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The abstracts of scientists, scientific and pedagogical workers, researchers, postgraduates and doctoral students, the participants of XXIV International conference on automated control "Automatics-2017" are presented in the collection, which discusses the current state and ways of economic development of Ukraine in the following sections:

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IDENTIFICATION AND PREDICTION OF MOISTURE DISTRIBUTION IN SOIL FOR IRRIGATION CONTROL

Annotation. Receiving the correct mathematical dependencies of various dynamical process is known to be complex scientific problem. Application of neural network along with experimental and semi-empirical data helps to predict the changes of soil structure during the watering process.

Key words: irrigation, soil, humidity, mathematical model, neural network.

Soil irrigation is known to be the most efficient way to increase the plants productivity among various agrotechnical methods. Retaining the correct water level for specific plant culture allows to receive the maximal crop. This task is solved by modern irrigation systems that manage different parameters from external environment and choose the necessary control impact. From the other side, the irrigation changes the wide set of soil parameters and effects on the destructive phenomena progress, such as soil erosion and salinization. The probabilistic nature of various processes complicates the general soil parameters accounting, which results in errors in water resources use and selection of irrigation standard. Thus it is important to consider not only the initial physical and chemical soil parameter, but also the general dynamic of stochastic processes of soil degradation.

Wide amount of research work is focused on analysis of structural soil changes under the external environment influence – the fractal model of soil structure is considered as well as water conduction index for specific models. The general provision of rain machines ecological reliability and assessment of irrigation erosion permissible norms are presented in [1]. An influence of soil faults and cracks on infiltration characteristic were analyzed in [2, 3]. The authors show that traditional methods for assessment of infiltration speed give the incorrect description of soil water level by omitting the soil cracks during soil humidification. Various publications are devoted to the analysis of preferential flow and its features.

The main aim of conducted research work is to analyze identification schemes of the infiltration characteristic during the irrigation and prediction of humidity distribution in the soil to properly organize irrigation process.

Let us consider the porous substance as fractal structure to construct mathematical model of the fluid flow in the porous medium. The dendritic structure with fractal dimension $D \approx 1.7$ can be obtained in the simplest case. The consideration of the probability of part adherence to the cluster – p increases the model flexibility and approximates it to the real conditions of moisture distribution with the presence of soil inhomogeneity. The minimal value of probability coefficient that will increase in time under the influence of adverse factors can be treated as initial model state.

This emerges the preferential flows appearance and violates the general moisture distribution in the soil. The graphics show that deep is increased with the reduction of moisture amount in the topsoil. The inhomogeneity of distribution characteristic effects the assessment accuracy and complicates the irrigation systems management.

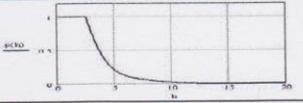
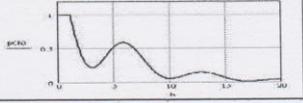
The transfer function of the second-order inertial oscillating cell was used as base for description of the output moisture distribution function (Table 1). The picture 1 shows the management structural scheme. An artificial neural network (NN) was applied to identify and predict moisture distribution characteristics.

The condition of moisture distribution in the soil under the constant irrigation norm within the presented model can be shown as following equality:

$$\int_0^{h_1} p_1(h)dh = \int_0^{h_2} p_2(h)dh \text{ при } V = const, \quad (1)$$

where p_1 and p_2 are relative humidity with different distribution variants; h – deep, m; V – volume, m^3 .

Table 1

Transfer function of inertial oscillating cell		
$W(p)$	Standard distribution characteristic	High inhomogeneity
$W(p) = \frac{k}{T_1^2 p^2 + T_2 p + 1}$		

The resulting moisture distribution function is compared against the standard model and sent to the NN input. The training set for NN was received from fractal model. NN modelling and synthesis was performed in MATLAB.

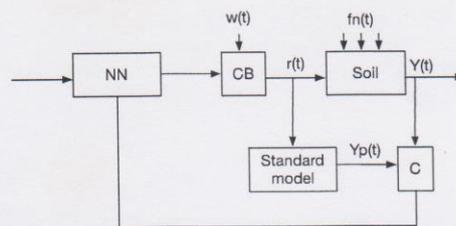


Figure 1 – Changes identification scheme in soil structure: CB – control block, C – control.

The combination of classical algorithm of back error propagation with coefficient of the learning speed adaptation along with its modified variant with “inertia” of weight and displacement correction was applied to train NN (Fig. 2).

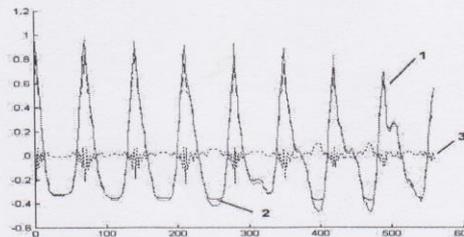


Figure 2 – Moisture distribution modelling results: 1 – correlation of moisture distribution functions; 2 – NN result; 3 – error.

Conclusions.

1. The presented application of NN and experimental semi-empirical data allows to predict changes in soil structure during hydration process. The homogeneity of moisture distribution is a basic criterion during the assessment of irrigation effectiveness.
2. The presented approach can be applied during organization of irrigation process.

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