Smart Water Conservation and Management System Using IOT

(Water Utility Monitoring and Control Using IOT Based Approach)

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Abstract

The water needs have increased unpredictably throughout the world during the past few decades. This increasing demand of water supply has become a major challenge. We present an IoT based design for water monitoring and control approach which supports internet based data collection on real time basis to overcome this challenge. The device comprises of: a computer system (Central Hub), the IOT Module, the switching unit and the Zigbee module. The Internet of Things is a robust network of devices, all embedded with electronics, software, and sensors that enable them to exchange and analyze data. Firstly, the centralized hub is used for distributing water individually based on the needs of each household. The centralized hub works with the help of IoT that assists in integration of communications, control, and information processing across the systems used. This allows us to sense the water quantity and quality at each structure in one particular sector and provide control of water supply through a remote access. According to the deficit or the excess water level in a rank, the centralized hub monitors and shares the water among the localized tanks or resupplies water from its reservoir. It is used to create personal area networks in this scenario where there is a need for wireless connection across the system. We also improve the quality of water distributed to every household by deploying UV treatment. Fluoride content level along with hardness checking is also done using respective test meters.

Keywords

IOT, pH Sensor, Central Hub, Water Monitoring

I. Introduction

Water is an important commodity which required for the survival of life on earth irrespective of its purposes. The water scarcity has become a major threat to our world. Increasing demand of water supply has become a major challenge. Wasteful usage of water, climatic changes and urbanization has further depleted the resource. The availability of pure water supply has been still a matter of question for the past few year and still a huge concern among densely populated areas. This paper is based on an IoT based Water control and management system which helps us to control the water supply to prevent water crisis and pure water enrichment. The IoT module which is proposed in this paper is controlled by concerned authorities in order to control excess usage of water. For this the IoT module enhances an interconnection, through which IoT devices are equipped with embedded sensors, microcontrollers, testers that completes the module to fulfil the purpose. IoT is not a single technology; rather it is an agglomeration of various technologies that work together in tandem which uses sensors and testers. These are devices which help in interacting with the physical environment to determine the water level and quality. The data collected by the sensors has to be stored and processed which can be done in a remote server. We use Zigbee protocol which is currently gaining traction in the Lower Power WAN group, is an open global standard and is designed specifically to be used in WPAN. The technology is inexpensive to run and doesn't require a lot of power, making it an ideal solution for our issue. The combination of all these modules requires a Microcontroller to Carry out all the desired processes that saves surplus amount of excess water and pure water distribution for the public across a city or particular geographical area. We implement all of these technologies combined as one particular module which enables us to monitor and control Water supply and water purification by using respective sensors and testers. Hence by providing this entire module to the hands of a public sector can ensure proper distribution of safe drinking water over a large metropolitan area.

II. System Architecture

We have used a system that comprises of PIC16f877a microcontroller which is used to connect the various input modules such as sensors, WSN-3226, IoT module(Bluetooth), etc and output modules such as the User cloud, Relay circuit, motors, etc. This whole setup is present at the Central hub which controls the whole water supply mechanism throughout a particular sector or area. It collects all the user related data, like the water quantity and quality, and transmit them to the Database via WSN-3226 module. Iot Module plays a crucial role in interconnection of Home level systems, the respective computer used for data transmission to the database and implementation of Zigbee to enhance the wireless connectivity in the region.

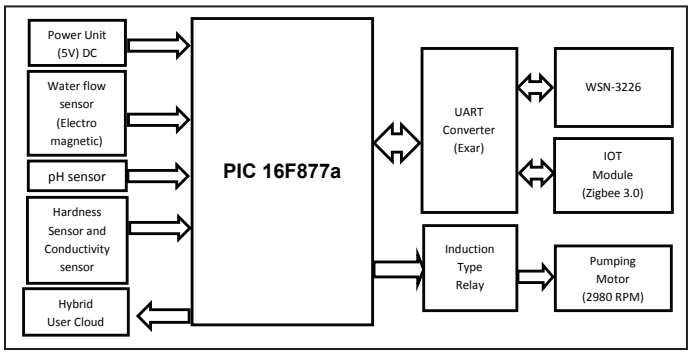

Fig. 1:

- The system we need a power supply of 5V for PIC16f877a, quality sensor, IoT module, pumping motor, WSN, Zigbee module and User cloud interface
- The PIC microcontroller PIC16f877a is one of the most renowned microcontrollers in the industry. This controller is very convenient to use, the coding or programming of this controller is also easier. One of the main advantages is that it can be write-erase as many times as possible because it uses FLASH memory technology. It has a total number of 40 pins and there are 33 pins for input and output. The 16F877A is a capable microcontroller that can do many tasks because it has a large enough programming memory (8k words and 368 Bytes of RAM). It contains everything needed to support

the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. With all these features of the microcontroller combined, it makes an ideal solution for our problem. Its high data transfer rates help us to control the amount of water supplied to multiple places with a considerable amount of ease.

- After measuring and checking all the parameters, the information needs to be sent online so that it can be monitored remotely. For this purpose, WSN module is used. It helps in making the system real time. The WSN Module helps in giving the microcontroller access to your Bluetooth network.
- In Zigbee data is transferred in two modes: Non-beacon mode and Beacon mode. In a beacon mode, the coordinators and routers continuously monitor active state of incoming data hence more power is consumed. In this mode, the routers and coordinators do not sleep because at any time any node can wake up and communicate. However, it requires more power supply and its overall power consumption is low because most of the devices are in an inactive state for over long periods in the network.

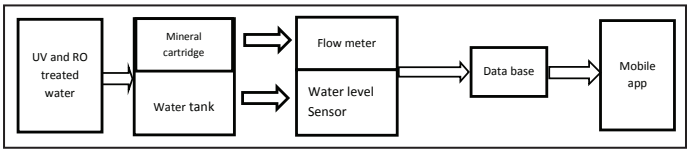

Fig. 2:

III. Working

This system can be implemented on the water supply system of a wide area. During the time of water crisis the entire available water of the city can be brought under the control of a government unit with the help of our proposed system. The water in each substation is controlled by the central hub. When a user runs out of water, the water level sensor in the tank will intimate the cental hub with the help of zigbee protocol through WSN module. Zigbee is a protocol which is implemented for control and sensor networks on IEEE 802.15.4 standard.

The below illustration depicts the actual model of our proposed system. Central Hub contains the Database for data sharing and communication. It also consists of the micro controller and this is responsible for all the monitoring processes. This analyses whether the water in the tank is either more or not meeting the minimum criteria of water in the tank. The central hub further analyses the user's current water level in his tank using IoT module and also his other available source of water like Rain water harvesting, RO plants etc.

Furthermore, UART converters are used to ensure efficient data sharing through WSN modules and relay motors are implemented to ensure the efficient flow of water to various substations. The central hub is the connected to the all the sensors used in the model through the use of IoT and the data inferred from the various sectors are stored in the user cloud. The data from this user cloud is processed and depending upon the data at hand, water is distributed to various subsystems at a controlled level.

The Substations are placed at various localities which collects the majority water supply from central hub's reservoir. Substations is used to purify the water using respective purifiers and supply water as per the prescribed level according to the demand of each house present within its proximity. The pH sensor, conductivity sensor and the hardness sensors are installed in the substation. The water from the central hub is of an impure nature and purification takes place in the substation. This purification process takes place through several levels which contains sedimentation tanks, RO system, UV treatment. The pH value and the hardness value is monitored both before and after the purification process. All these process need a high speed data sharing and swift water supply, thus it is done using the IoT module.

House level monitoring systems contain the water level sensors and water flow sensors to sense the water level present in a tank and the flow of water rate respectively. The house level system is also installed with pH and hardness sensor to ensure the purity level of the water and indicate the same using the user interface application. This user interface can be in the form of a mobile application or a computer program which helps him to analyze the quantity and quality of the water that he obtains from the central hub using IoT. The data from sensors is stored in the private Database user clouds and network through IoT. If the water is unused for a long time of period in one particular house, an intimation is sent to the central hub which in turn controls the pumping motor to reverse the excess water present back to substation for future use. Through this process we can efficiently control and minimalize excess water usage as well as the wastage. Hence our proposed system aims at helping the government and overcome various water crisis situations by limiting the water supply across the city to a prescribed level proposed by the government and also improving the water quality for the welfare of public.

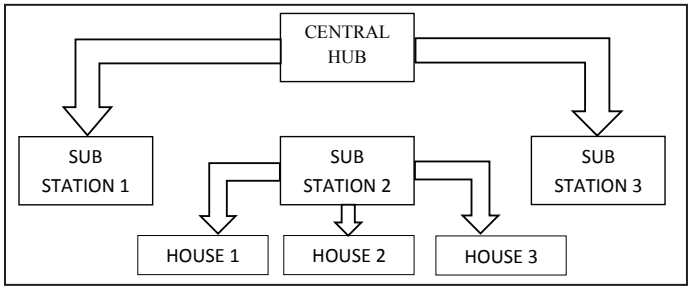

Fig. 3:

IV. Funtional Description

The functional decryption for the given system is as follows:

- The configuration of required hardware components is done to build the main system base. This involves connecting the hardware components to a 5V DC supply and turning these components ON.
- The pH sensor collects the given real time data of whether the water content is of an acidic or basic nature and feeds it into the user cloud through Iot
- Likewise, the hardness sensor detects the amount of calcium and manganese levels and fees the information on to the user cloud.
- For every 2 seconds the values are updated to regularly monitor the sensor readings in the webpage connected to the Cloud.
- Once these real time values are updated in the cloud and the cloud transports the data to the central hub wherein the monitoring and efficient distribution of water takes place.
- The central hub uses a pumping motor, an UART converter, a WSN module, relays and an IoT module for communication and interaction with various subsystems.
- The water flow sensor as well as the flow meter sensor are responsible for measuring and indicating the water level in the tank.

- If the water level in the tank is below the threshold level ie 5 litres, then the pumping motor connected to the central hub switches on automatically through the Iot monitoring module.
- The pumping motor supplies water from the subsystems to various households.
- The entire process is terminated and the monitoring process starts from the beginning, once the tank is full.
- The same process is done even if the water is above the threshold limit; That is, if the water level in the tank is well above the threshold level the process terminates and starts over the monitoring process from the beginning.

V. Results and Discussion Based on Quality

Water conductivity sensors are used in water-quality applications to measure how well a solution conducts an electrical current. This type of measurement assesses the concentration of ions in the solution. The more ions that are in the solution, the higher the conductivity, hence higher the impurities. We also use a mineral cartridge to replenish the mineral content of the purified water from the substation. But the mineral cartridge expires due to the usage of minerals present in it. The given graph represents water mineral content measurements for consecutive months. We took a survey based upon the mineral content intensity present in the tank of water and we've noted constant decrease in mineral content over time. We can see that the mineral content depletes to zero after 4 months of time. Hence an intimation is sent to the user interface which warns the user to replace the Mineral cartridge.

The drinking water as per WHO standards require certain amount of mineral content. These mineral content upgrades the overall quality of the water making it healthier and tastier to drink. As mentioned before the lack of these mineral content leads to deficiencies in the human body. To prevent the deficiency, the water content should have the following parameters with respect to WHO standards to obtain a mineralized water.

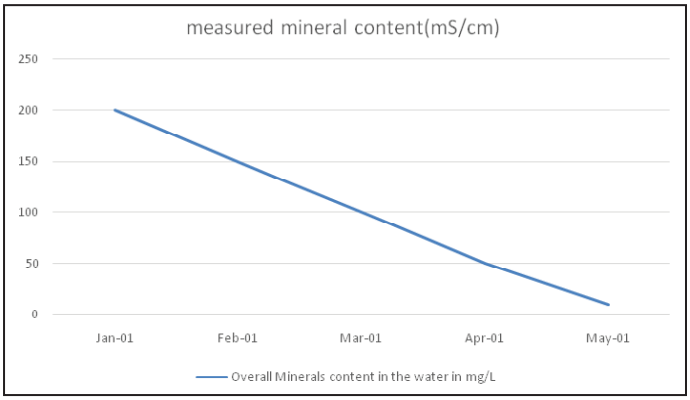

Fig. 4:

Table 1:

pH	6.5 to 8.5
Nitrates	<10 mg/l as NO3-N
Magnesium	>125 Mg/l
Manganese	0.07-0.12 mg/l
Calcium	>130 mg/l
Iron	<0.3 Mg/l
Total Hardness	<170 mg/l

The given table represents the standard level of mineral contents in drinking water as per the WHO standards. The values are represented in percentage with respect to the quantity of a water sample. Bottled mineral water contains more than four times of calcium, magnesium than regular water. Our study states that in drinking mineralized water, magnesium is able to lower the blood pressure. We use several type of sensors to measure the quantity of these minerals present in the water and other factors such as pH and hardness of the water. But there is no assurance that the supplies water would be pure enough for domestic and commercial purposes. Hence we use various type of sensors and mineral cartridges to monitor and alter the quality of the water to make it better. The Substation has the various filters like RO systems, UV treatment systems and sedimentation tanks which purifies the water to a point where the impurities and excess amount of minerals are removed. Also during this purification process, the essential mineral content (as per the given table) is lost. In recent surveys, an average human needs around 3 liters of mineralized water. But comparing this quantity to actual domestic purpose, it is very minimal in usage. Hence, the usage of Mineral cartridges is minimalized. Now let us discuss about minerals and other factors that affect the purity content id water.

One of the most important factor that affects the water purity is Hardness of the water. Water hardness is an aesthetic quality of water, and is caused mostly by the minerals calcium and magnesium, but is classified or measured based on the level of concentration of calcium carbonate. Water hardness sensor includes a sensing matrix in contact with the flow of water, an indicator that is used for analysing calcium carbonate and magnesium content. We get the actual content of hardness present in the water. Hard water can be classified into moderately hard (60-120 mg/L), hard as well as very hard water (>120 mg/L). Moderately hard water can be used for domestic purposes and apt of drinking water too. Very hard water is used for industrial purposes. Another factor that affects the quality of the water is the pH value of the water. For this we use a pH sensor which estimates the hydrogen content in the water and gives the acidic or basic nature of the water according to the pH value. We can control these two factors by purifying the water using RO system which can be placed at both substation and house level.

Now, we use Mineral cartridges to control the mineral content of the purified water in substation. After the purification process, the water mineral content is reduced. This water is good enough for both commercial and industrial purposes but not apt for drinking and cooking purposes. Hence we use mineral cartridges at house level to replenish the mineral contents lost during purification processes. As said before, the use of mineralized water is way too low when compared to commercial purpose. Thus the installation of the mineral cartridge is based on specific needs and requirements.

Thus by using our model we can monitor the quantity and quality of the water as well as improve it by various controlled purification systems such as UV and RO processes and mineral replenishment.

VI. Conclusion

This paper has given a brief discussion about smart water supply across a particular area by harnessing the technological usage of IoT concept, simultaneously Improving the Water quality of the Drinking Water. This idea could be implemented by various government across the world to save the water bodies from drying up caused by excess water usage. This system can also be implemented to reuse the water also to prevent water wastage. The

Purification and Conductivity test of water also plays a huge role in the welfare of public. This could reduce the overall Disease caused due to deficiency, thus creating a healthier society of people. This system can also be further enhanced by including modules which could improve the given situation further in order to prevent the excess usage of water and saving Underground water table.

VII. Acknowledgement

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