Research and Application of the Radar Intelligent Fault Diagnosis System Based on Dual-Mode Fusion

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***Abstract*—The emergence of a new generation of weather radar increases the complexity of radar control system and the difficulty of troubleshooting. In order to ensure the reliability and maintenance performance of weather radar systems, this paper describes a dual-mode weather radar intelligent fault diagnostic expert system based on the author's many years of experience in radar maintenance. The radar fault diagnosis principle of wavelet back propagation neural network with improved case-based reasoning is firstly introduced, and the dual-mode fusion algorithm based on the improved diagnosis system is given later. At the end, the paper used 3830 weather radar system as an example, focusing on analyzing the failure phenomenon of system drive and the failure types, combined with the practical application to show that dual mode fusion algorithm can effectively detect the fault of weather radar in device level, plate level and chip level, three levels of diagnosis. This application example of radar fault diagnosis demonstrated that the method described in this article is effective and practical.**

Keywords-Radar Fault Diagnosis; wavelet BP Neural Network; Case-Based Reasoning; Dual-Mode Fusion.

I. INTRODUCTION

In recent years, many scholars study the Fault Diagnosis Expert Systems, the use of human experts to provide expertise, simulated the thinking process of human experts, like a human expert to solve some technical problems in the field of intelligent systems. Among them, Khomfoi and Tolbert [1] proposed the Fault Diagnosis System for a multilevel makes using a Neural Network. Zhihong and Le [2] studied about radar test and repair support system. Chien [3] offered the Design and Implementation of a CBR (Case-based Reasoning) system for Marketing Plans. Cheng and Ma [4] proposed the data of multi-feature extraction-based on the data layer fusion and improved D-S information fusion method. New expert systems are developed for simple monotype and single subject to modalities and comprehensive, with many experts coordination, a variety of knowledge representation, artificial neural networks, the latest artificial intelligence technology such as knowledge acquisition and learning mechanism has become the important features of the new expert system.

The emergence of a new generation of weather radar improves the radar function and accuracy, but also increases the complexity of radar control systems and the difficulty of troubleshooting them. In order to ensure the radar system reliability and fast, accurate diagnosis, various fault diagnosis technologies combined with artificial intelligence method is the research hot spot, radar fault diagnosis technology has developed to the intelligent diagnosis stage. Diagnostic expert system based-on our many years of experience in radar maintenance, this paper designs a BP (Back Propagation)-CBR-based weather radar intelligent fault diagnosis expert system.

The article first introduces the principle of radar fault diagnosis based on BP neural network and CBR, and then discusses intelligent fault diagnosis method, finally gives applications in weather radar. As the long-term mechanical wear, radar servo system motor drive and motor are a high failure probability, we focus on CINRAD / CC radar antenna servo system hardware [6] characteristics detailed introduction of radar servo system motor drives and motor failure of reasoning method to judge, as well as hardware replacement parameter detection set expert guidance program. Three CINRAD/CC radar fault intelligent diagnosis cases show that this proposed method is effective and practical.

II. PRINCIPLES OF RADAR FAULT DIAGNOSIS BASED ON DUAL-MODE FUSION

A. Wavelet BP method

BP (Back Propagation) [1] is a widely used feed-forward neural network model, which is superior to other network forms for the systematicness, completeness and ease application of its algorithm; it is particularly suitable for fast pattern recognition and classification applications.

In order to improve the operating speed, the improved BP neural network model of Morlet wavelet function [4] is adopted in this paper. It has three layer structures: input layer X, middle H layer and output layer Y, each layer of network is composed by multiple neurons, as shown in Figure 1. The input layer of the network takes M nodes according to the type number of failure, output layer for fault diagnosis conclusion, suppose that there is N conclusion and implicit layer was washed with K nodes reasoning judgment. BP generally chooses S function as K node role function $f(x)=1/(1+e^{-x})$. The system selects the Morlet wavelet activation function as hidden layer neurons according to the characteristics of the radar system circuit failure [5, 6].

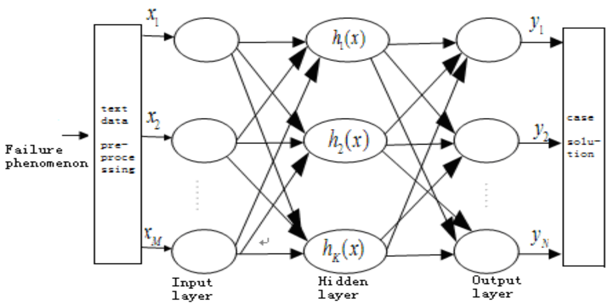

Figure 1. Wavelet BP neural network process

$$\mathrm{h}(\frac{x-b}{a})=\cos(1.75\frac{x-b}{a})\exp(-0.5(\frac{x-b}{a})^2) \tag{1}$$

The input and output samples is the given $P(p=1,2,\cdots P)$ group, learning rate is $\eta(\eta>0)$, momentum factor is $\lambda(0<\lambda<1)$, the target error function is

$$E=\sum_{p=1}^{P}E^p=\frac{1}{2P}\sum_{p=1}^{P}\sum_{n=1}^{N}(d_n^p-y_n^p) \tag{2}$$

d_n^p is the n node expected output of the output layer, y_n^p is the network actual output.

The goal of the algorithm is to make the error function reach a minimum by constantly adjust the parameters of the network.

Hidden layer output is [5]:

$$O_k^p=\mathrm{h}(\frac{I_k^p-b_k}{a_k}),\quad I_k^p=\sum_{m=1}^{M}w_{km}x_m^p \tag{3}$$

x_m^p is the input of the input layer, O_k^p is the output of the hidden layer, w_{km} is the weight between input layer node m and hidden layer k node, $\mathrm{h}()$ is the Morlet wavelet function.

The output of the output layer is [5]:

$$y_n^p=h(I_n^p),\quad I_n^p=\sum^{N}w_{nk}O_k^p \tag{4}$$

I_n^p is the input of the output layer, w_{nk} is the weight between hidden layer nodes.

k and output layer node n, y_n^p is the fault diagnosis result.

The weight adjustment formula between the nodes of the input layer and the hidden layer nodes is:

$$w_{km}^{new}=w_{km}^{old}+\eta\sum_{m=1}^{p}\delta_{km}+\lambda\Delta w_{km}^{old} \tag{5}$$

w_{km}^{old}、 w_{km}^{new} is respectively the weight value before the adjustment and the weight value after the adjustment between the input layer node m and the hidden layer node k, w_{km}^{old} is the momentum item.

In the training, the momentum is added in the weights and threshold correction algorithm and the former correction value is used to smooth learning path step, to avoid falling into the local minimum value and accelerate learning speed. In order to avoid causing the oscillation of the weights and threshold correction in the sample-by-sample training, we adopt batch training methods. The output of the network is not a simple weighted sum, but the network hidden layer wavelet node is weighted summation firstly, and then converted by the Sigmoid function [7], to obtain the final output of the network, this is conducive to the handling classification problems and reduce the possibility of divergence in the training process at the same time.

The direct fusion of wavelet and BP neural network, namely wavelet yuan [1] instead of neurons, is that the weights of the input layer to the hidden layer and the hidden layer threshold are respectively instead by the scaling of wavelet function and the translation parameters. On the same learning task, wavelet BP network has the characteristics of self-learning, adaptive, and fault tolerance, and it could avoid blindness on the BP neural network structure design, the structure is more simple, the speed of convergence is faster.

B. Improved CBR method

CBR puts forward solutions for the current fault by summing up the expert fault diagnosis experiences, using experts have successfully solved similar problems, comparing background and conditions of the old and new fault analysis, adjustment, modifying the existing fault diagnosis experience; so, it is also known as case-based reasoning method [2].

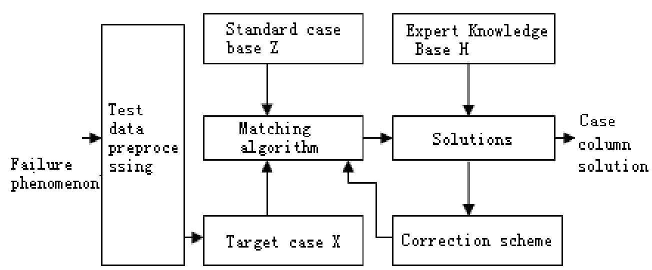

Figure 2. Improved CBR process diagram

Case Representation: Disposed case model, G = (A, B, C, S, R), which is based on the case model of the feature vector, each case G should contain the following: (1) Case No. A; (2) Case information B (fault phenomenon description, fault source); (3) Case description C behavior characteristics 1 (index 1, value 1), …, behavior characteristics N (index N, value N)]; (4) Solution S is the solution method for the failure; (5) Case retrieve information R (retrieval sequence number, frequency of use).

Standard case base Z stores series of case G in an interconnected database, Standard case base is divided into three layers: The first layer is the system layer, which is divided according to the main components in the weather radar system, such as antenna device system layer, power plant system layer, operating platform system layer, display device system layer, etc. The second layer is the representative case layer, corresponding to the typical representative cases that are under the system layer. The third layer is the sub-case layer which is a collection of a certain class of cases, each case of the same sub-case layer should be as similar as possible, each case of the different sub-case layer should be as far as possible not similar, and the same type of sub-case number should be at least 3.

Case Retrieval: The fault system uses the “hierarchical retrieval, the distance matching” method, focusing on the fault eigenvectors of target case, it makes sure that the failure occurred in what parts, and then finds the corresponding representative case in the system layer, the last fine in the sub-case select the cases corresponding to the minimum similarity distance, finally selects the corresponding minimum similarity distance case in the sub-cases. In a predetermined threshold range, there may be more than one sub-case to meet the requirements, or cannot find a matching case, at the time it could call the expertise libraries knowledge, for those who probability of occurrence is high, or have occurred many times of failure as a fixed case for feedback matching, regard the final solution as a case for a new solution and add to the standard case base after new solutions normalized. If there are hardware replacement requirements in solution, then the hardware replace adjusting parameter database will update the parameter testing procedures and specific parameter value debugging method. An improved CBR process is shown in Figure 2.

Similar distance function matching method: Case matching algorithm uses the similarity distance function matching method, which describes the credits of characteristic data group between target case X and the standard case Z. the similar distance function is:

$$Si = 1 - \frac{\left| \sum_{j=1}^{N} X_j \cdot W_{ij} \cdot Z_{ij} \right|}{\sqrt{\sum_{j=1}^{N} X_j^2 \cdot \sum_{j=1}^{N} Z_{ij}^2}} \quad (6)$$

where X_j is the j-dimensional vector-valued of target case, Z_{ij} is the j-*th* vector-value of i-*th* standard sub case, Si is the similarity between the target case and i- *th* standard sub case, W_{ij} is the weight coefficient, which is usually determined by expert experience data.

The definition of the similar distance function between the target case X and i- *th* standard case Z_i is:

$$di = 1 - Si < \theta \in (0,1) \quad (7)$$

where $\theta \in (0, 1)$ is the determination threshold, when d is less than the threshold, we can see that the fault exists similarity between standard case and target case.

C. *Dual mode fusion algorithm*

Multi-modal fusion fault diagnosis is the information processing technology that developed in the last decade, it males a variety of diagnostic information intelligent process as a whole, results more accurate and complete judgment than a single diagnosis and ultimately gives higher reliable fault diagnosis results [6,7]. It involves a multifaceted theories and techniques, such as signal processing, estimation theory, uncertainty theory, pattern recognition, and optimization techniques, neural networks, artificial intelligence, and so on. Multi-modal fusion fault diagnosis usually belongs to the decision-making level fusion, which associates the diagnostic results of different algorithms, and then gets the joint inference results through the correlation processing, decision-making fusion decision. The common methods are Bayesian inference [7], Dempster-Shafer evidence theory [8] and fuzzy set theory [8], the expert system [3], etc.

The overall diagnostic result is actually the decision that is made after integrate the individual diagnostic information. In the decision-level fusion of dual-mode radar fault diagnosis results, We actually obtained the number of diagnostic information is at least two or more than two, but it does not say that they have completely and accurately represent the overall diagnostic conclusions; so, the decision-making level fusion is needed. In the view of Bayesian statistical point, their diagnostic information can be viewed as random variables, these random variables is not necessarily the true value of the overall diagnosis, but only a random performance of the overall truth value, but they are all fraught with some information of the overall true value. Therefore, we could make re-integration of this information, eventually infer the overall diagnostic information, and give the best fault diagnosis results.

According to the Dempster-Shafer theory of evidence [8,9], setting up $h_i \quad (1 \le i \le m)$ as the failure basic probability distribution function exported by m independent diagnostic, the probability distribution function h jointly acted by m independent diagnosis is:

$$h = h_1 + h_2 + \cdots + h_m = \begin{cases} h(\gamma) = 0 & (D = 1) \\ h(K) = \dfrac{\sum_{(k_1 \cap k_2 \cap \cdots \cap k_m = K)} \prod h_i(k_i)}{1 - D} & (D \ne 1) \end{cases} \quad (8)$$

The $h(K)$ is the basic credibility of k; D represents the measure between different fault, The D is the greater, the greater the conflict between each fault, with:

$$D = \sum_{k_1 \cap k_2 \cap \cdots \cap k_m \ne \gamma} \prod h_i(k_i) \qquad (1 \le i \le m) \quad (9)$$

When there are M different diagnostic conclusions for the target, the sample library has J fault samples, the similar distance between target and sample is d, then the rate membership matrix of m times diagnosis is:

$$\beta_{m \times J} = \begin{bmatrix} d_{11} & d_{12} & \cdots & d_{1J} \\ d_{21} & d_{22} & \cdots & d_{2J} \\ \vdots & \vdots & \cdots & \vdots \\ d_{m1} & d_{m2} & \cdots & d_{mJ} \end{bmatrix} \quad (10)$$

The basic probability function value can be determined by the following formula [7, 8]:

$$h_m(k_i) = \delta_m \frac{1}{d_{mi}} \quad (i=1,2,\cdots,J) \tag{11a}$$

$$h_m(\Theta) = 1 - \sum_i^J \frac{1}{d_{mi}} \delta_m \tag{11b}$$

$h_m(k_i)$ indicates the confidence level of events "for diagnosis fault is the i fault of the standard fault library" confidence level, δ_i is the weight. 2 factors should be mainly considered in setting the weight δ_i: (a) Performance weight factors: Different fault feature extraction methods have different characteristics, so the fault diagnosis rate and stability are different too. After a large number of experiments, statistical diagnostic results in the actual environment, this paper uses average correct diagnosis rate of failure as performance weights. (b) Correlation weight factors: Making use of the improved DS combination rule requires the independence of each other between the various types of fault cases. However, there is a inevitably correlation between the information provided by each failure characterization in the practical application, so we should give larger weights for the separate fault cases, on the contrary, give smaller weights.

Thus, when $k_1, k_2 \subset \Theta$, Θ is the fault diagnostic framework, we take J sample of fault library. We could get: $h(k_1) = \max\{h(k_i)\}, (k_i \subset \Theta, i = 1, \cdots J)$,

$h(k_2) = \max\{h(k_i)\}, (k_i \subset \Theta, 且 k_i \neq k_1, i = 1, \cdots J)$ and:

$$\begin{cases} h(k_1) - h(k_2) > \alpha_1 \\ h(\Theta) < \alpha_2 \\ h(k_1) > h(\Theta) \end{cases} \tag{12}$$

The final diagnosis result is $h(k_1)$. $h(\Theta)$ represents uncertainty, α_1, α_2 is the set threshold. A dual-mode fusion radar intelligent fault diagnosis system based on improved DS is shown in Figure 3. Failure phenomena were respectively sent into wavelet BP neural network module and the improved case-based reasoning module for fault diagnosis of the first phase, the resulting case solution hi, hj and then fed into the improved the DS dual mode fusion module for fusion of the second order to obtain the highest reliable fault diagnosis conclusion and failure solutions, if the fault solutions exist hardware replacement requirements, the hardware replacement adjustment parameter database will give the corresponding parameter test steps after replace the components and specific debugging method of parameter values, which is a very practical expert knowledge base designed based on the author's many years of work experience [6, 10].

In the maintenance of the electronic systems, judging which one overall device damage to replace the whole device is often called a device-level maintenance, judging which one Printed Circuit Board (PCB) damage of device and replace the circuit board is called plate level maintenance, judging which one element, chip burnt out of the circuit board and replace the components and chip is called the maintenance of chip level. Therefore, we divide fault diagnosis level of the weather radar system into corresponding three levels: device level fault diagnosis, plate level fault diagnosis, chip level fault diagnosis, and give the corresponding failure maintenance solutions of the device-level, plate level and chip-level. The experimental data show that the wavelet BP method is particularly suitable in the chip-level fault diagnosis, improved CBR method is particularly suitable for device-level fault diagnosis; the plate level fault diagnosis method can use both.

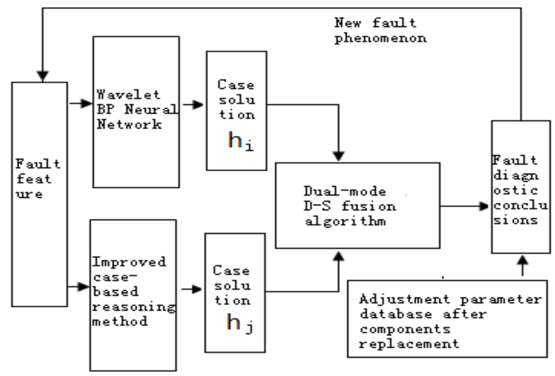

Figure 3. The block diagram of radar intelligentfault diagnosis system based on the improved d-s dual mode fusion

III. CASE ANALYSIS

Based on 3830 weather radar system [6], as an example, the analysis of the system of drive fault phenomena, fault type is the key. The drive function is receiving control instruction sent by servo control panel and R/D conversion board driver interface circuit, including antenna speed steering instructions, positioning position command, control mode selection instruction, etc., receiving motor with rotary encoder (code disc) delivery of the antenna at present speed, steering, etc. state information, and eventually generating a driving antenna rotational drive signal from the internal operation treatment sent to drive antenna scanning bearing motor and pitching machine. The 3830 weather radar system drive function diagram is shown in Figure 4. The drive maintenance of 3830 weather radar system is defined as a device-level fault diagnosis, the maintenance of drive plate and chip, is defined as the drive plate and chip plate level and chip-level fault diagnosis.

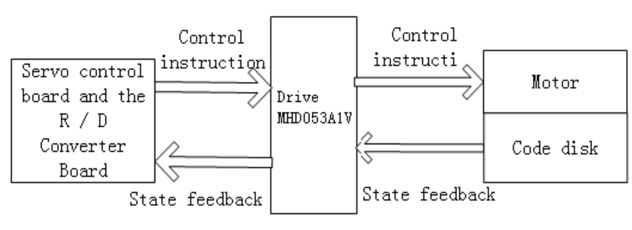

Figure 4. Functional diagram of 3830 weather radar system drive

A. Application of wavelet BP cases

For the maintenance characteristics of the drive plate and chip we set eight test points on the drive plate, only consider the 11 main consumable components transistors and integrated circuits, define the type of fault as 11, wavelet BP output nodes as11, the input nodes as 8, the number the hidden layer wavelet function nodes can be adjusted according to the actual training effect, in this case is taken as 16. BP wavelet fault diagnosis algorithm specific implementation steps are as follows:

1) Initialization of the network parameters. The random wavelet dilation factor, translation factor, the initial value of the network connection weights, Learning rate = 0.8, momentum factor = 0.1, learning number = 2000, counter = 1, system error = 0.001, is shown in Figure 5.

2) Entering the learning samples and network training. The training samples are usually obtained by a number of experimental data, or by entering the value after the normalization of Electronic Design Automation (EDA) software simulation data [6] into the network as training sample, less than 1000 training, and network convergence.

3) Circuit Fault Diagnosis. The voltage value of the test fault circuit and the test data after pretreatment input to the wavelet BP network have been trained well for the fault diagnosis of the circuit. For example, let the servo drive MHD053A1V plate in the circuit shown in Figure 6 VDC = 0V, namely the circuit's power supply is disconnected; the 7-th test point voltage value is 0V. Input all eight test point voltage value after normality to the wavelet BP network and the trained wavelet BP network can give the circuit fault diagnosis results for "VDC = 0V" number. Diagnostic results are the same with the actual situation, showing that the present method is effective for circuit fault diagnosis.

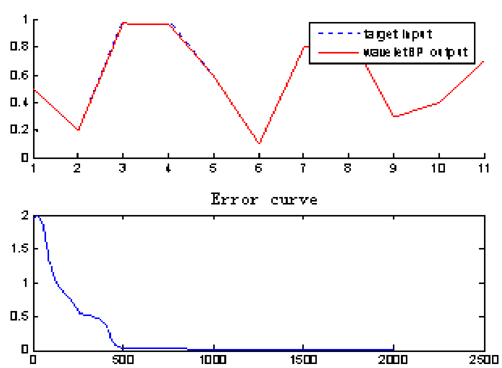

Figure 5. Wavelet BP neural network learning Effect and error curve

B. CBR application cases

3830 weather radar drive a fault case is shown in Table 1. Failure case Numbers is TQ3 and the T of TQ3 represents system layer of antenna device, Q represents case layer drive, 1 represents drive of the cases is 1 case, take Wij=1.

C. The application of the dual-mode Fusion

According to the previous dual-mode fusion algorithm and fault determination rules, wavelet BP usually takes larger value in credibility of the chip-level fault diagnosis, So their weights in the chip-level fault diagnosis can be set at 95%, 75%;

However, the improved CBR method take a larger value in the credibility of device-level fault diagnosis, their weights were set at 75%, 95%; Both methods have their own strengths in plate level fault diagnosis, the weights can be set at 50%, 50%. Then, follow the improved DS's dual mode fusion algorithm described in Section 2.3 to fusion, the α_1, α_2 were respectively 0.6, and 0.1.

D. The adjustment parameter database after components changing

Because after components replacement, usually, there is a need for adjustment and settings of some parameters to ensure that the radar system works in the best state; so, the fault diagnosis system especially adds an adjustment parameter database. For example, the CINRAD / CC radar servo system drive replacement parameter settings shown in Table 2. The calibration setting after the radar servo system antenna replacement is shown in Table 3.

E. Failure phenomenon: Antenna azimuth fixed

Feature 1: Without electricity, antenna could be more easily rotated, no abnormal noise; Feature 2: It has overload alarm; Feature 3: The electromagnetic brake act correctly; Feature 4.1: Motor connecting wire normal; Feature 4.2: The resistance value of the 1, 2, 3 line and ground resistance on XS03 is infinite; Feature 4.3: The mutual resistance of 5, 6, 7 line on XS03 is not basic equal.

If there is an input failure characteristics into the dual-mode weather radar intelligent fault diagnosis system, the diagnostic conclusion of these characteristics in wavelet BP is 0, the fault diagnostic conclusion in improved CBR is: The drive is damage, similar distance function d12 = 0.0012. The fault diagnostic conclusion in the improved DS's dual-mode is: the drive is damage, the credibility is 95%, exclusion program; solution is to replace the azimuth drive, and process according to the requirements of components replacement adjustment parameters database after components replacement.

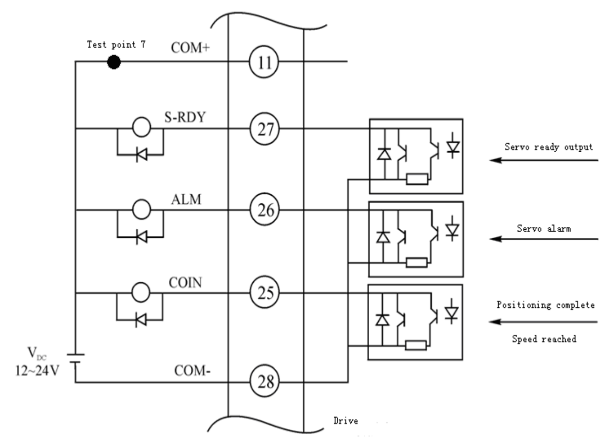

Figure 6. Feedback signal connecting circuit of the drive

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TABLE I. THE CASE OF A FAILURE OF THE DRIVE

Fault case Number A	Fault phenomenon B	Feature Description C	Troubleshooting solutions S	Retrieval information R
TQ1	Antenna pitching fixed	1 Without electricity, manual antenna can turn normal, and presence of abnormal noise; 2 Whether for a long time more than the rated load and torque run, overload alarm; 3 Whether electromagnetic brake malfunction; 4 Whether motor fault; 4.1 Check motor connecting line is normal or not; 4.2 Whether the resistance value of the 1,2,3 line and ground resistance on XS03 is infinite; 4.3 Whether the mutual resistance of 4,5,6 line on XS03 is the basic equal;	1 Eliminate antenna running met blocking or drive mechanism to be blocked; 2 Changing the pitch drive; 3 Remove electromagnetic brake in wrong action; 4 Repair or replace motor 4.1 Reconnect; 4.2 Motor on short circuit, the motor burnout, replace the motor; 4.3 Brush, collecting ring bad contact; Clean or replace carbon brush and collecting ring;	Has been used five times

TABLE II. CINRAD/CC RADAR SERVO SYSTEM DRIVE REPLACEMENT PARAMETER SETTINGS

Parameter code	Function	The set up in 3830	Setting Description
PRA 02	Control mode selection	This system is set to 2	Drive work in position control mode.
PRA 42	Instruction pulse input mode	This system is set to 3	Input command signal for "direction" and "pulse" way, changing input "direction" (high/low level) signal can change the motor rotation direction, changing the input "pulse" the signal frequency can change the speed of the motor speed.
PRA 4B	Instruction pulse frequency division denominator	This system is set to 500	Divide the frequency of the signal input "pulse": 1 / (10000/500), this parameter can be fine-tuning: when the radar antenna speed partial small (or Angle positioning "less than"), make the parameter a small adjustment; When radar antenna speed partial big (or Angle positioning "overshoot"), make the parameter a big adjustment.
PRA 5E	The first torque limit	This system is set to 12	We set the maximum motor output torque is 120% of the rated torque to prevent winter power the radar antenna instantaneous starting torque overload shutdown phenomenon.

TABLE III. CINRAD/CC RADAR SERVO SYSTEM DRIVE REPLACEMENT PARAMETER SETTINGS

Parameter code	Function	The set up in 3830	Setting Description
T1. 1	Antenna Angle calibration	The system uses solar tracking	（a） Using the control software to make the antenna beam aim at the sun gradually (the receiver output noise maximum just at the sun)； （b） Record the azimuth and elevation angle indicated by servo system as the noise level reach the maximum, and compare the angle with the sun actual angle； （c） Correct the antenna directive angle according to the comparison result.
T1. 2	Receiver noise factor test	The system is set to “noise coefficient calibration”	In the noise power on and off two kinds of state, the signal processor continuously samples receiver output noise level, shows the noise coefficient test value after calculation in the terminal display。The noise coefficient is generally 2 ~ 3 db。
T1. 3	The systems phase noise test	Doppler processing of the output I, Q signals	Make the antenna at a fixture, receive the echo signal. Doppler process the I and Q signals outputted by linear channel, give the phase φ, then find out phase noise σ_φ， Phase noise should be less than 0.3 °.

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The fault diagnosis conclusion could be regarded as a new phenomenon of the failure sent to the input of the system and then have a chip-level diagnosis of the drive failure. Collect eight test points voltage of the drive firstly, and then set the eight voltage values into the dual-mode weather radar intelligent fault diagnosis system as the new fault feature for secondary diagnosis. For example, the seven test point voltage = 0V, the voltage of the other test points is normal, then the diagnostic conclusion of these characteristics in wavelet BP is 10: the feedback signal connection circuit of drive power is abnormal; the fault diagnostic conclusion in CBR is 0; the fault diagnostic conclusion in the improved DS's dual-mode fusion is that the feedback signal connection circuit of drive power is abnormal, the credibility is 95%, exclusion program; remedy is to check the DC power supply of the feedback signal connection circuit or the circuit is partly open.

IV. CONCLUSION AND FUTURE WORK

The dual-mode weather radar intelligent fault diagnosis system is a practical intelligent fault diagnosis system. It is result of combined with theory and practice. The wavelet BP method is particularly suitable in the chip-level fault diagnosis, improved CBR method is particularly suitable for device-level fault diagnosis, and the plate level fault diagnosis method can use both. The fusion of the two kinds of fault diagnosis model increased the "adaptability" of radar circuit fault diagnosis system, which is effective for the radar fault diagnosis of device level, plate level, chip level, and give correspond the fault repair solutions at the same time, the improved d-s fusion algorithm of dual mode actually improved the credibility of the radar fault diagnosis, increased the radar equipment analytical, the radar fault components positioning accuracy can be improved. The parameter settings database after components replacement and the feedback processing functions of fault diagnosis conclusion are newly added in the system, these features are fully demonstrated the practicality and effectiveness of the system.

But, this system is relatively complex, calculations require long times. On the basis of the guarantee the accuracy of fault diagnosis, still need to improve the efficiency; this is the future research direction in this paper.

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