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Research on island detection technology based on AdaBoost-SVM algorithm

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Abstract. In order to ensure good power quality of photovoltaic power generation system and safety of equipment and physical .For traditional islanding detection method NDZ (Non-detection zone) is big and the introduction of a large disturbance reduce power quality, this paper presents a wavelet entropy and achieve a new algorithm uses adaboost islanding detection method by sampling the voltage of the common point and the inverter current extracted from the corresponding wavelet entropy feature quantity after the wavelet transform, and then use Adaboost-svm improved training and recognition algorithms, simulation results show that the use of this article the method can accurately identify very difficult to identify the traditional methods of island situations, and in the same learning algorithm, the accuracy rate is relatively high, with high accuracy and reliability in islanding detection.

Keywords. Island detection, multi resolution, wavelet entropy, Adaboost-SVM

As the energy problem becomes more and more serious, the photovoltaic power generation system has been developed rapidly in our country, more and more photovoltaic systems are started and connected to the large power system. But there are also some new problems, that is, the "island effect." In this paper, a new passive islanding detection method is proposed, which is based on the characteristics of the voltage and current changes in islanding operation of photovoltaic system. The basic principle is to analyze and extract the output current and common voltage of grid-connected PV system. Which can reflect the singular spectral entropy characteristics of dual-tree complex wavelet transform, and form the feature vector, and then through the adaboost-svm algorithm analysis to determine whether the island

1 Feature extraction based on double-tree complex wavelet transform and singular spectral entropy

1.1 Dual-tree complex wavelet transform

DT-CWT (double-tree complex wavelet transform) is an improved wavelet transform, can effectively improve the decomposition of the redundancy between bands.

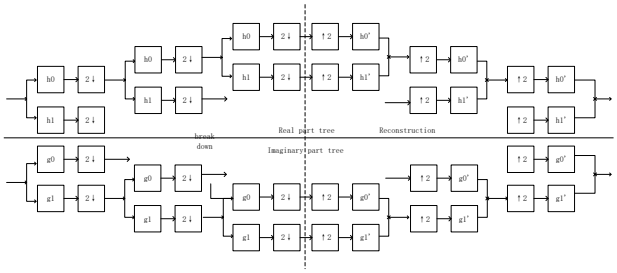

Figure 1. Decomposition and reconstmction process for DT—CWT

In order to eliminate the aliasing of the frequency bands existing in the signal analysis, Kingsbury uses two parallel real discrete wavelet transforms to implement the decomposition and reconstruction of the signal using different filter banks. The wavelet transform is called the real part tree and the imaginary part tree. Its decomposition diagram shown in Figure 1.

1.2 Singular spectrum entropy

As an effective time-domain analysis method, singular spectral entropy analysis can analyze the time-frequency of signal and can analyze singular value of signal energy distribution So the singular value vector of the layer can characterize the characteristics of the layer, but not too intuitive, so with entropy to give it a measure. So the singular spectrum entropy is very suitable for the islanding detection of photovoltaic grid-connected system.

1.3 Feature extraction based on double-tree complex wavelet transform and singular spectrum

1）Firstly, the common sampling point voltage V and the inverter current I are decomposed by wavelet decomposition. The decomposition layer is chosen as 6 layers, and the Q-shift double-tree filter constructed by Kingsbury is used. The voltage and current Sampling points were 1280. 2）And then the coefficients of each layer of the obtained double-tree complex wavelet transform are reconstructed in phase space to obtain $^{1153\times128}$ the voltage and current matrix ^{A_iB_i}.3）The singular value decomposition of the obtained phase space reconstructed matrix and the

singular value information entropy of the island state judgment are obtained by analyzing the singular value matrix. Since the number of decomposition layers is 6 layers, there are a voltage amount and a current amount, so-called eigenvectors can be obtained$T=[H_1,H_2,H_3,H_4,H_5,H_6,H_7,H_8,H_9,H_{10},H_{11},H_{12}]\cdot H_1-H_6$ is voltage signal decomposition and reconstruction of the information entropy， H_7-H_{12} is information Entropy of Current Signal. The use of information entropy to express the complexity of voltage and current signals is very simple, and the use of the concept of entropy, but also the complexity of the entire signal has a quantification. By knowing the change of entropy in each frequency band, the island state can be effectively judged.

2 Adaboost-SVM Variable-sigma Algorithm

2.1 Adaboost algorithm

With the development of technology, Freund proposed a new feasible method - adaptive (Adaptive) boost algorithm [8], so that weak classifier has also come into play. The algorithm is named Adaboost algorithm, because it can be based on the classification of weak classifier to weight, compared with the boost algorithm has a greater adaptability.

2.2 Construction of weak classifier for variable σ-SVM

Because the problem studied in this paper is islanding detection, the system only exists island state and normal state, so this problem is a typical binary classification problem, only need to use the basic SVM to do weak classifier. According to the actual problem to select the kernel function, this paper selects the RBF kernel. $K(x, x_i)=\exp(-\frac{|x-x_i|^2}{\sigma^2})$ (1)

According to Wang Xiaodan's description of the parameters [3], this paper decided to use adaboost algorithm for each use of the standard deviation of training samples to this time, the corresponding penalty factor C is set to 500. Adaboost algorithm in the case of a certain penalty factor, the variable method can greatly improve adboost generalization ability [3].Then the trained feature set is trained by adaboost algorithm, and a corresponding number of weak classifiers are constructed (the number of iterations is equal to 100), and the classification is determined by the final decision function. In this paper, simulink simulation to extract the samples we need, after feature extraction operations into the adaboost algorithm training, and finally the model used for island online detection.

3 Simulation examples and classification results

3.1 Training set simulation acquisition and construction and classification of classifiers

The 3kW grid-connected photovoltaic single-phase power generation system is simulated by Matlab / Simulink, and the effective voltage is 220V. The simulation sampling frequency is 6 400 Hz, sampling time is 0.2 s. Inverter output through the filter inductance to the load and the grid, the load using RLC parallel load, Simulink simulation shown in Figure 2. Where RLC is the local load, the grid voltage is replaced by the ideal voltage source, harmonic interference and voltage changes can be operated by changing the voltage source.

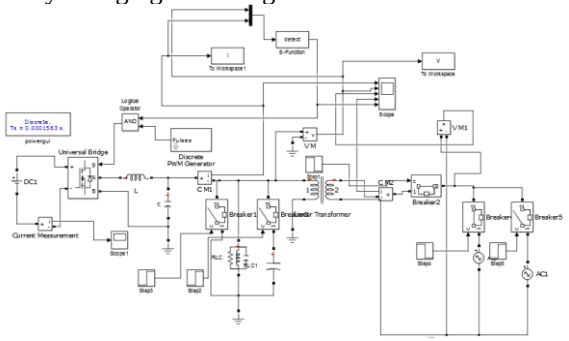

Figure 2. Simulink simulation diagram

According to Xie Dong et al in the literature [1] on the island detection success rate in Figure 2 designed five different situations to test the accuracy of islanding detection.

After the model is built, it can be adaboost-svm algorithm training. First, set the corresponding island state label to -1 and the remaining 4 states to 1. Then, the local load parameters are adjusted accordingly. Then, the label of the common point voltage, the inverter current information and the state under the five states are trained into adaboost-svm algorithm to get a strong classifier. The samples were divided into 50 groups, 10 groups were sampled after changing the local load in each state, and 40 sets of data were used as the training set and 10 groups as the test set by random sampling. In the case of successful cross-validation, the trained classifier is simulated by simulink.

3.2 Simulation results analysis

Finally, the correct classification rate of 98%, 50 sets of data, only one set of wrong points sample points.1) First, from the sampling of the characteristics of the analysis, in the case of a change in the load under each state of the entropy of each layer difference is not obvious. It is proved that the entropy has a relative stability to the response of the same state.2) The difference of the entropy of several layers between the ten groups of data in the isolated island state and the non-isolated state is more obvious. In different states, the entropy is used to reflect the essential difference of signal.3) In the selection of the same characteristics of the premise, we choose a different classification algorithm to test the algorithm, as shown, we choose adaboost the most common weak classification algorithm K-nearest neighbor algorithm to compare the classification effect, the following is the adaboost- Knn algorithm and adaboost-svm algorithm classification distinction.

It can be seen from Figure 3 that with the increase of the number of iterations, that is, the number of weak classifiers increases, the accuracy of classification can be increased steadily, And the use of K-nearest neighbor algorithm as a weak classification algorithm effect is obviously not SVM algorithm for weak classification algorithm is better. When adaboost-svm carries on the first iteration, because the weight of the sample is all the same, we can think that the accuracy rate of adopting svm algorithm classification is about 93%. So using adaboost-svm algorithm need to iteration 100 times, sacrificing a certain degree of detection time, but increased the recognition accuracy.

And we alone detection to do is in island detection standard time to as possible accurate detection island State, to completed corresponding protection action.

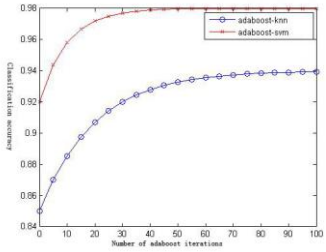

Figure 3. Algorithms classification success rate

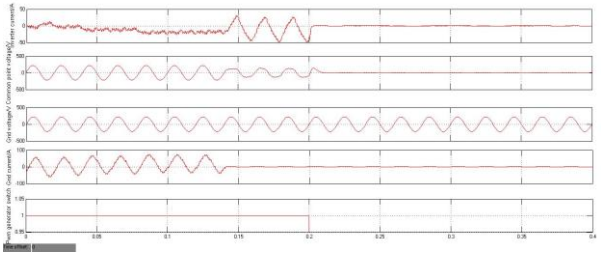

Figure 4. Online simulation after the islanding

3.3 Classifier application simulation

Put the classifier that obtained before into the simulation model for online experiments, respectively, to change the local load and then do online simulation, the results are as follows

As can be seen from the figure, the entire system 0.14 seconds at the occurrence of the accident, resulting in the island state, and our detection module at 0.2s detection of the island state, and accordingly lock the pwm wave generator, the entire inverse The converter module is closed, to complete the island state protection processing. The whole detection time of 0.06s used to meet the national standard GB / T19939-2005 on the island state required testing time requirements. Other non-isolated state also carried out on-line simulation experiments, and no false alarm occurred.

The above simulation results show that the method described in this paper can detect islanding accurately, and it will not malfunction when signal interference such as load input and exit, harmonic interference of the power grid, etc .; In addition, this method is not like the traditional Passive detection method has a large islanding detection blind area (DNZ) under load matching, and it does not affect the voltage quality caused by the disturbance signal introduced in the active detection method and overcomes many shortcomings of the traditional method.

4 Concluding remarks

In this paper, an islanding detection method based on double-tree complex wavelet entropy and adaboost-svm algorithm is proposed, and the corresponding simulation experiment is carried out for single-phase PV grid-connected power system. The simulation results show that the dual-tree complex wavelet entropy can reflect the characteristics of the essential characteristics of the signal, can quickly and steadily reflect the essential characteristics of islanding effect, while adaboost-svm algorithm and adaboost-knn algorithm to compare the classification effect, It is proved that the accuracy of adaboost-svm algorithm is relatively high. And the whole experimental results are experimented under different local load conditions, so this method can solve the situation that the traditional passive method can not detect the load matching, and do not introduce new interference quantity.

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