Output graphs of standard numbers and letters

4.3.2 Creating a neural network of Hopfield

The Hopfield neural network is modeled. With the function code Net = Newhop (T), a Hopfield neural network satisfying T is designed by using Newhop function.

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4.3.3 Generates a fixed/random noise matrix

The noise matrix adopted by the author in this paper is divided into two kinds, namely fixed noise method and random noise method:Fixed noise method refers to the method of manually modifying the standard character matrix, changing the value of some positions of the digital dot matrix (i.e. 1 to -1 or vice versa), so as to simulate the production of digital dot matrix with noise. Of course, if we want to produce different digital matrix graphs with noise, we need to make many modifications manually, which is undoubtedly troublesome [8]. Figure 7 is the MATLAB code using the fixed noise method. This method requires manual input of noise character matrix in advance, as shown in Figure 8. Figure 8 is the fixed noise matrix of the number 0, which is the fixed noise matrix obtained by the author by manually changing the standard matrix of the number 0, and other characters are similar.

```
noise_matrixM=load('noise_matrixM.txt');
```

Fig. 7 Fixed noise method code diagram

-1	1	1	-1	-1	-1	-1	1	1	-1
1	1	1	1	-1	-1	1	1	1	1
1	1	1	1	-1	-1	1	1	1	1
1	1	1	1	1	1	1	1	1	1
1	1	1	-1	1	1	-1	1	1	1
1	1	1	-1	-1	-1	-1	1	1	1
1	1	1	-1	-1	-1	-1	1	1	1
1	1	1	-1	-1	-1	-1	1	1	1
1	1	1	-1	-1	-1	-1	1	1	1
1	1	1	-1	-1	-1	-1	1	1	1

Fig. 8 The fixed noise matrix of the number 0

Compared with the fixed noise method, the random noise method can generate various types of character matrices with noise more conveniently, without manually changing the standard matrix one character at a time. The random noise method is to use the principle of generating random numbers to determine the position of the lattice number that needs to be modified (that is, the position of noise generation), and then modify the digital lattice. Since there are only two kinds of values in the digital lattice: 1 and -1, the modification here is to change 1 to -1, and -1 to 1[9].

```
noise_matrix=one;
for i=1:100
    a=rand;
    if a<0.15
        noise_matrix(i)=-one(i);
    end
end
```

Fig. 9 Code diagram of random noise method

4.3.4 Character recognition test

The sim() function can be used to simulate the neural network, and its call format is:

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$$[Y,AF,E,perf]=sim(net,P,Ai,T) \tag{5}$$

$$[Y,AF,E,perf]=sim(net,\{Q\ TS\},Ai,T) \tag{6}$$

Where Y is the output vector, that is, the recognition result; NET is an established Hopfield neural network satisfying T; Q is the number of vectors; TS is the number of steps of the test; Ai is the initial layer delay, no delay, marked as null; T is the training sample of composition [5].

```
net=newhop(T);
No22=sim(net, {1,5}, {}, {noise_matrixM(:)});
```

Fig.10 Character recognition code diagram

The author in the recognition of noise matrix, simulation recognition of 10 times, and then take the last result drawn character recognition graphics, but also want to output better recognition effect character graphics.

4.3.5 Letter recognition results output

As shown in Figure 11 and 12, subplot (m,n,p) and imshow() functions are required to display the corresponding graph of the matrix in order to output the characters with noise and the character renderings after recognition into graphs.

```
figure
subplot(2,3,1)
imshow(noise_matrixM);
title('A noisy sample');
```

Fig.11 Unrecognized output code diagram with noise characters

```
for ii=1:5
    subplot(2,3,1+ii)
    imshow(reshape(No22{ii},10,10));
    title(['The' num2str(ii) 'simulation results'])
end
```

Fig.12 Output code diagram with noise character recognition

4.4 Experimental analysis of simulation results

In this paper, the simulation operation of the two methods are identified respectively, and then the analysis and comparison summary, to compare the recognition effect of which is more accurate and efficient.

The simulation objects are divided into two categories: one is the domestic ship identification number, the sample is CN20159321603; The other category is the international common ship identification number, the example is IMO9481427. Will appear in the following identification analysis.

This paper will also do experiments on the connection between the number of simulation recognition and the recognition effect, by adjusting the number of recognition to observe the recognition simulation effect chart for analysis.

4.4.1 Simulation identification analysis of fixed noise method

1.Domestic Vessel Identification Number:

Enter the ship identification number CN20159321603, and the operating results are shown in Figure 13, 14 and 15.

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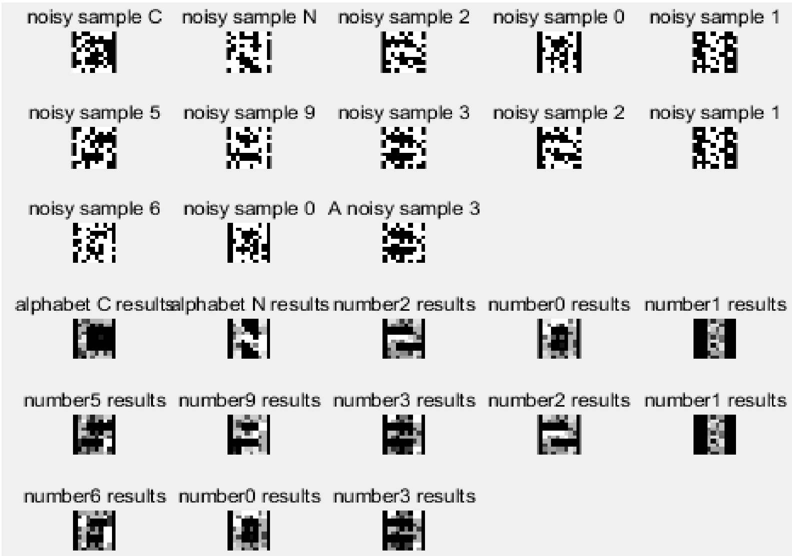

Fig. 13 Simulation identification 1 identification effect chart

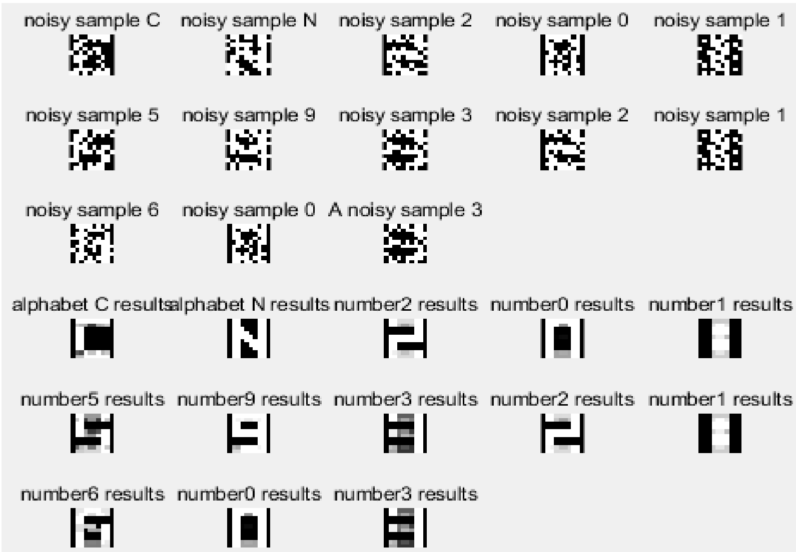

Fig. 14 Simulation identification of 5 identification effect chart

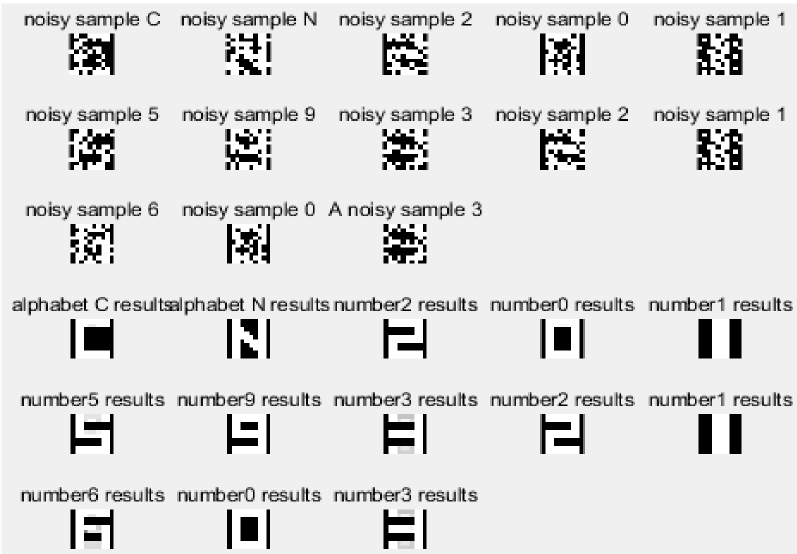

Fig. 15 Simulation identification 10 identification effect chart

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Fig. 13 is the simulation identification effect drawing of identifying the fixed noise matrix of ship identification number for one time. It can be clearly seen from Fig. 13 that the recognition effect is poor, which is similar to the noise sample figure above. However, some numbers and letters with low noise influence can be vaguely identified, and the recognition effect is poor.

Fig. 14 is the simulation identification effect drawing of identifying the fixed noise matrix of the ship identification number for five times. From this figure, the letters and numbers of the ship identification number can be observed clearly and completely. However, some areas of individual numbers and letters are still fuzzy and do not reach the desired effect.

Fig. 15 is the simulation identification effect drawing of identifying the fixed noise matrix of the ship identification number for 10 times. The identification number of the ship can be clearly read and taken out from this figure, and the identification effect is good.

Horizontal comparison of Fig. 13, Fig. 14 and Fig. 15 shows that when other conditions of simulation recognition remain unchanged, the higher the recognition times are, the clearer and more accurate the effect image obtained by simulation recognition is.

2. International Ship Identification Number:

Enter the ship identification number IMO9481427, and the operating results are shown in Figure 16, 17 and 18.

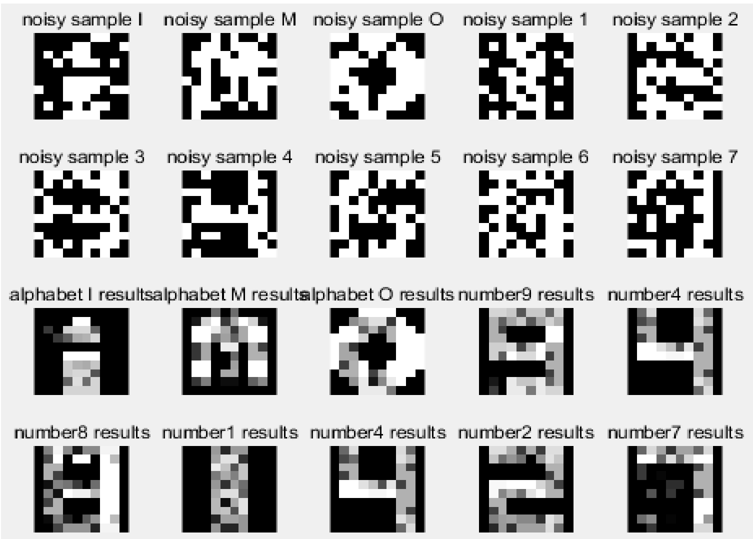

Fig. 16 Simulation identification 1 identification effect chart

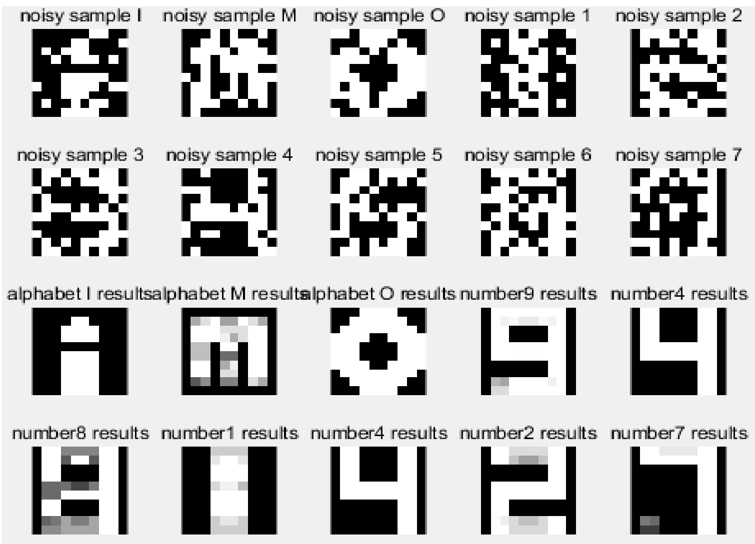

Fig. 17 Simulation identification of 5 identification effect chart

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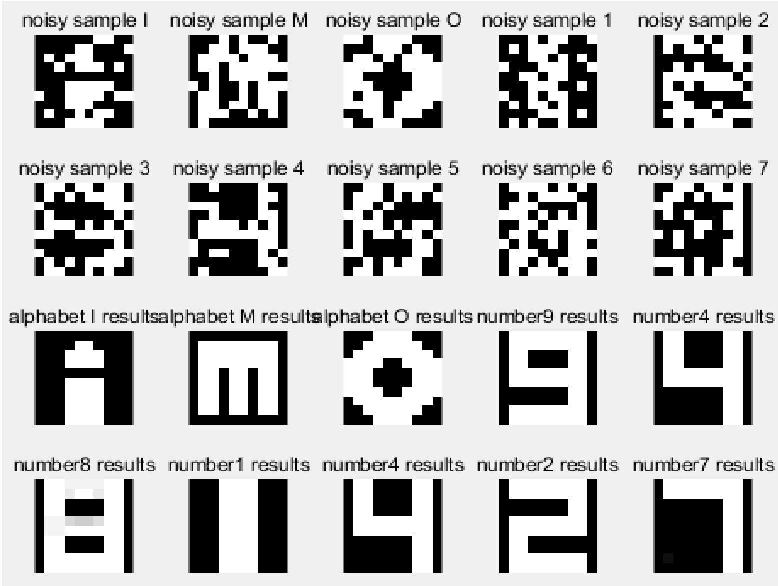

Fig. 18 imulation identification 10 identification effect chart

As can be seen from Fig. 16, Fig. 17 and Fig. 18, there is little difference between the identification result and that of domestic ship identification number.

The more times the simulation runs, the better the recognition effect.

In Fig. 18, the ship identification number can be extracted very accurately. It can be intuitively observed that the identification characters have no noise interference except for a few characters.

3. Summary and analysis:

Based on the simulation experiments of ship identification number at home and abroad, it can be concluded that the discrete Hopfield neural network has better simulation recognition effect when the input noise is fixed noise matrix. The higher the number of simulation recognition times, the more accurate the recognition effect will be, and the recognition characters can be close to the character image obtained by running the standard matrix.

4.4.2 Random noise method simulation identification analysis

1. Domestic Vessel Identification Number:

Enter the ship identification number CN20159321603, and the operating results are shown in Fig. 19, 20, 21 and 22.

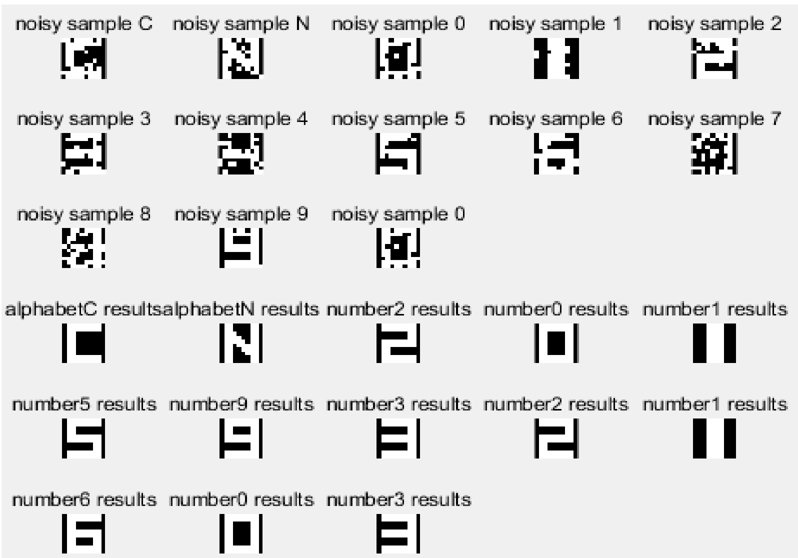

Fig. 19 The noise factor is 0.10 to identify the renderings

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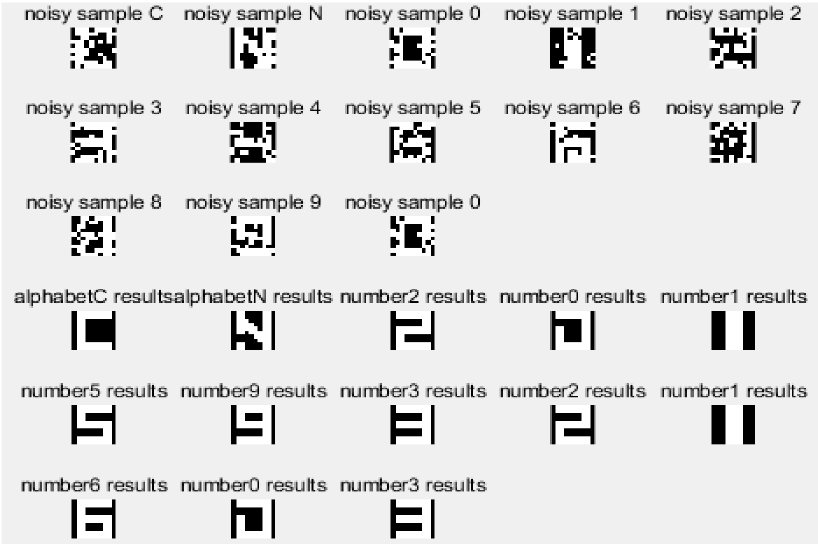

Fig. 20 he noise factor is 0.15 to identify the renderings

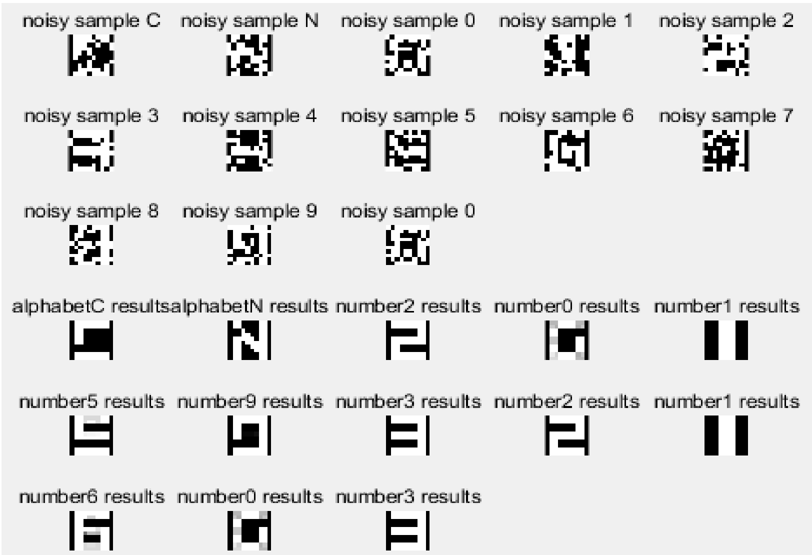

Fig. 21 he noise factor is 0.20 to identify the renderings

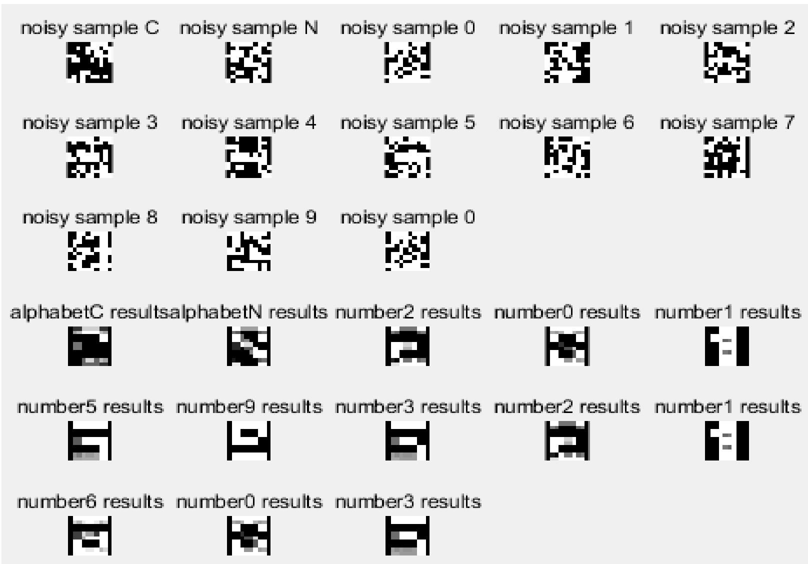

Fig. 22 he noise factor is 0.30 to identify the renderings

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The biggest difference between the random noise method and the fixed noise method is that the noise matrix is not arranged artificially and deliberately. Instead, the positions in the standard matrix are randomly determined according to the value of the noise factor. Therefore, the random simulation identification map generated by the random matrix is not fixed, and the simulation results are different for each time [10].

It can be seen from the four simulation running images in Figure 19, 20, 21 and 22 that: due to the increase of noise factor, the noise influence in the image is more and more intense, and the simulation recognition effect is more and more reduced; When the noise factor is greater than or equal to 0.3, the simulation results will lose their original accuracy, which is different from the initial standard matrix, and even there will be identification errors. The author confirmed the best recognition effect when the noise factor was controlled near 0.15.

2. International Ship Identification Number:

Enter the ship identification number IMO9481427, and the operating results are shown in Figure 23, 24, 25 and 26.

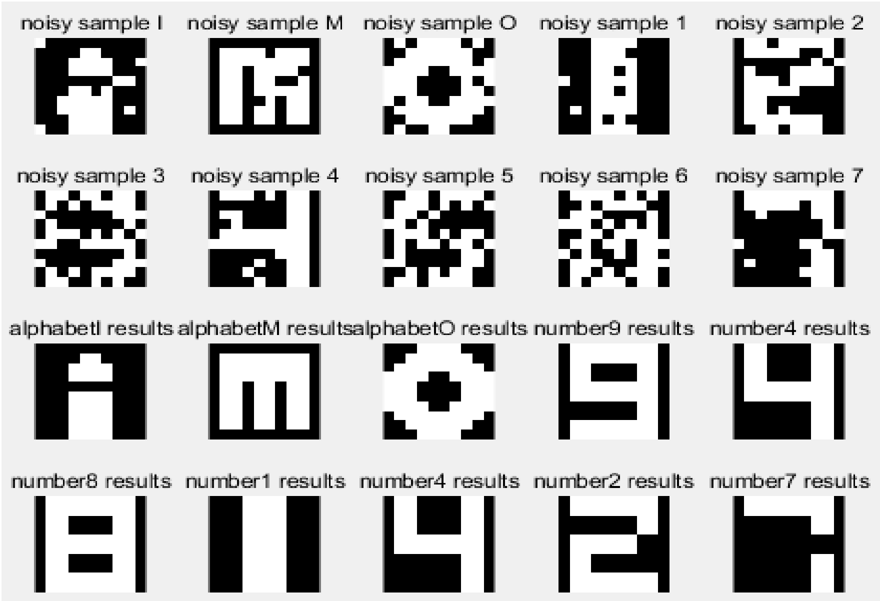

Fig. 23 The noise factor is 0.10 to identify the renderings

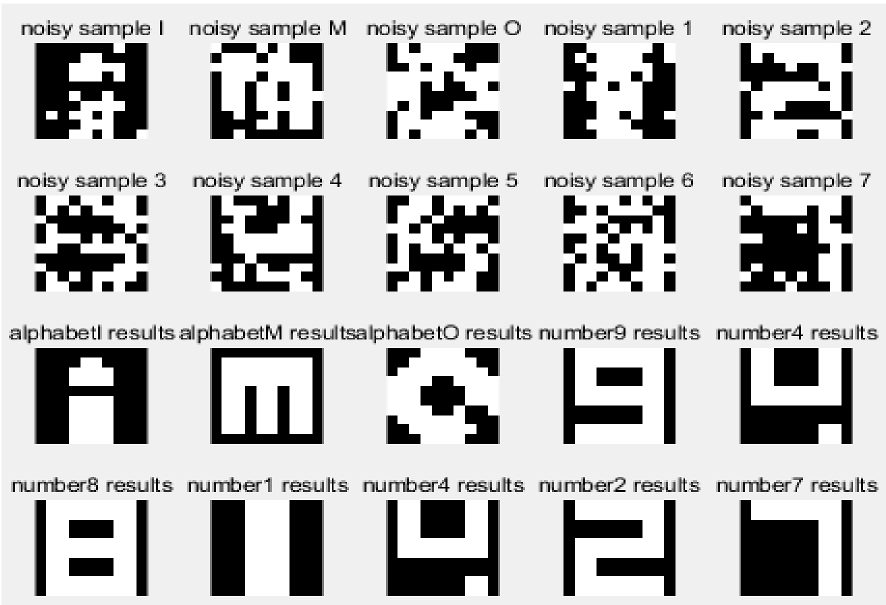

Fig. 24 The noise factor is 0.15 to identify the renderings

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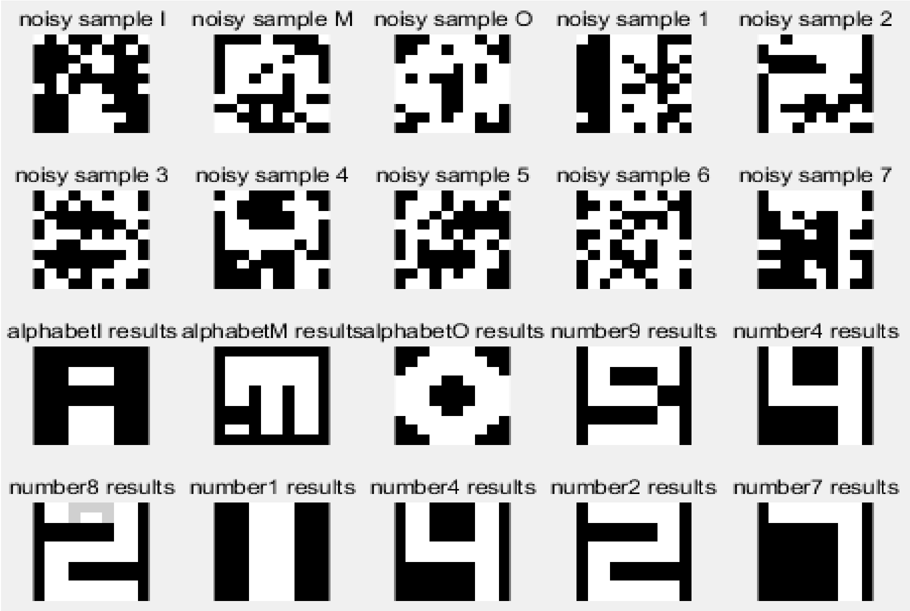

Fig. 25 The noise factor is 0.20 to identify the renderings

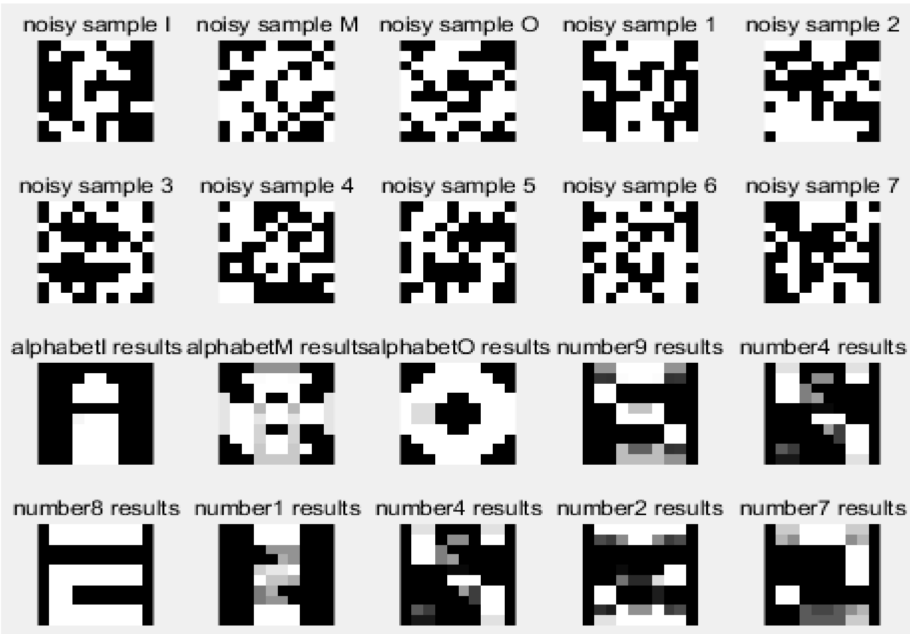

Fig. 26 The noise factor is 0.30 to identify the renderings

Similar to the results of simulation identification experiment of ship identification number in China, the recognition effect decreases when the noise factor is greater than 0.20, and the recognition error appears when the noise factor reaches 0.30. Some characters can not be identified in the simulation recognition images.

4.4.3 Comparison

Comparing the fixed noise method with the random noise method, it is not difficult to find that each of them has its own advantages and disadvantages.

Fixed noise noise matrix method requires human input characters in advance, and the random noise law, do not need to input as long as the standard matrix and then according to the random noise factor that determines the location of the noise form noise matrix can, in terms of the aspects of random noise method is more simple and convenient, and because of the uncertainty of the random noise can

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be many times the output of different noise matrix to identify simulation more renderings; Unlike the fixed noise method, if you want to change the output image, you need to manually change the position and quantity of noise in the noise matrix to achieve more different character graphics.

Comparatively speaking, the random noise method is more complex, but it is more efficient and more convenient in identifying a large number of noise matrices. The fixed noise method has a better recognition effect, but it is only suitable for the case of fewer characters. Moreover, compared with manual arrangement of matrix, it is more time-consuming and laborious and prone to error.

5. Conclusion

During the study of discrete Hopfield neural network, the author has a more specific concept and understanding of Hopfield neural network, and also has a wide range of reference scenarios for this kind of network. For the Hopfield neural network of ship identification number recognition has a more in-depth study, and the network is applied to identify the noise characters, has a very good effect. The most important thing is that the network construction is very simple, not difficult to implement, practical value is very high.

The author is also thinking about how to improve the identification ability of the network, or by using other algorithms to improve the limitations of the network itself, the identification of ship identification number can be more accurate and efficient; Or we can apply Hopfield neural network to other aspects. In a word, the author believes that Hopfield neural network has high application value and can be applied in many aspects of life. The author will continue the research in this field with perseverance.

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