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Research Article

Smart Water Conservation And Rainwater Harvesting System: A Step Towards Sustainable Water Management

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ABSTRACT

Water is the most important limited source of every living creature on the earth. Water scarcity is increasing day by day and it is essential to realize the true importance of drinking water. In this paper, water tank monitoring system is proposed that can help to reduce the wastage of water due to overflowing by automatically turning off the pump when the water level in the tank reaches upper threshold limit. It will also reduce human intervention as pump will be switched on automatically when water level falls below lower threshold limit. Proposed system for automatic rainwater harvesting can help to store rainwater by automatically opening lid of the tank when rain fall is detected and lid will be closed automatically when rainfall stops, maintaining quality of the water. With IOT, this entire activity can be monitored through the mobile application. This paper is a step towards sustainable water management.

Keywords: Rainwater harvesting, IOT, Sensor

I. INTRODUCTION

1.1 Background

Water is an integral part of our daily life, and we cannot survive without water. We use water for many purposes in our daily chores such as drinking, cooking, cleaning and in various fields like agriculture, horticulture, industries, etc. As a result of lack of water conservation facilities and excessive pollution of water bodies, we all are heading toward the scarcity of water,. This problem is quietly related to poor water allocation, inefficient use of water, and lack of adequate and proper management of water.

The demand of water is increasing day by day due to exponential rise in population, urbanization, growth in industrialization, advances in agriculture, etc. With the increase in pollution and growing industrialization, emission of greenhouse gases is also increasing day by day resulting in global warming and global climate change. Due to this, unpredictable shift in rainy season occurs. So, it is very essential to save the water and use water efficiently.
Therefore, water must be used in efficient ways and water monitoring are potential constraint for home or office water management system. Every living being in the world needs water to survive. Clean water is used to drink, grow crops for food, operate factories, and for swimming, fishing, and sailing. Proper monitoring of the quality of surface water will help protect our waterways from pollution. By using water monitoring system, we can save water from wastage, power consumption and easily prevent the water for our generation. So water conservation and rain-water harvesting is a need for society and our future generations.

Rainwater harvesting is the process or technology used to conserve Rainwater by collecting, storing, conveying, and purifying of Rainwater that runs off from rooftops, parks, roads, open grounds, etc. for later use. Collected rainwater can be used for washing, cleaning, bathing, cooking, irrigation, and for other household requirements. If every house, residential and commercial building, and organization can incorporate automated water management system and rainwater harvesting systems, then we will be able to save lot of water [1].

1.2 Rationale and Need

Water is essential for human civilization. Residential buildings, organizations, offices, industries, and houses store water from various sources in tanks using pump and switch to fulfil daily water requirement. This water is then

circulated to the bathroom, kitchen, gardening, etc with piping and taps. In cities and rural area, mostly all buildings and houses have water tanks in which water is pumped from wells, bore-wells, or pipelines to store water for daily needs. These roof-top water tanks are observed to be overflowing many times in many buildings of rural and urban cities of with consequent loss of water and energy. Efficient management of the water used at homes is very much necessary as, about 50% of water supplied to the cities gets wasted through its improper usage. In many installations, no device is fitted to automatically switch off the pump when level in the tank reaches full, resulting wastage of water and energy as the water pump is left running, leading to overflow. This leads to wastage of most valuable resource water, but along with that it also causes problems for the buildings. Sometimes it may damage water pump also. This problem is not taken seriously by consumers. So there is a need to design and implement sensor based fully automated system.

These rooftop tanks can be used for rainwater harvesting as well. Rainwater harvesting is a method of collection and storage of rainwater in surface or sub surface aquifer. Hence it is catching of rainwater when it falls and storing to use for daily chores. Manually we can be attentive and avoid water wastage due to overflow. But with the help of technology, we can make the system smart and minimize human intervention by saving water wastage and energy.

1.3 Objectives

The proposed method focuses on all the three the aspects- prevention of water wastage through overflow of tanks, storing rainwater in the tanks and designing fully IOT based automated system with maximum efficiency and minimum human intervention.

1. preventing water wastage by sensing a water level of tanks and automatically switching ON/OFF water pump based on water level
2. providing automated lid on rooftop tanks for rainwater harvesting. Upon detection of rainfall, the lids of the tank will be opened automatically to store the rainwater.
3. Updating the status to end user using mobile phone application using IOT for monitoring purpose.

As water is limited resource, we need to save each and every drop of water. This proposed system will definitely beneficial to the society in many aspects.

1.4 Study of Existing Models

Sanam Pudasaini et al. (2014)[12] designed Arduino based water level monitoring system with SMS alert using GSM modem to the user. Conductive sensor was used to examine level of the water. Based on water level, automatic pump switching is carried out. Continuous updates were given to the user via SMS with the help of GSM modem. The main drawback of this system was the accuracy and implementation with use of conductive sensor. Also the chances of corrosion and failures are more when sensor comes in contact with water.

Beza Negash Getu [2], developed a system which senses the water level in tank using level detector and then calibrates the status of the pump according to water level. 7-segment display is also used to display the current status. The proposed system consists of water level sensor, 7-segment display, water pump which is controlled by digital logic processor circuit.

Vennam M. [6] developed IOT based smart water quality monitoring system. The system was developed using ARM controller using wireless protocols and various sensors. WQM parameters such as water level, CO_2 level, pH level, water temperature was examined using various sensors to calculate quality of the water. The real time data is transferred to end users via web servers for monitoring purpose using wifi module. The WQM framework is set in continuous mode for real time monitoring and information is refreshed in every 5 seconds.

Nishmitha, P Shetty and et al [8] proposed water tank monitoring system in two modes- Automatic and Manual. In automatic mode, two sensors are used to detect water levels, one to detect low and one for high level. The data of sensors will be analysed by central controller Raspberry Pi and then automatic switching of water pump is done. In manual mode, data is updated on an android application. Based on the status, user can manually switch ON/OFF the water pump.

Manali B. [3] proposed IOT based smart rainwater harvesting system for Pune city. This paper presented different IOT based frameworks and strategies that can be used for improving existing systems. Based on Using the principle of precipitation, catchments of water reaping framework is recorded. Canals or conveyance framework was designed to move water from rooftop. With the help of IOT, data is stored on cloud and updates given to the end users using mobile application.

S Gowri and et al [4] proposed smart water tank overflow control module with mobile application. 8051 microcontroller was used as a main controller component and Bluetooth module is used to establish communication between controller and mobile application. Level sensor is used to identify three levels viz Low,

medium and Full. Moisture sensor used to determine the mentioned levels and then motor will be switched ON/OFF based on sensor data.

J. Vinod and Dr. Gavaskar [5] proposed IOT based smart rainwater harvesting techniques for smart city. The design is based on Arduino, rain-water sensors, motor and relays. When rainwater is detected, the automated door of water pit is opened and compound gate around the pit is raised to avoid any accident. Along with GSM module and wifi module, the data is updated to the end users. As rainwater is stored in pit, water is absorbed giving more efficient way of rainwater harvesting.

G. Verma [10] developed low-cost smart system for rainwater harvesting for Indian houses using IOT technology. The proposed system had two sub-systems viz rooftop water collection tank and ground system. Ground water system is controlled by Arduino Nano and Node MCU controller boards along with sensors. Water quality is examined in ground system using LDR and turbidity sensor. The dirty water is directed towards ground for gardening and clean water is directed towards ground storage tank.

R. Yawalkar and et al [11] proposed a design of rainwater harvesting system using rooftop method. The area under study was Government Polytechnic college in Sakoli district Bhandara. Authors carried out survey of rainfall data, total area calculation, volume of storage tanks, design of pipes, etc to support the study. Based on collected data, authors proposed new design of tanks and pipes for optimal and efficient solution for rainwater harvesting.

II. PROPOSED METHODOLOGY

The proposed design is divided into three modules-
1. Water monitoring and overflow prevention system
2. Rainwater collection system
3. Monitoring through mobile Application

The central controlling device of this system is Arduino uno. Different sensors will be interfaced with Arduino. Data collected from different sensors will be analysed by controller and then appropriate action will be taken by Arduino by driving actuators. The information processed will be transmitted to mobile application through wi-fi module. The user can monitor the entire status via mobile application and intervene as per the need.

Module 1- Water monitoring and overflow prevention system

Water level in the tank will be monitored using ultrasonic sensor HC-SR04. The sensor will be placed on the top of the tank. This sensor uses SONAR technique to determine distance of an object (water in this case). Its range is up to 2 cm to 400cm.

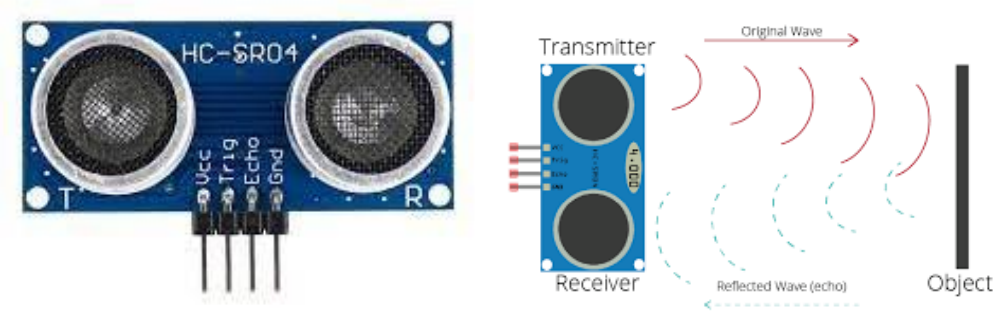
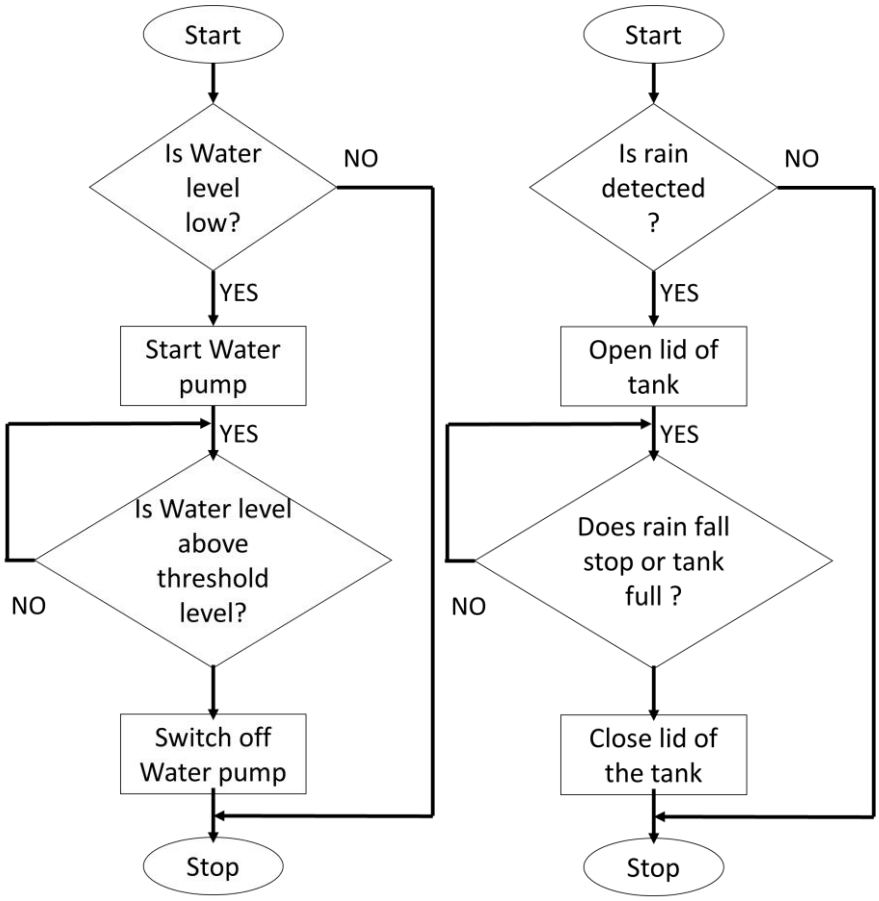


Figure 1- *Ultrasonic Sensor*

The distance of water level from ultrasonic sensor will be identified and based on that decision will be taken. If water level is not detected by the sensor, we can conclude that the water level is low and then automatically the pump switch will be ON.

When the distance between sensor and water level crosses the decided threshold value, then it will be concluded that the tank is about to overflow. So, motor will be switched off automatically.
Consider following flow diagram for the same.



A. Overflow Prevention Module **B. Rainwater harvesting Module**

Module 2- Rainwater collection system

Raindrop sensor is used to detect the rain fall. It has two modules; first module is rain board that detects rain drops and second module is control module that converts analog value into digital value.

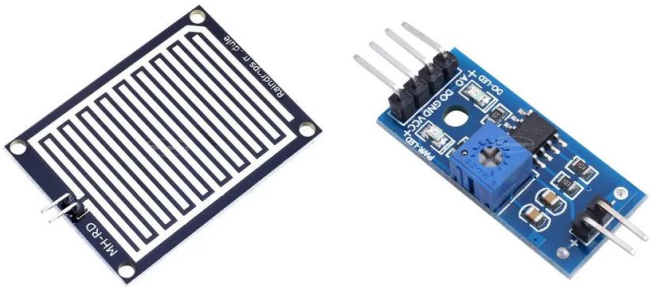


Figure 2- *Rain drop detector module*

The board has nickel coated lines that works on principle of resistance. Rain-drops are collected by the board and they create paths of parallel resistance that are measured by the operational amplifier. When there is no rain, the resistance on the board is high giving high voltage at the output. When rai drops are collected by board, water connects nickel lines in parallel so reduces resistance of the board which in turn reduces voltage at the output. So drop in the voltage indicates presence of rain.

When rains are detected by the sensor, the actuator part will be activated. The lid of the tank will be motor operated, and it will be opened automatically upon detection of rainfall. When rainfall stops, the lid will be shut automatically by driving motor. Here ultrasonic sensor output can also be used, as when the full tank level is detected, then water can be driven out to the large underground tank using valve.

Module 3- Monitoring through mobile Application

ESP8266 wifi module is wireless transceiver which is used to connect the system with internet. TCP/UDP communication protocol is used to connect with server/client.

Figure 3- *WiFi Module*

Mobile application will be developed for monitoring purpose. The data from sensors, the current status of the tank and all updates will be given to the users via App. The user can monitor the entire status via mobile application and intervene as per the need.

III. EXPECTED OUTCOME

- Proposed water tank monitoring system will monitor the water level of the tank continuously. The data collected will be stored on cloud and the current status of the tank will be updated on mobile application so that user will be able to track it.
- In the proposed system, if water level drops below the decided threshold level, the water pump will be switched on automatically and tank will start to fill up. The status of the same will be updated on mobile application.
- This system can help to reduce the wastage of water due to overflowing by automatically turning off the pump when the water level in the tank reaches upper threshold limit.
- Proposed system of automatic rainwater harvesting will detect the rainfall and can help to store rainwater by automatically opening lid of the tank when rain fall is detected. Same status will be logged on to the mobile application.
- Tank lid will be closed automatically when rainfall stops, maintaining quality of the water. With IOT, this entire activity can be monitored through the mobile application.

IV. CONCLUSION

Water monitoring, water conservation and rainwater harvesting is a need of today and future as water on the earth is limited. The proposed water monitoring system will help to reduce the water wastage due to overflow and it will help to save tons of water. As rainwater harvesting is a need of time, the rainwater harvesting system will help to store the rainwater in the automated tanks. Saving water is every individual's responsibility. Considering this, the proposed low-cost robust system can be implemented in each house, in each building, in every organization, we will be able to contribute towards our goal of saving each and every drop of water and conservation of water.
The proposed system can be implemented for bigger capacity tanks using high range ultrasonic sensors. Further, if the tank is filled completely by rainwater, then the automatic valve can be used which will transfer the water to big underground storage tank for future use. The water quality can be examined using CO2, pH and temperature sensor. Based on this data, we can decide whether water can be used for drinking or any other applications. Water purifier module can also be incorporated based on the quality of water detected by the sensors.

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