IOT BASED WATER QUALITY MEASUREMENT AND REPORTING SYSTEM: REVIEW

Dr. Sathishkumar[1] and Dr.S.Kannan[2]
Department of Electronics, Nehru Arts and Science College, Coimbatore, Tamilnadu, India.
**Corresponding Author:* mskeasc@gmail.com

ABSTRACT - Nowadays, internet of things (IoT) became a leading beginning process of technology in advances of information and communication. The technology of it provides the system welfare and convenes in the water quality of the present monitoring. In order to watch the level of water quality various techniques were implemented in the areas of water in various localities like monitoring of drinking water quality, management of water quality and irrigation water, lakes, treatment, and ponds. In this technology, the development of it for system monitoring of water quality processes as a core technology by the wireless sensor network (WSN). However, the networking process is to monitor the water quality using a sensor nodes lightweight and tiny-powered gathering. Nevertheless, in the application environment the development process of technology is proceeding without security consideration, which creates a confidentiality susceptibility of the system. In this research process, the major contribution is to develop a secure process of a modern monitoring system of water quality based on wireless sensor network. Successively, the embedded system depends on secure IoT is planned using WSN, which can resource fully realize those necessities

***Key Words*:** *IoT, Aqua, Rectifier, Sensor, Water quality, Real-time application*

1.INTRODUCTION

The quality evaluation of water is the substantial influence of several application environments like surveillance, human health, monitoring of ocean and habitat. Urban water quality is usually monitored by highly reliable networks of fixed locations as nodes. A fixed monitoring station can accurately measure a broad range of pollutants. However, permanent monitoring stations are frequently placed so as to measure ambient background concentrations or at potential hotspot locations and they are usually several kilometers apart. The importance of maintaining good water quality highlights the increasing need for advanced technologies to help monitor water and manage water quality. In particular, the IoT based implementation poses new challenges for supervisors who have traditionally observed water quality by taking samples and examining them in the test center. Figure 1 shows the landscape of internet of things. The thing of network is IoT, which are associated in approximate form of network. As per the RFID tag in the box is concerning to the whole thing, to a clever city and in numerical form of objects enlarged of things. In the 21th century, the maximum communication and powerful standards is the Internet of Things (IoT). In this environment, the daily process of objects becomes a network part because of the capabilities of communication and computing, which containing the digital process of transceivers communication and microcontrollers. It covers the network model with high persistent and it permits the unified collaborations between various device types like cameras monitoring, sensor environmental sensor and applications in medical and various fields. Due to this intention, the IoT has

developed additional creative in different locations such as environmental pollution monitoring systems and aqua quality of system management. It includes several inexpensive sensor categories in the environment and embedded, which will support the public by the services of modern quality monitoring and for the report without burden at anytime and wherever. Moreover, it is besides the progresses expressively as life quality of human's.

The primary objective of this work is to implement a low-cost IoT for monitoring several water pollutants namely Temperature, Conductivity, PHand Turbidity use integrated sensors. The specific objectives include:

1. Hardware implementation is by using WSN module and sensors.
2. Use of Arduino Uno software is to analyze, collect and filter raw data of water quality parameters readings using sensors.
3. The IoT based water quality monitoring and reporting system will provide information to the community about the risks of the continuous degradation of water quality in different areas such as nodes. Accessibility to such information is critical. A community without access to information compared to a well-informed community will not act in their personal way to help in environmental protection.

1.1 LITERATURE SURVEY

The advancement of IOT in water quality measurement applications has made reporting more feasible. Recently, several WSN environmental pollution kinds of research and procedures have been suggested, which determine the endless watching of water quality in different areas, Health care systems, and open management of the atmosphere (e.g. monitoring of athlete condition). This segment refers to insufficient projects of outmoded investigation about the systematic evaluation of a water feature by using it based sensor networks.

Wang et al. [1] connected pack detecting hypothesis to keep away from excess information in WSN's and IoT. Communication structure serves to information compacted testing [2], dynamic the transmission [3], precisely restoring information to lessen energy necessity [4], expanding system lifetime, and information repetition. Pai et al. [5] discussed an Alarm-network is describing the various abuse state of privacy like the vulnerable detail is in confrontational secrecy occurrences that are specially developed for monitoring the health of the patient in the atmosphere of the house and help out corporeal. The networks of sensor have the Alarm-net [6] and environmentally friendly networks of sensor help network and data security for physiological, environmental, behavioral parameters. Ying et al. [7] have predictable a style of

watching groundwater. This will determine the gathered information to take-off and the feedback design of the system is landing negative by a monitor of water level. Here, the single-chip of 89C51 and a comparator IC are considered. The devices recording randomly and associate with the combined code of dynamic have realized actual and interrupted groundwater with suitable observation [8]. Mo et al. [9] deliberate programmed menstruation and coverage of quality level of water in the system has been implemented. After that, the data square measurement of loud refers to the midpoint fulfillment within the SMS smartness by using the network of GSM. If there is excellent quality of the water, then the details is transferred to the center observance and mobile controlling's at a parallel time within the similar scheme. It's suitable for corresponding essential measures managing process of time period and determines the remote control process of water quality. Odey et al. [10] planned is constantly monitoring of parameters process in aqua environmental and provide an early alert or warning to the end user of the system. It exceeds the evaluation of thresholds bound of the square. The details made through the scheme to have provincially on the entry or transfer to the target of server on distant net. The data are associated with the server of remote net or info is retrieved with sufficient personal desktop or mobile phones.

Web-based frameworks on a cloud stage are presented by Nikolopoulos et al. [11] for the examination of vitality utilization and conduct designs, with the end goal of controlling the request reaction, and for anticipating of future application utilizing machine learning (ML) models which has been prepared with a massive dataset. Furthermore, this work proposes an electronic system operates on a cloud stage for the investigation and comprehension of vitality utilization, future request prediction, and remote control of machines in a college grounds. In any case, it is at the advancement stage.

1.2 PROPOSED WORK

This section provides the IoT system architecture, system requirements and its detailed description of hardware-software implementation with the basic structure and flow diagrams. Figure 2 shows the basic service of the proposed system and Fig. 3 shows the aqua care-IoT service design, which calm the nodes of sensors capable of being implanted. Every node is combined with the corresponding parameters of sensors like Temperature, PH, Turbidity and conductivity sensor, etc. These sensors collect the water quality parameters and forward them to a coordinator called data Processing Server Unit. The proposed work reduces human intervention by using the aqua care-IoT, and it is consists Arduino Uno controller, temperature, PH, Turbidity and conductivity sensor arrangement and Wi-Fi transceiver module. The Arduino microcontroller is connected to the data concentrator using USB cable. The Arduino microcontroller sends the water quality parameter's data which is read from the sensors to the cloud node server through Wi-Fi transceiver module. The data server mechanism is as a router among the nodes and

the essential server is proceeding by using the medium transformation of wireless process like the networks of

mobile mode 3G/CDMA/GPRS. Also, at what time of detecting the server of any irregularities is processed and offers an immediate alert to the Tamilnadu Water Supply And Drainage Board (TWAD) team in the particular area. The architecture of IoT consists of data acquisition sensor nodes with Different nodes (N1, N2, and N3), Data server and cloud sensor network with smart city environment. The aqua care-IoT data acquisition interface composed of sensors and various data collection terminals. The data server mechanism is as a router among the nodes and the essential server is proceeding by using the medium transformation of wireless process like the networks of mobile mode 3G/CDMA/GPRS. Also, at what time of detecting the server of any irregularities is processed and offers an immediate alert to the Tamilnadu Water Supply And Drainage Board (TWAD) team in the particular area. The architecture of IoT consists of data acquisition sensor nodes with Different nodes (N1, N2, and N3), Data server and cloud sensor network with smart city environment. The aqua care-IoT data acquisition interface composed of sensors and various data collection terminals. The proposed work reduces human intervention by using the aqua care-IoT, and it is consists Arduino Uno controller, temperature, PH, Turbidity and conductivity sensor arrangement and Wi-Fi transceiver module. The Arduino microcontroller is connected to the data concentrator using USB cable. The Arduino microcontroller sends the water quality parameter's data which is read from the sensors to the cloud node server through Wi-Fi transceiver module. Also, describe the requirements of aqua-care IoT based water quality monitoring sensor network. The proposed system of aqua care-IoT needs of sensor (Calibration/Resolution/ Sample rate) are Temperature, PH, Turbidity and conductivity sensors at each location. Temperature Sensor cares temperature level of the water at different nodes produces the proportional output voltage in Celsius (Centigrade) temperature. A pH measurement consists of sense the- hydrogen ion employed in the water environment, which produces the corresponding potential voltage difference between the electrodes. The pH communicates the values to the absorption of hydrogen ion, which ordinarily ranges are between 0 and 14. A pure water solution has a pH of approximately 7. On the high concentration of hydrogen ions shows a very acidic solution has a low pH value such as 0, 1, or 2 then the High ph values like 12, 13, 14 described as a less acidic solution.

2. HARDWARE AND SOFTWARE IMPLEMENTATION

In the Hardware implementation, the sensor LM35 minds the sample water tank temperature and transfer the value to the microcontroller of the present temperature. Likewise, the sensors conductivity, Turbidity and pH performances are obtained and communicated with the controller of the Arduino Uno controller

through the transceiver ofWi-Fi. The hardware implementation of aqua care-IoTmodule controllerwas shown in Fig. 5 and the sensor circuit

of the LM35 temperature is shown in Fig. 6. As a Sample, the sensitivity of the sensor in tank observes the present temperature and transfer to themicrocontroller.It operates the process in the range of temperature between−55 and +150 ◦C and process between the volts of 4–30. It pullsthe supply of 60μA and has less self-heating of below 0.1 ◦C in the motionless air. As a result, the IC provides 10mv/degree centigrade. In Electrical Conductivity, the key facilities are for passing the electric current and have common electrical resistance (ohms). Hence, it evaluates water conductivity or entire ion absorption and considered entire strategy of dissolved in aqueous clarification. Siemens is the conductivity unit and the probe is shown in Fig. 7. Also, its various value of set point is illustrated in Table 1. Similarly, Turbidity is the liquid fuzziness produced by various particles individually, which are physically not viewable to the naked eye and smoke in the air. Its unit is Formaz in Turbidity Unit (FTU) and it is suggested by ISO. Its voltage is rated to 5V DC, maximum current 30mA and the range of temperature to operate is between −10 deg Centigrade and 90 deg Centigrade. Figure 8 shows the sensor circuit of PH and Fig. 9 shows the turbidity

sensor. Every detail of the sensor is observed in the local system and reported to the cloud server. The information of the sensor can be uninterruptedly examined via network with an isolated address of IP by using the service of cloud computing.. For access of all sensor terminals the embedded c program was written to observe the value of sensors threshold randomly at specific intervals of the period. The Arduino Uno originates prepared for interfacing with a drivers range. Then the controller sends the data to the aqua care-IoT module sends the data to the google drive using cloud computing and also to WIFI for accessing network devices. Similarly, the implementation of Software included the transmitting and receiving of data reporting system based on master and slave process. The function of the control includes data processing and transmission. The primary role of the slave is data collection and then sending the data to the host control center and reporting the TWAD according to commands sending from the host control center. The master's host is Arduino controller and the slave's host CPU isWi-Fi chips. The procedure of embedded system control of all sensors monitoring is given below. The water quality measurement and control implemented by using the proposed Prominent Rule control Algorithm with diverse groupings. The Prominent Rule controls the water quality measurement error along with the threshold value. From the controlled prominent rules from the Ardiuno controller selects the predicted logic of error. The Prominent rule set algorithm is presented as below. The different sensor (e.g., temperature, PH, Turbidity) senses the water quality parameters and sendsthe data to the cloud-enabled system using Arduino. The microcontrollers on the board are programmed using Arduino programming

language based on wiring and the Arduino development based on the processing. In the frame work script of aqua care-IoT, the services are composed in different parts like Sensor Devices, Agent Servers, Agent Clients and Hosts as applications, which is shown in the architecture of the service as presented in Fig. 13. The Hosts can use the Agent Clients to access directly the Agent Servers or use the script to define all interactive behaviors of the entire group for smart applications completely. The Hosts can communicate with the Agent Servers through the Agent Clients to receive feedback from devices or to drive devices to take pre-determined actions and responses. The Agent Server also provides another interface that was connected to the Agent Client interface accessed by the host.

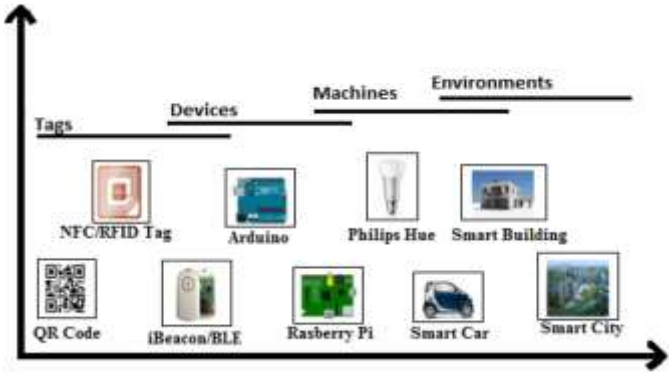
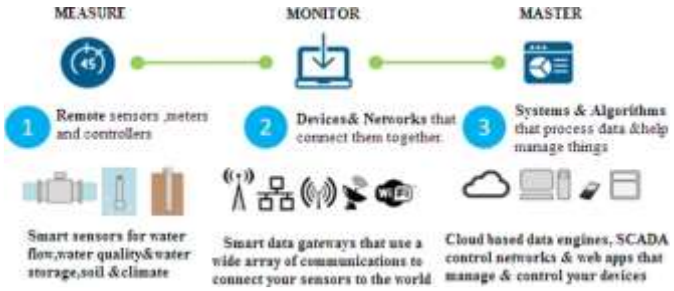


Fig - 1 : Landscape of IoT (internet of things)

Fig - 2 : Basic system service
(cited from http://aquamonix.com.au/)



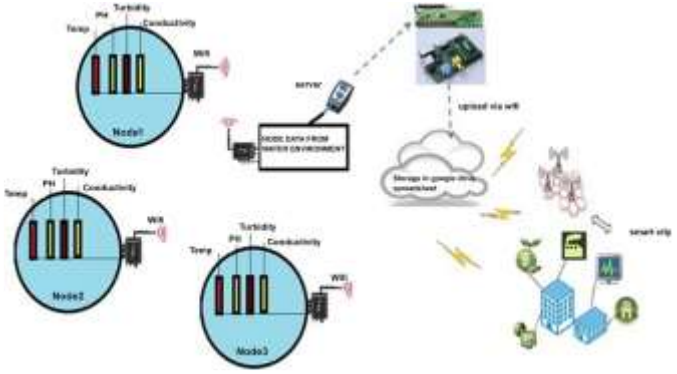


Fig. 3 Water quality environment with aqua care-IoT service architecture

The application program on the Host is in the form of the script, and the Agent Client must use as an API to access the Agent Server to compose the text. When the Host is not directly connected to the device, it relies on a survey of the Agent Client to determine all statuses in the group. The Host can register with

the Agent Service to cause it to execute particular scripts upon receiving particular <Key, Value> that are reported by devices. The Agent Client must also be installed in the Agent Server hardware to operate as the API to execute Scripts on the Agent Server. The procedure of reporting system of aqua care -IoT is given below.

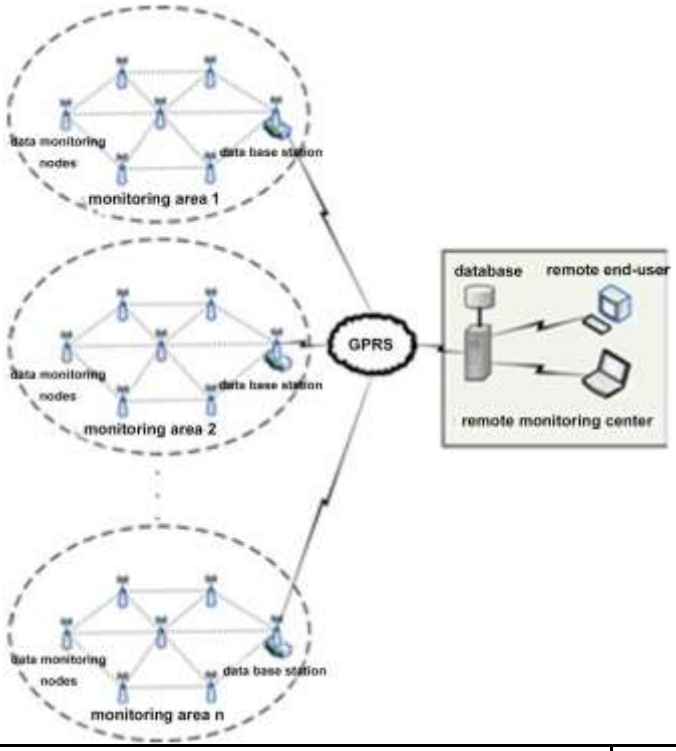


Fig. 4 Sample-area monitoring in cloud environment

Table -1: Various conductivity set points

0.042µS/cm	Ultrapure water (20 ◦C)
0.5–5µS/cm	Deionized water
100–300µS/cm	Soft ground water
45,000–55,000µS/cm	Sea water

The controller of the Arduino Uno controller through the transceiver of Wi-Fi. The hardware implementation of aqua care-IoT module controller was shown in Fig. 5 and the sensor circuit of the LM35 temperature is shown in Fig. 6. As a Sample, the sensitivity of the sensor in tank observes the present temperature and transfer to the microcontroller. It operates the process in the range of temperature between−55 and+150 ◦C and process between the volts of 4–30. It pulls the supply of 60µA and has less self-heating of below 0.1 ◦C in the motionless air. As a result, the IC provides 10mv/degree centigrade.

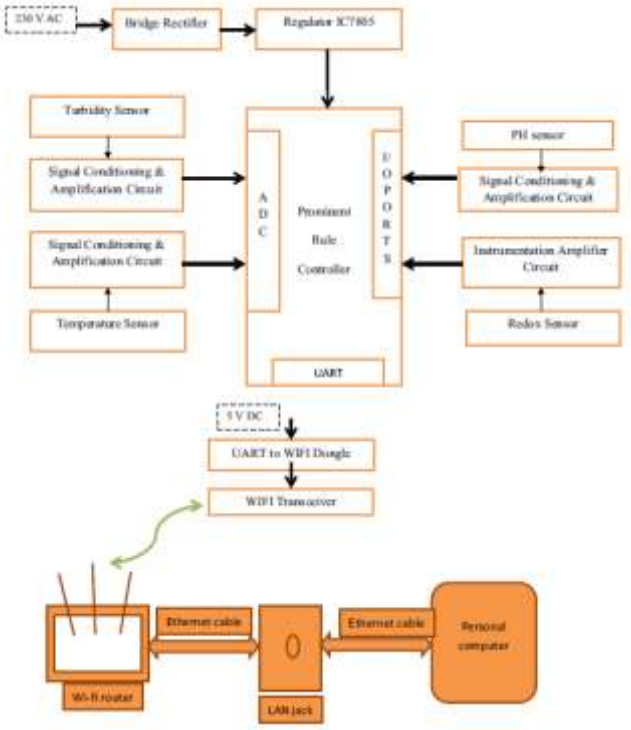


Fig. 5 Block diagram of the transceiver module

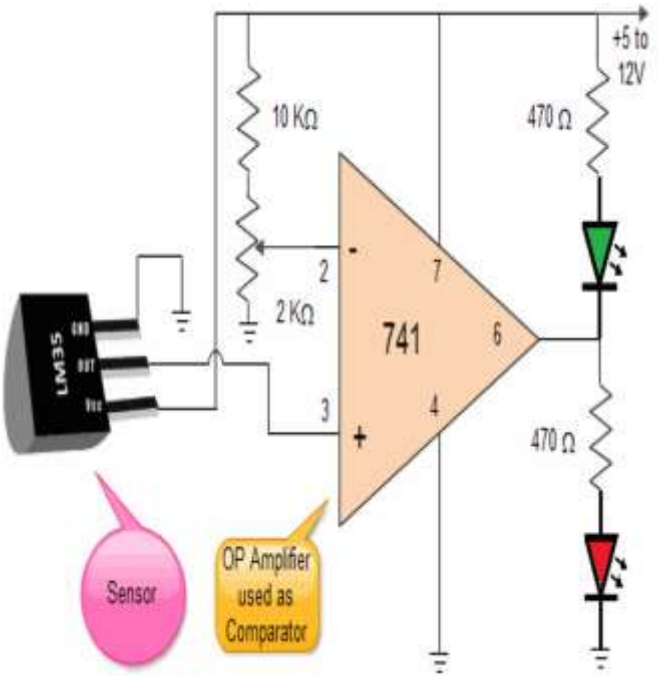


Fig. 6 LM35 temperature sensor circuit

Fig. 7 Conductivity probe

Fig. 8 pH sensor circuit

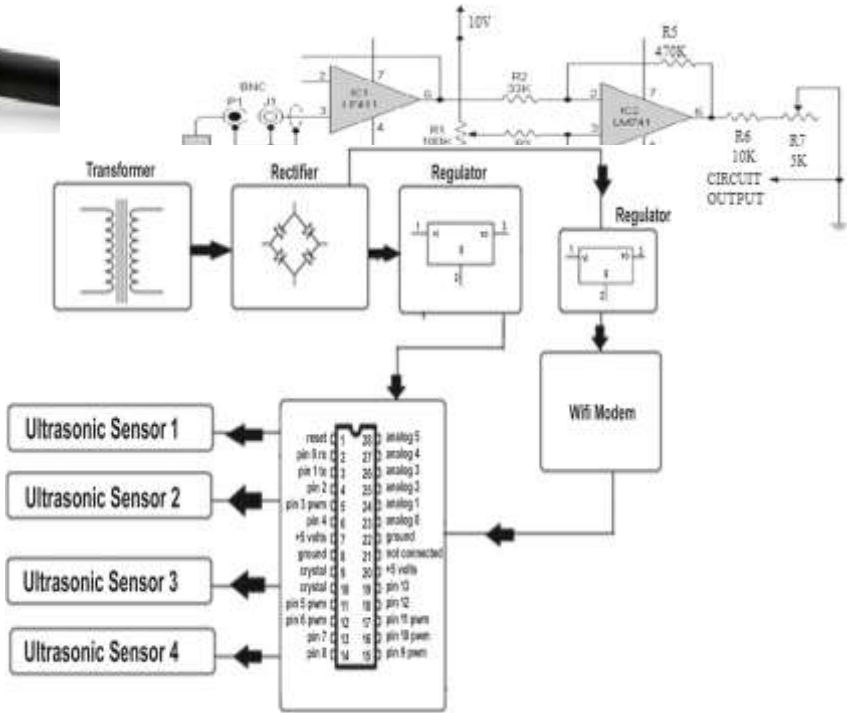


Fig. 9 Block diagram of IoT based system

3. RESULTS AND PERFORMANCE ANALYSIS

In this section, the simulation process of the proposed system design and implementation is carried out using Embedded C Programming. The prototype of water quality monitoring setup for aqua care-IoT applications. As per combination of the hardware module, the system gains little computational cost with a reduced number of CPU cycles, less execution time, least consumption of power, volume reduction and additional features. The analysis with the previous system of monitoring thewater quality using huge apparatus the proposed system provides further suitable and flexible process than the existing. It is relatively appropriate forthe monitoring scheme. The control process of the multimode can be recognized via the module of WSN. As per the planned idea the expenditure reduction is obtained and ensures the information gathered from the various nodes at entire atmosphere. The proposed solution has been implemented based on the cloud computing platform integrated with the proposed solution to evaluate the aqua care IoT methodology. The three different clouds were formed each one is running on different locations and three service providers who are running at N-Number of locations. The proposed solution has been hardwired with the proposed controller design and enabled Wi-Fi wireless communication to access the cloud service. The overall system performance of the proposed solution requires the following parameters are measured, namely T, PH, Turb, Cond Value and Overall Performance Ratio. The proposed system performance on the webpage the comparison values of different controllers namely PID, Fuzzy and Prominent rule controllerbased performance metrics. The different characteristics of Rise time (RT), Settling time (ST), Controlled Esteem (CE). Based on the observed characteristics the performance of prominent control algorithm is the best from remaining algorithms. Further parameters are needed to evaluate to make a comparison that to improve the standards of the waterquality monitoring system. The values of Rise time varies from 22(s) for PID, 26(s) for Fuzzy and 19(s) for proposed controllers for water area sample 1. Hence the prominent rule controller reduces the Rising time as small within a tolerable

limit. Benefits of RT is used improve the performance. The values of settling time varies for 35(s) for PID, 28(s) for Fuzzy and 19(s) for proposed controllers for water area sample 1. Hence the prominent rule controller reduces the Settling time as small within a tolerable limit. Benefits of ST is used improve the performance. The various water quality metrics are examined based on the separate controller models. The dissimilarities in the graph display a rich vision of CE, RT and ST parameter which varies for the different water sample. Further parameters are needed to evaluate to make a comparison that to improve the standards of the water quality monitoring system. Prominent rule controller is presented with the three parameters of water quality monitoring using IOT, and compared with the PID and Fuzzy controllers and ensures the proposed prominent rule controller is more efficient than the two methods as shown in Fig. 19. The values of CE decreased from 0.058 to 0.029 within a tolerable limit. Benefits of RT and ST are 19 and 21 reduced small, which is used improve the performance. The suggested aqua care-IoT scheme purpose is to determine the security issues in network based system and also to assure sensible overhead of computational with less execution time delay. In this section, the comparison of proposed aqua care-IoT water quality monitoring system is carried out with the existing networks such as Alarm-net [20] and Median [13] embedded and to address the security necessity and confidentiality of the thoughtful information. Therefore, to analyze the performance of the proposed aqua care-IoT scheme is shown in below graphs. The analysis related to previous system was specified because of differences and the involvement of the parameters of water quality on the respective site. The evaluation was expert the outcomes depend on the substantial parameters performance of the entire area. The computing power or resource of Agent Server and Agent Client are different. The analysis of performance based on CPU cycle and the execution time.

4. CONCLUSIONS

In this paper, the interface of aqua care IoT for system monitoring of water quality based on the IoT atmosphere via WSN is described. The information gathering of sensor system is carried out logically via network and developed the system based on a combined device of embedded prototype, IP address and communication application of IoT. This process will be suitable for the application of real time and concrete necessities of gaining system processed the information faster in the atmosphere of IoT. The planned system makes simpler the circuit design and system with high extensible and reliable. As per the Ip the integrity of information is enabled and various sensors are associated and connected, until the system terminates the process. As a final point, the water quality real time monitoring and reporting is performed better than the previous system. The simulation processed is tested to show the system

efficiency of the aqua-care IOT practical application, which produces effective performance with low computational cost and less execution time.

ACKNOWLEDGEMENT

The authors can acknowledge M. Parameswari, Department of Electrical and Electronic Engineering, Dhanalakshmi Srinivasan Engineering College, Perambalur, India for their support and usage of the content through Springer link.

REFERENCES

[1] S. Li, L. Xu, X. Wang, J. Wang, "Integration of hybrid wireless networks in cloud services oriented enterprise information systems", Enterp. Inf. Syst. 6(2), (2012), pp. 165–187.
[2] Q. Li, Z. Wang, Li. LiW, C. Wang, L. Du L, "Applications integration in a hybrid cloud computing environment: modelling and platform", Enterp. Inf. Syst. 7(3), (2013), pp 237–271.
[3] L. Wang, LD. Xu, Z. Bi, Y. Xu, "Data cleaning for RFID and WSN integration", IEEE Trans. Ind. Inform. 10(1), (2014), pp 408–418.
[4] Y. Fan, Y. Yin, L. Xu, Y. Zeng, F. Wu, "IoT based smart rehabilitation system", IEEE Trans. Inform. 10(2), (2014), pp 1568–1577.
[5] S. Pai, M. Meingast, T. Roosta, S. Bermudez, S. Wicker, D.K. Mulligan, S. Sastry, "Confidentiality in Sensor Networks: Transactional Information", IEEE Security and Privacy Magazine (2008).
[6] Y. Xiao, X. Shen, B. Sun, L. Cai, "Security and privacy in RFID and applications in telemedicine", IEEE Commun. Mag. 44, (2006), pp 64–72.
[7] X. Ying, "The automatic monitoring device of ground water level based on embedded systems". In: International Symposium on Information Processing (ISIP'09), pp 241–244.
[8] Z. Feng, "Research on water-saving irrigation automatic control system based on Internet of things", IEEE 9. Mo D Automatic measurement and reporting system of water quality based on GSM. In: Second. International Conference on Intelligent System Design and Engineering Application, (2012), pp. 1007–1010
[9] Aj. Odey, "Aqua Mesh design and implementation of smart wireless mesh sensor networks for aquaculture." Am. J. Netw. Commun., (2013) pp. 81–87
[10] V. Nikolopoulos, G. Mpardis, I. Giannoukos, I. Lykourentzou, V. Loumos, "Web-based decisionsupport system methodology for smart provision of adaptive digital energy services over cloud technologies". IET Softw. 5(5), (2011), pp 454–465.
[11] C.P. Qing, Y. Hairongn, C. Zhang, "A reconfigurable smart sensor interface for industrial WSN in IoT environment". IEEE Trans. Ind. Inform. 10, (2014), pp 1417–1425.
[12] S. Li, S. Da, X. Wang, "Compressed sensing signal and data acquisition in wireless sensor networks and internet of things". IEEE Trans. Ind. Inform. 9(4), (2013), pp. 2177–2186.
[13] P. Verma, A. Kumar, N. Rathod, P. Jain, S. Mallikarjun, R. Subramanian, B. Amrutur, M.M. Kumar, R. Sundaresan, "Towards an IoT based water management system for a campus". In: Smart Cities Conference (ISC2), 2015 IEEE First International, pp 1–6.
[14] X. Zhu, "A remote wireless system for water quality online monitoring in intensive fish culture", Comput Electron Agric, (2010) pp s3–s9.

[15] J. Matos, O. Postolache, "IoT enabled aquatic drone for environmental monitoring. In: 2016" International Conference and Exposition on Electrical and Power Engineering (EPE), pp. 598–603.
[16] W. He, G. Yan, L. Xu, "Developing vehicular data cloud services in the IoT environment" IEEE Trans. Ind. Inform. 10(2), (2014), pp. 1587–1595.
[17] V. Benini, Designing next-generation smart sensor hubs for the internet of-things. In: Proceedings of 5th IEEE International Workshop Advances in Sensors and Interfaces (IWASI), (2013).
[18] Y. Chen, V. Dinavahi, Multi-FPGA digital hardware design for detailed large-scale real-time electromagnetic transient simulation of power systems. IET Gener. Transm. Distrib. 7(5) (2013) 451–463.
[19] T. Gara, L. Fengting, I. Nhapi, C. Makate, W. Gumindoga, "Health safety of drinking water supplied in Africa: a closer look using applicable water-quality standards as a measure". Exposure and Health, pp 1–12.

[20] .kter, F.T. Jhohura, F. Akter, T.R. Chowdhury, S.K. Mistry, D. Dey, M. Rahman, "Water quality index for measuring drinking water quality in rural Bangladesh: a cross-sectional study," J Health Popul Nutr. 35(1):4 123.