Smart Water Pollution Monitoring And Control System

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Abstract—Water pollution is a major global issue today. Indian media report says that significant quantity of municipal water samples tested in various cities were found contaminated with hazardous pollutants due to various reasons. Urbanization and industrialization had cause pollution to the clean water sources. Generally purified water is pumped from the source point of municipal water pumping stations to the households. But on its way, pollutants from municipal sewer lines & other sources get mixed in to drinking water distribution lines which causes serious health issues in urban areas. Hence this project mainly focuses on monitoring and controlling of pollution in municipal water supplies. Although the research of the water quality monitoring system is widely done and applied, the existing laboratory oriented "Stand alone Analyzer system" is still expensive, small coverage and not user friendly for domestic / field level WQM (Water Quality Measurement) purpose. Hereby, it is important to have In-Line water quality monitoring system that provides Real-time water quality data when the water is pumped in to the distribution pipe lines and storage devices. Here a low-cost, large coverage, user-friendly and Hybrid water quality monitoring and control system with multi-sensor which is based on Wi-Fi Technology is presented to assist both the consumer & municipal authority effectively.

Keywords—WATER QUALITY MONITORING,CONTROL

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I. INTRODUCTION

In this paper the project of "Smart water pollution monitoring and control system" is aimed to monitor and control the spread of water pollution in municipal water distribution lines and household water lines. Here the water pollution is primarily monitored at consumer point & collected data are instantly reported to local municipal authorities for further analysis and action. In this hybrid system Real Time Water Pollution Monitoring system, water quality / pollution data such as TDS, PH, Turbidity etc., can be monitored on real time and viewed lively in mobile phones. Alert messages on water pollution can also be sent instantly to consumers / Municipal Water Authority. The multi-sensor circuit is designed to collect multiple data simultaneously. TDS/EC sensor, PHsensor, Turbidity sensor, Water level sensors, Low Pressure Fluidic Switch and Solenoid valves are incorporated in the system. The device is able to measure, collect and display the variants of the water quality and subsequently, the collected data is transmitted to the IOT platform via the Wi-Fi shield for real time monitoring. This innovative Hybrid RTWPM project developed for both Domestic and Laboratory use. The collected data is transmitted to IOT Cloud platform such as IOT, via Wi-Fi and can be viewed anywhere, anytime on Mobile Phones in real time. Implementation of various design and techniques used in this project prevents water pollution / contamination at very early stages of water distribution lines and thus eliminates expensive disinfection process in the water lines of municipality / households. Here the contaminated water is smartly diverted to the waste lines without affecting & contaminating all the tail lines. The motivation for this project is to reduce the cause of Water pollution across the world. Water pollution is a major global issue today. Media report says up to 20% of Chennai metro water sample tested were contaminated either with high biological contamination or had highly total dissolved solids. Mixing and contamination of sewerage water in the municipal drinking water pipelines is the main cause of water borne diseases. In this project of **Smart water pollution monitoring and control system** is aimed to solve and control the water pollution in municipal water distribution lines. Having monitored water pollution issues for the past several years in Southern part of Chennai we have come to the conclusion that this kind of issues to be eradicated with proper monitoring and control techniques. We have also found that the existing Stand-alone pollution monitoring devices used in metro water and other water quality testing laboratories cannot be used for monitoring the Real-time deduction of water pollution in the distribution lines and domestic connections. Hence there is a need for real-time monitoring of water pollution arises. Upon searching for suitable WQM instrument to solve the above said issues we found that there is no appropriate instrument commercially available so far in India. This situation motivated us to design and develop Real-time WQM using In-Line flow-through cells and Internet of Things based technologies.

II. EXISTING SYSTEM

The research of the water quality monitoring system is widely done and applied, the existing laboratory oriented "Stand alone Analyzer system" is still expensive , small coverage and not user-friendly for domestic/ field level WQM purpose, The standalone analyser system is an instrument where water samples collected from remote places are tested in a laboratory. It is otherwise called Off Flow-Line bench top laboratory Instruments where water samples to tested are in static mode without any motion.

III. PROPOSED SYSTEM

In-Line water quality monitoring system that provides Real-time water quality data when the water is pumped in to the distribution pipe lines and storage devices. Totally Hybrid system used for both domestic & laboratory WQM purposes. Key water quality parameters such as TDS/EC, PH, Turbidity and temperature are being analyzed continuously anywhere in municipal water distribution lines (consumer water connecting points) and the collected data can be viewed in real time on the mobile phones. Alert messages on the events of water pollution along with consumer details are being sent to both Municipal water authority and consumer. These Alert messages and Real time data with history files allows the municipal water authority to locate the place of water pollution instantly and take immediate action to cut-off the spread of water pollution in tail lines of water distribution network. This system is strategically designed to save lot of cost and labor involved in finding the location of water pollution and dis-infection process for the water authority. By totally stopping the entry of water pollution in to water storages of consumers, it allows consumers to maintain good hygiene and also save lot of cost involved in dis-infection process. This system makes use of four sensors namely pH, TDS/EC, Turbidity and Temperature. Arduino-UNO and Node-MCU microcontrollers are employed here for the capture of analog and digital data from the sensors , process them and upload the final data to the cloud IOT platform. Microcontroller accepts and processes the data collected from the sensors to the Web page via NODE MCU. This is carried out with the help of coding which is written in Embedded-C. Arduino IDE software being used here to simulate the code.

IV. BLOCK DIAGRAM
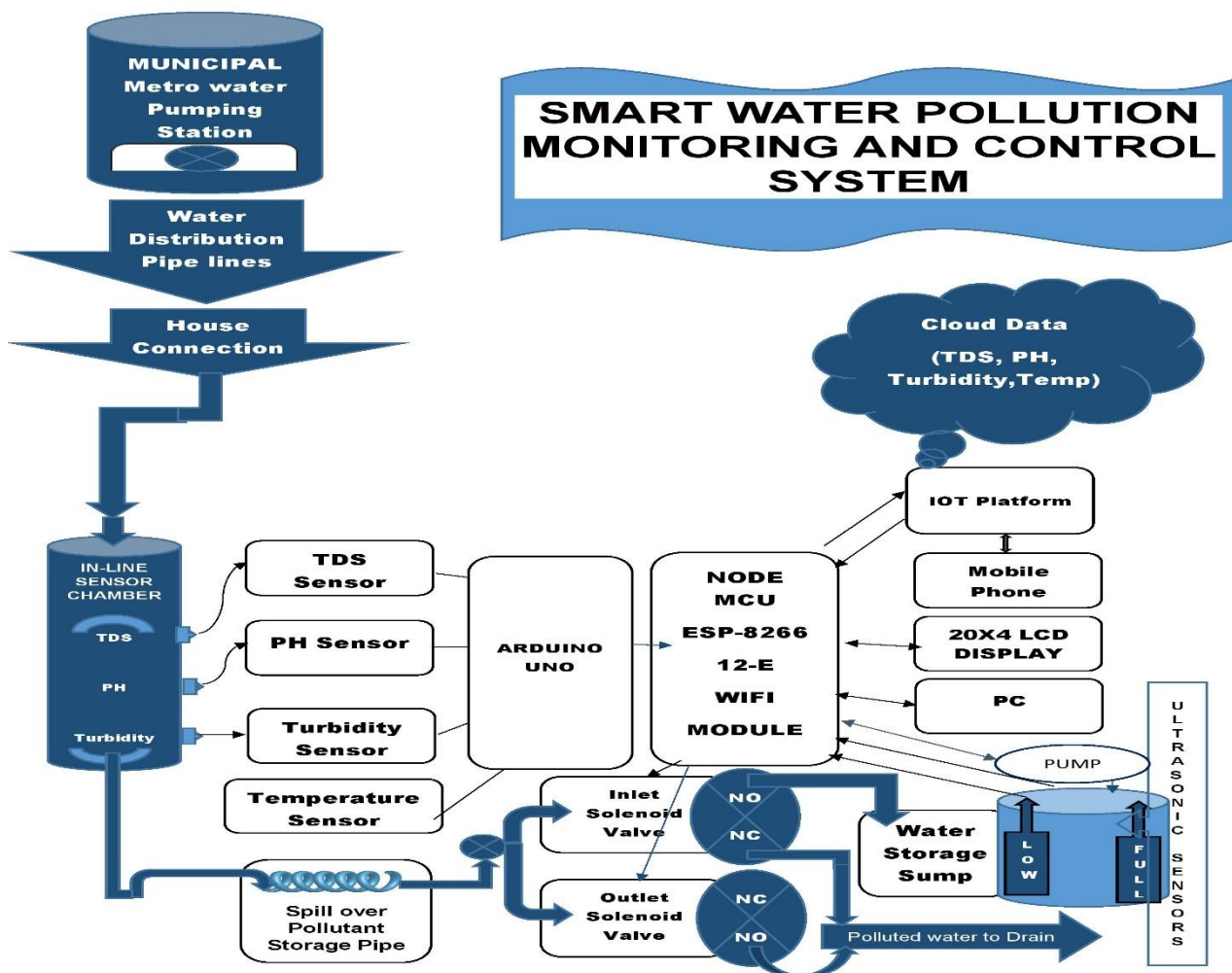
V. WORKING PRINCIPLE

❖ Raw water from the Municipal water pumping station or Overhead tank enters in to the house connection and then to, in-let connection of the system. Raw water is the pumped in to Sample Loop pipe, Flow cells of Temperature Sensor, TDS Sensor, Turbidity Sensor, PHsensor modules where all WQM parameters are detected, captured and then sent to Arduino-UNO controller. Captured analog and digital signals are processed with necessary ADC conversion by Arduino-Uno and sent to NODE MCU 8266 where these digital data is compared with predefined set points and In-let out let solenoid valves are controlled accordingly. The resultant WQM data are then sent to cloud for real time viewing and analysis through an IOT Platform. Here the NODE MCU processes the Sump water levels directly using ultrasonic sensor and controls the In-let out let solenoid valves accordingly.

❖ Alarm level of water quality parameters such as TDS (<500 TDS), Temperature (<40 Degrees), PH(Band of 5.0 PH to 9.0 PH) and Turbidity (Band of 2500 Raw data Units to 3000 RUs) can be set according to certain industrial standards in the program. When any one of these parameters exceeds the set level, the NODE MCU sends the control signal to close the entry of water by activating the Water storage sump inlet solenoid valve. At the same time NODE-MCU opens the outlet solenoid valve to drain out the polluted water. GSM-800-C module sends following Alert messages along with consumer details to both consumer and Municipal Water Authority.

1. "Water Pollution: PH is Low"
2. "Water Pollution: PH is High"
3. "Water Pollution: TDS is High"
4. "Water Pollution: Turbidity is High: Cloudy"
5. "Water Pollution: Turbidity high: Dirty"
6. "Water Temperature is High: >40 Degree C"
7. "Sump water level is Low" (only to consumers mobile phone)"

❖ All collected data are then viewed in the PC & Mobile phones in real time.

❖ Parameters such as TDS, Temperature, PH, Turbidity, Sump Water Level (Low, %, Full) and the process events such as "Flushing-Pollutant", TDS-High, PH-Low, PH-High, Turbidity-Cloudy, Turbidity-Dirty can be viewed on the built-in 20X4 I2C LCD Display.

❖ When the Sump water level is low (i.e between 20% & 99%) MCU has to activate the inlet valve and fill the water in to the sump. Subsequently when the water level is going to low below 20%, It should turn off the House-hold OHT pump to avoid dry run. OHT Pump will be turned on only when the sump water level is between 21% & 100%.

❖ Once the water level reaches 100%, "water sump-Full" event displayed and NODE-MCU send the control signal to in-let solenoid valve to close and subsequently opens the Out-Let solenoid valve so that excess water can be diverted to drain or other water reservoirs.

❖ Subsequently, the collected data is transmitted to the IOT plat-form., via built-in Wi-Fi shield of NODE-MCU. The data collected from the sensors is then stored and displayed via the IOT platform to ensure there is no data loss during the process of data transmission.

❖ Here **"Spillover Pollutant storage Pipe"** is strategically placed before the sump inlet valve connection. It is used to prevent the entry of polluted water into the storage sump at any point of time. There is a little chance of polluted water getting in to Spill over Storage Pipe due to some delay involved in process of detection and measurement. In order to avoid any spill at any point of time, **Pollutant flush program** in the NODE MCU-Arduino-IDE s/w for 3 minutes has been introduced. During this flush cycle, all the pollutants stuck inside the fluidic lines of the system are completely washed out. In case any pollutant is detected immediately after 3 Min Flush cycle, the system get in to one more flush cycle and wash out the pollutant again and again.

❖ **Fluidic low pressure switch** is employed here to monitor the optimum pressure level of incoming raw water. NODE-MCU has no connection to control this L.P.Switch.

❖ **Sample Loop Pipe:** This pipe is used to inject the water polluting samples in specific volume properly into the flow-cells of PH, Temp, TDS, and Turbidity sensors.

❖ **Time delay Relay Module:** For the proper power on reset and data transfer between Arduino-UNO and NODE-MCU controllers, a Time–Delay-Relay module has been incorporated here. When the main power is switched on, NODE-MCU gets the power immediately but not UNO. This Time relay module delays the power supply to Arduino-UNO for a couple of seconds.

❖ **Inlet solenoid valve:** It allows un-polluted / clean water in to the water sump. It diverts the raw water to the drain only when sump water level reached full.

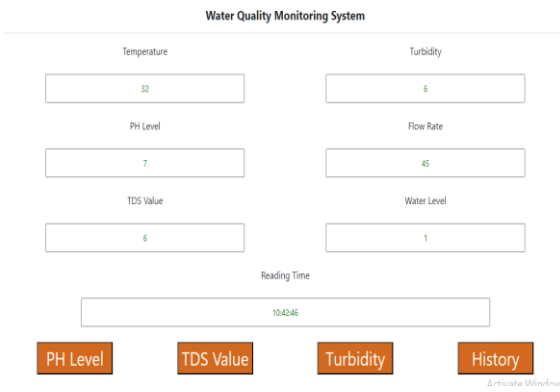❖ **Outlet solenoid valve:** It diverts all the pollutant to the waste / drain.
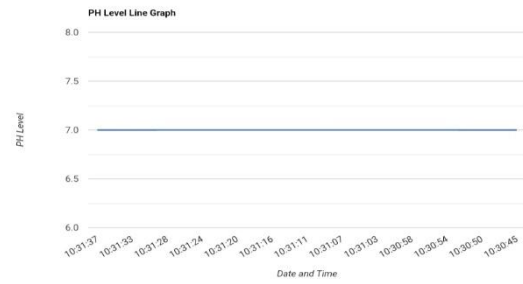
VI. RESULT
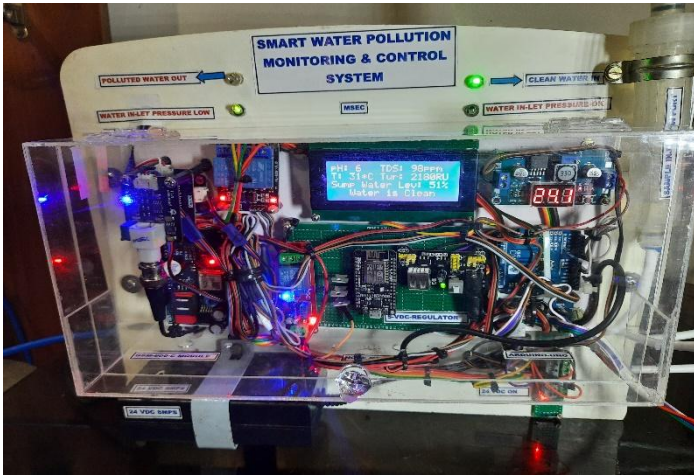
HARDWARE SETUP FRONT VIEW

IOT PLATFORM
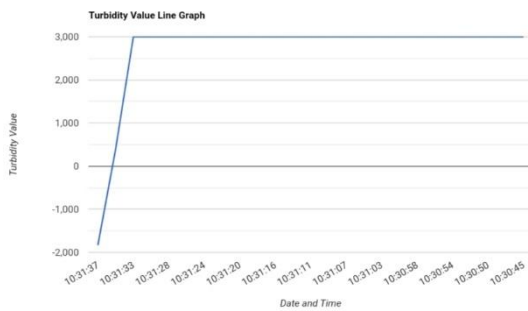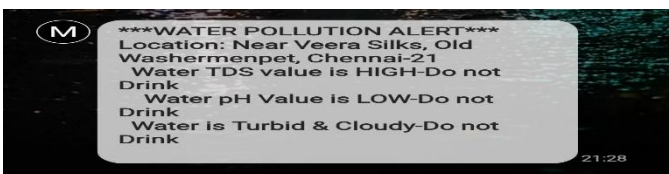

DATA ANALYSIS FOR PH LEVEL

DATA ANALYSIS FOR TURBIDITY

DATA ANALYSIS FOR TDS

ALLERT SMS USING GSM MODULE

HARDWARE SETUP BACK VIEW

VII. FUTURE ENHANCEMENT

- ❖ Water pollution monitoring and control in Municipal water distribution systems.

- ❖ Household Water Pollution Monitoring and Control.

- ❖ Breweries and Pharma Industries (with Optional modification)

- ❖ Water purification Industries (with Optional modification)

- ❖ Agricultural Water Quality Management (with Optional modification)

- ❖ Water purification Industries (with Optional modification)

- ❖ Field level WQM analysis @ Water reservoirs / Rivers & other water sources.

- ❖ Aquaculture Water Quality Management (with Optional modification)

- ❖ Industrial waste water & effluent treatment process (with Optional modification).

VIII. ADVANTAGES

- ❖ Can be implemented to monitor real time water pollution monitoring in household drinking water distribution line.

- ❖ Alert messages can be viewed and monitored lively by Municipal water pumping station staffs.

- ❖ Using this system, the water authority officials can keep track of the levels of pollutions occurring in the water distribution lines / water bodies and take immediate action to eradicate the man-made water pollutions and also send immediate warnings to the public.

- ❖ No such system is available so far in India. This system can be easily implemented in the field.

IX. CONCLUSION

Prototype model of "Smart water pollution monitoring and control system" has been designed. Hardware and Software part of this project has been tested. In this project we present a wireless system for water pollution monitoring and control. Here we integrate several sensors, transmitters, receivers, Node MCU microcontroller with Wi-Fi technology. To achieve industry standard performance, the Industrial Flow-Thru PH sensor and Turbidity sensors are needed. But in this project we used stand-alone PH-sensor and turbidity sensors, fitted them in to hand-made flow-cells to reduce the cost of the project to a greater extent. In this context, the performance of PH and Turbidity sensors are little compromised. Upon our study, we found that Industrial Flow-Thru-PH electrode & Quartz Crystal based Turbidity sensors are highly recommended for better quality study of WQM. But for pollution screening purposes, the proposed system is highly suitable. A suitable coding program has been developed to implement various functions such as System control / measurement / data logging and also for interfacing MCU with the sensors. The system supports 24-hour real-time water pollution monitoring. The user can monitor the system through the Internet and receive Alert messages in a mobile device from a remote site. Optionally our system also supports data analysis and statistical reports using open source s/w platforms. This Innovative / Hybrid / Low cost prototype model can easily be modified and developed as a commercial version for both domestic & industrial applications.

X. ABBREVATION

- ❖ LCD - Liquid Crystal Display

- ❖ RTWPM - Real Time Water Pollution Monitoring

- ❖ IOT – Internet Of Things

- ❖ RO – Reverse Osmosis

- ❖ WQM – Water Quality Monitoring or Water Quality Management

- ❖ WPM – Water Pollution Monitoring or Water Pollution Management

- ❖ PH – Potential of Hydrogen

- ❖ NTU – Nephelometric Turbidity Unit

- ❖ RU – Raw data Unit

- ❖ TDS – Total Dissolved Solids

- ❖ EC – Electricity Conductivity

- ❖ WHO – World Health Organization

- ❖ BIS – Bureau Indian Standard

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