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Remote Monitoring Approach for Contamination Detection in Drinking Water.

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ABSTRACT

Adequate water supply is essential for healthier life. Diagnosing critical phenomena like polluted water is very significant in present day scenario. Existing methods for handling waterborne microbe's diseases are too expensive, time conservative and slow responsive. The water quality parameters and probable health risks contrast throughout the sphere because of various reasons like concentration of ions, and acids. The proposed work presents an innovative methodology based on rough set theory, centered on the progress of low cost embedded devices for real time taxation of drinking water quality. The responsiveness of contaminated factors can be monitored remotely over internet by making use of HTTP. Data placed at server can be viewed on remote PC with internet connection. In this method prominence is given for reliable fast operation with help of low cost embedded devices. The structure and methodology accessible in this paper have the potentiality to be set as a convenient low cost tool for remote monitoring of water contaminated values.

Keywords: Water quality monitoring, rough set, ARM, Contamination detection

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INTRODUCTION

Drinking water practicalities face more challenges in their real-time process because of narrow water assets, demanding budget necessities, emergent population, mature infrastructure, progressively more rigid principles and enlarged devotion towards safeguarding water provisions from fortuitous or deliberate contamination. Drinking water is naturally more subtle to accidental and deliberate contamination. [1] Conventional laboratory methods depend on manual collection of water samples at various places and altered times, trailed by extensive chemical analysis for qualifying the drinking water. Such methods are no longer measured as efficient. Even though the laboratory methods include extensive research analysis, it devises several shortcomings such as

- Absence of tangible water monitoring information for assisting the critical decisions for public health (long delay between sample Collection & analysis)
- Manual operation is cost expensive (equipment and maintenance).Hence there a vibrant need for better online monitoring with precise event detection.

US based Environmental Protection Agency (USEPA) has carried out extensive research on water featured sensors for evaluating performance on different water contaminated parameters. The key parameters to estimate water contamination can be achieved through electro chemical and optical sensors such as electrical conductivity, turbidity and pH. Therefore it is potential to deduce the quality of drinking water through distinguishing variations in such parameters. The objective of proposed work is to develop a low cost device that can constantly monitor water parameters at consumer sites. For the accurate evaluation of contamination parameters all the available data sensors are fused. Water contamination event is conformed when the original water quality parameters are exterior to the predictable range, at which point caution (buzzer) is issued.

METHODOLOGIES

The chief Contamination Warning System (CWS) [2] is the most advanced mechanism that is available at present either to control or minimize the effects of adulteration of drinking water in a particular system. The World Health Organization (WHO) has set up some standard guidelines to check the contaminants in drinking water. It also specifies that the biological, chemical parameters must not exceed the permissible limits at any cost and it should be supervised at regular intervals in order to ensure the safety of consumers. So by considering all the standards set up by WHO, the CWS is designed to safeguard the public health. USEPA (2007) describes a conceptual model [3] for Contamination warning system operation as follows.

Monitoring and surveillance

It is a routine process which includes all the factors such as online monitoring of water tone, analysis of water samples, security supervision, consumer complaint scrutiny and public health monitoring.

Event detection and potential decision:

Event detection is a phenomenon in which an abnormal case or an eccentricity from the standard line is noticed.

Credible determination:

Credibility finding process is done by collecting all the data from contamination warning system elements. Whenever contamination is determined to be credible extra secure features and response actions will come in to force.

Confirmed decision:

It is the stage at which all the additional data is congregated to confirm the adulteration of drinking water. The extra secure features and response actions are extended and supplementary response actions are introduced.

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Remedy and retrievals

Once the authorization of contaminated water is obtained all the necessary actions are implemented. The actions include flushing, emergency warnings etc. [4]. The recovery actions which are pre-defined in the organization plan are executed to bring back the system to normal process. The advanced equipment such as online monitors and sensors are widely used in order to detect a pollution event in a particular system. This equipment is considered as the basic means to identify the contamination. Thus reliable and efficient data can be obtained by using suggested parameters as shown in Table – 1.

S.No	Parameters	Units	Quality range	Measure cost
1	pH	NTU	0 – 14	Low
2	Electrical Conductivity	µs/cm	30-100	Low
3	Temp	°C	-5 - 100	Low
4	Turbidity	NTU	0-50	Medium
5	%02	Mg/L	-	Medium

Table 1: Suggested parameters range to be monitored

WATER CONTAMINATION OUTCOME FINDING BY USING ROUGH SET METHOD

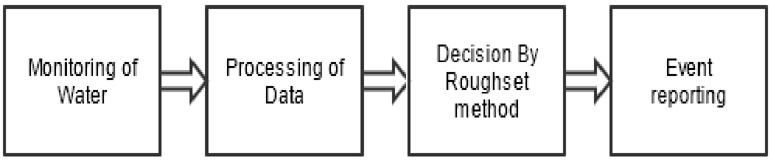

Figure 1: Schematic Method for Handling Event Detection

Rough set principle [5] has been using various arenas because of its capability to compact with the mathematical and numerical data. In this experimental study, rough set method is used to analyses the contaminated parameters from different external sources which confirm the quality of water. It is used to employ fusion technique which helps to solve the conflicts when contamination is detected.

Fusion Method

Fusion methods involve data processing, decision practice and recognition of patterns [6]. The proposed method analyses contamination in drinking water by using Rough set theory. Proposed system involves five stages: (1) monitoring water quality; (2) pre-processing of data (3) decision taking by rough set method (4) report of water quality contamination.

Water-quality monitoring depends upon a system of deliberately located sensors which collect, store and send data to the system managers [7]. The fusion evidence is the highest degree of residuals of the chosen parameters. These parameters are computed and compared with a specific threshold value in order to determine the exact status of water quality. Threshold values is assigned to the both normal and anomaly state of drinking water parameters. Real time parameters collected from the water samples [8]. The obtained values are processed for finding out most event detection. The sensitivity of the drinking water can be specified as N='Normal' and A='Anomaly'.

S.no	Input data					Prob.
Object	pH	E.Con	Tem	Turbidity	%o2	Avg
X1	4	58	30	45	26	32.6
X2	3	48	24	61	31	33.4
X3	3	52	33	37	58	38.8
X4	4	70	38	61	67	48
X5	6	44	26	56	51	36.6
X6	4	54	29	42	31	32

Table 2: Information set Regarding Water Samples

Step 1: In order to identify the performance of contaminated water, initially we build the sensor values as an information table as shown in table 2.

Step 2: To calculate the contaminated water parameters from the information table divide the objects corresponding equivalence classes(C). Equivalence classes are generated with most occurring average probability of the sensor

The equivalence classes are:

C = {x1, x6} {x2} {x3} {x4} {x5}

Step 3: The obtained equivalence classes can be grouped into data sets (D).

D1= {x1, x6} D2= {X2} D3= {X3} D4= {X4} D5={X5}

Step 4: Mass functions (M): Expand the datasets with the help of information table.

M1= {(4, 58, 30, 45, 26) (04, 54, 29, 42, 31)}
M2= {(03, 48, 24, 61, 31)}
M3= {(03, 52, 33, 37, 58)}
M4= {(04, 70, 38, 61, 67)}
M5= {(06, 44, 26, 56, 51)}

Step 5: The mass functions can be reduced by the union of elements denoted as F is as shown in the table 3.The confidence values can be calculated with the help of Mass functions {M1, M2, M3, M4, M5} and user considerations values. Assume user consideration value as E = {4, 54, 32, 51, and 47}. The confidence value can be computed as

$$D\left(\frac{F_j}{E}\right) = max_{j<m}\, D(\frac{F_j}{E})$$

Where F_j is union of elements.

S.no	Input data					Confidence
Union	pH	E.Con	Tem.	Turbidity	%o2.	Avg
F1	{4,4}	{58,54}	{30,24}	{45,42}	{26,31}	0.4
F2	3	48	24	61	31	0
F3	3	52	33	37	52	0.6
F4	4	70	38	61	67	0.2
F5	6	44	26	56	51	0.2

Table 3: Union of elements regarding Water Samples

Result: The graph shows at time period t1, 2 values are accorded out of 5 values (so 2/5 =0.4).Similarly at time periods (t2=0, t3=3/5=0.6, t4, t5=1/5=0.2). Hence probability of contaminated water is more at the average of 0.6 as it shows in the obtained graph.

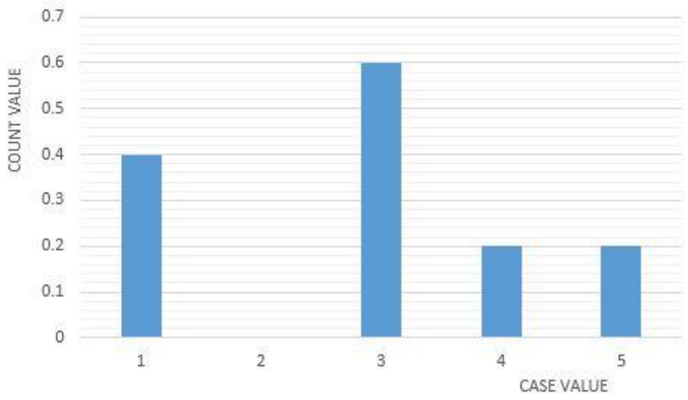

Figure 2: Analysis of contaminated water

SYSTEM DESCRIPTION

The system design comprises of two modules: 1) Sensing unit 2) Monitoring unit as shown in figure 4.1 and 4.2.

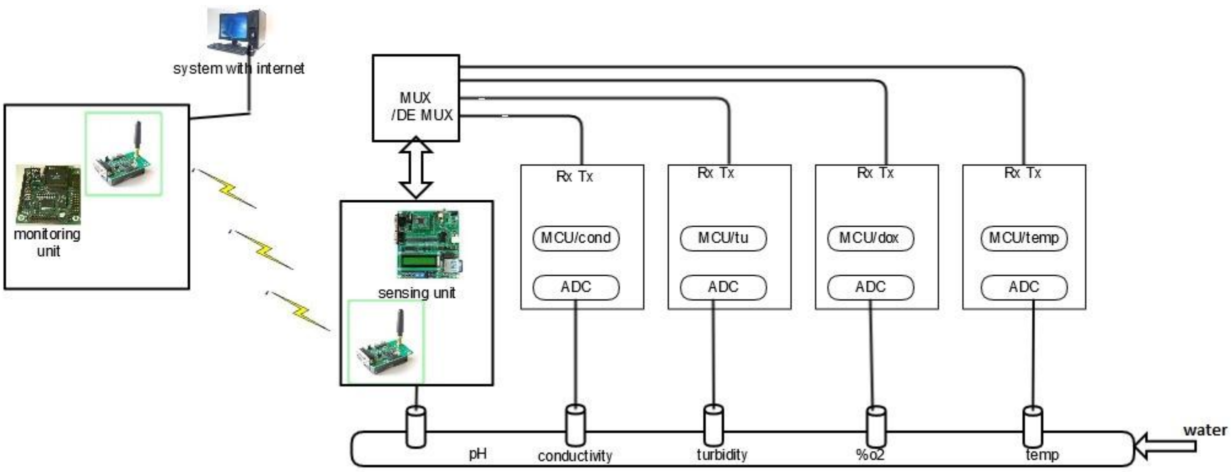

Figure 3: System Architecture

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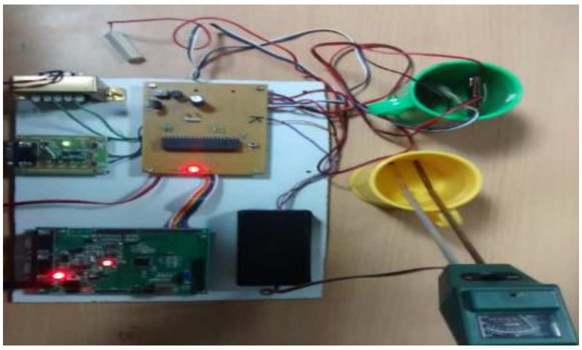

Figure 4: Sensing unit

The Figure 4 demonstrates Sensing unit (ARM based development board) utilizes LPC2148. For fast prototyping of acquired data Code Composer Studio (CCS) is used. The sensing unit provides an interface to the array of multi-sensors includes pH, temperature, electrical conductivity and turbidity finally sensing unit accumulates drinking water parameters from the interfaced sensors (pH, turbidity%02 Temp, conductivity) and implements the Rough set method for investigating the quality of the water. The sensing unit transmits the obtained information via Zigbee module to the wireless monitoring unit.

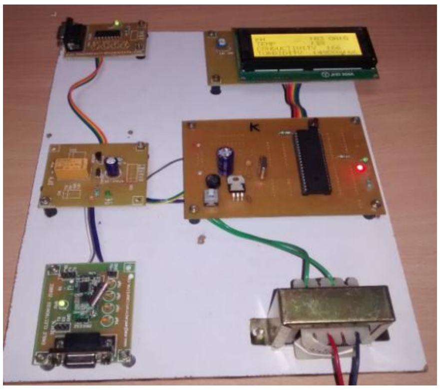

Figure 5: Monitoring Unit

Figure 5 (PIC microcontroller development board) with interrelated Zigbee module and also provides an interface to the web for continuous monitoring of the real time values. The sensing unit provides an interface to the array of multi-sensors includes pH, temperature, electrical conductivity and turbidity. The monitored values are shown in Figure 6.

Figure 6: Display Unit

Remote monitoring as shown in Figure 7 can be done through a system having internet [9]. The implementation involves that sensing unit transmits obtained values to monitoring unit wirelessly using Zigbee module. A monitoring unit is connected to a PC through USB to RS-232 cable, and received values are visualized in PC using an application. The front end of application is framed by using HTML tags and back end is developed using ASP.NET framework for uploading and retrieving values from the cloud. The values can be visualized continuously through the application and can be updated frequently to server [10].This visualization can be viewed by multiple users in multiple systems situated at different geographical locations in different instants [11].

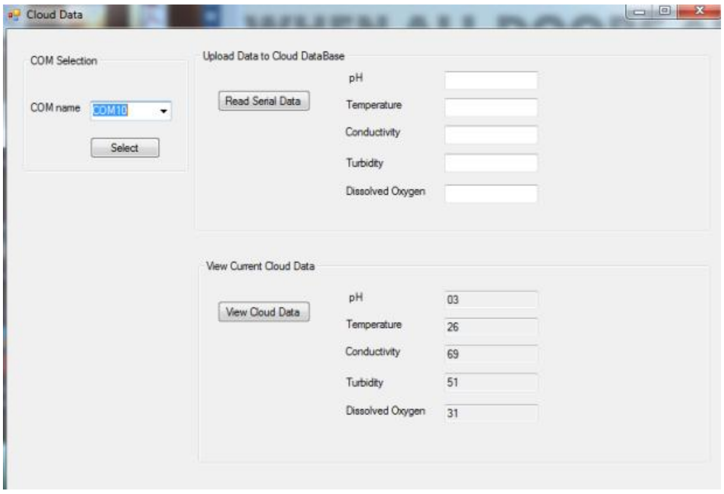

Figure 7: Remotely Monitoring Unit

CONCLUSION

In recent years the attention has been paid much to multi – node digital system, this article presents real time continuous water contamination detection by using fusion techniques. Fusion techniques assist for more accurate and reliable event detection by contrasting earlier available laboratory systems. The designed system is low weight, cost and capable of monitoring the data remotely. However the event detection algorithm (Rough set) enables the sensor nodes to mark choices and activates alarm when anomaly event is detected. In future preference is given to compute the acquired values with various event detection algorithms for better event identification.

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