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Construction of expert model for optimization of harvesting-transport complex

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Abstract.*In the article the technique, which in practice will solve the problem of vector optimization process of harvesting and transport complex in a limited number of statistics and to identify key relationships and regularities process for collecting and transporting the crop.*

Keywords: expert modeling bahatokryte-cal optimization, polynomial approximation, self-organization

Formulation of the problem. Ukraine agro-industrial production with huge potential, which experts estimate may significantly increase its economy. The use of this potential must be effective, be accompanied by sustainable development, and be ekolohichnobezpechnym resursovidnovnym.

Analysis of recent research. Harvesting crops belonging to energy and labor-intensive process, and it accounts for more than half of operating costs in the production costs of grain. From sound engineering and scientific organization of collected and transport systems greatly depends on the effectiveness of investment in agriculture [4].

When optimizing complex technical and economic systems, which is the harvesting and transportation systems is the need to build mathematical models, which do not always have enough experimental and statistical data. This significantly when optimization should be carried out on several quality criteria and thus they are protyrichni.

For failure conditions of experimental data offer the use of thoughts attract experts with sufficient experience in the construction and operation of complex technical systems doslidzhuvalnoho class that allow for modeling of complex process of harvesting and transport of the crop.

Studies conducted with the use of vector optimization for generalized criteria of reliability, cost. When reliability should understand probability of all defined parameters elements of harvesting and transport complex permissible in terms of efficiency limits.

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The use of expert modeling of complex technological systems in field crops will help explore patterns of changes in key functional parameters at work harvesting and transport systems, to make them worthwhile engineering assessment and on this basis to substantiate their rational structure, align compatible modes of individual units.

Naturally, at this stage of modeling we can talk about previous calculations that focus on identification of key factors influencing the reliability and cost of harvesting and transport sector.

Results. To resolve optimization problem must have the following starting data mathematical model.

1. criteria:

$$y_1' = f_1(x)\,;\;\; y_2 = f_2(x)\,,$$

where: y_1' - Reliability space facility (criterion maximization subject); U2 - cost measures that affect the reliability (criterion subject to minimizing); f1 and f2 - some criterion function; $x = \{x_i\}^n{}_{i=1}$ - N -dimensional vector of independent variables (arguments optimization).

2. Restrictions on independent variables $x \in X$ Where:

$$X = \{x \,|\, x_{i\,\min} \le x_i \le x_{i\,\max},\; i \in [1, n]\}\,.$$

3. Restrictions on the criteria $y \in M$ Where M - the domain of the vector criteria $y = \{y_k\}^S{}_{k=1}$ - s-dimensional vector minimizing integral criteria (s = 2). Note that the only way ekstremizatsii criteria chosen to minimize this problem. To feature a criterion for reliability and minimizing do, define $y_1 = 1 - y_1'$ (if 100% reliability is expressed in the unit). Then:

$$M = \{y \,|\, 0 \le y_k \le A_k,\; k \in [1;2]\}\,.$$

Limitation xi min and max on the arguments xi $x \in X$ and Ak the criteria $y \in M$ asked QuestionsBased on physical considerations. If the data is transferred starting, there are all prerequisites for optimizing space objects on the criteria of reliability and value, ie to determine compromise-optimal parameters $x^* = \{x^*{}_i\}^n{}_{i=1}$.

Given the obvious contradictory criteria necessary to resort to the theory of multi-specific methods (vector) optimization. If you are using scalar convolution method, the mathematical model of the task of vector optimization is represented as [2]:

$$x^* = \arg\min_{x \in X} Y\,[\,y(x)]\,, \tag{1}$$

where: Y (in) - scalar function in understanding scalar vector convolution of partial criteria, the type of which depends on the chosen scheme compromise. It should ensure that it leads to minimization of Pareto-the optimum solution: $x^* \in X^K$. In [1, 2] proposed convolution scalar nonlinear compromise scheme

$$Y[y(x)] = \sum_{k=1}^{s} A_k [A_k - y_k(x)]^{-1}, \tag{2}$$

where: S - the vector dimension criteria. Convolution (2) makes it possible to obtain Pareto formalized-optimal solution, appropriate given situation. When s = 2 model (1) becomes:

$$x^* = \arg\min_{x \in X} \left[\frac{A_1}{A_1 - y_1(x)} + \frac{A_2}{A_2 - y_2(x)} \right]. \tag{3}$$

Quality of the vector's quite diverse, and therefore this vector dimension n generally high. Full account's settings would lead to unnecessary complications criterion functions f1 and f2 and undue hardship decision optimization problem. Therefore, natural selection is only the most informative parameters x - coordinate space, which will be the optimization criteria U1 and U2, while other options are considered fixed and predetermined.

Selection will perform with experts. They are familiar with the conditions of the problem, that is called the specific type of developed space object (rocket or spacecraft), describe the terms of its design, manufacturing, testing and operation. Experts must identify the measures which they believe may affect the reliability and cost of space object at different stages of the life cycle of the product. These include the frequency of backup control systems (x1) coefficients stock strength structure (x2) and the power energy sources (x3); The relative volume of the input control of materials and components (x4); selection of production technologies and the relative amount of stability control (H5); the amount of control and sample tests (x6) the amount of experimental testing of components and systems in all modes (x7) the value of material incentives for staff (x8), etc. As a result, a special procedure [1] defined and adequate quality of the vector dimension n independent variables x1, x2, ..., n criterion functions f1 (x) and f2 (x).

Type of criterion function depends on the information available to the researcher to build the model. The range wide - from a full knowledge of the mechanisms of effects (deterministic model) to the total uncertainty ("black box"). Between these poles is probabilistic information level of uncertainty. Deterministic mathematical model f (x) any characteristics of the object space to develop difficult because of the complexity of the physical processes occurring object and reactions to complex internal and external factors.

For example, consider criteria for reliability function f1 (x) and approximate it to the many arguments $x \in X$ some approximate functions F1 (x, a) is known to within a vector of constants (coefficients) $a = \{a_j\}^m{}_{j=1}$.

When choosing the type of functions F1 (x, a) keep in mind [2] that the best results will be if the regression model is based on some information known about the mechanisms of the phenomena studied. Then the model is meaningful. In the absence of such information is necessary to work in the classroom and formal regression models to resort to large amounts of computing.

To formal model presented two conflicting requirements. On the one hand, brings function should be fairly easy to process calculations were not overly cumbersome. On the other hand, approximating dependence must have sufficient and accurate prognostic properties. In most practical cases, both of these requirements are met in a class of second order polynomial regression [2, 3]

$$F_1(x, a) = a_0 + \sum_{i=1}^{n} a_i x_i + \sum_{i,\, j=1,\, i<j}^{n} a_{ij} x_i x_j \,, \qquad (4)$$

where: a0, a1, aij - factors. Function (4) adapts quite well to the topography of the objective function f1 (x), it is able to express such features, such as ovrazhnist. In practice, various truncation polynomial regression (4), mainly linear approximation.

Determining factors as may be performed as the interpolation method and the method of least squares (OLS). Interpolation formulas provide an exact match approaches and target functions in supporting points (interpolation nodes), the amount of which is determined by the number of unknowns N constant and equal to t. Odds are a solution of a system of equations for reliability criterion:

$$F_1(x^{(u)}, a) = f_1(x^{(u)}), \; u \in [1, N = m], \qquad (5)$$

where: x (u) - interpolation nodes. It is assumed that the value of the objective function approximation in knots $f_1(x^{(u)}), u \in [1, N]$ famous. But to receive them should contact the experts. This - the key point in this work, which is discussed below. MLS provides for N control points (nodes approximation), the number N may be greater than or equal to (as a special case) number of constants m. Unknown factors brings the functions defined by the condition.

$$E(a) = \sum_{u=1}^{N} [F_1(x^{(u)}, a) - f_1(x^{(u)})]^2 = \min_a . \qquad (6)$$

With a necessary condition for the minimum functions get called in the theory of least squares normal equations for system reliability criteria [2]:

$$\frac{\partial E(a)}{\partial a_j} = 0 \,, \; j \in [1, m], \qquad (7)$$

decision which determines rates approximating function. Note that regardless of the number of selectable reference points N system of normal equations (7) is always certain.

For criterion value f2 (x) just all the above considerations, but instead $a = \{a_j\}^m{}_{j=1}$ in terms of approximation function F2 (x, a) generally appears another vector of unknown constants - $b = \{b_h\}^p{}_{h=1}$.

The specificity of the considered problem is the difficulty of obtaining values of the objective functions as reference points. Indeed, even for a single reference point, which corresponds to the established date of measures to ensure the reliability of space object of this class, there is a sufficient statistic for confident estimation of reliability. This especially applies to the newly designed objects that do not have a long period of use. And it is illusory possibility of objective evaluation of reliability for the existence of other points of argument region optimization $x \in X$.

In cases when the task vazhkoformalizuyuche, have to resort to methods of expert estimates. A qualified specialist (expert) having sufficient experience in the design, manufacture and operation of this class may conduct a thought experiment and provide the level of reliability of the object at different combinations of factors $x \in X$. Thus, the method is based on individual opinion (postulate), statements of professional experts about the object of evaluation, based on their professional experience. The main disadvantage is the possibility of postulating a subjective arbitrary choice. The method of expert assessments can reduce this disadvantage. According to the method for the evaluation of some quantitative characteristics postulates used not one but several persons competent in this matter. It is assumed that the "true" value unknown quantity characteristics is within the range of expert evaluations and collective thought is more credible. In [2] proposed data processing expert estimates, in which the received specified aggregate evaluation, and (as a by-product) ratios are determined by trust in the opinion of some experts. Applying this method to the treatment of the reliability of expert assessments and cost in each of the N domain of nodal points $x \in X$ We get two vectors ratings (kvazieksperymentalnoho data):

$$\{f_1(x^{(u)})\}_{u=1}^{N}, \ \{f_2(x^{(u)})\}_{u=1}^{N},$$

serving the basis for determining the vector constants a and b in the case of the method of interpolation or conditions (6), (7), if applicable MNCs. Thus defined mathematical regression models:

$$y_1 = f_1(x) \approx F_1(x); \ y_2 = f_2(x) \approx F_2(x),$$

involved in the optimization procedure (3). While the details of target functions in the field of approximation of the nodal points not obtained experimentally and by expert assessment, then the model F1 (x) F2 (x) are called expert regression model.

Consider the problem of choosing the method of approximation criterion functions specified circumstances. At various truncated polynomial regression (4) the number of unknown constants usually exceeds the amount of N nodes approximation, in which the expert can quite confidently give their estimate of criterion functions. Therefore, using the method of interpolation, get nedovyznachena system of equations in which the number of equations is less than the number of unknown constants. To prevent this, you should apply the method of least squares that mathematics is seen as a way to solve nedovyznachenyh, and overriding certain (as a special case) systems of equations.

Conclusion. The technique will allow the practice to solve the problem of vector optimization process of harvesting and transport complex in a limited number of statistics and to identify key relationships and regularities process for collecting and transporting the crop.

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Abstract.*In Article proposals technique kotoraja pozvolyt in practice Reshat task vektornoy process optimization work uborochno transport complex at ohranychennom Quantity statystycheskyh data, as well as vыyavyt Basic vzaymosvyazy and zakonomernosty tehnolohycheskoho process for Other cleaning and transportyrovke harvest.*

Keywords: эkspertnoe Modeling, mnohokryteryalnaya optimization, polynoмы approximation, self-organization

Annotation.*The paper proposes a method that allows in practice to solve the problem of vector optimization process work harvesting and transport complex with a limited amount of statistical data and to identify*

the basic relationships and patterns of the process for harvesting and transporting crops.
Key words: expert modeling, multi-criteria optimization, polynomial approximation, self-organization

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ENERGY ASSESSMENT RESULTS TECHNICAL SUPPORT GRAIN CROPS HARVESTING

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Abstract. *The article presents the results of the energy evaluationthe use of modern combine harvesters, depending*
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the volume of harvested grain. To analyze the indicators used in gross energy harvesting and the total capacity of the park combine harvesters. As a result of analysis of the dependence of the total fleet capacity combine harvesters from Ukraine variables acreage, yield and average gross yield energy crops.
Keywords: crops, gross yield, zernozby-eral processor, power, energy intensity, energy

Formulation of the problem. For efficient picking crops using modern high-performance combine harvesters of different manufacturers, which differ as indicators of the technical characteristics and quality of the process. In recent decades, the observed upward trend in capacity, bandwidth and weight combine harvesters [1, 2, 3, 4]. Thus, during the years 1990-2004 the average power engines combine harvesters increased from 134.1 to 179.4 kW and kombaynobudivni leading firms produce cars with engine capacity from 80 to 400 kW [5]. With increasing engine power combine increased his weight, fuel consumption and other performance indicators. [3]

According to statistical data and marked an annual growth of gross harvest of grain [6]. In determining the profitability of appropriate conditions for the use of a cleaning machine in addition to important