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RESEARCH ARTICLE OPEN ACCESS

SMART HYDRO SYSTEM

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Abstract:

Water management is a crucial aspect of daily life, and improper monitoring often leads to wastage and resource depletion. With the increasing demand for efficient water usage, automation plays a vital role in optimizing water consumption. This project presents an automatic water level indicator and control system using the Raspberry Pi Pico, an ultrasonic sensor, and a water motor. The system continuously monitors the water level in a tank and automatically controls the motor to maintain an optimal level.

Keywords — **Water Management**, **Automation**, **Raspberry Pi Pico**, **Ultrasonic Sensor**,**Water Level Control**

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I. INTRODUCTION

Water is a vital resource for daily activities, and efficient management is thus essential to prevent its wastage and depletion. With technological advancements, however, automation harnesses a far more accurate and simple means of preventing Wastage

This project has an Automatic Water Level Indicator and Control System based upon the Raspberry Pi Pico, with ultrasonic sensors and a water motor. The system will keep monitoring the water level in the tank 24/7 and automatically control the operation of a motor to maintain it at an optimal level. The ultrasonic sensor monitors the water levels, while the control of the pumping mechanism through the Raspberry Pi Pico takes place according to the predefined threshold levels. Moreover, the system is equipped with an LCD display that showcases the water level in real-time, whereas an HC-05 Bluetooth module will facilitate the wireless monitoring and control of the system.

With further modifications regarding IoT connectivity and remote access, the proposed system can find an extensive category of applications in commercial, agricultural, and domestic areas. It produces an efficient, easy, and scalable solution to smart water management for sustainability towards future generations.

II. OBJECTIVE

The goal of this project is to create an automatic water level monitoring and control system using a

Raspberry Pi Pico, an ultrasonic sensor, and a water motor. This setup is designed to optimize water usage and minimize Waste

The system will keep a close eye on the water level in a storage tank with the help of an ultrasonic sensor. If the water level drops down at a certain point, the motor kicks in automatically to pump water back into the tank. Once the water hits the desired upper limit, the system shuts off the motor to avoid overflow and save energy. This hands-free approach means no more manual checks are needed, making water management much more efficient and dependable.

On top of that, the system offers real-time water level updates via an LCD display and can be upgraded with Bluetooth or IoT features for remote monitoring. with Ensuring a steady water supply, cutting down on electricity use, and preventing the motor from running dry, this project plays a vital role in promoting sustainable water management. It is Affordable

Looking ahead, future enhancements could include cloud connectivity, advanced sensors, and AI-driven automation to boost its efficiency and usability even further.

III. OVERVIEW OF THE SYSTEM

Smart Hydro System, which involves automated water level monitoring, and control is an intelligent solution specifically designed for water use optimization through waste prevention technology. It is based on a Raspberry Pi Pico, ultrasonic sensor, water pump motor, and LCD display which the whole system works in synchrony. The system can monotonous the water level of the tank and automatically run the pump to achieve the water level.

Ultrasonic sensor calculates the distance to the water surface through the utilization of sound waves coming back. By the way, Raspberry Pi Pico is the one that processes the data to decide the water pump to work or not. Should the water volume dip to a certain fixed point, the pump is turned on for filling the tank. The water level is maintained to avoid flooding and thus, the overuse of electricity or the risk of an electric outage is the bottleneck in this hydrogen production process.

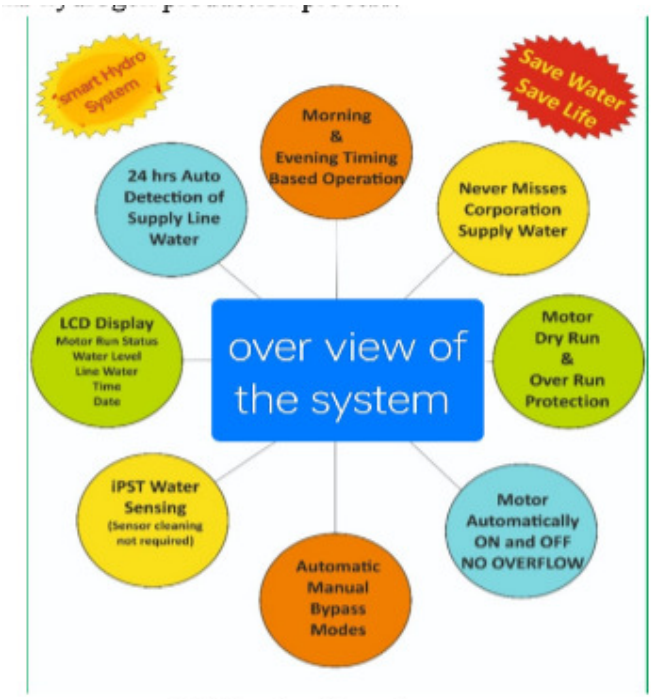

Fig 1:Overviewof the system

The display is actually a tool for the user to view, it is a piece of hardware that is also responsible for the water level updates. The HC-05 Bluetooth module makes possible the control and monitoring of the system remotely using a smartphone or computer. Moreover, a temperature NTC thermistor looks for the temperature of the system to make sure system is working safety.

IV KEY FEATURES

A Water Level Indicator and Control System that can Work Automatically is Raspberry Pi Pico, an ultrasonic sensor, and a water motor are all part of the setup. The motor is controlled by the system such that it stops the pump when it reaches the limit and runs it only when pure water is available. The basic technique involved is:

1) Real-time Water Monitoring: A water-measuring ultrasonic sensor is to determine water depth precisely.
2) Automated Motor Control: A water pump is turned on/off by using predefined water level thresholds.

3) LCD Display & Alerts: The-coded water level status of water stored in real-time together with the buzzer alerts.
4) Energy Efficiency: The water pump is turned on only when the need arises hence cutting down on power consumption. The electricity usage reduction occurs through the pump running only for the necessary period of time.
5) Remote Monitoring: With the placement of IoT, it can be remotely controlled and connected to smartphones or computers by wireless means.

This system is a way to make sure that water is used effectively, the waste is at the lowest level and the needed manual labor is much less**.**

V COMPONENTS

The Automatic Water Level Indicator and Control System blends some important components to produce water management effectively. With these components in place, the system can either monitor or regulate the water level in a tank automatically.

Raspberry Pi Pico – This microcontroller serves as the brain of the system by processing the sensor data and managing the water pump. It is a low-cost, high-performance board with multiple GPIO pins for interfacing with other components.

Ultrasonic Sensor (HC-SR04) – One of the sensors is a device that is used to measure the water level of the tank. It throws ultrasonic waves that reflect from the water surface back to the sensor. the time taken for the waves to return is used to calculate the distance to the water surface. This allows for accurate level detection.

Water Pump Motor – Thisr is the main part of the system, will conduct water to the tank whenever the system detects a low water level. The component called Raspberry Pi Pico, will control motor through the TIP122 transistor

TIP122 Transistor – The TIP122 transistor is a peripheral to a microcontroller and the board control the water pump by providing the necessary current.

LCD Display – A 16x2 LCD display provides real-time feedback on the water level, motor status, and temperature.

Bluetooth Module (HC-05) – This module allows wireless connection, which gives the user the opportunity to monitor and control the system remotely off a smartphone or PC.

NTC Thermistor – The sensor is used to check the temperature of the water, which will make the system keep working correctly and stop overheating. Resistors & Connecting Wires – Resistors keep current flow under control and connecting wires allow for a flawlessly smooth process of information transfer between the electronic parts.

VI PROGRAMMING CODE

```
from PIL import Image, ImageDraw, ImageFont

text = """from machine import Pin, UART
import utime
from gpio_lcd import GpioLcd

# Set up pins for ultrasonic
sensor and motor
trigger = Pin(14, Pin.OUT)
echo = Pin(15, Pin.IN)
m = Pin(7, Pin.OUT)
uart = UART(0, baudrate=9600)

# Initialize LCD
lcd = GpioLcd(rs_pin=Pin(9),
              enable_pin=Pin(8),
              d4_pin=Pin(5),
              d5_pin=Pin(4),
              d6_pin=Pin(3),
              d7_pin=Pin(2),
              num_lines=2, num_columns=16)
```



```
lcd.putstr('WATER LVL CTRL ')
MAX_DISTANCE_CM = 25.0

def ultra():
    trigger.low()
    utime.sleep_us(5)
    trigger.high()
    utime.sleep_us(10)
    trigger.low()

    while echo.value() == 0:
        signaloff = utime.ticks_us()
    while echo.value() == 1:
        signalon = utime.ticks_us()

    timepassed = signalon - signaloff
    distance = (timepassed * 0.0343) / 2
    return distance
```

```
        # Control motor and send alerts
        if percentage < 5:
            print('water low')
            uart.write('water low\n')
            m.value(0)
        elif percentage > 85:
            print('water high')
            uart.write('water high\n')
            m.value(1)

        utime.sleep(1)

    except Exception as e:
        print(f"Error: {e}")
```

Fig 2: Implementation Code

VII BLOCK DIAGRAM

Block diagram of the Smart Hydro System illustrates the exchange between different elements that make the water management automated. The central processing unit is the Raspberry Pi Pico, which takes in input from the ultrasonic sensor, which quantifies the level of water within the tank using the transmission and reception of sound waves.

When the water level drops below the minimum, the Raspberry Pi Pico switches on the motor via a TIP122 transistor. When the water is at the optimal level, the system off the motor to avoid overflow. A 16x2 LCD display gives real-time updates of the water level, and allow the users to see the status of the tank.

In addition, a Bluetooth module (HC-05) provides remote monitoring and control through a smartphone. A temperature sensor (NTC thermistor) can be added to measure water temperature, further increasing the functionality of the system. The whole system is powered by a suitable power supply, making it reliable.
This block diagram well illustrates an automated, real-time, and energy-saving water level management system that can be applied in residential, industrial, and agricultural sectors.

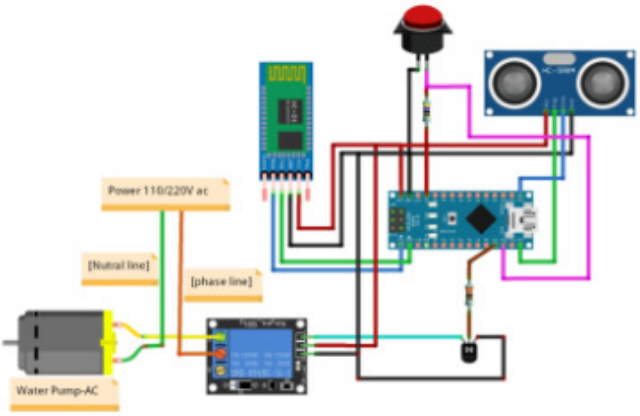

Fig 3:Block Diagam

VIII WORKING PRINCIPLE

[1] Intelligent Water Level Management System works in such a way that it continuously takes readings of the water level in the tank through an ultrasonic sensor, automatically keeping the water level by controlling a motor so that it is set to the desired value. The ultrasonic sensor is set at the top level of the tank, sending ultrasonic the waves that are reflected by water surface. The output signal of the ultrasonic sensor measures the time taken for the waves to return and sends this information to a Raspberry Pi Pico microcontroller, detecting

the prevailing distance and allowing the system to calculate the water level within the tank.

[2] Whenever the water level decreases the threshold previously set for this specific application, the Raspberry Pi Pico activates the motor via a TIP122 transistor used as an electronic switch to fill the tank with water to the maximum level. When the tank is full to the desired level, the system automatically turns off the motor to avoid overflow. In the display is an LCD, showing real-time data on the water level, while an HC-05 Bluetooth module allows remote monitoring and control.

[3] Thus, the entire process is automated and does not require human intervention, thereby saving water and conserving energy. It offers optimum utilization of water, protects the motor from dry-run conditions, and is useful in the sustainable management of resources.

IX ADVANTAGES AND APPLICATIONS

1)Automation and Efficiency : minimizes human intervention, water saving and avoiding wastage motor damage

2)Real-Time Monitoring- It employs ultrasonic sensors for precision water level indication, whereas LCD displays help visualization. Remote Access & Bluetooth module enables user command and monitoring of water levels from remote access.

3)Energy Conservation - Powering the pump only when required, hence saving electricity.

4)Cost-Effective - All the components used are cheap; for instance, the Raspberry Pi Pico makes the system cheap.

5) Residential- Automates the home water tank against overflow.

6) Agricultural- Controls irrigation systems based on available water.

7) Industrial- Maintains water levels in cooling systems and storage tanks.

8) Aquaculture- Keeping fish tanks and ponds with proper levels of water.

9) Rainwater- Harvesting primarily for optimum storage and utilization

X FUTURE ENHANCEMENT

1) Integration of IOT – It Allows remote monitoring and control from a mobile app or a cloud-based platform.

2) AI-Based Optimization – Use machine learning to forecast water usage trends and enhance motor performance.

3) Water Sensors – Incorporate pH, turbidity, and temperature sensors to keep an eye on water quality in real-time.

4) Solar Power Compatibility – Add solar panels to ensure the system is energy-efficient and eco-friendly.

5) Multiple Tank Support – Scale up the system to handle several water tanks for larger applications.

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