Liquescence - A Smart Water Management Model

Gunjan

Assistant Professor
Department of Computer Science and Engineering,
Maharaja Surajmal Institute of Technology, New Delhi, India

Abstract: Water is indeed the most crucial resource on Earth for life and its subsistence. Although the availability seems plentiful, it is not an unlimited resource, especially the clean portable water which is an utter necessity to human survival. With no preservation efforts, this vital supply of water may be depleted. Preservation carries monetary benefits as well, energy and equipment are also conserved as a straight outcome of water conservation efforts. A smart water management model is proposed that relies on the Internet of Things (IoT) to contribute towards water conservation, water demand and water quality monitoring requirements in this work. A model is presented which helps in tracking the water level inside the water tanks, water consumption of a place and its real-time quality. The proposed model comprises various sensors like water quality sensor, water level sensor, water flow sensor and an Arduino Uno acting as basic controller device. The data collected from the sensors is processed by a microcontroller before being sent to the cloud platform via an ESP8266 wireless module.

Index Terms—Internet of Things (IoT), sensors, smart water management.

I. INTRODUCTION:

There is a lack of awareness among common households about the importance of conservation of water resources; water overflow in households leads to huge wastage of water [1, 2]. Also, the obliviousness about inadequate quality of water consumed by people every day is really dangerous, the prevalent water quality systems cannot identify the presence of dissolved elements like chemicals. Worldwide, the most common water treatment problem is eutrophication, a consequence of high-nutrient presence primarily nitrogen and phosphorus, that aggressively degrades the helpful uses of water [3].

Overflowing water tanks in residences, schools, colleges, municipal overhead tanks, hospitals etc. can contribute to massive amounts of water wastage. Neither can we monitor the quality of water in the tank nor the amount that has overflown. As of now, all the above has to be manually checked and no single present solution resolves all of these problems.

The proposed IOT based model will help monitor the water flow, water level and quality of water. Putting forward this model it shows how one can detect water levels and prevent overflowing of water tanks and monitor the quantity of water used day to day through a single mobile application. It simplifies conservation of water, makes people aware about the quality of water they are consuming as well as creating a conscience among people to save water by helping them monitor their daily usage [4,5].

A. IoT:

IoT is basically a platform where embedded systems can make a connection with the internet, and hence they can exchange and control data with one another [6, 7]. Also this allowssystems to collaborate and gain knowledge from each other'sexperiences such as people do. The amount of systems making connections to the internet is getting bigger every day. The cost associated with system to system communication through mobile networks is more economical when compared to fixed networks. Today peopleavail connectivity anytime from anywhere for anything [8]. Theworldwide market for IoT is now closing to $520 billion by2025, constituting an increase of approx 50 percent every consecutive year since 2017. It allows organizations to automate operations and retain the cost of labor. IoT also curbs wastage and boosts service delivery as well, becomingless expensive to manufacture and provide goods and delivering transparency into user transactions [9].

B. Hybrid Mobile Application:

Hybrid Cross-Platform Mobile applications are created fora variety of mobile platforms and have similar capabilities to pure native mobile apps. Cross-platform app development, as the name implies, means designing mobile apps that are compatible with a variety of operating systems and may function seamlessly on any platform a user likes. As a result,for early-stage companies and start-ups, developing a cross-platform mobile app is a must-have. Businesses may ensurethat their software is accessible to the widest possible audience by developing an app that can be used on any platform. This enables them to design application software that is safer, faster, and of greater quality, allowing consumers to have a more seamless experience. The primaryadvantage of cross-platform hybrid apps is in their creation rather than the final app that is available for download fromthe App and Play Stores [10]. Many advantages exist between cross-platform and hybrid mobile app development and native mobile app development, including:

- In the long run, a common codebase is easier to maintain.
- The quickest development time — several apps can be developed in the same amount of time.
- UI that is consistent across both platforms
- Low cost - less time spent developing and less upkeep (single platform dev needed compare to multiple)

II. SMART WATER MANAGEMENT USING IOT:

A. WATER LEVEL MONITORING:

The aim is to develop an appropriate prototype that revolves around the need of water storages located at universities, corporate campuses, big societies as well as industry level [11, 12, and 13]. Model is presented by the help of block diagram, shown in fig.1.This system can also be used at a single household, small societies and village/city level. But the maximum efficiency of this system can be highlighted at household level. For a locality built up with many blocks of similar planned buildings. And noticeably these buildings must be accommodating individual water storing facilities. With this, every house is serviced by the supply water from Water Corporations which is pumped to the water tanks using water pumps installed in every house. There are two generalized connection arrangements to be structured: One at the tanks and the other at the socket from where the water pump gets its power. So, Arduino and a Wi-Fi Module (ESP2866), which is a microcontroller, is connected to the internet. Tanks should be in reach of a Wi-Fi for internet connection. Another requisite concern is of the electric motors in the house that pumps water, signal range for interconnectivity, so that the Module administers the connected relay to switch on/off the motor. The ultrasonic sensor positioned in the inner side of the tank (high up), must be interfaced with an Arduino Wi-Fi Module past which the data is relayed to the water pump socket. Here comes the requirement of distant transmission technique as the least separation between the transmitter (sensor located in the interior of the tank) and the recipient (at the socket) is not being judged, so these must be in the same wireless network connection.

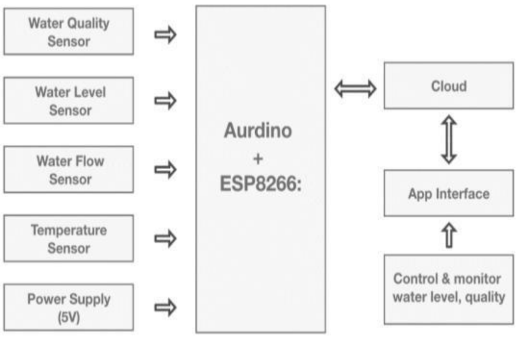

Fig. 1 Block Diagram for the model

The Ultrasonic Sensor emits a high-frequency sound pulse and then measures the time it takes for the sound's echo to return. On the front of the sensor, there are two openings. The one on the left transmits ultrasonic waves (like a little speaker), while the one on the right receives them (like a tiny microphone) as shown in the circuit diagram in fig 2.

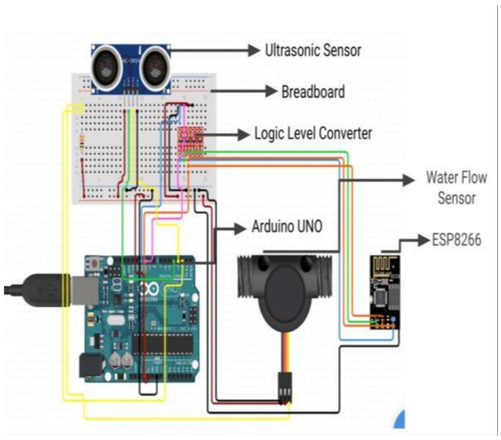

Fig. 2 Circuit diagram for proposed IoT system

In air, sound travels at a speed of around 341 metres (1100 feet) per second. This information, coupled with the time delay between sending and receiving the sound pulse, is used by the ultrasonic sensor to calculate the distance to an item. It use the following mathematical formula:

$$Distance = \frac{time \times speed\ of\ sound}{2} \quad (1)$$

Following the catch of signals from respective water tanks, the task of ESP8266 comes into action. The mechanism decides whether the electric water pump needs to be switched off. So, for this purpose, a pre-set waterline has been contrived i.e., surpassing a threshold level, the electric motor pump switch of that particular tank/building gets to be turned off. Such pre-decided threshold levels differ from tanks to tanks depending on the quantity of water those tanks can bear. Now, in the wake of the pronouncement of switching off or on of the electric motors, this action must be sent as a direction to the local server. So, that it transmits the action and then in turn, the microcontroller responds to the data with up-to which extent, the tank is being loaded with water. The very system is automated, so one just has to set up the devices at its designated place and configure the mobile application to store the records. Then, no one must do the tiresome task of switching the systems and wait for a long time or just fail to recall. This does all tasks automatically, reads the water level and makes the decision to switch off the motor pump. Thus, making the model highly flexible and the scalability of its use varies from place to place, from a small household to a big corporate campus and universities.

B. WATER QUALITY MONITORING:

The initial step was to decide which water quality criteria would be controlled for the study of consumable water quality for daily activities such as bathing, cleaning, washing, and drinking, in order to specifically determine if the water quality met the World Health Organization's collection of regulations (WHO).It was discovered that tracking water parameters such as sulphate levels, free nitrate concentrations, and dissolved oxygen is not cost efficient, and that reliable readings over long periods of time require regular upkeep and calibration [14]. For a long-term, real- time water quality monitoring system, this would be inconvenient. The only water parameters on which this project is based are water flow and pH. These physicochemical parameters may be used to identify some water contaminants that may be present in water before it is deposited in the tanker or that may have accumulated over time in the storage tank due to impurities. Since it tests the acidity and basicity of water, the pH of the water is one of the most significant variables to consider when monitoring its consistency [15]. Acidic water (pH 5 and below) is corrosive and can cause discomfort. The eyes, skin, and mucous membranes can all be irritated by water with a pH of 10 or higher.

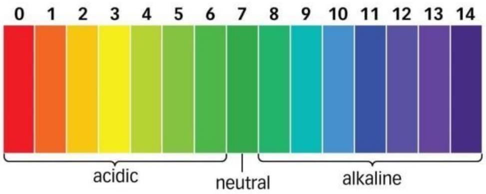

Fig 3. pH scale of water

pH range for water

- pH 0-6 : acidic
- pH 7 - neutral
- pH 8- 14 : alkaline

Water fit for drinking lies in the ranger - 6.5 to 8.5, depicted in fig 3. Since reference electrodes are required, both the pH and water flow parameters are difficult to measure precisely. When used for a long period of time, these reference electrodes carry a solution with a defined pH or Oxidation- reduction potential value and involve recalibration. The World Health Organization guidelines have already established the appropriate and accepted ranges for human consumption of each water parameter. The pH sensor continuously measures the pH of the water inside the tank and notifies in real time when the pH moves out of safe range.

C. WATER CONSUMPTION:

Water flow sensors are fixed at the water source or pipes to determine the rate of water flow and calculate the volume of water that has passed through. Flow rate of water is measured as cubic meters or liters per hour.

A plastic valve allows water to pass through the water flow sensor. The water flow is sensed and measured by a water rotor and a Hall Effect sensor. The rotor rotates as water passes through the valve. The speed of the motor will change as a result of this. The Hall Effect sensor calculates this transition as a pulsated signal as the output result. As a result, the rate of water flow can be determined. The Hall Effect is the perfect working theory behind the application of this sensor. According to this theory, the rotation of the rotor induces a voltage difference in the conductor in this sensor. The electric current is affected by the induced voltage difference. The rotor rotates and produces voltage as the moving fan rotates due to the flow of water. The Hall Effect sensor measures the induced voltage and displays it on the LCD screen. A liquid's flow rate is a measurement of how much liquid moves in a given length of time. The flow rate is determinedby the equation2. The flow rate can be measured in meters cubed per second (m3/s), or in liters per second (L/s).

$$Fluid\ flow\ rate = area\ of\ pipe\ or\ channel\ \times velocity\ of\ fluid \qquad (2)$$

Hot water, cold water, clean water, warm water, and polluted water can all be used with the water flow sensor. Different measurements are available for these sensors with different flow rate ranges. The sensor is placed at the orifice of the pipe. Three wires make up the sensor. The supply voltage is attached to the red cable. A black wire connects to ground, and a yellow wire collects the Hall Effect sensor's data. 5V to 18V DC is needed for supply voltage. The flow of water detected by the flow sensor is then multiplied by the time for which the motor pump remained on gives us the estimated value of the water that flowed into the water storage tank. The value obtained is then displayed on the mobile application.

III. IMPLEMENTATION:

The Smart Water Management Model App for controlling water pumps, monitoring water quality and daily water usage has been developed as a Hybrid App. It is prepared as a multiple screen application that allows the user to control their electric motor (turn Off/On) and check for pH levels of the water stored in the water tank to ensure if it needs cleaning and also monitor his daily water usage room wise(usage in Kitchen, Bathrooms etc.), screenshots are shown in fig 4. Also, the app shows this usage in a graphical manner making users aware of their water usage and helping them save water as depicted in fig 5.

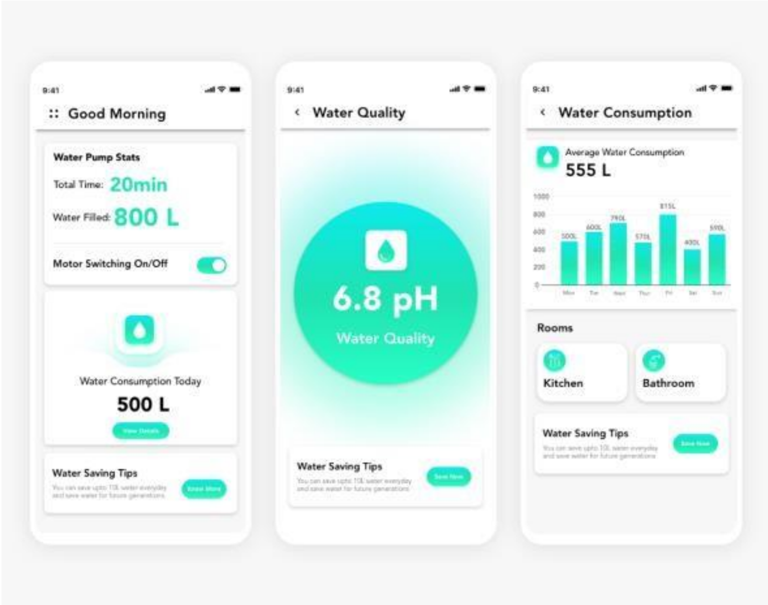

Fig. 4 Liquisense App Screenshots

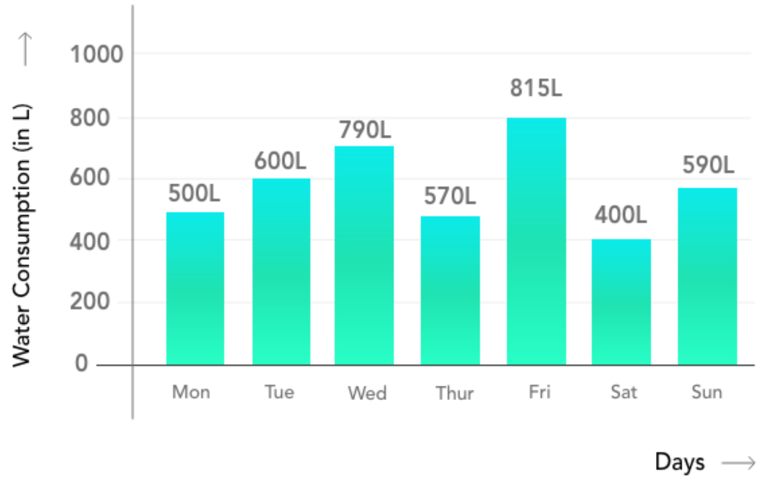

Fig. 5 Graph Depicting Daily Water Consumption of House

IV. CONCLUSION:

The objective of this research work was to create and demonstrate a flexible, cost effective, easy to use and predominantly, a portable system which can solve our water wastage problem. The suggested system is created with the use of different sensors, Arduino UNO R3 as controller and Cloud (firebase) for storing the information obtained from it and instructing the system for measuring water quality, water level and usage using flow. The data obtained can be viewed using a smartphone application. The main benefit of the system is to provide information on all the important water parameters every household needs to know for judicial consumption and developing a conscience towards conservation of this precious resource.

V. FUTURE SCOPE:

The proposed model can be introduced as a smart city component. Automated water level monitoring systems, especially in the industrial and agricultural sectors, have a bright future. Water quality control systems can be made more capable in order to achieve more efficient and accurateperformance. Multiple sensors for measuring dissolved oxygen, oils and hydrocarbons, chemical oxygen demand, nitrates, phosphates, calcium, magnesium, sodium, biochemical oxygen demand, sulphate, and carbonates maybe added to expand the amount of parameters that can be sensed. The system can be expanded to monitor industrial use, water pollution, agricultural production and more. Withthe advancement of technology featuring AI and machine learning these can be used to build and incorporate smart home applications and control devices including monitoring air quality, thermostats, and other home appliances.

REFERENCES:

[1] N. A. Cloete, R. Malekian and L. Nair, "Design of Smart Sensors for Real-Time Water Quality Monitoring," in IEEE Access, vol. 4, pp. 3975-3990, 2016,

[2] Pradeep, Preeja & Narendran, Sreekanth & Vinodini Ramesh, Maneesha. (2017). An Internet of Things (IoT) based Sustainable Water Management. 10.1109/GHTC.2017.823320

[3] F Ntambi, CP Kruger, BJ Silva and GP Hancke, "Designof a water management system", IEEE pp.97814799,2015.

[4] Sayali Wadekar, Vinayak Vakare, Ramaratan Prajapati, "Smart water management using IoT", IEEE pp: 978- 15090,2016.

[5] G. Asirvatham, P. Jagathambal, E. J. James, "A Study onDeficiencies Causing Water and Energy Losses in the Roof Top Water Storage Tank Installations in India",ISSN: 2321-9653,2018

[6] Joy Shah, An Internet of Things Based Model for SmartWater Distribution with Level Monitoring, International Journal Of Innovative Research In Science, Engineering And Technology, 2017.

[7] N Vijaykumar, R Ramya, "The real time monitoring of water quality in an IoT environment", IEEE pp: 978-1-47996818,2015.

[8] Malche T., Maheshwary P. (2017) Internet of Things (IoT) Based Water Level Monitoring System for Smart Village. In: Modi N., Verma P., Trivedi B. (eds) Proceedingsof International Conference on Communication and Networks. Advances in Intelligent Systems and Computing,vol 508. Springer, Singapore.

[9] Botta, Alessio, Walter De Donato, Valerio Persico, and Antonio Pescapé, "On the integration of cloud computing and internet of things", In Future Internet of Things and Cloud (FiCloud), 2014 International Conference on, pp. 23-30. IEEE, 2014

[10] Hashem, Ibrahim Abaker Targio, Ibrar Yaqoob, Nor Badrul Anuar, Salimah Mokhtar, Abdullah Gani, and SameeUllah Khan, "The rise of "big data" on cloud computing: Review and open research issues", Information Systems 47,pp.98-115, 2015.

[11] Kang, Byeongkwan, Sunghoi Park, Tacklim Lee, and Sehyun Park, "IoT-based monitoring system using tri-level

[12] Zhu, Qian, Ruicong Wang, Qi Chen, Yan Liu, and Weijun Qin, "Iot gateway: Bridging wireless sensor networks into internet of things", In Embedded and Ubiquitous Computing (EUC), 2010 IEEE/IFIP 8th International Conference on, pp. 347-352. IEEE, 2010.

[13] Hadipour, Morteza, Javad Farrokhi Derakhshandeh, and Mohsen Aghazadeh Shiran. "An experimental setup ofa multi-intelligent control system (MICS) of water management using the Internet of Things (IoT)." ISA transactions (2019)