Real Time Water Quality Monitoring System With Smart Sensor Using SEP and BFOA Algorithm

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Abstract—For drinking water quality PH(public health)is an essential. It is require to prevent any interference into water division systems and to detect pollution as soon as possible, whether accidental or intentional. Thus, we supposed of integrating a section to detect the anomalies or corruption that could affect the drinking water quality. Hence, a study of the evolution of water quality is necessary protect. In this we implement a centralized anomaly detection method in destinations. Our research work depends on a WSNs (Wireless Sensor Networks) in collaboration with a network platform. In research work, an effective and optimized (BFOA) detection algorithm is centralized in the destination sensor network , where a world-wide and coherent WQ (Water Quality) should be attained from the considerations taken locally. The optimization algorithm takes into account the variable features of the water quality metrics. Certainly , the water quality metrics like as a PH scale, Turbidity can unexpectedly exceed the standard thresholds during a consider window and then it retains SVs (Standard Values). Our Research Work method triggers an alarm only, if the anomaly persists during several of successive windows defined by the manage center.

The performance computed in this phase is intended to compute the network efficiency the ratio between the several of received data packets and the number of sent data packets as a method of the packets inter-arrival time. Then, they are interested in the evolution of the sensitivity network according to the simulation time (msec) and simulator used MATLAB 2016a.

Keywords— WSN (Wireless sensor network), BFOA (bacteria foraging optimization algorithm) and SEP (Stable Election Protocol).

I INTRODUCTION

A network is a cluster connected with 3 or many notebook systems that are paired alongside for you to talk collectively. It’s really a telecommunication community that allows computers to change know-how. Within notebook sites, networked computing devices do know-how for you to every distinct about know-how contacts. The particular contacts between nodes are established mistreatment often were advertising or Wi-Fi advertising [1].

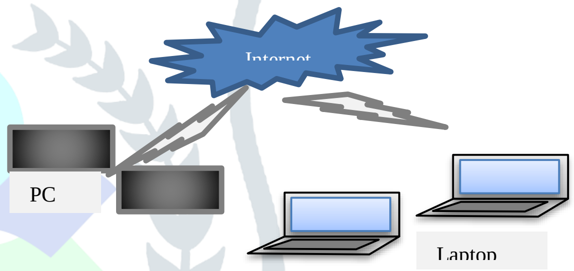

Fig.1. Wireless Sensor Network [2]

The major applications of WSN are described as remote overhead water quality monitoring system, quality monitoring in reservoirs, in sea water quality equipment and it can be utilized for industrial use [3]. WSN can manage every one of the inadequacies of manual strategy and present us with a few advantages in correlation to past strategies [4]. Several benefits such as infrastructure less, delay tolerant, temporal contamination, real time monitoring and the early warnings.

A. Water Atmosphere

The water atmosphere, consisting of the surface water atmosphere and underground water environment, can be differentiated to water bodies like rivers, lakes, reservoirs, oceans, swamps, glaciers, springs, & shallow or bottomless underground waters. The water environment, as well as other environmental elements like soil, organism and atmosphere, etc., constitutes an organic compound. Once a change or damage to the water environment is observed in this compound, changes to other environmental elements inevitably occurs [5]. Due to the speed of Indian's economic improvement, we can also see the resulting speeding-up of contamination & damage to the water environment.

Fig.2. Water Environment

B. Problem Occurring in Water Level Monitoring

Cities are facing unprecedented challenges. The pace of urbanization is cumulative exponentially. Every day, urban areas produce by almost 150 000 people, either due to migration or births. In addition, due to climate change and other environmental pressures, cities are progressively required to become "smart" & take substantial measures to meet stringent targets imposed by commitments and legal obligations [6]. Technical answers exist for every city to become cleverer. The challenge today is primarily to implement appropriate solutions efficiently, rather than only focusing on new technology development. Smart cities cannot be established through a patchwork approach, but by the step-by-step acceptance of incremental improvements [7].

C. Need of Water Level Monitoring

Over the past decade, online water quality monitoring has been widely used in many countries known to have serious issues related to environmental pollution [8]. The water is limited and essential resource for industry, agriculture, and all the creatures existing on the earth including human being. Any imbalance in water quality would severely affect the health of the humans, animals & also affect the ecological balance amongst species [9]. In the 21st century there were lots of inventions, but at that time were pollutions, global warming & so on are also being formed, as of this there is no safe drinking water for the world's population [10]. The WHO (world health organization) estimated, in India among 77 million persons is suffering due to not having safe water. WHO also estimates that 21% of syndromes are related to unsafe water in India. The water quality parameter pH show water is acidic or simple. Pure water has 7 pH values, less than 7 values indicate acidity and more than 7 indicate alkalinity. The normal range of pH is 6 to 8.5.It is considered as a good measure of the excellence of water. Water temperature, indicates how water is hot or cold. The worsening of water resources becomes a common human problem [11]. Traditional methods of the water quality finding have the disadvantages like complex methodology, long waiting time for results, low measurement precision and high cost [12]. Therefore, there is a need for continuous monitoring of water quality parameters in real time.

The entire research work is divided into six sections. Section I composes of the general information about the wireless sensor network and the water atmosphere. Section II is defining the structure of the monitoring system which is created for water quality. Section III involves the previous researchers. Section IV is about the explanation of used methods such as SEP and BFOA. Section V depicted the process of results obtained and at last Section IV contains the conclusion and future scope of the present work.

I. ARCHITECTURE OF WATER MONITORING SYSTEM

A. Significance to Control Water level Monitoring

Everyone knows the importance of having clean, potable water. The water used to supply your milk house, to clean your equipment, and to feed your animals, which in most cases is the same water that supplies the farmhouse, must meet the same standards as drinking water. Rule 761 of the Milk Act requires that all milk houses have a resource of potable water. Ontario Drinking Water Standards describe potable water as having zero E. coli & zero coliform per 100 ml. Water contaminated by certain bacteria can cause serious animal health issues that directly affect milk quality. Pseudomonas bacteria can also readily generate stubborn biofilms which adhere themselves to equipment surfaces, and intermittently shed high levels of bacteria into the milk supply.

Fig. 3. Significance to Control Water Level Monitoring

Problems that arise from poor water quality are not limited to bacteriological quality. Hard water, buffers, & sediment can reduce the effectiveness of chlorinated alkali cleaners, acids and sanitizers in your milk line. Also be aware that changes in land use next to wells, and well repairs may also impact water quality and are therefore good times to test. Everyone should be aware of and test their own well water out of concern for their own health, the health of their animals, and the impact it may have on their milk quality.

B. System Architecture of Water Monitoring System

First the water level indicator is used to indicate level of water in the tank. LED light sensor will fixed in the side of the tank. In the tank we fixed the Number of Led light based on size of the tank. For example: We use LED 1, LED 2 and LED 3 sensor fixed. LED 1 is the lowest point, LED 2 is the middle point and LED 3 is the highest point. When the water will reach the Lowest Point LED 1 sensor light, The microcontroller (PID) will passed the input signal to the pump and the pump will automatically ON. Then when the water will reaches the highest point LED 3 sensor then the pump will be automatically off. By using this concept we easily avoid overflowing and the water level will be indicate to user on monitoring.

The second one is water quality level checking used three parameters such as pH, Temperature and turbidity sensor. The pH sensor, temperature & turbidity sensor will localize into the water inside on the chamber. PH sensor is used to check the hydrogen value in the water. Temperature sensor is used to find the value of temperature in water [13]. The third one is Pipes leakage detection. Using Pressure sensor is used to detect the leakage pipes. This sensor will fixed between the pipes. A comparative pressure sensing method based on force sensitive resistors (FSR) is used for pressure quantities in the proposed UWSN for pipeline monitoring. All the sensors are connected to the wireless sensor network. A wireless sensor network is a group of specialized transducers with infrastructures arrangement that uses radio to monitor and record physical or environmental conditions. GSM (Global System for Mobile Communication) is a digital mobile telephony system. GSM is a cellular arrangement which resources that cell phones joint to it by penetrating for cells in the immediate vicinity.

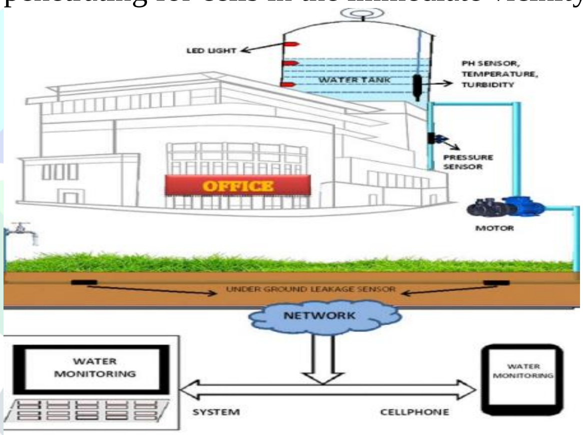

Fig.4. Architecture of Water Monitoring

III PRIMITIVES

C. Parmar, N.M., et al., (2015) [16] Presented a request of wireless network: the sensing of DO for a fish farm. Application necessary sensor module for sensing a required data, wireless module for data transmission through radio channel and a gateway module as monitoring center. In this case, the association was one master with two slaves using a transmission rate of 9600 b/s. The wireless broadcast follow the usual IEEE 802.15.4 protocol and implement the routing protocol based on ZigBee usual. This was a qualitative and quantitative approach for a water quality monitoring. Main future of this request was that it was easy and effective way for doing real time water quality monitoring .

D. Mithila Barabde et al., 2015 [17] Proposed a sensor-based water quality monitoring system. The system architecture consists of data monitoring nodes, a base station and a remote station. All these stations were connected using wireless communication link. The data from nodes were send to the base station consisting of ARM controller designed for special compact space application. Data collected by the base station such as pH, turbidity, conductivity, sent to the remote monitoring station. Data collected at the remote site could be displayed in visual format on a server PC with the help of MATLAB and was also compared with standard values. If the obtained value was above the threshold value automated warning SMS alert will be sent to the agent. The uniqueness of proposed approach was to obtain the water monitoring system with high frequency, high mobility and low powered.

E. Adamo, F., et.al., (2015) [18] Presented a network of smart sensors, based on ISO/IEC/IEEE 21451 suite of standards, for in situ and in continuous space-time monitoring of superficial water bodies, in particular for seawater. The scheme was meant to be an important tool for evaluating water quality and a valid support to strategic decisions concerning critical atmosphere issues. The aim of the proposed scheme was to capture possible extreme events and to collect long term periods of data

F. Kaskina, et al., 2014 [19] Planned to propel the utilization of Remote Sensing with regards to overseeing water asset by coordinating high determination remote detecting innovation into a knowledge management system for the administration of water assets and the framework to control them. Remote detecting innovation could specifically add to water asset administration and gives one of kind techniques and answers for meet the data prerequisites of water engineers in charge of water assets administration. Remote sensing technology was utilized to supplement the improvement of a knowledge management system by propelling the remote detecting ability and picture handling to close constant. This capacity could be utilized to screen and evaluate a waterway bowl to create surge degree and forecasts.

G. O'Flynn, B., et al., (2007) [20] Described the "Smart Coast" Multi Sensor System for water quality monitoring. This system was aimed at providing a platform capable of meeting the monitoring requirements of the water framework instruction. The key parameters below investigation included temperature, phosphate, dissolved oxygen, conductivity, pH, turbidity and water level. The "Plug & Play" capabilities enabled by the wireless sensor network (WSN) platform established at tyndall allow for integration of sensors as required were described, as well as the custom sensors under development within the project.

. TABLE 1. Comparison of Literature Review

Author's Name and Year	Technique Used	Advantages	Research Gap
D. Kaskina., et al., 2014	Remote Sensing Technology	Enhanced the knowledge management system	Managing and controlling the pictures.
Mithila Barabde., et al., 2015	Sensor based water quality monitoring system	Applicable for compact space application	Frequency and mobility of nodes.
O'Fynn, B., et al., 2007	Smart coast Multi sensor system	Tendency to enhance all the requirements of monitoring systems.	Integration of sensors.
Adamo, F., et al., 2015	Smart Sensors	Ability for space time monitoring.	Evaluation of water quality.

Parmar, N.M., et al., 2015	Zigbee	Easy and effective process.	Real time monitoring .

II. PROPOSED METHODS

A. SEP Protocol

Existing SEP [19] is a heterogeneity-aware protocol and election probabilities of nodes are weighted by initial energy of each node relative to that of other nodes in a network. A Stable Election Protocol for clustered heterogeneous wireless sensor networks (SEP) is developed for the two-level heterogeneous networks, which include two types of nodes, the advance nodes and normal nodes according to the initial energy. The revolving epoch with election probability is directly correlated with the initial energy of nodes. The probability threshold, which each node *s* uses to determine whether itself to become a cluster-head in every one round, is as follow:

$$T(s) = \begin{cases} \frac{p}{1-p*\mathrm{mod}(r,\mathrm{round}(\frac{1}{p}))} & \mathrm{if} s \in G \end{cases} \qquad (i)$$

Where G is the set of nodes that are eligible to be cluster heads at round r. In each one round r, when node s find it is eligible to be a cluster head, it will decide a casual number between 0 and 1. If the amount is less than threshold (s), the node si becomes a cluster head through the current round. Also, for two-level heterogeneous networks, p is defined as follow:

$$pnrm = \frac{popt}{1+a.m} \qquad (ii)$$

If s is the normal node

$$padv = \frac{popt}{1+a.m} \times (1+a) \qquad (iii)$$

if s is the advanced node SEP, which improves the stable region of the clustering hierarchy process. The fraction of advanced nodes (m) and the additional energy factor between advanced and normal nodes (α). The novel heterogeneous setting (with advanced & normal nodes) has no effect on the spatial density of the system so the a priori setting of popt, from Equation (1), does not change. On the other hand, the total energy of the system changes. Assume that Eo is the first energy of every normal sensor.

Now increase the stable region of the sensor network by 1+α·m times, if (i) each normal node becomes a cluster head once every 1 popt (1+α ·m) rounds per epoch; (ii) each advanced node becomes a cluster head exactly 1+α times every 1 popt (1+α·m) rounds per epoch; and (iii) the average number of cluster heads per round per epoch is equal to n × popt (the spatial density does not change).

Restraint is very strict— If at the end of each epoch the number of times that an progressive sensor has become a cluster head is not equal to 1 + α then the energy is not well distributed and the average number of cluster heads per round per epoch will be less than n×popt. This problem can be reduced to a problem of optimal threshold T(s) setting , with the constraint that each node has to become a cluster head as many times as its initial energy divided by the energy of a normal node.

$$T(Snrm) = \begin{cases} \frac{pnrm}{1-pnrm*\mathrm{mod}(r,\mathrm{round}(\frac{1}{pnrm}))} & \mathrm{if} s \in G1 \end{cases}$$

(iv)

$$T(Sadv) = \begin{cases} \frac{pnrm}{1-padv*\mathrm{mod}(r,\mathrm{round}(\frac{1}{padv}))} & \mathrm{if} s \in G1 \end{cases}$$

(v)

B. BFOA (Bacteria Foraging Optimization Algorithm*)*

BFOA is considered as a world widely used optimization process and accessed for the optimization and control in the distribution manner. Generally, BFOA is relied on the behavior of social foraging Escherichia coli. While the process of foraging is initialized, the real bacteria movement is acquired by using different groups of stretchy flagella. It is a concept which referred to the Escherichia coli for the further process even in tumble or swim. Basically, these are the two major and most crucial procedure followed by bacterial foraging optimization algorithm. Whenever, rotation takes place, these are begun towards the forward direction and in this way, the flagellum influenced the cell. After this it become independent and finally, bacterium flips with reduced count of tumbling to discover NG (Nutrient Gradient). On the other hand, in the direction of counter clock-wise. The flagella utilized to move bacterium to swim in extremely fast speed [20].

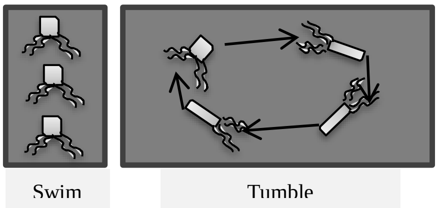

Fig.5. Swim and Tumble in BFOA [20]

Escherichia coli is a plasma member and a cell wall which includes the cytoplasm and nucleoid. The pili are assumed for the transformation of genes to another Escherichia coli specifically for the movement. The size of cell is between 1min diameter and 2cm in length. As usually an Escherichia coli is composed of 70% of water.

1)**Chemotaxis:** This process is a collaboration of the locomotion of escherichia coli through the two processes as namely as swim and tumble by using flagella. The chemotaxis of bacteria foraging are described as follows-

$$\propto (I+1, P, J) = \propto (I, P, J) + Q(i') \frac{\Delta(i')}{\sqrt{\Delta^{t}(i')\Delta(i')}}$$

(vi)

Δ represent the unit length in the random directions.

2)Swarming: These are the crucial behaviors of the motile species which involved in the bacteria such as escherichia coli and the styphimurium. At this place, the constant and most reliant patterns are generated specifically in the nutrient region.

3)Reproduction: The bacteria that become dead due to the less healthy when other bacteria are healthier as compared to it. Then the bacteria partitioned it into two bacteria which considered at the same position. In this way, the size of swarm being stable and constant. It also inclined the process of discovering parameters.

4)Dispersal: In this step, some of the bacteria are settled at random locations and contains a reduced probability when the new placements are introduced in the search space [21].

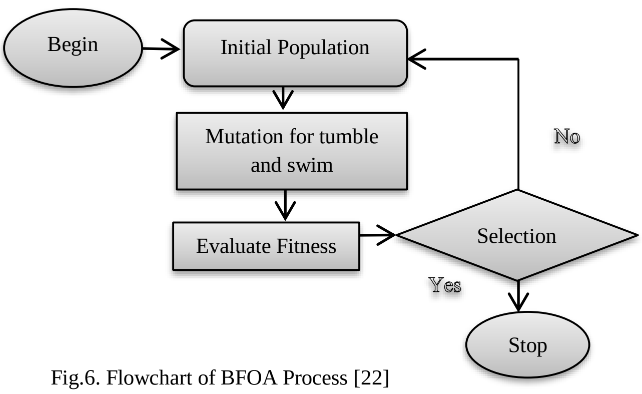

Fig.6. Flowchart of BFOA Process [22]

III. RESULT

In this section, we describe the results with novel approach in water quality monitoring. In BFOA algorithm has been implemented to reduce the network failures and enhance the quality parameters like as network sensitivity and many more.

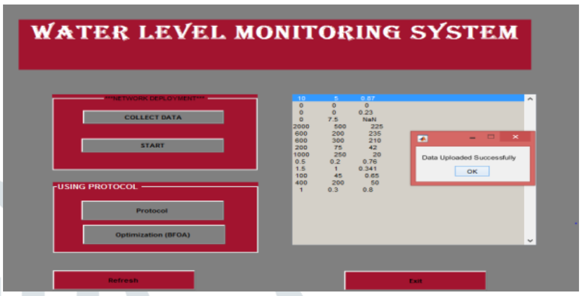

Fig.7. Data

The above figure shows the uploaded data in list box. The data after clicking on the uploaded button which will be received by the sensor nodes. The parameters like PH level, nitrate level, chloride, fluoride etc. are taken.

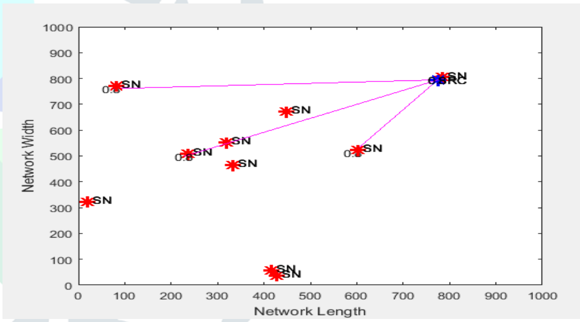

Fig. 8. Network Deployment

The above figure shows the network having area of 1000*1000 meters and the nodes are deployed in the network which is in red color and shows that nodes are receiving data which are uploaded from the database. The blue color is the source node from which the data is started and communicates with the other nodes and receiving of the data takes place to that node having more energy to transmit the data.

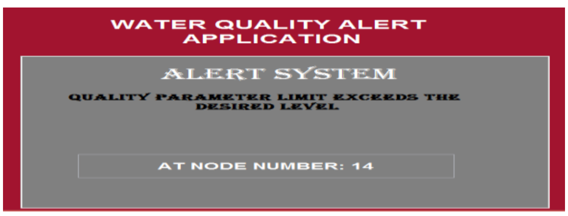

Fig.9. Alert System

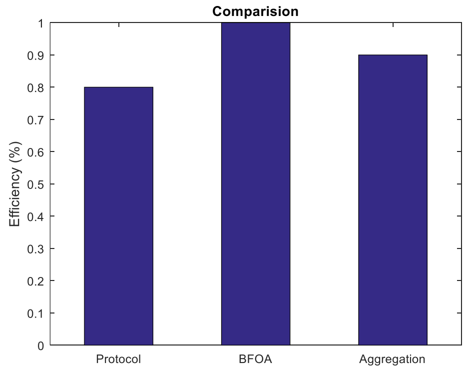

Fig.10. Comparison – Efficiency

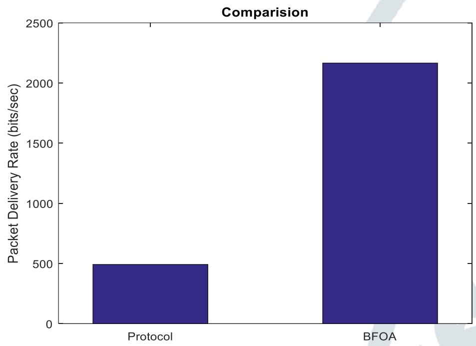

Fig.11. Packet Delivery Rate – SEP and BFOA

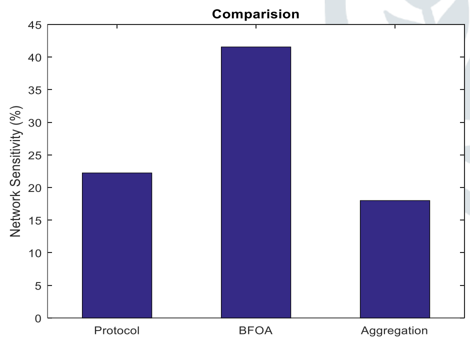

Fig. 12. Comparison Network Sensitivity

The above figure 10, 11 and 12 comparisons between proposed and existing work performance metrics like as a network sensitivity, Packet Delivery rate and Network efficiency rate. The network efficiency increase by the binary methods during the evolution of the data packet arrival time is explained by the minimize of the network load. Sensitivity network has null values for a simulation interval time is less than the size of binary success window and reaches its maximum value is 85%, if the anomaly persevere than twice windows. Table 2. Comparison Proposed Parameters.

Parameters	**Values**
Network Sensitivity	42
Efficiency	1.0
Packet Delivery Rate (%)	2001

TABLE 3. Comparison – Proposed and Existing Work

Metrics	**Protocol**	**BFOA**	**Aggregation**
Network Sensitivity	0.8	1.0	0.87
Network Efficiency	24	42	18
Packet Delivery Rate	500	2001	-

Table 1 and 2 described that the comparison between proposed and existing work performance metrics to enhance the packet delivery rate, efficiency and network sensitivity rate. The above figure shows the shows the alert system when the limit exceeds than the desired limit then it will pop up a raise system with node id that at which node the limit is exceeding which will interact with the real world scenario.

IV. CONCLUSION AND FUTURE SCOPE

In this conclusion, has been the vector of various technical advances. Proposed a detailed structure of the drinking water monitoring system in a water division network. Our research work depends on WSNs (Wireless Sensor Networks) in collaboration with a network platform. In research work, an effective and optimized (BFOA) detection algorithm centralized in the destination sensor network, where a world-wide and coherent WQ (Water Quality) should be attained from the considerations taken locally. The optimization algorithm takes into account the variable features of the water quality metrics. Certainly, the water quality metrics like as a PH scale, the research work using BFOA methods avoids Fas due to the false considers made by WSs. Measuring the homogeneity of the assets in research work, we implemented a Protocol

(SEP), Aggregation and BFOA algorithm in order to reduce the quantities of information transmitted by the start nodes to the destination node. In this approach to maximize the life-time of the sources and reduces the network load. In research work, improves the packet delivery rate and network efficiency rate.

On the other hand, detection method is a reactive method. It can't anticipate the anomalies which can act on the water quality. Our BFOA algorithm re-groups only the same data packets. It can use other coding techniques to reduce the amount of data packet transmitted by the sources. In upcoming work, to reduce the transmission delay (ms) and enhance the throughput (%).

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