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Automatic control process for drying a cotton on the basis of fuzzy logic

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ABSTRACT: The issues of improving the control system of the process of cotton drying on the basis of neural-fuzzy technology are considered. Formalized the process of cotton drying in the form of a neural network, allowing to take into account various types of uncertainties that arise during the operation of the drying unit. For training of the neural network, the data corresponding to the technological regulations were used.

KEYWORDS: fuzzy logic, neural network, membership function, fuzzy rules, linguistic terms, knowledge bases, control system, process of cotton drying.

I. INTRODUCTION

In the existing technological processes of cotton processing, drying of raw cotton is obligatory, since the main part of raw material is harvested at a humidity higher than the standard one. Even at procurement points in riots, a number of measures are being taken to reduce the moisture of cotton. These activities should include the breakthrough of the ventilation channels and tunnels in the riots, the suction of moist air from the riots, the dismantling of the riots, the drying of the raw, etc.

The most effective method of bringing raw cotton to the technological norm of moisture and ensuring its normal cleaning from weed impurities and ginning is drying the raw cotton in dryers [1...3].

At present, cotton dryers of the 2SB-10, SBO and SBT brands are the most widely distributed at the cotton processing enterprises of the CIS countries. These dryers have high performance in wet raw cotton, but insufficient moisture removal.

Recently, fundamentally new laws of regulation based on neuro - technology and fuzzy logic (Neuron & Fuzzy Logic) [l] are actively developing to control various technological processes.

This is due to the fact that many technological processes are characterized by uncertainty, vagueness, vagueness. These categories include the processing of raw cotton, characterized by a variety of technological regulations of processed cotton, uneven distribution of the thermal agent in the dryer drum, and non-stationary dynamic characteristics of the raw cotton drying process [3]. Under these conditions, to formalize the process of drying raw cotton, the most convenient mathematical scheme is a neural network.

II. MODEL DESCRIPTION

Using the neural network allows you to implement an approach to the formation of the membership function of fuzzy sets. When selecting the parameters of the membership function, its forms and parameters are adjusted using neural network learning algorithms obtained from a training sample, in which the experimental data are approximated using fuzzy systems.

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When this fuzzy-neural network can be realized by display $\{(\bar{x}^i, y^i)\}$. Where $\bar{x}^i = (x_1^i, \ldots, x_n^i)$- vector of input values, y^i- output value $(i = \overline{1, N})$. The most difficult part of using fuzzy logic in the management process is a process of learning neurons. Education neurons is carried out using a decision rule that looks like this:

IF x_1, there $\tilde{A}_{1j}$ And there x_2 $\tilde{A}_{2j}$ And ... And there x_n $\tilde{A}_{nj}$ TO $y = z_i$. $j = \overline{1, m}$

where $\tilde{A}_{ij}$ - fuzzy number, z_i- real number [4].

To form a decision rule, it is necessary to have knowledge bases about the subject area in which a fuzzy-production model of knowledge representation is used. For the process of drying raw cotton, as a knowledge base, we take the quantitative values of the technological procedure for the process of drying raw cotton, which allow you to select the operating mode of the drying unit. The choice is based on a practical analysis of the parameters of processed cotton [5]. In this case, the standard taken standard reference data provided by the technological regulations (table 1.)

Table 1.
Technological regulations dry cotton.

Cotton		Lowering the humidity (%)	Performance	Temperature of the drying agent	Density air (mm Hg)
Humidity (%)	grade				
12	1-3	3-4	11,0	130-135	412(42)
13	1-3	3-4	11,0	140-150	422(43)
14	1-3	5	11,0	160-170	432(44)
	4-5	4	10	175	452(46)
15	1-3	6	10,5	190-200	442(45)
	4-5	5	10	205	462(47)
16	1-3	7	10	210-220	452(46)
	4-5	6	9	225	472(48)
17	1-3	8	9,5	240	462(47)
	4-5	7	9	245	482(49)
18	1-3	9	9	245	492(50)
	4-5	8	8,5	250	492(50)

For fuzzy process control, it is necessary to introduce linguistic variables that are in good agreement with the fuzzy logic of information processing. The key concepts of fuzzy logic include [4]:

- fuzzification (transformation of the set of values of the argument x to a certain function and the belonging of $M(x)$);
- defuzzification (reverse fuzzification process).

The system with fuzzy logic functions according to the following principle: the information from the sensors is fused, processed, and then sent as usual signals to the actuators.

Consider the principle of temperature control of the drying drum using fuzzy logic.

The mode of drying of cotton is determined by the difference between the temperature of the thermal agent and the setpoint temperature. This variable linguistically can be formulated as a "temperature difference" and take the values "small", "medium" and "large". Naturally, with a large temperature difference, more thermal agent is supplied. Based on this, we define the second linguistic variable - “the rate of temperature change” in the drying drum. With a high rate of temperature change in the dryer drum, more heat agent is required to be supplied. The output variable is the spent test agent, which assigns the following terms: “very small”, “small”, “medium”, “large” and “very large”. The relationship between the input and output of the drum, we write in Table 2, taking into account the fuzzy rules.

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Table 2.
The dependence of the drying of cotton on the temperature difference and its drying rate.

Speed variations of temperature	**temperature difference**		
	Small	**Central**	**Greater**
small	very small	small	medium
central	small	medium	greater
greater	medium	greater	very big

Each entry corresponds to its odd rule. For example, if the temperature difference is "medium" and the rate of change is "large", then the drying process should be "large".

The control system of the drying drum operating with fuzzy logic works according to the following principle: The signals from the sensors will be fused and the received data in the form of signals will be sent to the position fan dampers, which will change according to the value of the membership function. We construct the membership functions for the "temperature difference Δt" (Figure 1) and for the "rate of change of temperatures V_t" (Figure 2). For the first function, the temperature range is from 0 to 250 °C, and for the second, from 0 to 0.23 C/min.

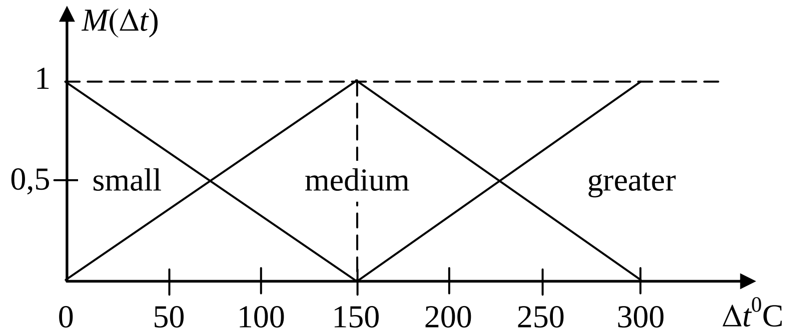

Figure 1. Membership functions for the linguistic argument "temperature difference"

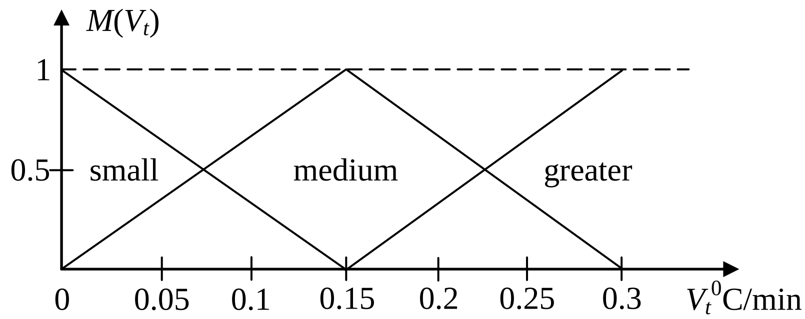

Figure 2. Membership functions for the linguistic argument "Rate of temperature change".

The result of the joint influence of the two membership functions $M_{\Sigma} = f\left[M(\Delta t), M(V_t)\right]$ on the values of the output parameter of the heat agent is determined by the corresponding program embedded in the logic device. Given that the temperature in the dryer drum is proportional to the position of the fan flap, it is possible to construct the dependence of the regulatory function of belonging on the position of the flap, giving the linguistic terms of the position of the flap with the rank of 1.0 to the following values (Figure 3); small - 15, medium - 40, large - 65 and very large - 90.

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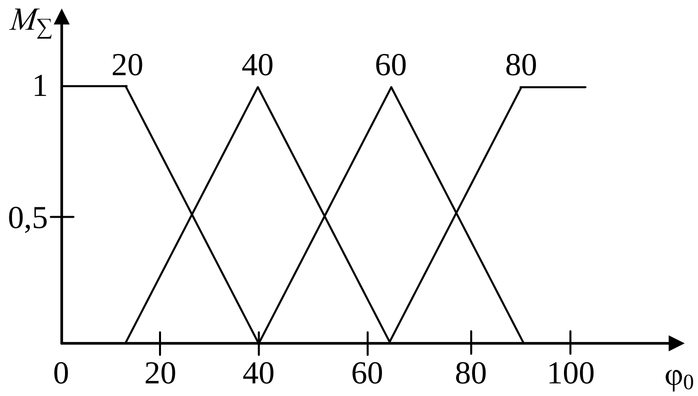

Figure 3. The dependence of the parameter "gate position" on the value of the total membership function.

III. CONCLUSION

Controlling the temperature mode of a raw cotton drying drum using fuzzy logic makes it possible to take into account the uncertainty and ambiguity of changes in moisture values and debris of dried cotton, which saves energy (fuel) consumption by reducing the transition time in the dynamic mode of the drying unit.

The reliability of the obtained results was checked by conducting simulation experiments and comparison with real data.

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