resistances, switching time etc. should be measured. Most tests are performed manually.

The aim of the work is the investigation of the application of the wavelet trans-form for fault diagnostics of the neutral signalling relay.

For investigations there were taken ten different signalling neutral relays in op-erable condition. The dependences of transient current in relay coil on time during relay energizing at different applied voltages with subsequent de-energizing by short-circuiting of the coil have been measured.

Analyses of the transient currents were performed by using of segmentation of the relay current characteristics. The transient currents at the first and third seg-ments that corresponded to unmovable anchor, increased with time approximately as the exponential function.

The time constants calculated by fitting of the transient current at first segment by using of the exponential function were practically independent on contact springs faults but strongly depended on condition of relay coil and magnetic circuit. Such behavior allows us to conclude that time constants for first segment can be used for monitoring of relay electromagnetic system condition. The faults caused by defects of armature and contact springs led to the appearance of additional features on the second segment of the transient current which corresponded to the movement of the armature

During the armature movement, contacts and springs mechanically connected to it are bent. As a result the some tiny features appear at the second segment of the relay transient current. For analysis such non-periodic non stationary signals the wavelet transform is widely and successfully used last two decades.

The features (spikes) at the relay transient current curve which correspond to contact springs faults were clearly distinguishable by using wavelet transform modifications (CWT, DWT, DWPT), which allowed us to clearly extract fault fea-tures. The relative differences in values of spikes for DWT and DWPT energy plots were caused by different scale parameters used in these transforms.

Since the number and amplitude of spikes on DWPT energy plots increased with increasing of armature and contact springs faults, it allows us to use single in-tegrated parameter for the fast monitoring of the relay armature and contacts condi-tion. It was shown that for these purposes can be used the WEPSE of transient cur-rent, which values increased with the increasing of the faults in relay contact springs.

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USING A HYBRID NEURO-FUZZY SYSTEM FOR DIAGNOSING COMPLEX OBJECTS

In determining the technical condition of the complex technical facilities major critical factor is the time of the decision to localize faults. Using a hybrid diagnostic system with a neurofuzzy network knowledge base provides decision support in situations for which the diagnostic algorithm is not known and is formed from the initial data in the form of production rules. To automate the process of accumulating knowledge in a diagnostic system, it is advisable to use object sensors, with which the values of diagnostic parameters are measured. Advances in wireless technologies have enabled to make use of wireless sensor networks (WSN) for to measure the values of the controlled parameters. There is a wide variety of WSN applications, such as environment monitoring, scientific observation, emergency detection, field surveillance, structure monitoring, and so on. In those applications, hundreds or even thousands of sensor nodes are assumed to be deployed in the target fields.

One of the most important types is tolerance control, which sets the relationship between the values of the controlled parameter and established in a certain way the boundaries (tolerances) in its deviations. For tolerance control, an object with parameters is suitable, the measurement results of which are within the specified tolerances, and unsuitable - with parameters, measurement results which are not within the specified limits. Boundaries are established by experience or calculation for the values of the parameters of an object at which it is able to perform specified functions, maintaining its performance for the required time under certain conditions. The value of the operational limits is established by the instruction manual or other relevant documents for those parameters of the object, which are monitored under operating conditions.

Let us consider the effectiveness of control of a certain object for one parameter X, the state of which is characterized by its numerical value. We believe that in order to establish compliance with the norm, statistical processing of the results is required.

Tolerance control allows you to assess the quality of an object without measuring the exact value of the parameter X. Examples of a parameter can be controlled within certain limits, temperature, humidity, etc.

We consider the values of X as a random variable with the distribution density f (X). Let an operability condition be specified for the object, at which X should be in the range $a<x<b$. If this condition is met, X is in the tolerance region and H0 is serviceable. If this condition is not met, then the object has a fault H1

A feature of modern diagnostic system (DS) for information processing and control is that the result depends on the number of input diagnostic parameters (DP) and the corresponding linguistic variables (LV). The initial data at this stage is a list of all possible inputs (diagnostic signs), on which the output depends (the result of diagnostics). Too large number of them will be more difficult diagnosis algorithm, so it is advisable to use only independent diagnostic features. In the manual synthesis of knowledge base must be removed from the list of non-essential features that will simplify the diagnosis object model and improve its performance. However, in the case of an automated method for replenishing a knowledge base, the number of input variables is determined by the number of the sensors.

For an example of the DS functioning, we consider that it is possible to measure numerical values for N diagnostic parameters (DP1, ..., DPn) from N sensors. The sensor readings are obtained at discrete times t0, t1, t2,…, ti. The time interval (ti+1 - ti) between two adjacent measurements is selected taking into account the rate of change of diagnostic parameters. All N characteristics will play the role of diagnostic parameters in the intelligent diagnosis process.

Consider the membership function of an arbitrary input variable DPi, which corresponds to some diagnostic feature.

To evaluate the of the values a sensor node, a binary logic function X is often used with a set of its values {0,1}. At the same time, if x is 1, then the node is operational and if x is 0, then the node is inoperable. However, fuzzy X values are required to use in the DS. For the fuzzification of input the crisp values convert of the input variables X and output variables Y into fuzzy, select the appropriate distribution functions and the number and values terms.

We consider a crisp variable between “a” and “b” and it has five terms with the following limits. – "0-0.1" - "Very Close to a" ; – "0.1-0.2" - "Close to a"; – "0.2-0.8" - "AverageValue"; – “0.8-0.9” - “Close to b”; – "0.9-1" - "Very Close to b".

We apply this fuzzification for all input variables and for output variables. At the fig. 1 is shown five membership functions of the input variable X.

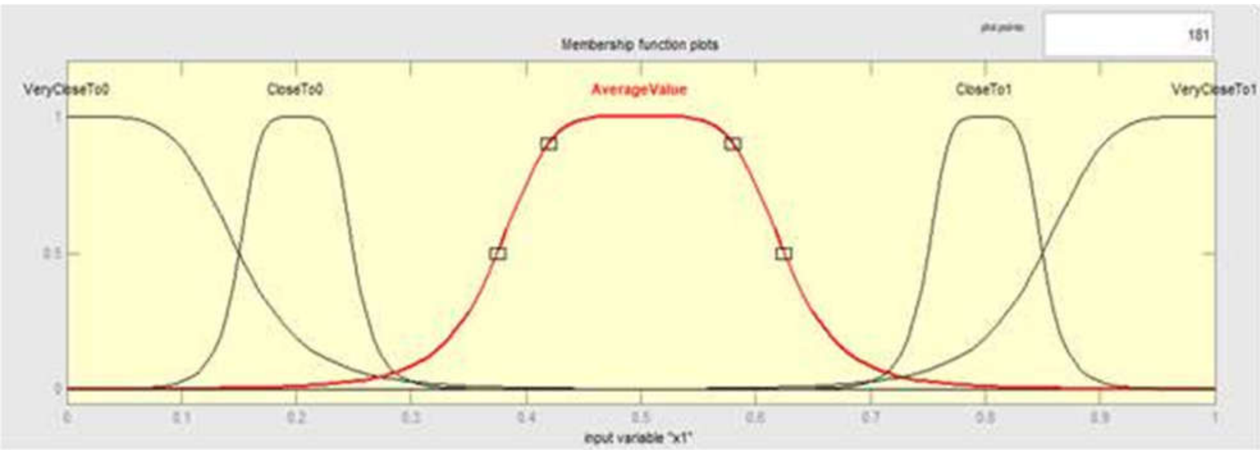

Fig. 1. Membership functions of the input variable X

To implement the diagnostic algorithms, we use the MatLab and ANFIS system.

The adaptive network-based fuzzy inference systems (ANFIS) is used to solve problems related to parameter identification. ANFIS is basically a graphical network representation of Sugeno-type fuzzy systems endowed with the neural learning capabilities. The network is comprised of nodes with specific functions collected in layers. ANFIS is able to construct a network realization of IF / THEN rules. All computations can be presented in a diagram form. ANFIS normally has 5 layers of neurons of which neurons in the same layer are of the same function family.

Layer 1 (L1): Each node generates the membership grades of a linguistic label.

Layer 2 (L2): Each node calculates the firing strength of each rule using the min or prod operator. In general, any other fuzzy AND operation can be used.

Layer 3 (L3): The nodes calculate the ratios of the rule’s firing strength to the sum of all the rules firing strength. The result is a normalised firing strength.

Layer 4 (L4): The nodes compute a parameter function on the layer 3 output. Parameters in this layer are called consequent parameters.

Layer 5 (L5): Normally a single node that aggregates the overall outputs the summation of all incoming signals

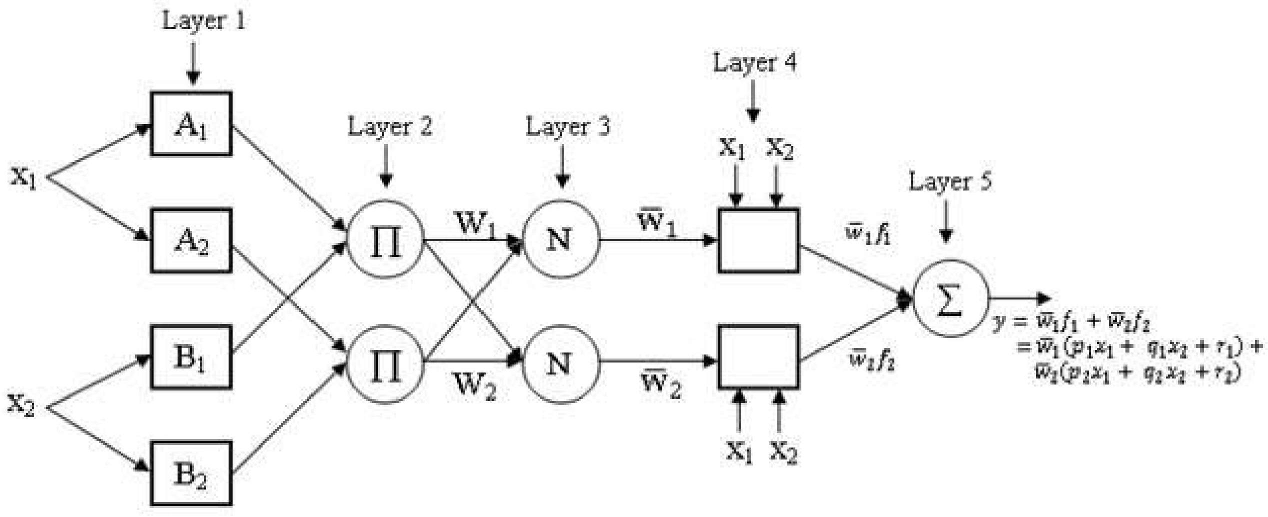

Fig. 2. Structure of the ANFIS network.

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НЕЙРОМЕРЕЖЕВИЙ СТИСК ВІДЕОЗОБРАЖЕННЯ

Добре відомо, що зображення, внаслідок своєї двомірності і багатоспектральності, займають дуже великий обсяг пам'яті і їх компактне зберігання (архівування) представляє серйозну проблему. У зв'язку з цим актуальною науково-технічною проблемою є розробка і створення засобів для компресії і декомпресії відеоданих.

Проблема стиснення зображень і видеопоследовательностей актуальна також при створенні центрів зберігання, архівів і каталогів (баз даних) зображень і видеопоследовательностей в цифровому вигляді (медичні зображення, космічні зображення, отримані за допомогою датчиків дистанційного зондування, фотозображення та ін.). Вирішення цієї проблеми дозволить зменшити обсяг інформації, що зберігається на носіях.

Завдання стиснення зображення можна представити таким чином. Цифрове зображення являє собою двовимірний масив даних розміром. Якщо за M позначити кількість рядків, а за N - кількість стовпців, то можна компактно записати повне цифрове зображення у вигляді матриці.

Завдання стиснення зображення полягає в тому, щоб найбільш економічно уявити зображення послідовністю двійкових символів, задовольняючи деяким додатковим умови. Додаткові умови полягають в тому, щоб можна було в точності відновити зображення за отриманою послідовності, або в допустимій мірі спотворення зображення при його відновленні по відношенню до вихідного.

Для виконання процесу стиснення зображень пропонується використовувати рекуррентну нейронну мережу.

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