Development, modeling and technical implementation of automated control system of soil's moistness by underground irrigation

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Abstract - **In this paper a structure of automated control system of soil's moistness within the modular field by underground irrigation is developed and simulated in Simulink Editor of Matlab. Technical implementation of the ACS is proposed.**

Keywords – **soil, fertility, plant, transpiration, vaporization, evapotranspiration, irrigation, green-house period, sucking soil pressure, automated control system, groundwater level, control fountain, collector-drained system, modular field of soil, drained-humidifier system, neural network, neuro-fuzzy inference system, fuzzy controller.**

I. INTRODUCTION

During the agricultural cultures' growing it's important to keep required water regime of soil, which is provided by assorted irrigation's regime with certain rates, terms and amount of flooding. The water's flow for irrigation is determined by cumulative vaporization, which depends on climatic conditions, amount of thermal energy, soil's moistness, sort and yield of the plant. The task of the work is to design a structure, algorithm of work, mathematical model and technical implementation of automated control system (ACS) of soil's moistness with the underground moistening of agricultural cultures subject to random disturbances actions.

II. MODELING OF THE ACS OF SOIL'S MOSTURE

The cascade-combined ACS of soil's moistness by underground irrigation within the modular field consists of 2 contours: contour of regulation of water's level in the control fountain (Obj.1), contour of regulation of sucking soil's pressure, which characterize soil's moistness. The control object #2 is a soil's field with collector-drained system. It is presented in the form of two elements. The first element Obj.2.1 is a collector- drained system and a rich absorbent part of soil, which transform level of water in the control fountain into hydraulic drop in the system of drainage and hydraulic drop – into the groundwater level. The second element Obj.2.2 is a non-saturated part of soil and transforms the groundwater level into the soil's moistness of root-inhabited soil's zone, which is characterized by sucking soil's pressure in this case. Many disturbances influence onto the Object 2, such as: air's temperature, fallout, level of light, wind speed, air's moisture, structure of soil, phase of plant's development. Disturbance factors have stochastic nature and permanently vary in time, that's why the ACS must efficiently calculate the regime of underground moistening all the time and realize it on the controlling modular fields of drained-humidifier system by means of hardware. It is proposed to present the controller of the sucking soil's pressure in the form of neuro-fuzzy inference system, where input parameters are: fallout (mm), deficit of air moisture (mbar), the sucking soil's pressure (m) in the certain soil's layer, the output parameter is the groundwater level from the ground surface (m). Plants pass some phases during growing. Evolution of aerial and buried (root) parts of plants take place at the time of these periods. In this connection some controllers, oriented to moisture's control in concrete soil's layers (0-10, 10-20, 30-40 sm) and mean value of moisture in the layer of 0-40 sm, were developed. Switching between controllers is performed regarding to the plants' root age's development.

The work of ACS of soil's moisture in the layer of 30-40 sm during the first 4 weeks of green-house period was modeled by means of Simulink Editor of Matlab. Analysis of dynamic properties of ACS on the task's canal have been done. Control object Obj.2.2 - a non-saturated part of soil – was presented during modeling in the form of neural network with 11 input parameters.

III. TECHNICAL IMPLEMENTATION OF ACS OF SOIL'S MOSTURE

Technically ACS of soil's moisture with underground watering is proposed to realize on such base units: hydraulic governor, equipped by microprocessor control unit, the measuring station, equipped by microprocessor unit, automated workstation of drained-humidifier system's dispatcher on the basis of personal computer. The microprocessor units of hydraulic governor and measuring station is proposed to realize on the basis of microcontrollers PIC16F690 of Microchip company.

IV. CONCLUSION

Proposed ACS of soil's moisture within the modular field by underground irrigation will allow increasing of control accuracy thanking to operative accounting of random disturbances on the object. It'll provide for receipt of plan crop capacity in the time of efficient use of energetic and water resources.

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