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WaterO: A Smart Water Device

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Abstract: Availability of water at limited times is a common issue specifically in the cities of Pakistan. Usually, availability of water is checked manually, and if available, motor is turned on and similarly when a water tank is full, it is turned off. This paper made an attempt to resolve these manual human efforts which is a common problem in Pakistan and discusses the development of a smart water device named WaterO, that controls and automate the flow of water by automating the complete process with minimal human interference. This device is designed specifically considering the situation of water unavailability in Pakistan and saves energy, water and human efforts.

Keywords: WaterO; Water device; Water controller system; Design

I. INTRODUCTION

Water is an important resource and its unavailability at households creates numerous issues. Pakistan is a country that deals with the shortage of water which is reflected in unavailability of water several hours a day, with no accurate schedule of when water would be available again. The International Monetary Fund (IMF) recently reported Pakistan's rank as third in countries facing a shortage of water. [1]. According to the Pakistan council of research in water resources (PCRWR) there will be a complete scarcity of water by 2025 [2].

This unavailability is affecting the normal household chores, especially in the cities of Pakistan. People of Pakistan are concerned and uncertain about the schedule of availability of water at their homes which results in being in charge of collecting water themselves. The responsible person usually sacrifices sleep and social activities just for the collection of water which is an ineffective approach.

This paper discusses the development of an automatic water controller system entitled as "WaterO". This system is developed specifically after considering the issue of water unavailability in Pakistan. This system is automated and requires few initial configurations made through an android application. Once configured, this system works without human intervention, but informs status to the user through android application.

The remaining paper is organized as follows. Section II discusses the literature review of similar systems. Section III elaborates the hardware and application design of the system. Section IV explains the working of the system. In Section V, discussion is presented. Finally, Section VI concludes the paper and discusses the potential future work.

II. LITERATURE REVIEW

The literature review is presented with the brief discussion of few recent works on water automation are made.

Paul et al. [3] in year 2015 presented a model in which the control of water is managed through smart phones. The water pump is controlled with the aid of radio transmitter and Wi-Fi (wireless fidelity) routers. This presented model aids in remote management of the flow of water.

Patil and Nikam [4] in year 2015 proposed a solution to control of water remotely on agricultural devices using Bluetooth technology and microcontroller. The system was designed as an automated solution that manages the irrigation process through a water pump remotely. The system also provides reminder facility to users.

Raykar [5] et al. in year 2016 presented a model which collects the expenses and usage of water from customer's end and detects the leakages in the distribution of water. Further, this system saves potential wastage of water through leaks, reduces the periodic tours of water providers for meter checks and related activities.

Karande et el. [6] in year 2017 presented a system of water control on agricultural land. This system checks the water level in agriculture land and monitors the water pump. The status and control of water and motor pump is informed to users through an android application. This system lessens human efforts, saves time and adjusts soil moisture.

Nikam et al. [7] in year 2017 proposed a water usage monitoring system. The system is designed using ultrasonic sensor and data is transferred to server using a Wi-Fi module. The system notifies the administrator using a short messaging service (SMS). Through android application users may control and monitor water usage. Any left-open tap can also

be managed by controlling a solenoid valve through android application.

Mahaisen et al [8] in year 2018 designed a self-powered IoT device to minimize the water waste. The proposed system is proposed as a cloud-based solution that informs the users about the status of water from remote locations.

Shirode et al. [9] in year 2019 presented the design of a water quality monitoring system that analyses the water pollution with the detection of present metals. The system is designed using the Arduino controller integrated with the pH sensor, turbidity sensor, temperature sensor and conductivity sensor.

Kanagaraj et al. [10] in year 2020 evaluated the current designs of water quality monitoring systems and proposes the design of web based and a cost-effective water monitoring system that monitors the turbidity and temperature of water.

The reviewed literature presented the latest tools and techniques to design the solutions that results in management of control of water, however, none of the discussed studies focuses on the problem of water unavailability or availability for the limited time only. Therefore, the solution of this problem is a necessity for the people of Pakistan.

III. DESIGN SPECIFICATIONS OF WATER CONTROLLER SYSTEM

In the literature survey of the mentioned water controller systems it is observed that there is a lack of a system that is suitable for water control in the households of Pakistan. Further, the existing systems are developed in an improvised manner, and are not built on an appropriate framework.

A. Hardware specification

The hardware used in the development of proposed system are mentioned as under:

- Arduino Nano microcontroller board name ATmega328 is adopted due to its small size, flexibility and its support in automated and controlled systems.
- Ultrasonic sensor to measure distance between the emission and reception.
- The HC-05 Bluetooth module for connectivity between Arduino and smartphone.
- DS3231 RTC module as a real time clock (RTC).
- An organic light emitting diode (OLED) display to show the status information.
- A switch to control motor functions.
- A relay module for remote device switching.
- Few water sensor and level sensor
- A 12v adapter for power
- Few wires and resistors.
- An Android based smartphone that supports Bluetooth connectivity.

B. Hardware design and implementation

The design of hardware manages water availability in tank by controlling the motor. This keeps the water tank from overflow and being empty. Similarly, the hardware design also detects the availability of water in pipeline. If water is available for certain time of a day, this system automatically detects and manages the motor on that particular time by turning the motor on and allowing the tank to be filled. The hardware design of the proposed system is depicted in Figure 1.

The hardware design and its implementation are focused to achieve the basic two purposes mentioned in the subsequent subsections.

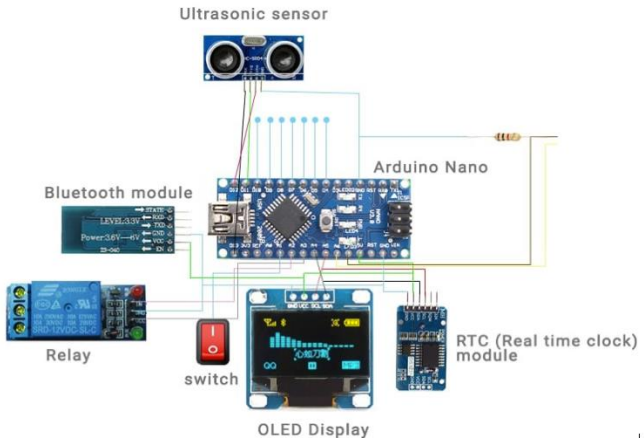
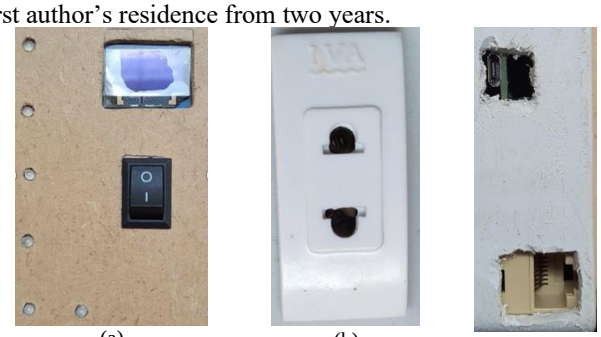


Figure 1. The hardware design

Detection of water availability: The control of motor is based on the availability of water which is detected by the water sensor. When the water is available, the motor turns on, and when it is not available, the motor automatically turns off.

Controlling of water levels: The water levels are controlled with the help of the water level sensor. This water level control prevents water from overflow when the tank is full. If the system detects the full tank, the motor automatically turns off.

The Figure 2 represents the implementation of the system. This system is implemented and working successfully at the first author's residence from two years.



(a) (b) (c)

Figure 2. Hardware implementation

In Figure 2(a), the bottom left small lights represents the status of a motor and the other four on the left-hand side

reflects the level of the tank. The switch controls the power of the motor, whereas the OLED display shows the information regarding tank level, time information and Bluetooth connection.

The Figure 2(b) is the slot for the AC supply of the motor. The Figure 2(c) shows the Arduino supply and local area network (LAN) connection. The LAN connection is used to communicate the information regarding the water sensor and water level.

C. Design of Android application

For the design of Android application, Android Studio and Arduino integrated development environment (IDE) is used. This application is designed considering the ease of use and usability. Snapshots of the application are mentioned in Figure 3.

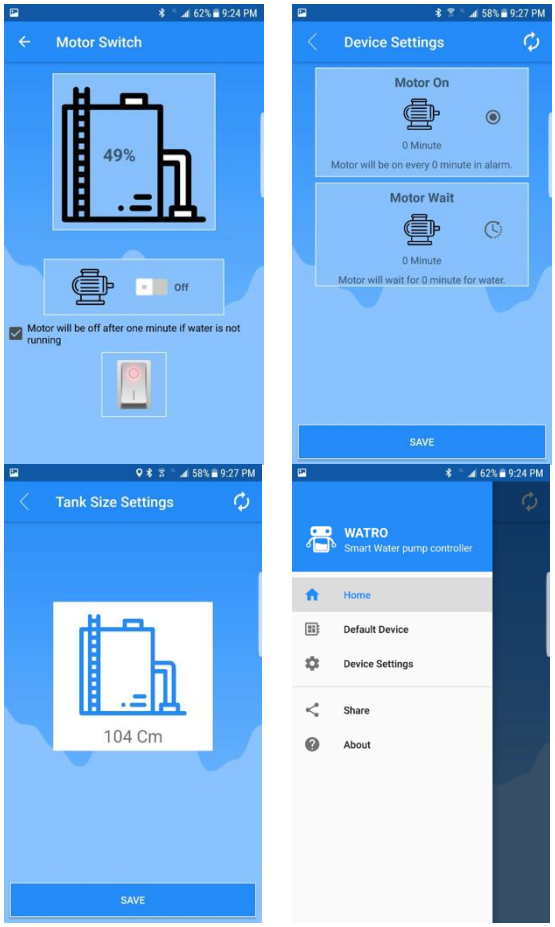


Figure 3. The design of Android application

IV. WORKING OF THE SYSTEM

The initial step is the configuration of hardware along with the installation of water sensor (in a place where the availability of water is detected) and level sensor (in the tank).

Once hardware is configured, the next step is the configuration of the Android application. Through the application, one can pair the smartphone via Bluetooth using Bluetooth module. The application allows a user to set the tank size, the status of motor, the approximate time when water is available and the timing information of how much motor should wait if water goes off. User at any instance may check the status of tank and motor.

The operation and control of the motor can be automated by setting few pre-set conditions. Through these settings, the application automatically turns off the motor whenever tank is full. Similarly, the application may automatically check the availability of water and whenever the water is available, the motor turns on automatically.

The status of motor and tank is also reflected on the hardware system as well using LED as shown in Figure 2.

The complete workflow of the system is depicted in Figure 4.

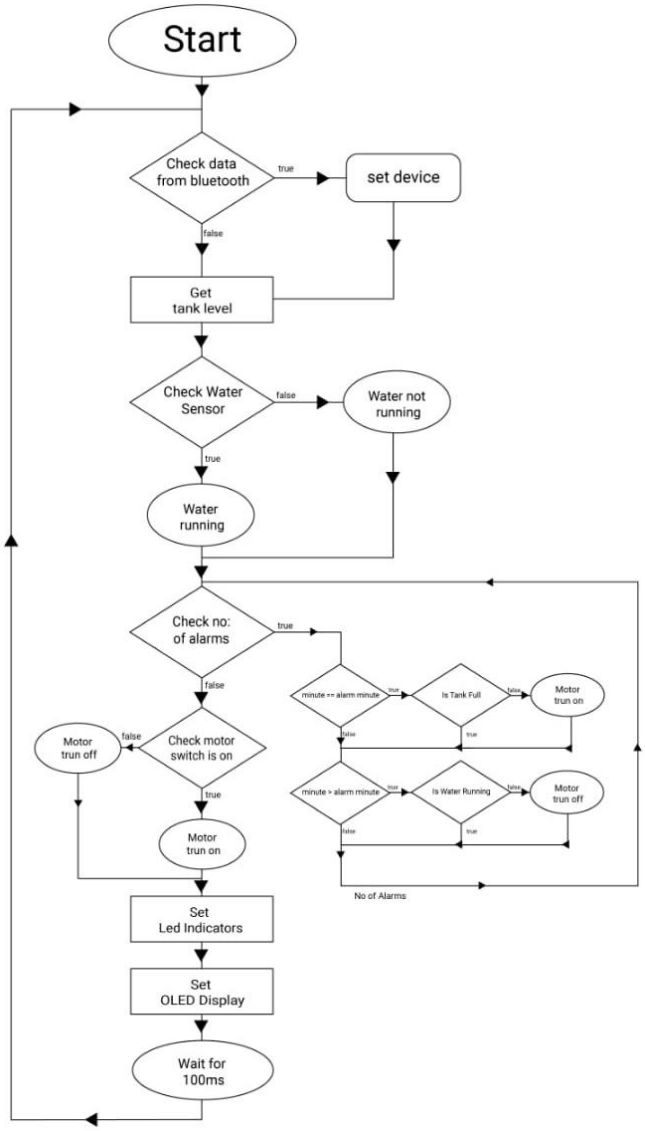


Figure 4. Workflow diagram

V. DISCUSSIONS

This paper presented a solution named "WaterO" to a commonly occurring problem in Pakistan i.e. unavailability and limited availability of water at homes.

The design of WaterO is focused on automated control of the motor specifically due to the unavailability and time-specific availability of water in the households of Pakistan. The device detects the availability of water and operates the motor accordingly. Similarly, based on the level of water in the tank, the motor is operated. Moreover, the Android application monitors and controls the motor remotely as well.

This device is a basic need of the people of Pakistan and should be commercialized to resolve the water collection problem in water tanks. This device is designed using simple Arduino Nano microcontroller and other related devices which are economic in price as well. The design of the water controller system is explained clearly with the hardware specifications, its design and implementation. Further, the design of Android application is also discussed, which provides the status of tank, water availability and controls the other related functions accordingly.

VI. CONCLUSION AND FUTURE WORK

Water is an important natural resource which should be used efficiently. Normally in Pakistan, users are supposed to check the water level in their water tanks manually, or the water level valve is used to stop water from wastage. The mentioned methods of checking water levels need manual efforts.

To avoid human efforts and manual management of availability of water and its level, a design of a water device is proposed in this paper. The WaterO is a water automation and control system that is managed and controlled using Android Application. The automation feature lets the motor turns on and off on specific conditions. The control feature of this application allows user to manage the control of water levels and motor operations. This application also lets user to set alarms to remind user to perform the operations manually. Through the development of this system the efficiency and economy is achieved, and the water wastage and human efforts are reduced. If this system is commercialized appropriately, it is a real need for the people of Pakistan as every second household in Pakistan is dealing with the water unavailability issues.

The possible future work of this system may involve the implementation of this system using WiFi module and implement this system with state-of-the-art internet of things (IOT) technology.

The working of this system may be predicted and trained for the automated maintenance and control of motor using a collected dataset over a period of time with the application of machine learning algorithms.

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