

## INFORMATION TECHNOLOGY OF EDDY CURRENT INSPECTION IN THE CONDITIONS OF ACTION OF HIGH-INTENSITY NOISES OF COMPLEX STRUCTURE

**Abstract.** *We developed informational technology which combines earlier offered methods and algorithms of information processing in real time in eddy current defectoscopy in time and spectral domains. Activity diagrams which describe behavior of system with explicit selection of data and control flows are constructed.*

**Keywords:** *information technology, activity diagram, control flow, data flow, UML.*

**Problem definition.** Defectoscopy of materials, defectometry of the surface and subsurface defects of continuity over the past years developed, generally in the direction of development and improvement of the determined computational methods and the experimental assessment of parameters of defects, signals and sensor designs, the compensation modes of the disturbing factors. This direction evolves for several decades and much in what already exhausted the opportunities. And for the nonuniform materials with the composite surface relief as, for example, composite materials with carbon stratifils which are characterized by a vacillation of electrical conductance in volume and on the material surface as a result of noncontrolled changes of reinforcing coefficient and core temperature in technological process of manufacture of products, the considerable surface roughness, the irregular defect forms application of the determined defectoscopic methods is significantly limited.

To replace the determined methods of increase in metrological and production characteristics of the defectoscopic equipment methods which include statistical and correlative signal processing, spectral transformations in different bases, fuzzy logic technologies come. It allows considering statistical property of process of a defectoscopy and defectometry, feature of the quasi determined interferences and measurement noise caused by influence of defectoscopic object, the scanning mode, the mechanism of information transformation in measuring channels of the defectoscopic equipment. Therefore, the problem of creation of informational technology of eddy current

defectoscopy which combines the modern technologies of information processing is urgent.

**The aim of the work** is creation of informational technology on the basis of the methods and algorithms of the information processing in time and spectral domains offered earlier [1-7] directed to probability identification of defect signal in the conditions of action of the quasi determined interferences, called by an uncontrollable tilt or lift-off of the eddy current sensor along the scanning trajectory, and the high-intensity noise caused by the considerable roughness of material surface especially composite with reinforcing fibers.

**Analysis of researches.** In works [1-2] algorithms and methods of the information processing in eddy current defectoscopy in a time domain are offered. In works [3-5] spectral identification methods of defect signals in the conditions of interferences of the complex structure and the intensive noise caused by surface roughness of the tested material are offered and investigated. In works [6-7] spectral, in Fourier basis, method gained further development.

**Main part.** Visualization, designing and documenting of information technology is executed by the Unified Modeling Language (UML) [8] considering openness of the standard and the fact that this language is de facto the industry standard for documenting of information systems, technologies, different software now.

UML language allows describing technology in the form of many diagrams, each of which contains many types of components and relations. For modeling of business processes, technological processes, consecutive and parallel computations use activity diagram. Activity diagrams describe behavior with explicit allocation of data and control flows. The control flow is the sequence of the elementary steps necessary for realization of complex use case. A data flow is the communication description between output data of one action with the input data of other actions.

For convenience of the analysis of the offered information technology its activity is displayed on two diagrams: diagram of preparatory process (Fig. 1) and diagram of the main process (Fig. 2).

At a preparatory stage, it is necessary to execute selection of data on the defect free area of a surface of the studied material, to define a mean square deviation of noise (Sd) and to compute a spectrum of this

sample. It is necessary to determine by the relation between  $S_d$  and amplitudes of test modulation pulses (MP) of test cracks what kind of smoothing needs to be carried out (output parameter  $C_s$ ). Using the received spectrum, we calculate the sum of the first 14 harmonics (output parameter  $S_n$ ). The received parameters are used in the main process (Fig. 2).

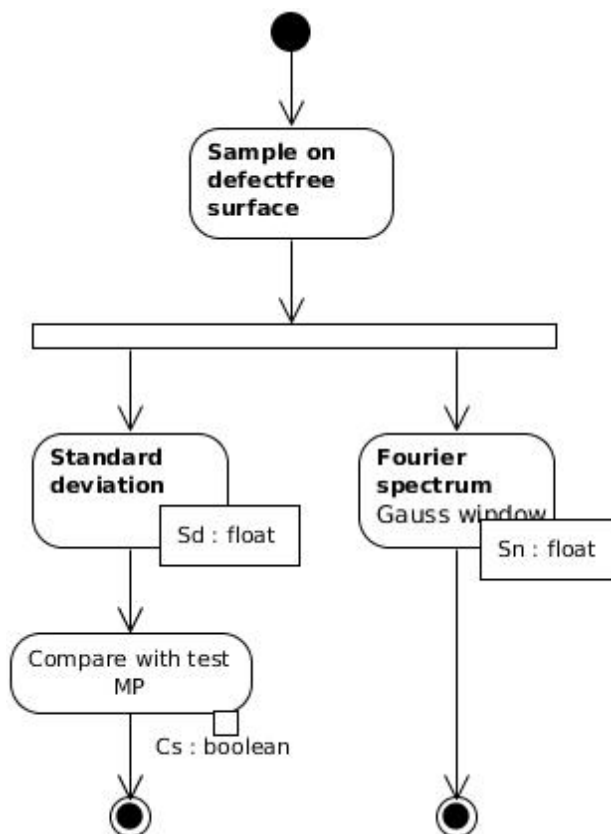


Fig. 1 – Preparation for defectoscopy process

The main process of defectoscopy begins with formation of the sliding window of data which are mix of modulation pulses of surface cracks, tilt signals of sensors and noise. Depending on value of parameter  $C_s$  linear or nonlinear smoothing is carried out [1-2]. At the following stage in case of 2 synchronized sensors processing by cross-correlation function (CCF), in case of one sensor — by algorithm of autocorrelation type is carried out [2].

After the specified data processing in a time domain is carried out calculation of excesses of threshold level by points of the current window. At achievement of boundary value — the signal is sent to calculation of Fourier spectrum of initial sample of data with use of Gauss window [6]. The spectral identification criterion  $Kh$  [3] and the

modified criterion  $Knn$  [7] with use of previously prepared value  $Sn$  is calculated.

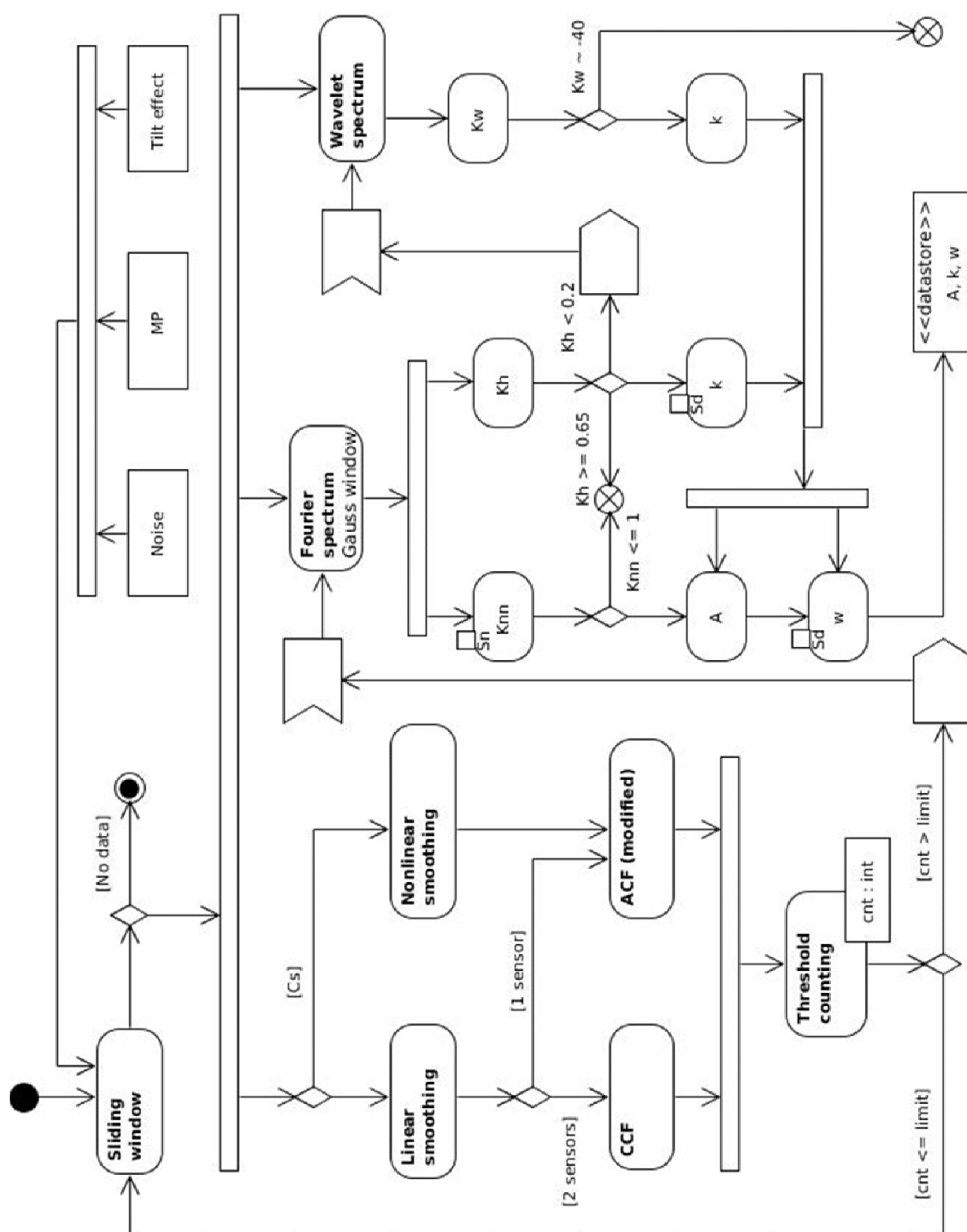


Fig. 2 – The main process of defectoscopy

Value  $Kh \geq 0.65$  demonstrates that in current window there is no signal and in further information processing is no sense. In a case  $0.2 \leq Kh < 0.65$  by its value the coefficient  $k$  [3, 5] which as a first

approximation corresponds to length of a surface crack is defined. In a case  $Kh < 0.2$  it is impossible to define  $k$  without additional processing and therefore the signal goes to calculation wavelet spectrum and the corresponding spectral identification criterion  $Kw$  [4]. Value  $Kw \sim -40$  demonstrates that the found signal is a signal of tilt-effect of the sensor [4, 5] and in further information processing there is also no sense. Otherwise through value  $Kw$  coefficient  $k$  is defined.

If the coefficient  $k$  is defined through criterion  $Kh$  or  $Kw$ , then using  $Knn$  it is possible to estimate amplitude of a modulation pulse  $A$  [7] which as a first approximation corresponds to depth of a surface crack. At the same time value  $Knn \leq 1$  demonstrates that amplitude of a modulation pulse is very small in comparison with noise level and it is impossible to estimate it in such a way.

At the last stage, according to the obtained data on noise level  $Sd$ , amplitude  $A$  and a form of a modulation pulse  $k$  it is defined probabilities of defect detection with corresponding parameters [3-5, 7] and all results are included in data storage, displayed or fixed in other convenient way.

**Conclusions.** It is offered information technology of eddy current inspection in the conditions of action of high intensity noises of complex structure which combines methods and algorithms in formation processing in time and spectral domains. For annex planation control and data flows is used activity diagrams.

#### References:

1. Хандецкий В. С., Герасимов В. В. Вопросы цифровой фильтрации при вихретоковой дефектоскопии композитных материалов / Дефектоскопия. 1997. № 7. – С. 3 – 14.
2. Хандецкий В. С., Герасимов В. В. Корреляционная обработка сигналов при вихретоковой дефектоскопии композитов / Дефектоскопия. 1998. № 10. – С. 3 – 13.
3. Хандецкий В. С., Герасимов В. В. Спектральная идентификация сигналов в дефектоскопии композитов с использованием теории статистических испытаний / Вісник Дніпропетр. ун-ту. Фізика. Радіоелектроніка. 2003. Вип. 10. – С. 128 – 132.
4. Хандецкий В. С., Герасимов В. В., Гноевой С. Н. Вероятностная дефектоскопия углеродсодержащих полимерных композитов с

- использованием вейвлет-спектров / Вісник Дніпропетр. ун-ту. Фізика. Радіоелектроніка. 2004. Вип. 12. – С. 3 – 9.
5. Gerasimov V., Khandetsky V., Gnoevoy S. Research of probability characteristics in defect detection of composite materials using wavelet transform. // Int. J. Materials and Product Technology, Vol. 27, Nos. 3/4, 2006. — P. 210 – 220.
  6. Хандецький В. С., Герасимов В. В. Вплив віконних функцій на розпізнавання сигналів в дефектоскопії композитних матеріалів / Системні технології. Регіональний міжвузівський збірник наукових праць. Вип. 5(88). Дніпропетровськ, 2013. – С. 42 – 49.
  7. Герасимов В. В., Хандецький В. С. Развитие спектрального метода идентификации модуляционных импульсов в дефектоскопии композитных материалов / Системні технології. Регіональний міжвузівський збірник наукових праць. Вип. 1(102). Дніпропетровськ, 2016. – С. 3 – 11.
  8. Unified Modeling Language 2.5. [Електронний ресурс]— Object Management Group, 2015. 794 P. URL:  
<http://www.omg.org/spec/UML/2.5/PDF/>