EXPERIMENTAL INSTALLATION FOR INVESTIGATION OF THE EGGS AUTOMATIC SORTING INTO CATEGORIES IN STREAM

ЭКСПЕРИМЕНТАЛЬНАЯ УСТАНОВКА ДЛЯ ИССЛЕДОВАНИЯ ПРОЦЕССА АВТОМАТИЧЕСКОЙ СОРТИРОВКИ ЯИЦ НА КАТЕГОРИИ В ПОТОКЕ

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Abstract: *A modified flow line for eggs sorting by geometric parameters and forms is discussed in the paper. A method for eggs sorting by shape factor allowing to remove sub-standard eggs is proposed. Also the algorithm for determining the geometric parameters of the eggs using a vision system is considered. The fundamental difference of experimental installation for automatic eggs sorting on the category from existing sorting machines, that share eggs on a category by weight, is separation of eggs on a categories by size and separation substandard eggs in the stream. In the experimental installation mechanism for moving the eggs dismantled and replaced to an endless rope transporter with independent frequency-controlled electric drive. As a result of the experimental verification of system parameters of technical vision on the experimental installation showed that the time required for classification of the eggs is not more than 340 ms.*
***KEYWORDS**: AUTOMATED DEVICE, METHODS, THE RESULTS, EXPERIMENT, EGGS, VISION SYSTEM, SHAPE FACTOR, LABVIEW*

1. Introduction

Sort of eggs has huge economic significance, and is a fundamental problem in the poultry industry. Processing of eggs has four stages: collection, disinfecting, sorting and packing. Collection processes, disinfection and packaging are mechanized and do not require large manual labor. To sort the eggs is required large expenditures of manual labor and accordingly cash. In addition, the person is unable to provide the required accuracy and quality sorting. Currently eggs for sale are sorted into categories by weight, eggs for incubation selected manually by using the organoleptic methods. Separating eggs on a conditional defect and conditioning is difficult because of the lack of criteria grading and subjectivity of visual assessment [1]. The development and commercial execution sorting machines of eggs are engaged many firms. Known machines have a limited speed, due to the inertia of the mechanical weighing mechanisms, on them is impossible to separate eggs, which have a non-standard shape and defects of the shell, have limited technological opportunities and used for sorting food eggs on category by weight and sorting of incubation eggs is produced mainly by using the organoleptic methods. The most acceptable and promising solution to the problem of egg sorting is the creation of robotic technology conveyors using tools of technical vision and automatic recognition of the indicators of quality on digital images with subsequent distribution of original flow into categories with different quality parameters. The use of vision system to determine the quality indicators of eggs creates the potential increase in productivity and accuracy of perform the necessary measurements and expansion of technological capabilities sorting machines [2].

2. Work principle of system for sorting eggs

The principal difference the experimental installation for the automatic sorting of eggs on the category from the existing sorting machines that separate the eggs on category by weight, is the separation of eggs on category by size and separating substandard eggs in the stream: Overall work algorithm (the experimental installation) of technological line is shown in Figure 1.

Chicken eggs (1) are fed to the roller conveyor (2), where the alignment and distribution of eggs to equal the distance between them, then the eggs one by one pass in the control area of smart cameras (3), the resulting image is transferred to the embedded microprocessor with installed software LabVIEW (4), in a medium which is a special program and algorithm for analyzing and classifying the eggs parameters (5), after which an egg is moved to the rope conveyor (8), and the resulting data is sent to the controller (6), wherein are formed the operation control command pneumatic valves (7) which directs eggs with air stream from rope conveyor (8) in storage (9) of the respective category.

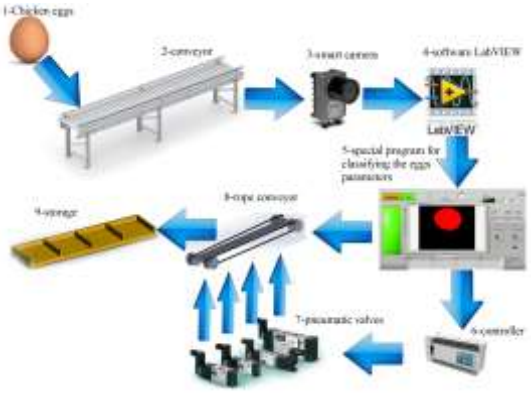

***Figure 1** – Work principle of technological line (the experimental installation).*

For the conducting research is made experimental installation on the basis of machine for eggs sorting on category "RITM 8-3", which allows determine the geometric parameters of eggs in real time. In figure 2 are designated the hardware components of the technological line for eggs sorting in size and shape in the stream to which received a patent Republic of Kazakhstan for utility model [3].

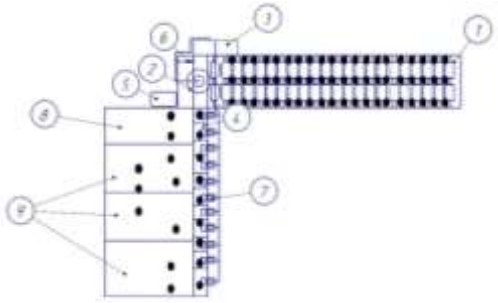

***Figure 2** - The technological scheme of line separation of eggs on category based on the system of technical vision.*
1 - Orientation conveyor and rotation of eggs; 2 - Smart Camera; 3 - Controller; 4 - transverse conveyor line; 5 - Compressor; 6 - Inductive sensors; 7 - Pneumatic (kickers);
8 - Tray with non-standard eggs; 9 - trays of eggs in various categories.

Eggs are fed to the conveyor of orientation and rotation, which arranges them in three rows, with the help of special devices eggs is shifted on a moving mechanism in one row towards to the lens a smart camera. At hit in a zone of control chamber of each egg, the inductive sensor is triggered, which sends a signal to the processor of smart cameras, and it captures the image, performs analysis, the allocation of the object from the general background of the image

and determines the parameters (perimeter, area and shape factor), and sends the information in digital form to the controller. The controller depending on the received parameter values sends a signal to corresponding actuator, for separating the eggs on category and to reset the eggs into the appropriate tray.

All the mechanisms of technological line of machine "RITM 8-3," is driven by a single motor. Transmission Systems moments on working arrangements are complex multi-stage mechanical parts, which reduce the efficiency of the electric drive and require additional operational costs. The most difficult, inefficient and metal consumption are translational linear conveyor of moving eggs on weight mechanism. In experimental installation mechanism for moving the eggs dismantled and replaced by an endless rope conveyor with independent frequency-controlled electric drive. Instead of weighing mechanism is installed smart camera and a pneumatic valve actuator. As a result, a proposed modernization is appearing possible determine the size and shape of the eggs in the stream (dynamic mode), that provides productivity increase compared the base variant. Potentially replacing of weighing mechanism on the vision system provides increased productivity by at least 2-fold compared the base variant. To realize the potential opportunity technological line on based technical vision system need to be upgraded and the existing egg supply system to the control zone.

3. Algorithm and software of vision system

Determined the choice of software and hardware of the processing of the video stream on base study of a number of industrial cameras and digital image processing software environments in real time. Was selected smart camera of type NI-1772-EF00303A and programming environment for video image processing of firm «NI» NI Vision Builder. Photographs of eggs takes place in the flow, by Sensor "The presence of eggs under the camera." When the egg is suitable camera control zone, sensor "the presence of eggs under the camera" outputs a signal to the camera, the camera photographs the object. Image capture is performed with software tools providing a number of algorithms, figure 4.

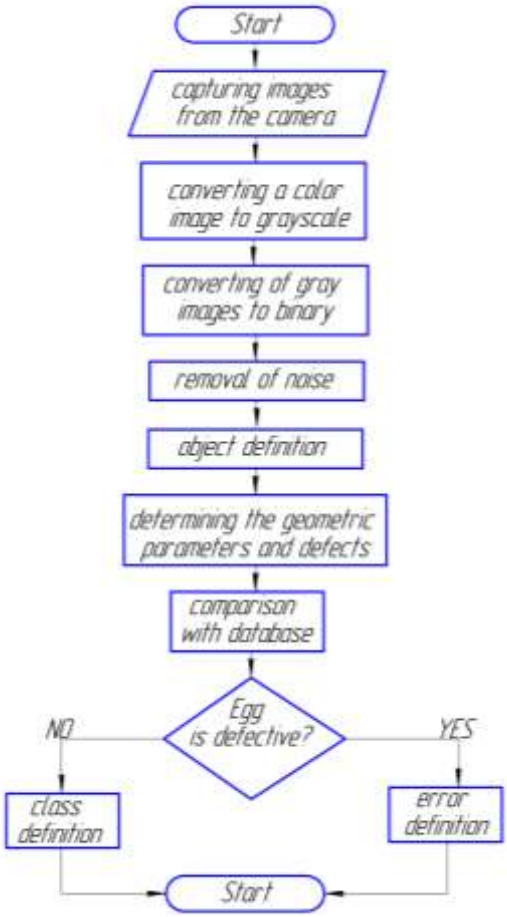

Figure 4. *The algorithm of the program for eggs sorting*

Used the following sequence of actions - search a closed figure with method carrying tangents to the boundaries of the closed surface (optical projection image on a matrix of camera in pixels) [4]. Points obtained at the intersection of the closed surface and tangents connected among themselves forms a certain figure. Further the obtained figures are classified by the size of area object image. If the object covers an area of more than a predetermined value, consider that this object is the egg, others are objects of smaller size, not be processed are objects, obtained from interference, including the presence of glare from substandard lighting, the presence of small objects and other interference. To select an object (image of projection eggs) performed image processing, determine the large and small diameter, area, perimeter in the pixel and the value of shape factor [5]. The obtained data is transmitted to the controller on request. After that, the data are zeroed to obtain new data. The program of processing video image developed in «LabView» environment. Fragments of the program are presented in Figure 5.

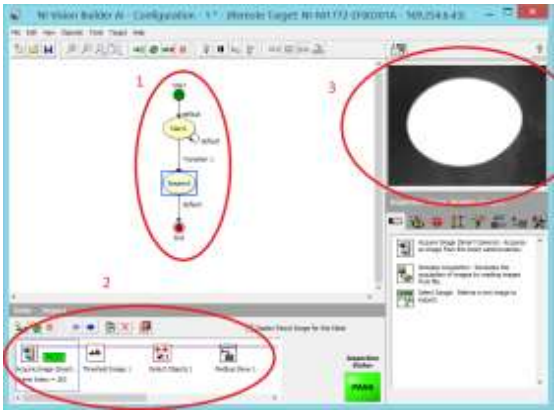

Figure 5 *- Program of processing video image*

In Figure 5 shows a table of data transmitted from the camera to the controller.

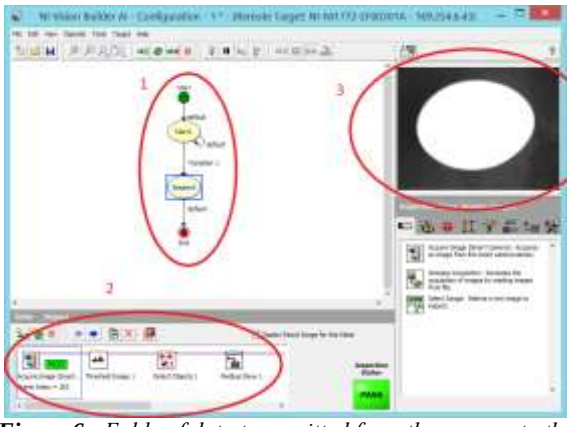

Figure 6 *- Eable of data transmitted from the camera to the controller.*

General structure of the program is designed so that the program receives data from the relevant sources. The program performs calculations in accordance with the information processing algorithm. The results of information processing on the parameters of each egg introduced a special structure, that defines all possible states of the eggs (suitability, geometric characteristics, which in a sorting tray is necessary to reset the egg, etc.) [6,7]. The structure is formed for each egg at the time of receiving data from the camera and destroyed at the time of egg reset to the appropriate tray. Substandard eggs coming last tray. The program for the controller is developed in Codesys environment in language ST. The work algorithm of the program is as follows: by a given formula

$$K = \frac{L^2}{S} \quad (1)$$

Where:
K – shape factor;
L – longitudinal section perimeter;
S – square longitudinal section;
that includes geometric characteristics of eggs is determined ‘'shape coefficient" for each egg and computed value of shape factor is compared with a predetermined range of variation of shape factor values in accordance with the requirements of the standard. If the current value falls within the specified range is considered to be the egg meets the requirements of the standard on Form, otherwise the egg is not fit for incubation. Similarly, eggs are separated by size.

4. Conclusion

For experimental verification of the accuracy of intellectual classifier egg sorting by size and shape is necessary eggs parameters obtained in digital form (pixel) to convert to the metric system. More simple method for camera calibrating used in the setup conditions of the experimental installation is developed. The essence is the following - after the installation of the camera and setup to the sharpness in the field of the frame is put two rulers perpendicular to each other. The measurement error of linear dimensions of smart camera, after calibration by this method is not greater than 0.25 mm. As a result of experimental verification of the technical vision system parameters of the experimental installation the following results are obtained:
- The processing speed of the image in the camera - no more than 140 ms.
- The speed of data processing in the controller - no more than 100 microseconds.
- The exchange data time of controller with camera and pneumatic valves is no more than 200 ms.
The total time required for classification of one egg is no more than 340 ms.

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