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Research Article

GENERAL FRAME WORK FOR WATER QUALITY MONITORING SYSTEM

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ABSTRACT

Drinking water in almost all the locations was found to be highly contaminated, except a few locations, where it was found to be moderately contaminated for both the monsoons. Neural provides an easy and rapid method of monitoring of water quality. It also becomes easier to compare the quality levels in different locations and to give priority for the required treatment to the location. Data collected by various sensors at the node side such as pH, turbidity and oxygen level is sent via WSN to the base station. Data collected from the remote site can be displayed in visual format as well as it can be analyzed using different simulation tools at base station. The water various parameters like pH, Dissolved oxygen, electrical conductivity, turbidity and total dissolved solids data's are collected that given to the neural network. A neural network usually involves a large number of processors operating in parallel, each with its own small sphere of knowledge and access to data in its local memory. An input data are multiplexed and given to the neural network. The various water parameter ranges are taken from water. The water ranges are input data for a neural network. An input data are given to the multiplexer and the multiplexed output data are given to the neural network. It decides the output based on the input range. It will give an output of the water quality. This novel system has advantages such as no carbon emission, low power consumption, more flexible to deploy at remote site and so on. The performance of the proposed model is compared with that of fuzzy based models, demonstrating the robustness, accuracy, and effectiveness of our method. The simulated using Matlab tool and finally the data results are sent to the water pollution control board in the regular intervals through Matlab server.

Keywords: Water Quality, Architecture, pH, Oxygen, Conductivity, Dissolved solids.

INTRODUCTION

The 21st century is said to be century of inventions, century of development, century of globalization and the lot much else, but the same coin has second side too, that is nothing but 21st century is century of the pollution, global warming, insecurity and helpless health factors!

One of the important and basic barrier is world's population does not have safe water for drinking. The situation is even worse in some developing countries, where dirty or contaminated water is being used for drinking without any proper & prior treatment.

One of the reasons for this happening is the ignorance of public & administration and the lack of water quality monitoring system and which creates serious health issues. The idea struck into mind that a system should be implemented so that it can monitor water quality in easy way so that some important and critical factors of water can be easily analyzed to take preventive actions for quality maintenance. Using different sensors, these systems can collect various environmental parameters from water, such as temperature, pH, oxygen density, turbidity and so on. The rapid development of Wireless Sensor Network (WSN) technology provides us a novel approach to real-time data acquisition, transmission and processing[1-4].

The users can get real time water quality data from faraway. In a system of this kind, there are several nodes and a base station. Each node contains a group of sensors and the nodes are distributed in different water bodies. Data collected by sensors is sent to the base station via WSN channel. The base station is usually a PC with Graphic User Interface (GUI) for users to analyze water quality data or alarm automatically when water quality detected is below preset standards. After the recorded data can be analyzed automatically using neural network and Fuzzy based system simulation tools in MAT LAB 7.12. The analyzed data gives the output of water quality level based on this water quality should be maintained. Then the data automatically send to the Email through MATLAB Server. So we can analyze all the data whenever need based on the problem[5].

SYSTEM ARCHITECTURE

Water is essential resource of life for each living organism on the earth. Oxygen level in water plays important role in examining quality of water. Water quality plays important role in the health issues of human, plant and living organisms on the earth. Generally, main sources of water are rain, rivers and lakes. Rain water running over the lands contains many useful as well as harmful contents, may be soluble or insoluble. Acidity of water is decided by the salt and particles in soil. Traditional measure of water quality is transparency of water that means insoluble particles mixed in water degrades usefulness of water for particular application. The main aim is to measure the oxygen level, acidity and turbidity of drinking water as well as water that may be used for agriculture and industrial processes. The remote access of water quality measurement parameters using wireless communication facilitates quality control, record keeping and analysis using simulation software at base station. Oxygen level, pH, Total dissolved solids, Electrical conductivity and turbidity level are the parameters that are analyzed and control to improve water quality[6].

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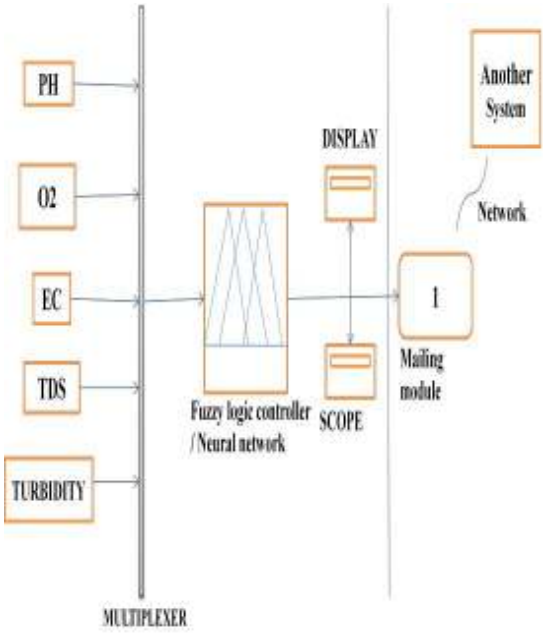

Figure 1: Block diagram of Proposed System

The main aim is to measure the oxygen level, acidity and turbidity of drinking water as well as water that may be used for agriculture and industrial processes. The remote access of water quality measurement parameters using wireless communication facilitates quality control, record keeping and analysis using simulation software at base station. Oxygen level, pH, turbidity and various parameters level that is analyzed and controls to improve water quality.

The water various parameters data's are collected that given to the neural network. Neural network is the knowledge based system in which the input parameters like pH, Oxygen content, turbidity level etc. The neural network is a system of programs and data structures that approximates the operation of the human brain. A neural network usually involves a large number of processors operating in parallel, each with its own small sphere of knowledge and access to data in its local memory. An input data are multiplexed and given to the neural network. The various water parameter ranges are taken from water. The water ranges are input data for a neural network. An input data are given to the multiplexer and the multiplexed output data are given to the neural network. it decides the output based on the input range. It will give an output of the water quality[8].

Table 1: Various water parameters and their standard values

Parameters	Min	Max	Avg
pH	6.5	8.5	8.5
Dissolved O_2	60	120	100
Conductivity	0	800	400
Chlorides	0	500	250
Sulphate	0	250	250
Alkalinity	0.001	0.002	120
Hardness	0	270	300
Total Dissolved solids mg/l	100	1000	500
Turbidity	0	10	5
Calcium	40	80	75
Magnesium	20	30	30

The neural network automatically calculates the water ranges and it gives the output of water quality condition. The neural networks are used in the MATLAB. In MATLAB, neural network use coding to analyze the water quality to give an output in GUI. Table-1 shows the various water parameters and their standard values based on this the water quality is maintained.

PROPOSED METHODOLOGY

NEURAL NETWORK

A neural network is a system of programs and data structures that approximates the operation of the human brain. A neural network usually involves a large number of processors operating in parallel, each with its own small sphere of knowledge and access to data in its local memory. Typically, a neural network is initially "trained" or fed large amounts of data and rules about data relationships (for example, "A grandfather is older than a person's father"). A program can then tell the network how to behave in response to an external stimulus (for example, to input from a computer user who is interacting with the network) or can initiate activity on its own (within the limits of its access to the external world).

First of all, when we are talking about a neural network, we should more properly say "artificial neural network" (ANN), because that is what we mean most of the time. Biological neural networks are much more complicated than the mathematical models we use for ANNs. But it is customary to be lazy and drop the "A" or the "artificial". An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons. This is true of ANNs as well[9].

Some Other Definitions of a Neural Network include:

According to the DARPA Neural Network Study (1988, AFCEA International Press, p. 60): A neural network is a system composed of many simple processing elements operating in parallel whose function is determined by network structure, connection strengths, and the processing performed at computing elements or nodes.

According to Haykin, S. (1994), Neural Networks: A Comprehensive Foundation, NY: Macmillan, p. 2: A neural network is a massively parallel distributed processor that has a natural propensity for storing experiential knowledge and making it available for use.

It resembles the brain in two respects: • Knowledge is acquired by the
network through a learning process.

• Interneuron connection strengths known as synaptic weights are used to store the knowledge.

pH

The indicator for acidity, alkalinity, or basic is known as the pH value. A pH value of 7 means a substance is neutral. The lower value indicates acidity, and a higher value is a sign of alkalinity. To better understand the range in pH, take a look at these examples:

• Apple Juice – 3 • Orange Juice - 3.5 • Coffee - 5.5 • Milk - 6.2 • Baking Soda - 8.5 • Soapy water – 10 • Bleach – 12

Basically, the pH value is a good indicator of whether water is hard or soft. The pH of pure water is 7. In general, water with a pH lower than 7 is considered acidic, and with a pH greater than 7 is considered basic. The normal range for pH in surface water systems is 6.5 to 8.5, and the pH range for groundwater systems is between 6 to 8.5. Alkalinity is a measure of the capacity of the water to resist a change in pH that would tend to make the water more acidic. The measurement of alkalinity and pH is needed to determine the corrosiveness of the water.

DISSOLVED OXYGEN

A high DO level in a community water supply is good because it makes drinking water taste better. However, high DO levels speed up corrosion in water pipes. For this reason, industries use water with the least possible amount of dissolved oxygen. Water used in very low pressure boilers have no more than 2.0 ppm of DO, but most boiler plant operators try to keep oxygen levels to 0.007 ppm or less. Dissolved oxygen (DO) refers to the amount of oxygen dissolved in water and is particularly important in limnology (aquatic ecology). Oxygen comprises approximately 21% of the total gas in the atmosphere; however, it is much less available in water. The amount of oxygen water can hold depends upon temperature (more oxygen can be dissolved in colder water), pressure (more oxygen can be dissolved in water at greater pressure), and salinity (more oxygen can be dissolved in water of lower salinity). Many lakes and ponds have anoxic (oxygen deficient) bottom layers in the summer because of decomposition processes depleting the oxygen. The amount of Dissolved Oxygen often determines the number and types of organisms living in that body of water. Decay of organic material in water caused by either chemical processes or microbial action on untreated sewage or dead vegetation can severely reduce Dissolved Oxygen concentration. This is the most common cause of fish kills, especially in summer months when warm water holds less oxygen anyway.

CONDUCTIVITY

The conductivity (or specific conductance) of an electrolyte solution is a measure of its ability to conduct electricity. The SI unit of conductivity is siemens per meter (S/m). Conductivity measurements are used routinely in many industrial and environmental applications as a fast, inexpensive and reliable way of measuring the ionic content in a solution. High quality deionized water has a conductivity of about 5.5 µS/m, typical drinking water in the range of 5-50 mS/m, while sea water about 5 S/m (i.e., sea water's conductivity is one million times higher than that of deionized water).The electrical conductivity of water estimates the total amount of solids dissolved in water -TDS, which stands for Total Dissolved Solids. TDS is measured in ppm (parts per million) or in mg/l. Since the Electrical Conductivity is a measure to the capacity of water to conduct electrical current, it is directly related to the concentration of salts dissolved in water, and therefore to the Total Dissolved Solids (TDS). Salts dissolve into positively charged ions and negatively charged ions, which conduct electricity. Since it is difficult to measure TDS in the field, the Electrical Conductivity of the water is used as a measure. The Electrical Conductivity of the water can be determined in a quick and inexpensive way, using portable meters. Distilled water does not contain dissolved salts and, as a result, it does not conduct electricity and has an Electrical Conductivity of zero.

TOTAL DISSOLVED SOILDS

Total Dissolved Solids (TDS) are the total amount of mobile charged ions, including minerals, salts or metals dissolved in a given volume of water, expressed in units of mg per unit volume of water (mg/L), also referred to as parts per million (ppm). "Dissolved solids" refer to any minerals, salts, metals, cations or anions dissolved in water. This includes anything present in water other than the pure water (H20) molecule and suspended solids. (Suspended solids are any particles/substances that are neither dissolved nor settled in the water, such as wood pulp.)In general, the total dissolved solids concentration is the sum of the cations (positively charged)

and anions (negatively charged) ions in the water. Parts per Million (ppm) is the weight-to-weight ratio of any ion to water. A TDS meter is based on the electrical conductivity (EC) of water. Pure H20 has virtually zero conductivity. Conductivity is usually about 100 times the total cations or anions expressed as equivalents. TDS is calculated by converting the EC by a factor of 0.5 to 1.0 times the EC, depending upon the levels. Typically, the higher the level of EC, the higher the conversion factor to determine the TDS. NOTE - While a TDS meter is based on conductivity, TDS and conductivity are not the same thing[10].

TURBIDITY

Excessive turbidity, or cloudiness, in drinking water is aesthetically unappealing, and may also represent a health concern. Turbidity can provide food and shelter for pathogens. If not removed, turbidity can promote re growth of pathogens in the distribution system, leading to waterborne disease outbreaks, which have caused significant cases of gastroenteritis throughout the United States and the world. Although turbidity is not a direct indicator of health risk, numerous studies show a strong relationship between removal of turbidity and removal of protozoa. The particles of turbidity provide "shelter" for microbes by reducing their exposure to attack by disinfectants. Microbial attachment to particulate material has been considered to aid in microbe survival. Fortunately, traditional water treatment processes have the ability to effectively remove turbidity when operated properly.

SOFTWARE DESIGN

INTRODUCTION TO MATLAB

MATLAB (MATrix LABoratory) is a numerical computing environment and fourth-generation programming language developed by Math Works. MATLAB allows matrix manipulations, plotting of functions and data implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++ and Fortran. Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation and Model-Based Design for dynamic and embedded systems.

MATLAB BASED DESIGN

MATLAB is a high-level language and interactive environment for numerical computation, visualization, and programming. Using MATLAB, we can analyze data, develop algorithms, and create models and applications. The language, tools, and built-in math functions enable you to explore multiple approaches and reach a solution faster than with spreadsheets or traditional programming languages, such as C/C++ or Java. We can use MATLAB for a range of applications, including signal processing and communications, image and video processing, control systems, test and measurement, computational finance, and computational biology. More than a million engineers and scientists in industry and academia use MATLAB, the language of technical computing.

Version and Regulation of MATLAB used in Proposed: R2011a (Version 7.12)

DESCRIPTION OF NEURAL NETWORK

In information technology, a neural network is a system of programs and data structures that approximates the operation of the human brain. A neural network usually involves a large number of processors operating in parallel, each with its own small sphere of knowledge and access to data in its local memory. Typically, a neural network is initially "trained" or fed large amounts of data and rules about data relationships (for example, "A grandfather is older than a person's father"). A program can then tell the network how to behave in response to an external stimulus (for example, to input from a computer user who is interacting with the network) or can initiate activity on its own (within the limits of its access to the external world).

In making determinations, neural networks use several principles, including gradient-based training, fuzzy logic, genetic algorithms, and Bayesian methods. Neural networks are sometimes described in terms of knowledge layers, with, in general, more complex networks having deeper layers. In feed forward systems, learned relationships about data can "feed forward" to higher layers of knowledge. Neural networks can also learn temporal concepts and have been widely used in signal processing and time series analysis.

RESULTS

The researching and designing have been done. Meanwhile in the proposed is where all the simulations results will be analyzed and compared. The theoretical or calculated values will be compared with the simulations results. The analysis and comparison will determine the progress and success of the proposed either the objective of the analysis is achieved or not.

MATLAB MODEL FOR NEURAL NETWORK

In simulation first step is run the Matlab, a display shows command window. Then go files click and go open click then open corresponding neural network coding folder. Load the codes in the editor window. Fig.2 shows the coding of neural network loaded in MATLAB editor.

Figure 2: Coding of Neural Network in MATLAB

Fig.3 shows after running the program water quality monitoring system window. That means loading the codes into the editor window save the files. Then run the program another one window will display. That window shows the neural network graphical user interface window. The window includes important five water parameters are ph value, dissolved O_2, conductivity, total dissolved solids and turbidity.

Figure 3: After Running Neural Network

Fig.4 shows after loading input values to the water quality monitoring system. That means give the input values to the various water parameters then click load data. If you want to reset the values means there is an option click reset or you want exit from this display click exit.

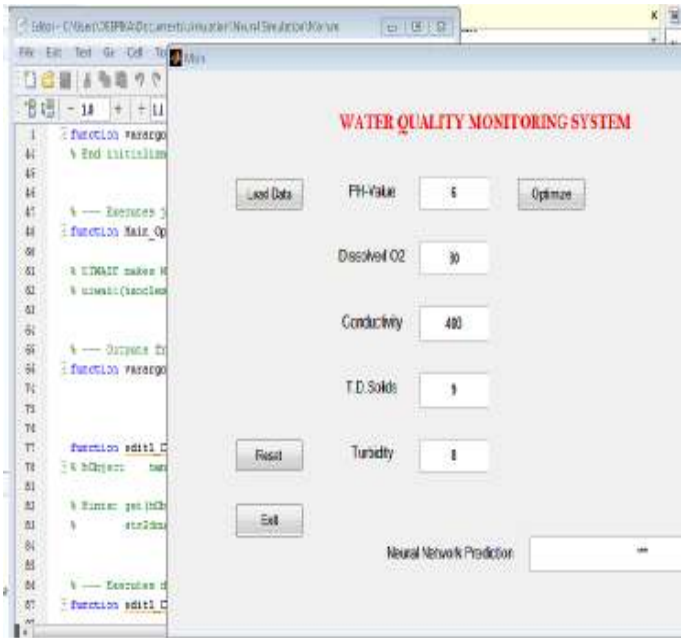

Figure 4: After loading input values

Fig.5 shows optimization of the input values. After click on the load data, the data loaded in the window. Then click optimize, a neural network window will be displayed. The window shows the neural network connections, algorithms, progress and plots. This window shows optimization result of the proposed.

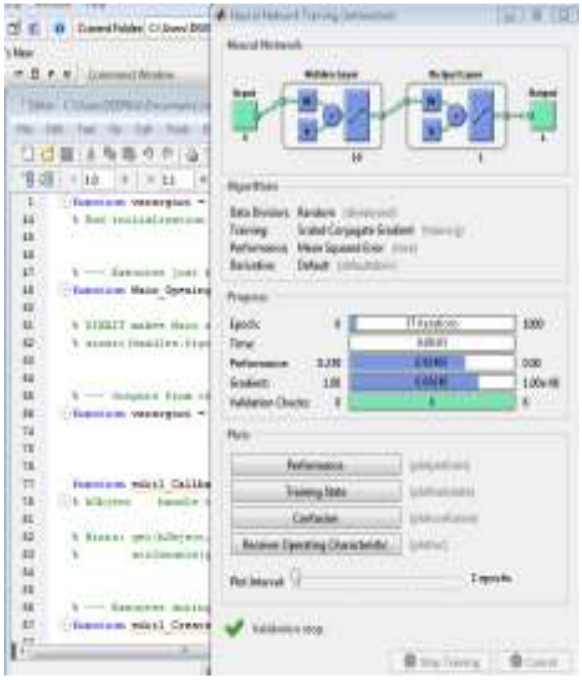

Figure 5: After optimization

Figure 6 Neural Network Simulation

Output

Fig.6 shows simulation output for the neural network. Here the water quality output is shown based on the neural network optimization. By using this method, we can control the water quality for an application.

Table.2 shows the input, output and various water parameters in simulation output. Those analyze various range of the input and give output of the simulation result.

Table 2: Results of the Proposed Method

Range/Input parameters	Min	Max	Avg
pH value	3	9	5
Dissolved O_2	40	150	89
Turbidity	0	15	9
T.D solids	90	500	6
Conductivity	0	900	400
Water Quality	Bad	Bad	Good

FUTURE ENHANCEMENTS

Based on the analysis of the Neural network based system the outputs seems to be maximum of 90%.This is because the neural network oscillates when the data exists nearer to the threshold. And for the purpose of training the neural network it may take long time for the training, validation and testing process. Since the fuzzy based approach is used for comparison and the performance of these system will be evaluated as a future work. In Matlab the Anfiseditor tool in the Fuzzy logic toolbox is used to evaluate the output class.

CONCLUSION

The proposed mainly focuses on the analyze of water quality monitoring system using neural network method. The coding has been designed based on the neural network and simulated using MATLAB. The standard ranges of various water parameter values have been tabulated and the simulation results were gained through MATLAB simulations. The simulation results gives an output based on the standard values. If the simulation input values are out of maximum or minimum standard ranges means it will give an output of the water quality is bad. Otherwise it will give an output of the water quality is good. From the results and progress throughout the proposed, water various parameters are automatically analyzed and provide an output of the water quality using the neural network method.

REFERENCES

1. Akyildiz lan F, Su Weilian, Sankara Subramaniam Yogesh etc. A Survey on Sensor Networks 0163-6804/02 2002 IEEE.
2. Akyildiz F, Su. W, Sankara Subramaniam. Y and Cayirci. E, Wireless sensor networks: a survey, Computer Networks, Volume 38, Issue 4, pp 393-422, 2002
3. Chang CL., Lo. SL, Hu. CY, Wang. LH and Ma. CL, Relationship between turbidity in the Linnei water treatment plant and its upstream hydrologic environment. 2009 Water Resource Management Conference, Taipei, Taiwan. (in Chinese), 2010.
4. Jiang Peng, Huang Qingbo, Wang Jianzhong, Research on "Wireless Sensor Networks Routing Protocol for Water Environment Monitoring" 0-7695-2616-0/06 2006 IEEE.
5. Karul C., Soyupak S., Cilesiz. AF., Akbay N. and Germen. E. Case studies on the use of neural networks in eutrophication modeling. Ecological Modeling, 2000; 134: 145-152.
6. Lee TL and Jeng DS. Application of artificial neural networks in tide forecasting. Ocean Engineering, 2002; 29: 1003-1022.
7. Lee TL. Predictions of typhoon storm surge in Taiwan using artificial neural networks. Advances in Engineering Software, 2009; 40: 1200-1206.
8. Lin Yangzheng, Li Jiding Zeng Chuyi, Chen Cuixian Prediction of Solid-Liquid Equilibrium for KCl in Mixed Water-Ethanol Solutions Using the LIQUAC Model Tsinghua Science And Technology ISSN 1007-0214 05/20 pp548-553 Volume 10, Number 5, October 2005.
9. Marco Grossi, Roberto Lazzarini, Massimo Lanzoni, Member, IEEE, Anna Pompei, Diego Matteuzzi, and Bruno Riccò, Fellow, IEEE A Portable Sensor With Disposable Electrodes for Water Bacterial Quality Assessment" IEEE Sensors Journal, 2013; 13: 5.
10. Maier HR. and Dandy GC. Neural networks for the prediction and forecasting of water resources variables: a review of modeling issues and applications. Environmental Modeling and Software, 2000; 15: 101-124.

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