средственным образом связана с данной АСУ и функционирует как составная её часть при дистанционном режиме управления оборудованием. Также данная система сможет использоваться как самостоятельное программное приложение.

В качестве обучающего метода для нейронной сети был выбран метод обратного распространения ошибки [2]. Это наиболее подходящий метод, т.к. за многие годы работы очистных сооружений была наработана достаточно большая база данных о процессе биологической очистки. После приведения среднеквадратичной ошибки сети к минимуму и наиболее корректной настройки, тем самым, весовых коэффициентов, сеть стала пригодна для работы в реальных условиях.

Нейронная сеть для системы поддержки принятия решений будет реализована и протестирована в MATLAB, а именно, с помощью окна инструментария Neural Network, специально предназначенного для моделирования и обучения нейронных сетей.

Данная система поддержки принятия решений будет иметь не только теоретический, но и практический характер. Впоследствии планируется внедрение системы на Минской станции аэрации №1.

Специально для демонстрации принципа работы системы поддержки принятия решений для биологической очистки в аэротенках разработано приложение в Scada-системе Trace Mode. Данное приложение позволяет наглядно представить результаты работы моделируемой системы при заданных исходных данных, а также проследить за изменением характеристик биологической очистки после выполнения управляющих команд. Это позволяет оценить работоспособность системы в псевдореальных условиях.

Экономический эффект от внедрения системы поддержки принятия решений может наблюдаться не сразу, но такое решение может окупиться даже в течение одного - двух лет, что является неоспоримым плюсом в пользу внедрения системы.

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## SIMULATION OF THE DECISION-MAKING SYSTEM FOR BIOLOGICAL REFINEMENT OF SEWAGE IN AEROTANKS BY MEANS OF MULTILAYER NEURAL NETWORKS

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Keywords: decision-making system, biological refinement, neural network, back-propagation algorithm.

Last years in a life of society the role and the place of personal computers and information technologies have radically changed. The list of spheres of public life where such technologies are applied, besides personal use by people which also rapidly increased, has extended.

Not exception for use of high technologies sewage disposal plants are and, in particular, biological refinement in aerotanks as one of production stages computers can be involved in. The reason for it is the strained ecological situation in the country, and more local one is a need to react on-the-fly to changes in system work.

The process of biological refinement can be described as a direct contact of pollution and optimal amount of organisms of active silt which have to interact during required time and in the presence of proper amount of dissolved oxygen. The last stage is to separate active silt from pure water [1].

An aerotank is a tank of a rectangular section in which the waste liquid mixed with active silt proceeds. Air, added by means of pneumatic or mechanical devices, mixes the treated liquid with active silt and saturates it with oxygen essential for bacteria's life [1].

The main purpose of the system is to provide help to a dispatcher in decision-making in any current and, especially, non-standard situations in real time for the high quality control and management of technology processes of biological refinement in aerotanks.

The tasks of the system are:

1. Optimization of air expenses.
2. Smoothing of dissolved oxygen concentration in aerotanks.
3. Minimization of electric power expenses on air feeding.

It is supposed, that the multilayer neural network will be used to reach for the above aim and solutions of these tasks. One of the most important reason the neural network has been chosen is its high ability to be trained with samples and to recognize unknown ones. Also the multilayer neural network is capable to carry out any reflection from input vectors into target ones [2].

The definition of a neural network as a «set of neural elements and connections between them» [2] is possible to extend as a «set of the input, intermediate and output data and technology connections between them». Neural networks allow to build processing algorithms bringing the opportunity to find out latent dependences between input and output data which beyond the bounds of traditional approaches.

Neural networks are especially popular in fields of financial markets, contemporary trade and markets of capital [3].

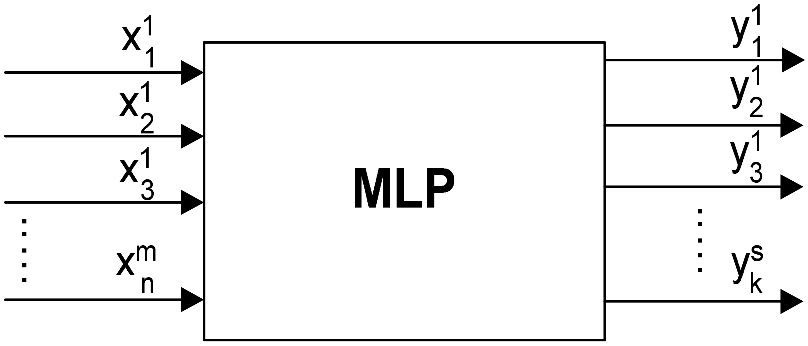


***Fig.1. Simplified model of the decision-making system, where MLP is a multilayer perceptron***

For the developed decision-making system the input data are $x^m_n$ (entry data for MLP):

1. Production equipment state (states of superchargers (switched on/off), percents of gates is opened for airway, circulating silt and superchargers, existence of an equipment emergency state).

2. Current measures of consumption indicators of air, circulating silt, clarified and spillway water, sensors for concentration of dissolved oxygen in checkpoints and spillway, registration of aeration intensity.

3. Technology commands by the dispatcher:

a. basic values, maximum deviations, minimum and maximum limits of concentration of dissolved oxygen in each checkpoints;

b. minimum intensity of aeration in aerotanks;

c. level of recirculation in aerotanks;

d. controlled gates steps and their conditional «percent null»;

e. gates involvement in the control scheme indicators;

f. concentration sensors for dissolved oxygen involvement in the control scheme indicators;

g. value for supercharge gates involvement in control;

h. value for supercharges involvement in control.

These data is possible to connect with input neurons.

The output data of the system ($y^s_k$) are suggestions of operating commands to the production equipments (e.g. open/close a gate, switch on/off a supercharger):

1. Suggestions to switch on/off a supercharger.
2. Suggestions to open/close gates to airway, circulating silt and superchargers.
3. Suggestions of the percent, gates to circulating silt to be opened.

The system output data are considered as output neurons.

The signals will be flowed in real time to inputs of the neural network in the processed form from the automated control system of technology processes (ACS TP) of biological refinement in aerotanks and the signals from the output layer flow back in ACS TP. The developed decision-making system will be directly involved in the given ACS TP and will work as its component under the remote equipment control mode. Also the given system will be possibly used as an independent program.

The back-propagation algorithm has been chosen as a training method for the neural network [2]. It is the most appropriate method because there is enough big database containing a lot of information about biological refinement processes gathered for many years of sewage disposal plants work. After minimization of the mean-square error of the network and getting of rather correct weights the network is good for work in real environment.

The neural network for the decision-making system will be realized and tested with MATLAB by means of the Neural Network Toolbox specially intended for neural network training and simulation.

The given decision-making system will have not only theoretical, but also practical importance. In future the system is planed to apply to Minsk aeration station No. 1.

The special program is developed in Scada-system Trace Mode for demonstration of decision-making system operation for biological refinement in aerotanks. The given program allows visually to present results of simulated system operation on a set of initial data, and also to trace changes in biological refinement after execution of control commands. It allows to estimate system performance on pseudo-real conditions.

Economic profit on this decision-making system setup can be gained not at once, but it can pay back even during one, two years that is a definite advantage of this setup.

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## ROBOT'S MOTION CONTROL ALGORITHMS ON A TASK OF LINE-FOLLOWING

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Keywords: task of line-following, algorithms “Avoidance of the line”, “Hold the aim in the center”, “The best approximation with an arc”.

At the System Engineering Laboratory, Hochschule Ravensburg-Weingarten, Germany the mobile robot “MAX” was developed and realized [1] (see Fig. 1). There is a rich set of control commands for it. It has an incorporated web-camera to observe space in front of. So it was a natural step to improve it to follow under the defined route – it's so called line-following task.