COMPUTER-AIDED DESIGN SYSTEMS

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EVALUATION FOR AN AUTOMATED SYSTEM FOR DETERMINING GRAIN QUALITY PARAMETERS BY SIMULATION MODEL

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Abstract—*System of express analysis of grain crops for estimation the effectiveness of the work is developed, simulation model is built, evaluation of efficiency of the system by simulation model is done, research of electrostatic field is carried out.*

Index terms—Express analysis; imitation modeling, grain-crops, grain quality criteria, electrostatic field, humidity.

I. INTRODUCTION

Agroindustrial complex of Ukraine is a powerful segment of production, which largely determines the socio-economic development and living standards, providing state with the appropriate foodstuffs and raw materials. Among the agricultural fields of Ukraine the most important is the grain farming. This is the basis of all agricultural production. Grain farming of the country forms the grocery fund, provides livestock with feed grain, backs state grain reserves and creates a certain share of exports. Component of grain production process is the quality control. To hold high positions in the grain market, we must strictly monitor the quality and comply with the requirements.

With the standardization of agricultural products it is necessary to regulate the following quality indicators that reveal its customer value and specify quality requirements given its intended use. Grain farming plays a vital role in the agricultural sector of Ukraine, ensuring a steady supply of bread and bakery products as well as raw materials for industrial processing [1].

Transportation, storage, processing, and sales of grain complex, scientific and research support are essential and indispensable conditions of operation and development of the grain industry. For highly effective organization of grain production a well developed material and technical base is required. In those households where a high level of material and technical base and intensity of grain production was achieved, cereal yields 10–25 % higher than the average of other countries Logistical support of grain production and labor efficiency does not meet the world standards and needs of the industry. So one of the lines for improving the economic efficiency in grain production is the introduction of comprehensive mechanization and automation. The solution contributes primarily to increase of productivity in agriculture, which is the main quality factor of economic and social development. Strengthening the industry's material and technical base, introduction of intensive production technologies and advanced forms of work organization resulted in growth of grain yield and increase of grain production [2].

For today in Ukraine there are many agricultural enterprises engaged exactly in reception and checking of grain products. In order to ensure prompt and precise the operation of these organizations, we should improve the process of grain receiving. Particular attention should be given to quality control at the initial stage to resolve the issues of determining the grain quality, transport stream organization and improvement of workers' quality.

This problem can be solved with the help of express analysis system that can lead to a progressive improvement and automation of the grain quality monitoring process, so there arises a need in creating of a system of this type.

II. DETERMINATION OF GRAIN QUALITY CRITERIA

At the estimation of grain quality it is determine the number of parameters that characterize the grain party as a whole : organoleptic properties, humidity, impurities, naturalness, absence or presence of pests. It is universal indicators, after that we get an idea about food, feed and technological high quality of any party of grain, about firmness of it in storage. Depending on the importance indicators of grain quality are divided into three groups:

– required for all parties of grain and seed of any culture, that used for any aims. These values determine at all stages of work with grain, beginning from forming of parties at harvesting. They include: signs of maturity and grain freshness (appearance, smell and taste), pest infestation, moisture and impurities (grade). They are included in state standards they set restrictive conditions (quality standards). Given these parameters parties grains is prepared for sale, storage and processing;

– required in the evaluation of parties of some grain crops or grain parties for a specific purpose.

– additional quality indexes

Color and characteristic shine, that provided to good ripe grain by waxy coating on the surface, easily lost if moist grain to long is not dried, it starts to get warm and microorganisms develop on his surface. The smell and taste of healthy grain is specific to each culture and poorly expressed, almost insipid. But grain is a good sorbent and easily absorbs any extraneous smells.

Grain Moisture is one of the main factors that determine its conservation. Increased of humidity leads to the appearance of a number of free water, characterized by low energy due to its grain tissues. It can take an active part in the physical and chemical ferment processes that take place in the grain. The standard provides four states of humidity (in%): dry is the 13–14; medium is the dry - 14.1–15.5; wet is the 15.6–17 and crude is more than 17. for keeping is suitable only dry grain.

Contamination of grain has negative impact on quality processed products. However, the degree of decrease in their quality of different fractions of impurities is different, that is why they are usually subdivided into two groups – grain and foreign material. Grain impurities include the following components of the grain mass, which allow them a certain amount of food. Foreign material include inclusion that provide a very negative impact on the quality of the food processing of primary culture.

Grain impurities include defective primary grain crops greatly underdeveloped – shrunken, frost, sprouted, broken, damaged by pests such it was black at spontaneous heating or drying; here also include grains damaged by bug-ridden.

Making sure in homogeneity of the sample, is composed the output sample. Required characteristics (moisture, signs of freshness and maturity, impurity content and pest infestation) are express analysis of grain quality. These are general indicators that must to be measured for each party.

III. BLOCK DIAGRAM OF THE SYSTEM

Block diagram of technical mean was created, which allows to determine the main parameters grain quality (humidity, impurities, infection, original appearance), the system is designed, which gives an integrated evaluation based on the criteria for determining grain quality, which allows you to make the process of rapid analysis more accurate and fast.

This system has the following principle of work: using loading mechanism investigated sample falls into compartment for measurement of humidity; then under the influence of feeding mechanism grain reaches the separator that divides the sample in three fractions (sieve). The camera takes pictures of separated grain, and the corresponding microcontroller 1 receives and analyzes data. The microcontroller 3 makes processing results with microcontroller 1 and microcontroller 2, which fixing humidity, and displays data (Fig. 1).

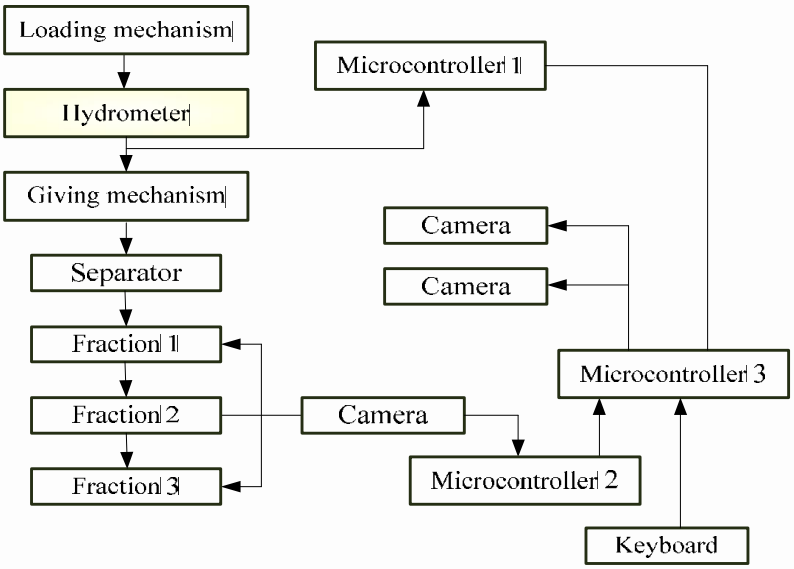

Fig. 1. The block diagram of express analysis

IV. IMITATION MODELING

During the observation system may find that experimental research will lack the information, there may be a problem, the likelihood of which was not included during the development In this case, we turn to simulation modeling – a method of research in which the investigated system is replaced by a model that describes with sufficient accuracy the real system, with it performed experiments to obtain information about the system.

These pseudo observation of system used to analyze its behavior using the model. Thus, the lack of observational data generated by the system is compensated by parameters according to our hypotheses and their probability distribution. To the advantages of simulation modeling method also may include: decisions of tasks, for which analytical methods are not suitable, you can analyze system-wide situations and decision-making by computer, including such complex systems, for which the choice of criterion of comparison of strategies of that at the level of planning can not be carried out, reduction of terms and search of project decisions, that are optimal on some criteria of estimation of efficiency.

Based on the knowledge acquired during the design of simulation model can identify ways to improve the system, which is modeled. By changing input data during simulation and observing the output data can be detected which variables are most important and how do they interact. Simulation can be used as a method to improve the solutions obtained in the analytical analysis, and to verify the analytical solutions. Simulation can be used for the experiments with new projects and their implementation strategies to advance to predict the results [3].

Simulation can be used to determine the requirements that must meet a device or system. Simulation models can be used for operator training of complex processes without unnecessary expenses for equipment that can be damaged, and preventing the accidents.

So to avoid financial losses during experiments on real objects, prolonged research in real time, or even failure of the project, it is advisable to use simulation.

Development of the block diagram of the imitation model of the system (Fig. 2).

V. MODELING OF ELECTROSTATIC FIELD OF CAPACITIVE GAUGE

Theoretical bases of capacitive transducers depend on the theory of electromagnetic fields. Capacitive measuring method use the dependence of the electrical capacitance between the electrodes of the converter. The main parameter that has useful information is the value of capacitance.

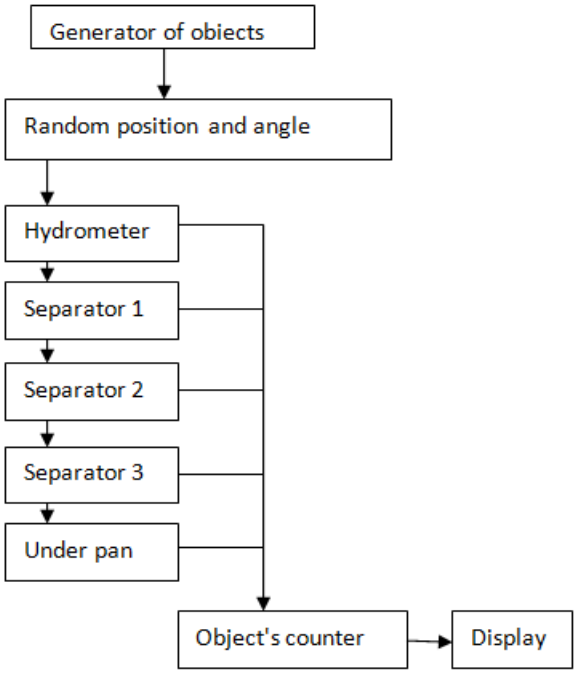

Fig. 2. The block diagram of imitation model

The electrostatic field is a special case of the electromagnetic field when the sources of the field are static electric charges. The electrostatic field is the so-called stationary force field, characterized by the fact that they do not change with time. The surface of conductors is the natural boundary of the electrostatic field because inside the conductor it can not exist. Thus, at any point of the surface potential of the conductor is constant.

The choice of the shape and size of the computational domain, the size and location of the model of the capacitive transducer. Capacitive transducer with substantially non uniform field consists of a system of electrodes, sources of potentials of emitted electrodes of the receiving electrode (electrodes) and measuring circuit.

Method of determining the boundary conditions. The greatest difficulty is to assign numerical values of the potentials of the electrodes, which is proposed to calculate this technique. If the algebraic sum of all charges conductors is zero, the system is electrically neutral. Thus

$$Q_1 + Q_2 + Q_3 + Q_4 = 0.$$

Based on the symmetry of the arrangement of electrodes that emit, we have

$$U_1 = U_4;\ C_{12} = C_{14};\ C_{44} = C_{11}.$$

Value potentials and charges, capacities depend only on the geometry of the conductors and electrical properties of the medium, important only

charge distribution on the conductors and potentials in the space surrounding the conductors and their relationship. Then system will be

$$Q_i = 2C_{11}U_1 + (C_{22} + C_{33})U_2 = 0.$$

By entering designation $C_{11E} = 2C_{11}$; $C_{22E} = C_{22} + C_{33}$ we get

$$U_2 = -(C_{11E}/C_{22E})U_1.$$

Task of destination of potentials model reduces to the calculation C_{11E} and C_{22E} values or its relationship. This problem can only be solved by calculating the electrostatic field that surrounds the conductors. Value of potentials are arbitrary ($U_1 = U_2 = U_3 = U_4$). Substitute these values

$$Q_1 = C_{11}U_1;\ Q_2 = C_{22}U_1;\ Q_3 = C_{33}U_1;\ Q_4 = C_{44}U_1.$$

We know $C_{44}=C_{11}$, and $Q_i = 0$, thus

$$C_{11E}/C_{22E} = 2Q_1/(Q_2 + Q_3).$$

Select Template operator and output calculation formula. Method of determining the charge distribution.

For approximate calculation of definite integrals by numerical methods we use quadrature formula of trapezoids.

Development of the potential field calculation method in the expanding calculated areas with variable step. With a uniform mesh steps it is impossible to get a good assessment of the force field nature based on the results of calculations near the of potentials sources since in the area of the sources a thickening flow of the electromagnetic field is observed. Selecting a smaller grid spacing leads to a significant increase in the volume of grid points and can lead to the unsolvable problem of due to limited technical resources of computers. On the other hand calculation of potentials at some distance from the sources does not require small steps due to the insignificant changes in their values. The problem described can be solved in two ways: the introduction of variable pitch or scaling a regular square grid in a certain area near the sources.

After performing the calculations potentials in the field of the settlement grid points under appointed model potentials $U_1 = U_2 = U_3 = U_4 = 100$ we calculate the electrodes' charge and their relationships. As indicated earlier, the choice of potential values can be arbitrary, as a numerical value is meant percentages it is important to know only the charge ratio or coefficient of electrostatic induction.

It should be noted that the calculation of only one curve requires considerable computing time due to the significant volume of calculations, so the program is made up of two software modules. This will ease the debugging process the program, make it more affordable to introduce the correction of individual fragments of the program.

The purpose of modeling is to provide a conversion function of capacitive transducer, the study of influencing factors and the search for ways to achieve the desired type of conversion function. There is the following approach to the problem of modeling of the capacitive transducer electromagnetic field. Between the charges and potentials of any conductor there exists an unambiguous linear relationship, to express which we introduce the concept of electric capacity.

Thus, taking into account presented material, problem of modeling can be solved using the following algorithm.

1. Selection of the computational domain and the definition of its shape and size.
2. Selection of the shape, size and placement of the model of capacitive transducer.
3. Selection of a template operator and output of calculation formula (numerical analog of the Laplace equation).
4. The calculation of the surrounding potentials space model provided equal potentials of all elements of the model.
5. Determination of the amount of charge of model elements and their relationships based on the results the calculation of the potential field.
6. Calculation and assignment of boundary conditions in the model based on the calculated values of the charges.
7. Calculation of potentials of the surrounding space model under appointed border and boundary conditions.
8. Determination of the amount of charge on the receiving electrode and the coefficient of electrostatic induction (inter electrode capacitance) at the receiving electrode.

The main objective of the simulation is to calculate the potentials in a given area under appointed boundary conditions. The boundary conditions in this case are designated by the value of the potentials on the boundaries of geometric models of object the body electrodes placed on it, as well as the potentials at the boundaries of the computational domain. The last requirement is due to the fact that the search for solution in analytical form is extremely complex, and the problem must be solved numerically. To solve the problem by the grid method it's necessary to perform the migration from the source Laplace equation to a system of linear algebraic equations that can be solved on a computer. The transition is performed by compiling

a difference equation, which is analogous to the Laplace differential equation. Model of capacitive transducer should be chosen such that the outline is placed at the nodes of the mesh [4].

VI. IMITATION MODELING FOR EXPRESS SYSTEM

Before the separation of investigated sample the model of hydrometer is simulates humidity measurement and shows the results. Then according to the result of imitation of separator work we get 3 sections with grain that have different composition of grains and impurities.

Simulation model allows to determine the moisture content, debris and pests, it can also change the amount of grain (Fig. 3).

In according to stages of the work of express analysis system output image is realized which was formed as a result of loading grain sample to the system.

Fig. 3. The simulation model that determine the moisture content, trash and pests

Result of filing and separation of grain sample. After execution of program we get the results we interested in.

Total quantity:	4250	Moisture: 12.7
Seed quantity:	3834	Bug percent in 1:
Bug quantity:	416	2,612
Deffect quantity:	0	
Weed quantity:	0	

CONCLUSION

It is installed the necessity of simulation system design for the automated system for the determining grain quality parameters. This simulation system is design based on imitation models of hydrometer, separator and image recognition software. The results of modeling show the effectiveness of computed-aided design of proposed equipment.

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М. В. Чаругін, О. С. Галатенко, І. А. Івахненко. Оцінка автоматизованої системи для визначення параметрів якості зерна за імітаційною моделлю

Розглянуто принцип роботи системи експрес-аналізу зернових культур, побудовано імітаційну модель, оцінено ефективність системи за імітаційною моделлю, здійснено дослідження електростатичного поля.
Ключові слова: експрес-аналіз; імітаційне моделювання; зернові культури; електростатичне поле; вологість.

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В. М. Синеглазов, О. С. Галатенко, И. А. Ивахненко. Оценка автоматизированной системы для определения параметров качества зерна по имитационной модели

Рассмотрен принцип работы системы экспресс-анализа зерновых культур, построена имитационная модель, произведена оценка эффективности системы по имитационной модели, осуществлено исследование электростатического поля.
Ключевые слова: экспресс-анализ; имитационное моделирование; зерновые культуры; электростатическое поле; влажность.

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