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INTELLIGENT CONTROL TEMPERATURE AND HUMIDITY CONDITIONS IN THE GREENHOUSE

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Reviewed by a major problem for the establishment of control temperature and humidity conditions in the greenhouse; selected neural mathematical tools to solve them. Developed synthesis sequence control system and it practically implemented. Using genetic algorithm analyzes the significance of the input parameters. An experiment on active production facility and received training data sets. Synthesized and tested for adequacy of mathematical model of micro-processes in the greenhouse. Calculated energy efficient learning sample based on neural network control system established -volohisnym temperature regime in the greenhouse, verified by simulation modeling of high-quality functional performance.

Microclimate, greenhouse, intelligent control, genetic algorithm, neural network.

C. Members glasshouse as object control temperature and humidity conditions characterized by poor performance and non- stationarity options [1]. This and hrotehnichni rules stipulate strict requirements and high accuracy temperature stabilization (1ºS) timely change it depending on the level of F-tosyntetychno active radiation phase of plant development and the time of day and so on. Technologically justified [2], etc. For efficient operation системи керування температурно -вологісним режим ом необхідно, to heat power heating system provided a steady difference between internal and external temperature - taking into account the impact of disturbances, nonlinearities and transient. Bahatoparametrychnist same problem [3], which solves such systems in greenhouses and arch type polyaha is in support for these real-time balance between desired and current values of temperatures, soil temperature and relative humidity.

In fact, the control system should not work on traditional quantitative basis when making control action linked to the number of foods (vegetables) at the output and input variables quantitative indicators, and on quantitative and qualitative, as in the case of climate control in greenhouses is stochastic oscillation parameters from possibility of changing the structure of relationships between vhi dnymy technological values that is, system must manage the object type "black box".

The purpose of research - study and development of control system of temperature and humidity conditions in the greenhouse.

Materials and methods research. As an object of study and selected Blvd. greenhouse hangar type, which is located in the village. Severynka Kirovograd area Kirovograd region. To carry out experimental studies reliably measure micro-climatic conditions in the greenhouse and in the environment, and a system of automatic monitoring of temperature and humidity in the greenhouse th regime that represents cal program-technical measuring system (Fig. 1), connected to a personal computer.

Fig.1. The general view of the experimental setup (Ukraine patent number 8716)

The values that relate to the input control system for temperature and humidity conditions in greenhouses [4]: external air temperature; Outdoor humidity; heat index; pressure;solar radiation; internal temperature; internal humidity; temperature near the plant. Parameters that function as control actions: power heater air heater capacity of soil. The depth of the sample was - 1440 Observed entalnyh observations.

T o solve the problem of selection of input data, that is, reducing their number, which is very important in solving the optimization problem in electrical systems using genetic algorithm.

The creation of the system of control was carried out on the basis of mathematical apparatus of artificial neural networks (ANN) [5].

Results. After loading the experimental study temperature and humidity regime in greenhouses software "Statistica" assessed the significance of the impact of input parameters for the weekend (Fig. 2).

	Исчерпывающее оценивание (Таблица данных1)								
	Ошибка	Var1	Var2	Var3	Var4	Var5	Var6	Var7	Var8
Конечный	0,016590	Да	Да	Да	-	Да	-	-	Да

Fig. 2. Multiparametric optimization of experimental research data in the temperature-humidity conditions in the greenhouse among the "Statistica"

For rezultataty using genetic algorithm was "eliminated" as the input parameters: pressure, solar radiation, internal temperature.

As input values will use: external air temperature, S exter humidity, heat index, th internal humidity, temperature near the plants.

For the synthesis and study of relevant W HM use software package "Statistica Neural Networks ". Rieter K - minimizing mistakes artificial neural network. For efficient simulation package Statistica Neural Networks inputs automatically divided three parts: training, test, test. Three blocks is not mandatory, but a test unit improves further work, as it enables to ensure that there was no "re-education» (overfitting) network.

As a result of previous expert research, in terms of the adequacy and effectiveness of future use in research, it was decided to use the architecture of ANN-type radial basis function (RBF).

It neuron output signal pattern - is a function only of the distance between the input vector *X* preserved and center *C:*

$$f(X) = \varphi(\frac{\|X - C\|}{\sigma}). \quad (1)$$

where: C_{and} - Centers - Radial deviation elements.

The output layer is linear network so that the network outputs are determined by the expression:

$$y_j = \sum_{i=1}^{K} w_{ij} \varphi(\frac{\|X - C_i\|}{\sigma_i}),\ j = 1,2,...,m, \qquad (2)$$

where: *w* - the weights of the neural network.

As inputs used those identified as a result bahatoparamet algebraic optimization output - power heater and air heater capacity of soil.

As a result of iterative learning were acceptable network adequacy of appropriate architecture (Fig. 3, 4).

Analysis of the results in the synthesis graphics ANN her studies demonstrated the flexibility of the model for "peak" amplitude values of both power output (Fig. 5), which is important for further research greenhouse, which is characterized by non- stationarity parameter values microclimate.

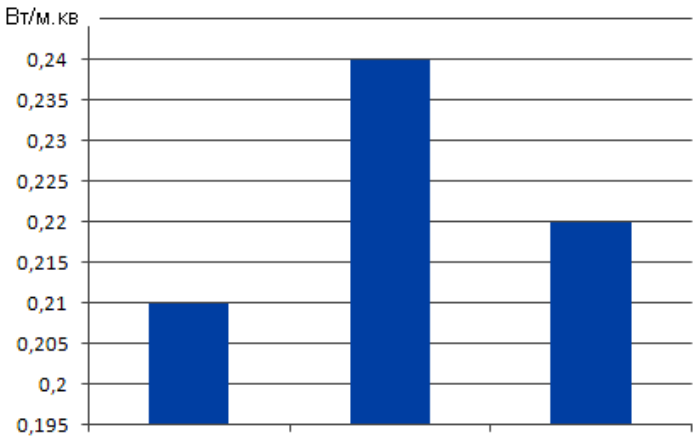


Fig. 3. Check for adequate NM W model temperature and humidity regime

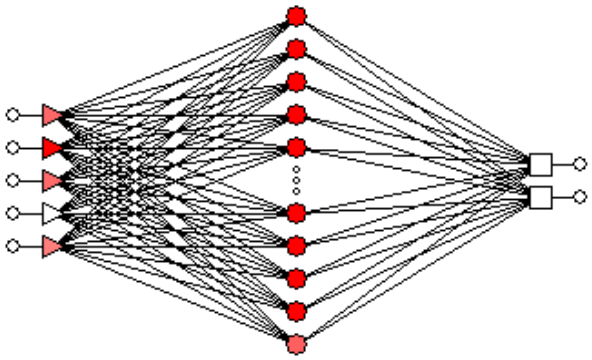


Fig. 4. The architecture of ANN model temperature and humidity in the greenhouse th mode

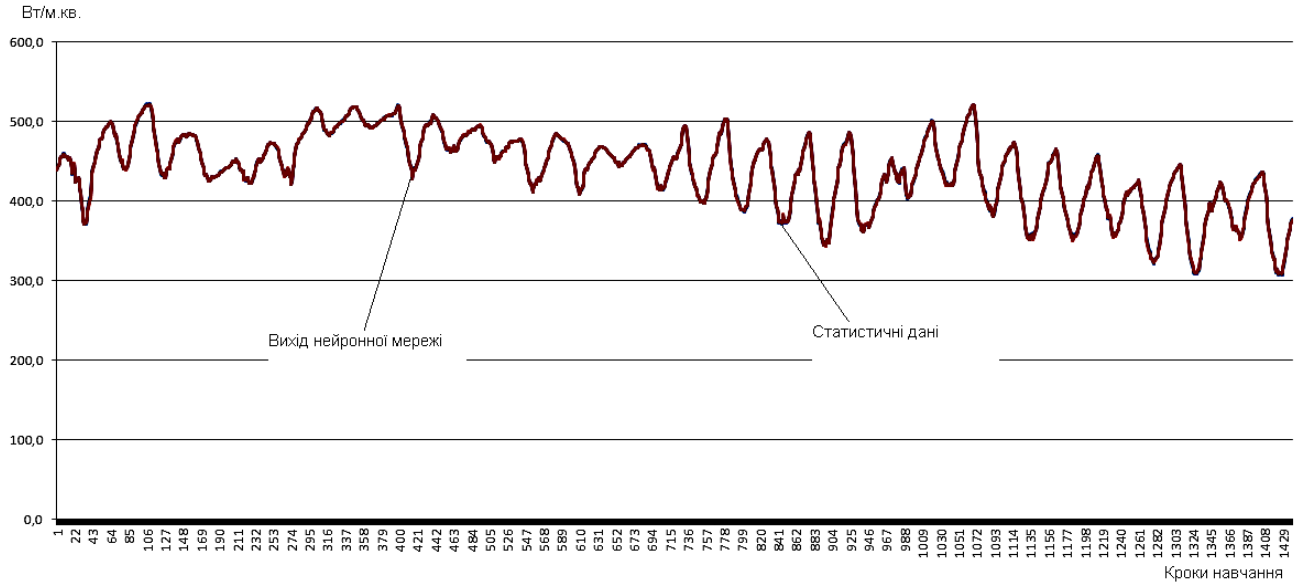


Fig. 5. Quality assessment modeling total value of capacity (power + heater air heater power ground)

Then, using established adequate NM W (see. Fig. 4), the form data to the synthesis of intelligent system controls (Fig. 6).

Formation of such a sample is as follows:

1. Outdoor temperature, outdoor humidity, heat index S Installations are a whole range of possible values of these parameters in order to maximize filling the entire technological field.

2. ANN estimation using temperature and humidity regime in the greenhouse (See. Fig. 4) changes the value of capacity heaters air and soil until t emperatura air near the Russian tench and humidity vstanovlyatsya equal regulatory requirements.

3. This data set will be stored and used to generate neural network control system.

The criterion by which energy data for selected training samples:

$$\begin{cases} ACT \rightarrow \min \\ AR \rightarrow const \end{cases} \quad (3)$$

Where: ACT - total power heaters, AR - agronomic requirements.

Using this approach was formed in 1400 training sample data sets. Moreover, the value of t emperatura air near the plant and humidity are not stored in absolute terms, the difference:

Normative value difference = - Primary (4)

Using this sample and edu cational software "Statistica", based on radial-basic architecture NM W, these networks are built with sufficient adequacy (Fig. 6).

The package of applied mathematical software "MatLAB Simulink ", which contains a block neural network simulation carried out simulation studies of intellectual functioning system control temperature and humidity conditions in the greenhouse (Fig. 7), where the function is a mathematical model of the greenhouse ANN performed (see. Fig. 4).

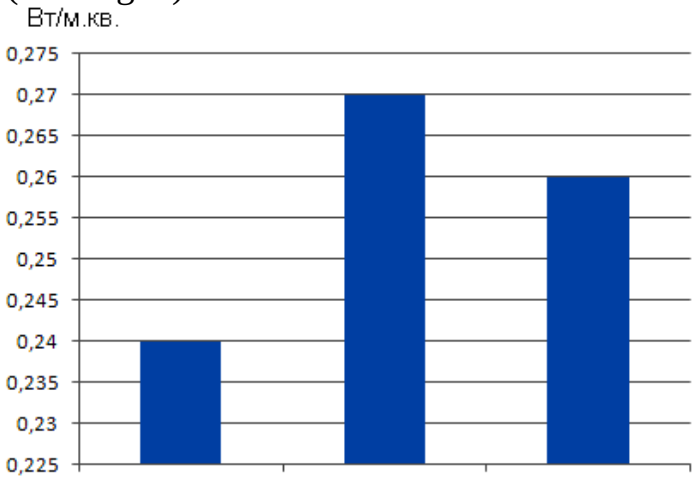


Fig. 6. Check for adequate management of HM W

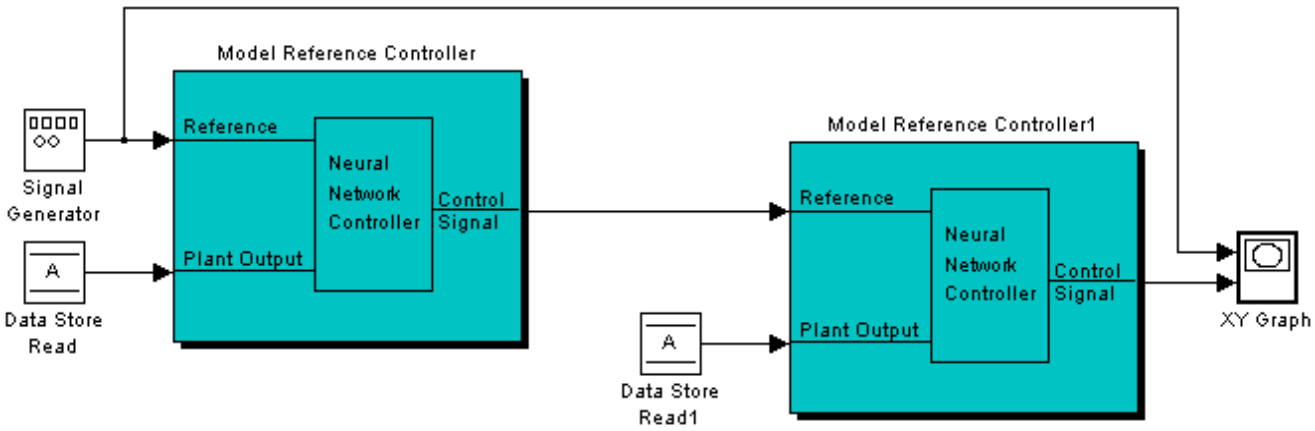
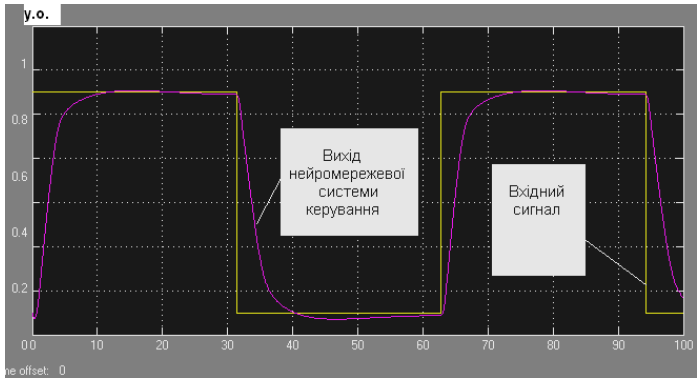


Fig. 7. A simulation model of intelligent system controls temperature and humidity conditions in the greenhouse (environment "MatLAB Simulink ")

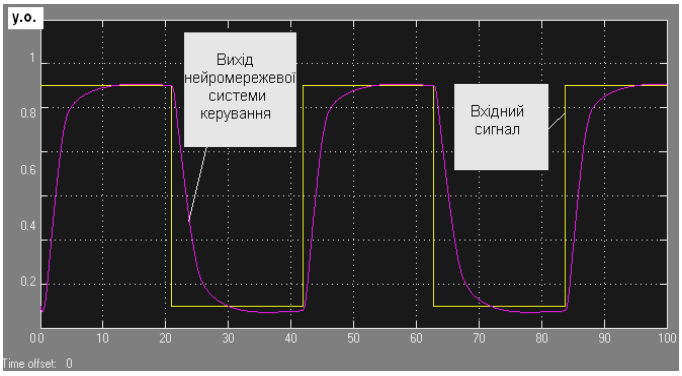
For rezultataty simulation modeling intellectual functioning control system temperature and humidity conditions in the greenhouse revealed that its quality characteristics for both outputs, according to the requirements of automatic control theory, following (Fig. 8):

1. Overshoot: on the upper front - 0% on lower front - 2.5 -3.75%.
2. M aksymalne dynamic mo dhylennya: the upper front - 0 at the lower front - 0.02 -0.03.
3. K ilkist napivkolyvan: the upper front - 0 at the bottom frontom- 1.

These characteristics of the control system, especially taking into account the possibility of "relearning" in normal mode of operation based on the storage and processing of production data in real greenhouse enterprise information knowledge base, satisfactorily technological requirements.



A)



B)

Fig. 8. The results of simulation modeling of intellectual functioning neural network control system of temperature and humidity conditions in the greenhouse for control channel: A - air heater, B - heater soil

Conclusions

The control system of temperature and humidity conditions in the greenhouse through the use of mathematical tools of artificial neural networks and pre-analysis, genetic algorithm input data demonstrated sufficient quality and appropriateness of its production research.

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