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Monitoring of Water Purification Process Based on IoT

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Abstract: *Water is essentially to human life and the health of the environment. To establish a good quality of water, it is required a monitoring system which developed based wireless sensor network and IoT. Wireless sensor network used to measure water quality by sensing the change of pH, TDS of water after the purification process. In this paper wireless sensor interface with microcontroller device using two nodes of NRF24L01 one of them considered to be transmitting node while the other considered to be receiving node. the status of system will send to Web with IP defined address in order to monitor the status of system numerically and graphically. The esp8266 module has been used because it is allowing microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections with wireless sensor network.*

Keywords: *WSN, IoT, pH sensor, TDS sensor, microcontrollers, water purification*

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I. Introduction

According World Health Organization many people around the world suffered from the quality of drinking water [1], so that the company of water race to gives good quality water with suitable cost [2]. Many techniques have been investigated to enhanced the quality of drinking water, however water filtering is the process of removing harmful chemicals, biological contains, suspended solids, and gases from water[3], and main water purification methods are:

A – Boiling: Boiling water is the cheapest and safest technique of water purification. In this way, clean water should be brought to boil and left boiling for 1-3 minutes. Boiled water should be covered and left to cool before drinking [4].

B – Filtration: Filtration is one of the sufficient ways of purifying water and when using the suitable filters, it's effective in remove water of the compounds. This method uses both chemical and physical processes to purify water and make it safe for human use[5].

C – Distillation: Distillation is a water purification way that used heat to collect pure water in the form of vapor. This technique is effective by the scientific reality that water has a lower boiling degree than other contaminants and elements found in water that causing disease. Water is subjected to a heat source until it reaches its boiling degree. It is then left at the boiling degree until it vaporizes. This vapor is directed into a condenser to cool. Upon cooling, vapor is reversed into liquid water which is clean and safe for drinking[6].

D – Chlorination: Chlorine is a powerful chemical method that has been in use for many years to enhanced water for home purification. Chlorine is an effective water purification method that kills germs, parasites that causing disease that found in ground or tap water[7].

II. Water Purification Monitoring

A monitoring device for a drinking water purification system consist of a microcontrollers that controls the overall process of the purification system[8], LCD indicating circuit that tell the information to maintenance person, a detecting means that analyses data for determining the healthy condition of the filtration elements, a warning means that produces message or sound for warning consumers about the unhealthy condition of the water filtration elements, and a power switching devices means switch off electricity supply to the water pump of the purification system. In process, the filtration elements will be sensed by impurities after being used for a period of time[8].If the filtration elements are clogged, the monitoring device will make a sound to warn of such condition of the filtration elements and will immediately switch offpower supply or reduce of speedof the pump in order to stopping water supplement [9][10] if the filtration elements are not replaced after a certain period of time. The monitoring of water purification process described in Figure (1)[11]:

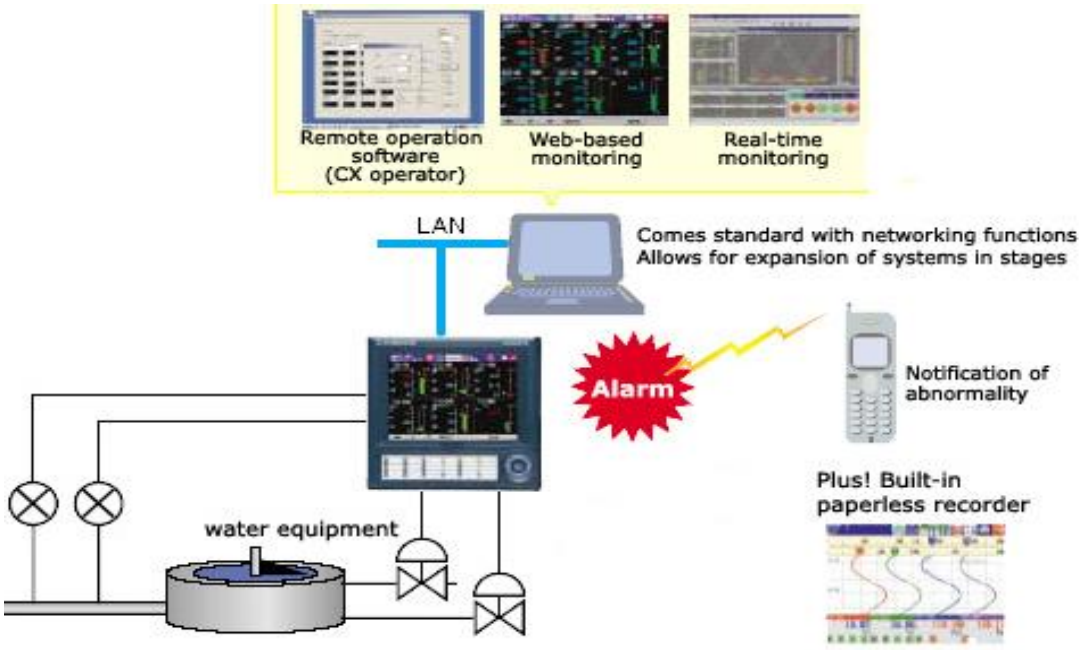

Figure 1: Water Purification Monitoring System

III. Proposed Work

In this paper, water purification station based wireless sensor network has been designed by controlling and WEB Monitoring System**,** by measure and monitor the quality of water and also send the status of purification station to maintenance persons how's have the authentication to access to WEB, however when sensing elements read a change goes beyond critical values of both pH and TDS, the suggested system switch off the motor that supplied the purification unit and send a message told maintenance persons that one or both of the measured values goes far from its acceptance range, and the purification needed to have a suitable maintenance by defining two nodes of sensing elements one of them considered be a transmitter while the other considered to be a receiver , the receiving node connecting directly to Wi-Fi module use to connect the system with internet . when the system connected to internet the Wi-Fi module send the data to a global database system in order to process data and make a decision about the quality of water, and display the status of the purification system on a corresponding defined IP address Web. finally, the proposed work described as shown in Figure (2):

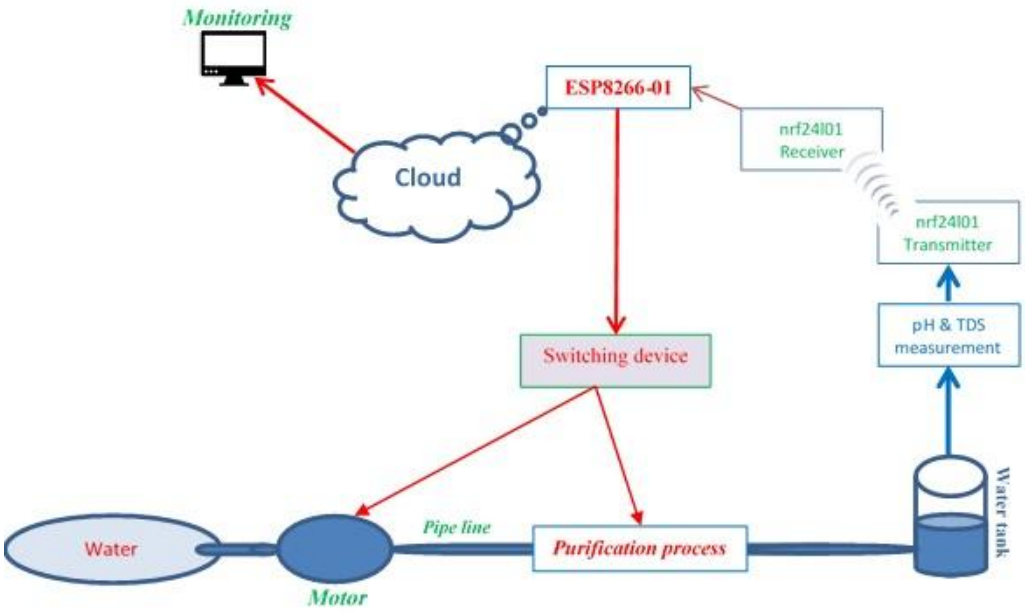

Figure 2: Block Diagram for Proposed System

IV. System Requirement

The system consists of two microcontrollers, one of them is Arduino Uno used to interface the sensing element and sending the measured values via NRF24L01 which acts as transmitting node[12] [13], while the other microcontroller is ESP8266 which is used to receive the measured values by interfacing anther node of NRF24L01 and sending the status of purification system to global database server in order to suggest the water quality, the server send the status of the system to a secure web, that tell the status of purification system to maintenance person, however a monitoring means that display measured value and the switching on/off of the purification process according of the measured value that readied from the sensors , in order to determining a good water condition result from purification system, a warning has been established by produces message and graphical figures deals to the unhealthy condition of the water filtration elements. The power switching devices used to switch OFF electricity supply from the motor that pump water to the purification system. In process, the filtration elements will be sensed by impurities after being used for a period of time.

V. System Implementation and Result

The decision making of a good water quality has been implemented according the following algorithm, by consider the range of acceptable values of pH and TDS, and suggesting the status of system with respect to each of pH and TDS separately according equations (1)(2):

$$SystemStatuswithrespecttopH = \begin{cases} 1 & when pH within the acceptance range \\ 0 & when pH out of the acceptance range \end{cases} \quad (1)$$

$$SystemStatuswithrespecttoTDS = \begin{cases} 1 & when TDS within the acceptance range \\ 0 & when TDS out of the acceptance range \end{cases} \quad (2)$$

However, the resultant status from equations (1) and (2) can be determined as shown in table (1):

Table 1: Operation Algorithm to Suggest the Status of System

Acceptance range of pH	system status with respect to pH	Acceptance range of TDS	system status with respect to TDS
Yes	1	Yes	1
No	0	No	0

the final decision of the system status suggests that the system be in ON state only when the both measured values of pH and TDS gives an ON stateotherwise the system of water purification is in OFF state as shown in table (2):

Table 2: ON / OFF Status of System

system status with respect to pH	system status with respect to TDS	Final system status
0	0	Off
0	1	Off
1	0	Off
1	1	On

According to the described tables the system programming flowchartcan be establish in Figure (3):

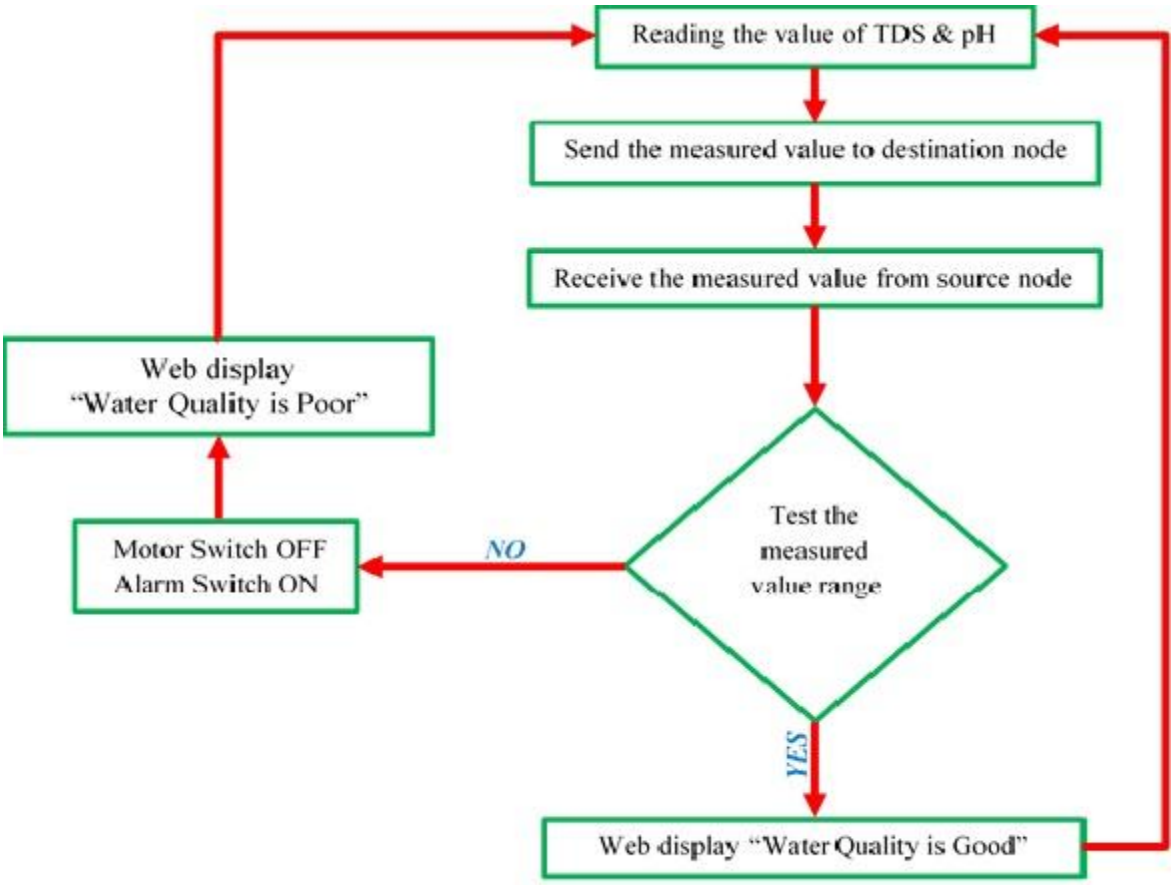

Figure 3: Decision Making System

Finally, the implementation required building up WEB with static secure address using HTML programming web according to the following network topology which is shown in Figure (4):

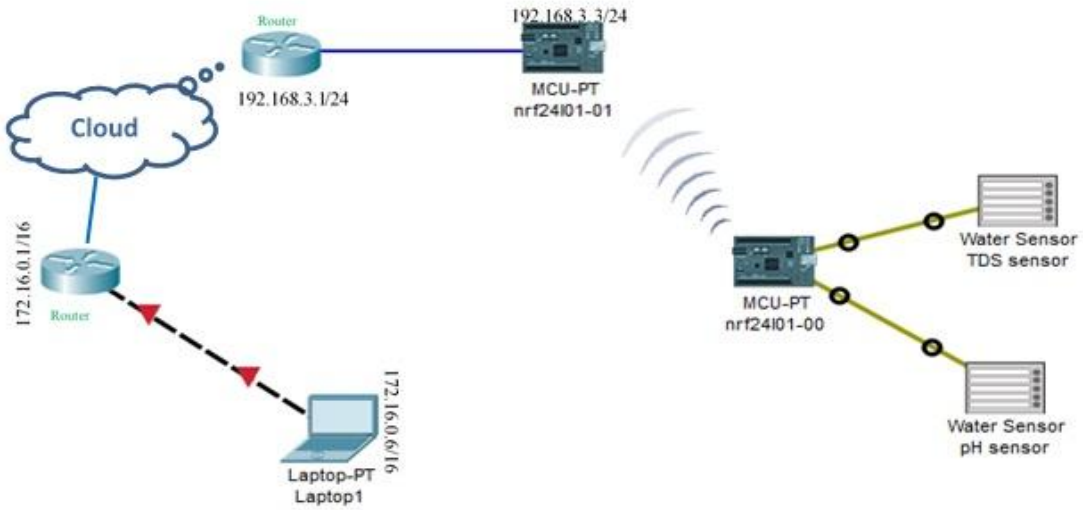

Figure 4: Network Topology Configuration

Actual measurements for pH and TDS have been taken for a period from 1-12-2018 to 14-3-2019, and according to described algorithm the status of the system decision was decided after each readings,however the monitoring suggest the status of purification unit with respect to pH and TDS measurements, and decide the final status of system asshown in table (3):

Table 3: system measurement and decision making state

Date	TDS measured value (g/l)	pH measured value	system status with respect to TDS	system status with respect to pH	Final system status
01-12-2018	0.372	7.9	1	1	1
20-12-2018	0.346	7.8	1	1	1
05-01-2019	0.6	8	0	1	0
05-01-2019	0.332	7.5	1	1	1
25-01-2019	0.402	8	1	1	1
08-02-2019	0.76	8.1	0	1	0
16-02-2019	0.35	8.6	1	0	0
19-02-2019	0.35	6.5	1	1	1
25-02-2019	0.42	7.7	1	1	1
28-02-2019	0.3	8.3	1	1	1
03-03-2019	0.7	8.8	0	0	0
03-03-2019	0.76	7.5	0	1	0
06-03-2019	0.9	7.7	0	1	0
11-03-2019	1.1	8.2	0	1	0
11-03-2019	0.45	8.8	1	0	0
14-03-2019	0.555	7.5	1	1	1

After the measured values and decision making result from suggested algorithm have been achieved, the measured values and decision making status will be send to theweb thatmonitoring the system graphically and numerically, however the change in both pH and TDS measured values for the previous period described above, are and the graphically representedas shown in Figure 5:

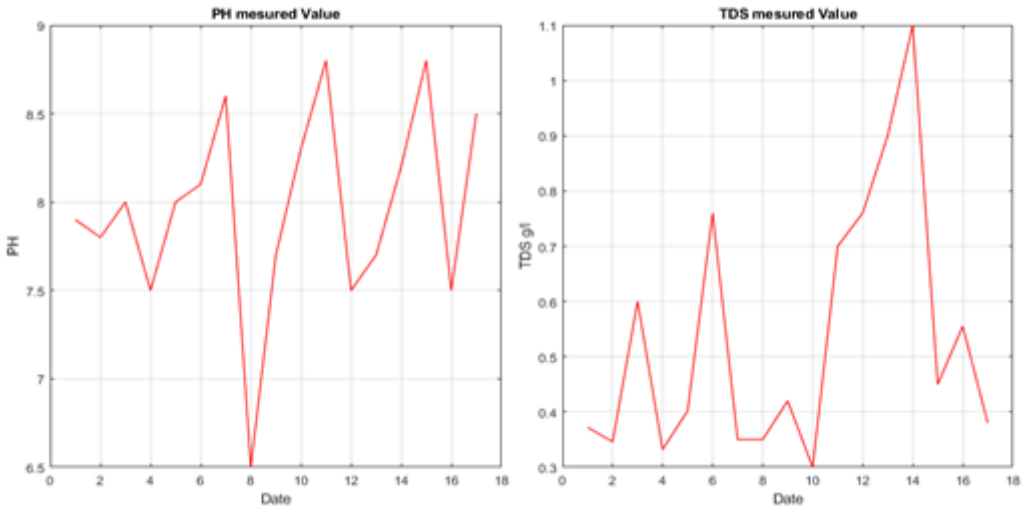

Figure 5: The Graphical Representation of pH and TDS Measured Value

And graphically decision making for the system can be displayed in web which is described as shown in Figure 6:

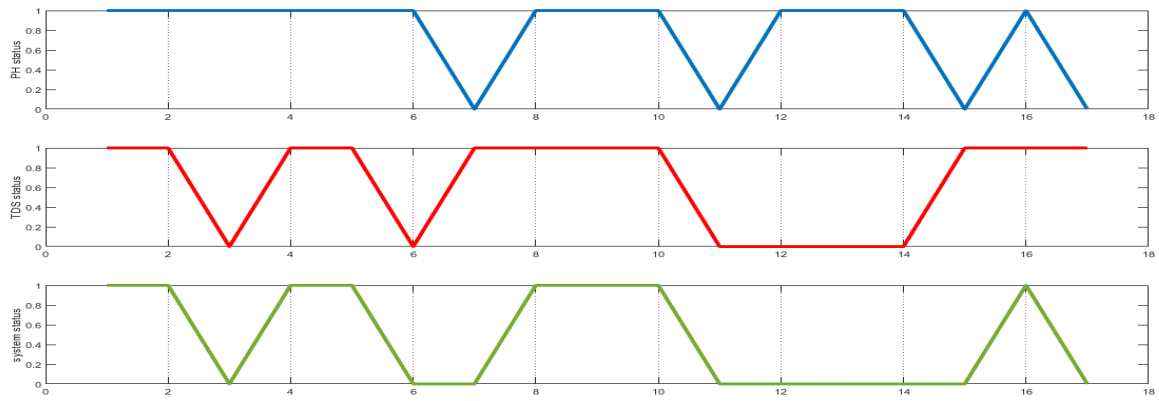

Figure 6: The Graphical Representation of System Decision

Finally, the WEB used to monitor the status of system numerically at each reading by display values of measured values of pH and TDS and determine the status of system with respect to these values and determine the decision making as a text massage noticed by the maintenance persons, however the structure of monitoring WEB shown in Figure (7).

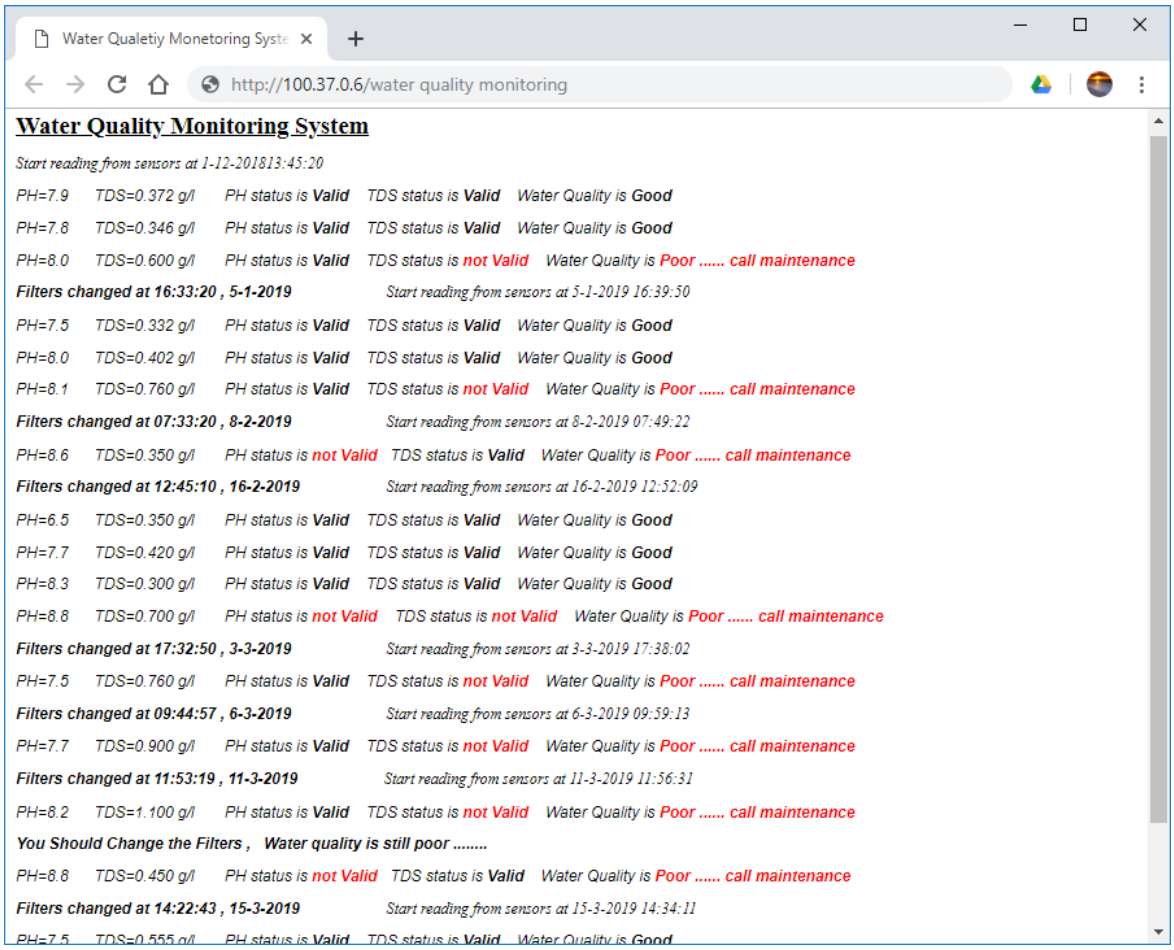

Figure 7: The Status of Purification System Displayed in Monitoring Web

VI. Conclusion

The investigated system can monitor quality of water automatically withoutintervention of human, and it is considered to be low in cost. This system is used to keep the water is being pure by measuring both pH and TDS using wireless sensor networks nodes and monitoring the status of purification system by internet using secured Web at home, offices etc. according that the water quality monitoring become more economical, convenient and fast. This paper gives smart water system monitoring system can be easily applied to home, offices, and schools and at any places where watertanks are used. By building described system in a smart building, the users will be capable toread and analyze the water usage specifications of the residents and save a lot of water from wastage.

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