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Environmental Water Pollution Based Abrupt Event Monitoring - A Survey

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Abstract - The importance of maintaining good water environment highlights the increasing need for advanced and good technologies. This paper presents a system that proposes a novel design of water environment monitoring system; the functions of remote detection and real-time monitoring of natural water are implemented through the Zigbee wireless data transmission technology. Water pollution monitoring based - the abrupt event monitoring is a challenging and critical issue in water environment systems. In this system, a novel abrupt event monitoring approach based on kernel principal component analysis (KPCA) and deep learning machine (DLM) mechanism is proposed. The system consists of wireless water quality monitoring network and remote data centre. The parameters involved in the water quality determination such as the pH level, temperature and turbidity is measured in the real time by the sensors that send the data to the base station or control/monitoring room. This system proposes how such monitoring system can be setup emphasizing on the aspects of low cost, easy installation and easy to handling and maintain. form is a necessary condition for its publication, as well as its content.

Keywords - *Wireless sensor network, Abrupt event, water environment system, kernel principal component analysis (KPCA) and deep learning machine (DLM), ZigBee*

1. Introduction

Water is an essential resource and an important biological component for all the living organics of the earth to survive. Water environment, consisted of surface water environment and underground water environment, which can be differentiated to different water bodies like: river, lake, reservoir, ocean, glacier, spring and shallow/deep underground waters. Once a change or damage of water environment is observed in this complex environment, change of other environmental elements also occurs. Water is suffering from various pollutions due to thousands of reasons. As society and economy has developed, water pollution and its hazards have become one of the most prominent problems in the human society.

The frequently occurring water pollution accidents have attracted more and more attention in the whole human society, so it's the need of time to monitor the water environment systems .As complexity of water environment is very high, there are two main different abrupt events in the water environment sensor system, they are, the emergency water pollution accident and the abrupt sensor fault. The emergency water pollution is caused mostly due to discharging the harmful polluted water into the water environment directly without any prior treatments [1]. However, the abrupt sensor fault is one type of sensor fault, which is mostly caused by monitoring objects as heavy corrosive pollutants or the design flaws.

If it is an emergency water pollution accident, then it should be detected and dealt with in time. Otherwise, it will lead to serious consequences. The consequences can be- increase of fish death rate, shortage of drinking water which is the most important biological component, and high economic losses. If it is second type, an abrupt sensor fault, the faulty sensor should be detected and replaced timely to keep the sensor system working normally and in a proper way. The treatments of both these events are different, so monitoring these abrupt events timely and accurately is a challenging and critical issue in water environment. The sensor faults can be classified into two types first one is drift faults and second one is abrupt faults. The abrupt faults may cause much more serious problem and results than drift faults. So in this system research is focused on the detection and isolation abrupt sensor fault. Thus it is of great

importance to develop an effective water pollution monitoring system to monitor the polluted water and avoid future hazards related to it.

1.1 Nature of the Problem

The traditional water inspection method is also called as offline inspection approach. In this approach inspectors goes near the monitoring area, collect sample water from that monitored area and then bring them back to the laboratory for analysis. This system leads to various disadvantages, they are - the inspection circle is long, sometimes it takes a few days or long time to get the result, the analysis result is limited to sampling area, it is unable to carry out real time monitoring in big range, high cost and low efficiency, it is laborious and time-consuming. Water samples changes frequently and if pollution is not detected in a timely fashion, the transmission may affect the analyzed results. It is of great problem in remote locations or we can say under poor and extreme weather conditions where it is a difficult to get a comprehensive and objective response to the change of water environment and its parameters.

In order to improve water environment quality, it is of great importance to develop advanced real-time online monitoring systems for water resource development and utilization based on WSN. As a rising network technology and an outcome of the combination of computer technology, communication technology and sensor network technology, it is regarded as the first of 21st century top 10 new technologies that changed world [4]. With strong data capture and process abilities Wireless Sensor Network in it has very expansive application foreground in the fields of military, building monitoring, asset tracking, environmental monitoring , health monitoring and educational research disaster prevention and biomedicine, especially in some special fields such as Environment monitoring and disaster rescue with nobody on duty, it has advantages that traditional technologies could never compare [2][3].WSN is of specific advantages on water pollution monitoring. WSN have attracted a great deal of interest due to low cost, convenience in monitoring arrangement in the sense as varieties of parameters for collection, the monitoring parameters are flexible ,high detective accuracy and high accountability of the monitoring network, self-organization, flexible network extension, smart sensor nodes deploying, low power consumption for data transmission, which is very suitable for a long-term, long-distance automatic data collection, ability to perform multiple functions simultaneously and make decisions based on information gathered from various sensing elements placed at different locations and the node distribution can be much denser. With the local/remote data monitoring centre, a complete monitoring interface can be implemented to carry out historical data queries, real-time data and display of network state, analysis of data and alarming for non-normal status, etc.

2. Related work

Various methods to deal with the sensor fault problem and water environment based abrupt event monitoring have been proposed.

Jianjun Ni, Member, IEEE, Chuanbiao Zhang, Li Ren, and Simon X. Yang, Senior Member,IEEE proposed "Abrupt Event Monitoring for Water Environment System Based on KPCA and SVM" [1] a Trust mechanism that reduces the interference of external noise and improve the performance of quick response to the abrupt events and its monitoring. In this work a spare data area is set up to store the data for the KPCA modelling which is used to detect the abrupt events. The data in the spare data area are updated continuously and so as the KPCA model, is updated subsequently to improve the adaptability of the KPCA model for the abrupt event monitoring and support vector machines (SVMs) is used to detect the type of abrupt event .

Ning Jin, Renzhi Ma, Yunfeng Lv, Xizhong Lou, Qingjian Wei Department of Information Engineering China Jiliang University Hang Zhou, 310018, China proposed " A Novel Design of Water Environment Monitoring System Based on WSN" [2] a novel design of water environment monitoring system based on wireless sensor networks (WSN). In this proposed work the sensor nodes have been constructed with arbitrary parameter modules such as PH, dissolved oxygen (DO), conductivity and temperature.

Xia Hong-bo, Jiang Peng Institute of Information and Control Hangzhou Dianzi University, Hangzhou, China , Wu Kai-hua Institute for Biomedical Engineering and Instrumentation Hangzhou Dianzi University, Hangzhou, China proposed " Design of Water Environment Data Monitoring Node Based on ZigBee Technology" [3] a design of a new water environmental monitoring system based on wireless sensor networks which is best suitable for the monitoring of complex and large-scale water environment. This system research is based on the low-power data monitoring node which is based on ZigBee wireless technology, and develops its hardware and software. This proposed work tested the water monitoring in an artificial lake, to realize the remote and automatic

on-line monitoring both on the pH value and temperature of the lake water.

Shuiping Zhang, Lin Zhang JiangXi University of Science and Technology, GanZhou 341000 ,P.R.China proposed" Water Pollution Monitoring System based on Zigbee Wireless Sensor Network" [4] a water pollution monitoring system based on Zigbee wireless sensor network taking into account the current severe situation of global water pollution, with Low-cost, low-consumption and easy-expansion, the system is capable of inspecting the water pollution level timely, which provides important proofs for related departments of environments to make decisions and take appropriate actions based on that decisions. This work described the detailed hardware and software designs of sensor node. The system possess a feature of self-organized and self-adaptive, and works in terms of communication even if the location of network node changes. This system is applicable to synchronized monitoring on water pollution in water bodies like rivers, lakes, springs and oceans. If it is considered that the differences of energy demand and energy consumption of different nodes in the same sensor network may bring bottleneck of the whole network since the energy consumption of some nodes in the same sensor network is much bigger, to balance the energy consumption of all the nodes, the system collects and transfer data via cluster network.

Shuang-chun Yang, Yi Pan Liaoning University of Petroleum & Chemical Technology Fushun, China proposed "The Application of the Wireless Sensor Network (WSN) in the Monitoring of Fushun Reach River in China" [5] the possible application of WSN technology in the water quality monitoring area to overcome the shortcomings of the existing system in China .A new remote river quality monitoring system based on the wireless sensor network is proposed which was introduced for its low power consumption, lower cost, self communication, long lasting operation time and ease of implementation in large area. This was applied in the Monitoring of Fushun Reach River in China. Whenever the pollution emergencies occur, the environmental department is capable of detecting these emergencies on-time and dispose them quickly.

Dong He, Li-Xin Zhang, 1Institute of Mechanical and electronic information, China University of Geosciences (WuHan), WuHan,China proposed" The Water Quality Monitoring System Based on WSN" [7] a water quality monitoring system that can be used by environmental protection department in a particular area of the water quality requirements .This system is based on the Wireless Sensor Network (WSN). It consists of Wireless Water Quality Monitoring Network and Remote Data Centre as its major parts. In this system the sensor network is built in accordance with Zigbee wireless transmission agreement. WSN Sample the water quality and then send the data to Internet with the help of the GPRS DTU which has a built-in TCP/IP protocol function. Through the Internet, Remote Data Centre gets the real –time water quality data, and then it is analysed, processed and recorded (data). Based on this the environmental protection department can provide real-time guidance to those industries which depends on regional water quality conditions, like industrial, plant and aqua culture. The most important is that this work is more efficient and less cost**.** This proposed design works in mesh network which can be convenient to build an automatic network, and has a good expansibility.

Ji Wang 1Information School, Guangdong Ocean University, Zhanjiang, China, Xiao-li Ren1 Information School, Guangdong Ocean University Zhanjiang, China proposed " A Remote Wireless Sensor Networks for Water Quality Monitoring" [8] a novel system of remote water quality measuring and monitoring based on wireless sensor network (WSN) and Code Division Multiple Access (CDMA) technology. These functions of remote detection and real-time monitoring of natural water are implemented through the CDMA wireless data transmission. The system has a simple architecture, and is not confined by the geographical position .The proposed system uses cluster technique.

Steven Silva , Hoang N ghia Nguyen , Valentina Tiporlini and Kamal Alameh Electron Science Research Institute, Edith Cowan University, 270 Joondalup Dr, Joondalup, WA 6027, Australia proposed "Web Based Water Quality Monitoring with Sensor Network: Employing ZigBee and WiMax Technologies" [9] the development of a web based wireless sensor network application for monitoring water pollution using Zigbee and WiMax technologies. Web based sensor network application for monitoring water pollution is based on the use of Zigbee and WiMax that is used for collecting and processing information and making decisions in real time via a remote web server. The technologies used for developing the system consist of a local Zigbee network, which is capable of acquiring various water quality parameters with a WiMax network and capable a host computer for web based monitoring. The data is being sent from sensor nodes through the Zigbee gateway to the web server via WiMax network, thus it allows users to remotely monitor the water quality from their offices instead of gathering data from the scene. In the system

proposed WSN has been deployed for monitoring the water quality of a university's manmade lake using five different types of sensors.

This paper is organized as follows. Section 1 presents introduction and related work. Section 2 describes proposed system design, working methods and proposed approach. Finally the conclusion is given in Section 3.

3. Proposed system

WSN is a kind of AD-Hoc network which is easy to configure, without infrastructure, such as cables. This leads saving system investment a lot.

The proposed system consists of

- several wireless sensor nodes that are distributed or positioned in the environment
- sink nodes
- remote centre

In the proposed system as shown in the Fig. the parameters from the water environment will be collected by the sensors that are interfaced with nodes. These collected parameters such as water temperature ,turbidity and ph level will then be transmitted to the remote centre with the help of zigbee. This remote centre is responsible for transmitting this information to the environmental department.

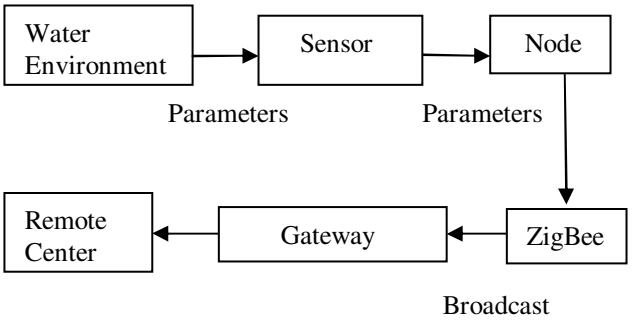

Fig. 1 System design and its working

The parameters such as turbidity, ph level, temperature will be collected and detected by sensors from water environment. In the proposed system three type of sensors i.e. turbidity sensors, ph level sensors, temperature sensors will be used to detect parameters turbidity, ph level, temperature of water environment respectively.

Node is the basic functional unit of wireless sensor Network. As sensor nodes are distributed in the water environment. Each node is expected to detect events of interest and estimate related parameters that characterize these events. It is responsible for the collection and storage of on site parameters, such as water temperature, PH value, turbidity,send and receive data, mainly acquire information of the source of pollution.The resulting information of each inspected area (as per specific rules to collect the data, dispose and transfer the data) from nodes needs to be transmitted to the sink node or ,we can say, through several other nodes in the network via ZigBee module.

3.1 ZigBee technology

Monitoring nodes is the basic unit of the monitoring area of the water environment. At present, the major functions of the monitoring nodes in water environment monitoring are:

(1) To collect the parameters - temperature, turbidity and pH value of the water area to be monitored.

(2) Set up wireless network based on the ZigBee agreement technology.

A promising communication technology called ZigBee has emerged. The proposed system consists of a local ZigBee network which is capable of acquiring various water quality parameters from the water environment and transferring them to the remote centre.

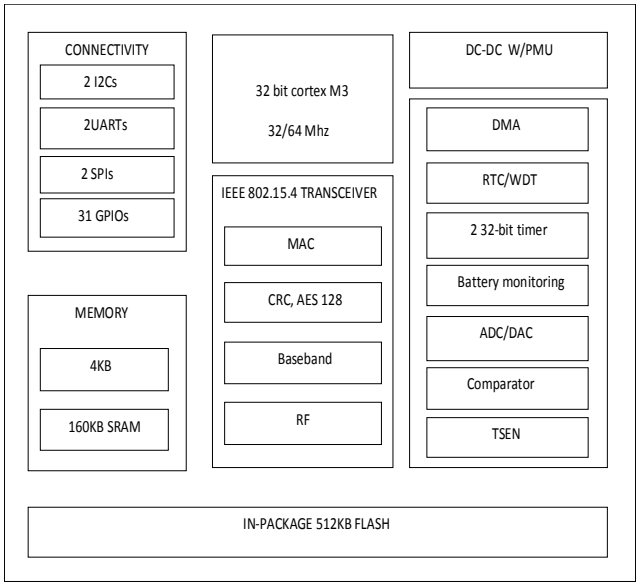

Fig. 2 Basic fundamental blocks of ZigBee

The 88MZ100 integrates features historically found in four different chips:

- A ZigBee compliant platform and IEEE 802.15.4- 2003/2006 transceiver
- 32 bit ARM Cortex M3 microcontroller running at 32 or 64 MHz with Marvell's proven peripheral IPs and up to 31 GPIOs that enable use of rich microcontroller applications
- On-chip DC-DC converter that directly takes input range from 2 volt to 3.6 volt
- In-package 512KB serial flash with QSPI interface to Cortex M3 along with AES encryption capability

3.1.1 Applications of ZigBee

ZigBee is a optimized standard for WSN, which has its several applications such as sensors interconnection, monitoring and automating different systems in hospitals, home, manufactories and agriculture. In recent years, many successful research works have been done in the field of environmental monitoring areas. The application of low-consumption Zigbee technology in wireless sensor network to monitor water pollution brings great convenience to that wireless sensor network water pollution system that actually finds it inconvenient to recycle energy and has to last for long working time in extreme severe outdoor environment, thus improve the overall performance of the system.

3.1.2 Characteristics of ZigBee

Zigbee is a newly rising low-complexity, low-speed-rate, low-cost and low-consumption two-way wireless communication technology. The working frequencies bands include, 868MHz for Europe, 915 MHz for the U.S.A or 2.4 GHz globally ISM Frequency Bands. If we see its application it is used for personal area network and a peer-to-peer network. According to the standard IEEE 802.15.4, it can hold 64000 sensor nodes that has communicating capacity with each other. Through radio waves with the help of zigbee, data will be transferred from one node to another one with very high transmission efficiency. On comparing zigbee with other wireless network technologies present, it is easily-applicable, it require low-consumption, it has strong-networking ability and is of high-reliability and low cost.

The sink node is also considered as a coordinating node or we can say it acts as a gateway. The sink nodes play a very important role of receiving the data from sensor nodes (i.e. data collection), command analysis & identification, carrying out data processing and integration, and lastly transmitting the data packets to the data monitoring centre .It will deal with the data which comes from (terminal) sensor nodes and its objective is to send it to the data monitoring centre. Each sink nodes could send time message to remote monitoring centre through ZigBee. It could be set at sleep mode at peacetime, the data collection will be initiated and message will be sent to monitoring centre only upon receiving of data commands.

Each node (sensor node and sink node) individually is responsible for their respective functions. At the same time, they are support by each other for completing network establishment and operations. Each node is connected with and controlled by the remote station with the help of ZigBee Communication agreement.

3.2 Remote Centre

Through the ZigBee, Remote Data Centre obtains the real–time water quality information, here presence of application software memorise, analyse, process and record water quality data and display of the collected data takes place. Remote Data Centre includes the PC, application software and database.

This data will be helpful for industrial, agricultural production, environmental departments. Users can access the remote monitoring centre at real-time, enquire and even monitor the system.

3.2.1 Functions of remote monitoring center

- Display graphic display of data: Create a real-time curve of the data from the database and issue on Web for future purpose.
- Memory and output: Storing and reporting data by the real-time monitoring, statistically analyzing the historic data, draw the historic trend curve and output and print different report form for future use.
- When a pollution emergency is encountered, the environmental department could be able to detect it on-time and dispose quickly.

This information can be broadcasted to the environmental protection department and this can provide real-time guidance to those industry which depends on regional

water quality conditions, like industrial, plant and aquaculture etc. The most important is that the work can be more efficient and less costly.

The main objective of proposed work is to create a system which interacts with the authorized or centralized servers. In this system the abrupt event monitoring water environmental system based on a wireless sensor network is proposed to check the water parameters. There are many researches done on monitoring the abrupt sensor fault or the emergency water pollution accident, but very few considered the two problems together. As changed characteristics of the measured data during the two different abrupt events are similar, so presence of conventional methods is not capable of recognizing the abrupt event efficiently. There are two main tasks in the monitoring of abrupt event. First task is that the abnormality in the sensor system should be detected quickly and in an accurate way. Second one is that the type of abrupt events should be recognized correctly as soon as after the abnormality is being detected.

To accomplish this abrupt event monitoring task efficiently, a novel adaptive approach based on kernel principal component analysis (KPCA) and deep learning machine (DLM) mechanism is proposed. In the proposed approach, the KPCA method is used to detect the abrupt event (i.e. the first task mentioned above) and the DLM mechanism is used to recognize the abrupt event (i.e. the second task mentioned above).

The proposed system has various advantages like dealing with noise and recognizing which parameter changes abruptly on the occurrence of the water pollution accident.

The monitoring of water environment is a very tedious task, two abrupt events happen frequently in the wireless sensor system. First abrupt event comes from the sensors, and the second abrupt event comes from the water environment. The data characteristics representation of these two conditions are similar, so it is very difficult for by general methods in the sensor fault diagnosis or water environment monitoring fields to recognize accurately the type of abrupt event. Hence a novel approach is proposed for abrupt event detection and recognition.

The KPCA method is the extension of Principal Component (PC) analysis in the nonlinear area, which is a novel non-linear multivariate analytical redundancy method. In the system, the KPCA method is used to detect the presence of abrupt event. In this, various specifications about temperature, voltage, current is specified. If any change in such parameters results in some abnormality defect. The main objective of KPCA method in the system is to detect the presence of abrupt event.

The Deep learning machine is used to solve presence of complicated functions that read high level abstraction. Its architecture consists of multiple levels of non-linear operations. eg. neural networks that has many hidden layers. Deep learning is a set of algorithms in machine learning that attempt to learn layered models of inputs that are commonly neural networks. The layers in such type of models correspond to distinct levels of concepts, in which higher-level concepts are defined from lower-level concepts, and the same lower-level concepts can help to define many higher-level concepts. The main objective of DLM in system in the system is to recognise the occurrence of type of abrupt event. Its objective is to classify the different type of data of the sensor then form a single output then check the result.

4. Conclusion

In this paper wireless sensor network that has various advantages over traditional inspection method is being explained. Abrupt event based water pollution monitoring system based on wireless sensor network is the basic idea of this paper. Different water quality sensors can be installed on the node in order to meet the real-time monitoring for a wide range of water environment parameters. Sensor nodes based on Zigbee wireless technology are designed to suit with arbitrary parameter such as PH, temperature and turbidity. The low-consuming ZigBee-based wireless sensor network is becoming more and more popular, and has various advantages over other technologies. KPCA is used to detect the abrupt event and DLM is used to recognize the type of abrupt event in water monitoring system. This information can be further broadcasted to the environmental protection department and this can provide real-time guidance to those industries which depends on regional water quality conditions.

References

[1] Jianjun Ni, Member, IEEE, Chuanbiao Zhang, Li Ren, and Simon X. Yang, Senior Member,IEEE “Abrupt Event Monitoring for Water Environment System Based on KPCA andSVM”.IEEE transactions on instrumentation and measurement, vol. 61,NO. 4, APRIL 2012.

[2] Ning Jin,Renzhi Ma,Yunfeng Lv,Xizhong Lou, Qingjian Wei Department of Information Engineering China Jiliang University Hang Zhou, 310018, China,” A Novel Design of Water Environment Monitoring

System Based on WSN", 2010 International Conference On Computer Design And Applications (ICCDA 2010).

[3] Xia Hong-bo, Jiang Peng Institute of Information and Control Hangzhou Dianzi University, Hangzhou, China , Wu Kai-hua Institute for Biomedical Engineering and Instrumentation Hangzhou Dianzi University, Hangzhou, China," Design of Water Environment Data Monitoring Node Based on ZigBee Technology" 978-1-4244-4507-3/09/$25.00 ©2009 IEEE,

[4] Shuiping Zhang, Lin Zhang JiangXi University of Science and Technology, GanZhou 341000 ,P.R.China," Water Pollution Monitoring System based on Zigbee Wireless Sensor Network". 978-1-4577-0321-8/11/$26.00 @2011 IEEE.

[5] Shuang-chun Yang, Yi Pan Liaoning University of Petroleum & Chemical Technology Fushun, China "The Application of the Wireless Sensor Network (WSN) in the Monitoring of Fushun Reach River in China". Second International Conference on Computer and Network Technology . 978-0-7695-4042-9/10 $26.00 © 2010 IEEE.

[6] Tian Jinghuan Wang Yi North China University of Water Resources and Electric Power," A Novel Water Pollution Monitoring Approach based on 3s Technique", 2010 International Conference on E-Health Networking, Digital Ecosystems and Technologies.

[7] Dong He, Li-Xin Zhang, 1Institute of Mechanical and electronic information, China University of Geosciences (WuHan), WuHan,China," The Water Quality Monitoring System Based on WSN", 978-1-4577-1415-3/12/$26.00 ©2012 IEEE.

[8] Ji Wang 1Information School, Guangdong Ocean University, Zhanjiang , China, Xiao-li Ren1*Information School, Guangdong Ocean University Zhanjiang , China," A Remote Wireless Sensor Networks for Water Quality Monitoring", 2010 International Conference on Innovative Computing and Communication and 2010 Asia-Pacific Conference on Information Technology and Ocean Engineering.

[9] Steven Silva , Hoang N ghia Nguyen , Valentina Tiporlini and Kamal Alameh Electron Science Research Institute, Edith Cowan University, 270 Joondalup Dr, Joondalup, WA 6027, Australia,"Web Based Water Quality Monitoring with Sensor Network: Employing ZigBee and WiMax Technologies", 978-1-4577-1169-5/11/$26.00 ©2011 IEEE.

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