Smart Water Fountain

PROBLEM:

Today, more people around the world have pets than ever before. According to American Pet Products Association's survey in 2020, 67% of U.S. households own a pet which is about 84.9 million homes.
A source of fresh clean running water can encourage pets to drink. As a result, a water fountain is essential to most households having cats or dogs as pets .

Our goal is to design a smart water fountain that can monitor the water quality and automatically replace water when polluted (not healthy) or running out. We will use sensors to measure the water quality. Common water quality measurement factors include temperature, Ph-value, conductance, turbidity and hardness [3]. Considering the pollution at home can only affect limited factors, we choose temperature, Ph-value and conductance to be the three properties used for calculating water quality in our water fountain. These data will be collected, calculated, and reflected to the user in terms of "Good", "Average" and "Bad". The water fountain is also designed to self-filter the water every time when water is pumped through the submersible water pump.

DESIGN COMPONENT:

- Arduino uno
- Relay module
- LED display
- USB cable
- Connecting wires
- Temperature sensor
- Ph-value sensor
- Water level sensor
- Water quality sensor
- Pump and value
- Power supply
- Bread board
- Connecting wires
- laptop

PHYSICAL DESIGN:

A pictorial representation of your project that puts your solution in context. Not necessarily restricted to your design. Include other external systems relevant to your project (e.g. if your solution connects to a phone via Bluetooth, draw a dotted line between your device and the phone). Note that this is not a block diagram and should explain how the solution is used, not a breakdown of inner components.
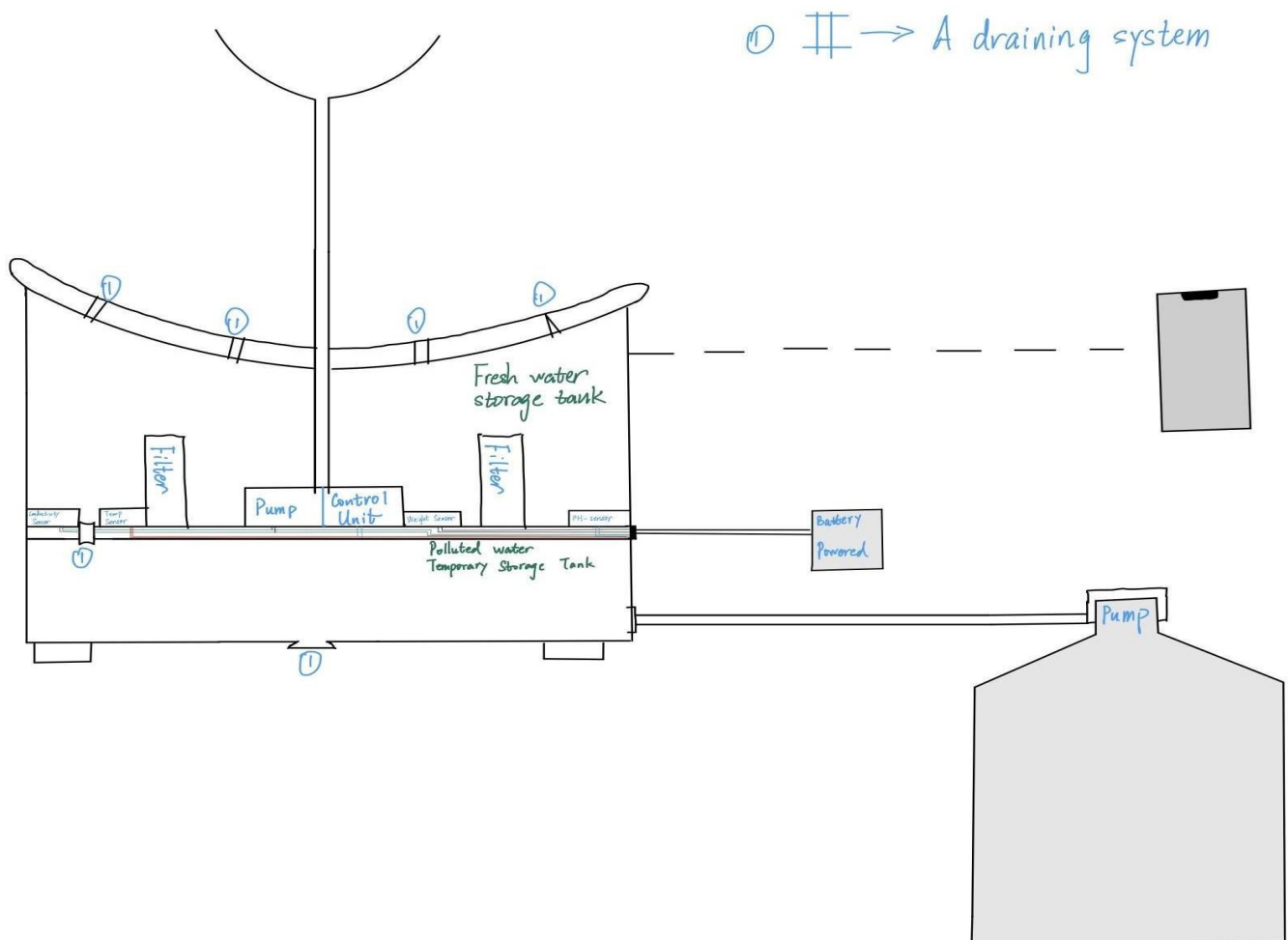

Figure 1 Smart Fountain Physical Diagram

High-level requirements list:

- Able to drain the polluted water and replace it with fresh water. Specifically, the polluted water will be drained by a motor-controlled valve to the "polluted water temporary storage tank" part. After completing the draining process, fresh water will be pumped from the general water supply(as described in the right down corner of the physical design, Figure 1).

- The fountain must accurately monitor the water quality, including measuring water temperature up to 48.89C and pH values between 6.5 and 8.5.

- Able to be connected to the users' devices through WIFI. Prompt feedback from the smart water fountain to users' interface with relevant information including the remaining water level and water quality index: 'Good', 'Average' and 'Poor'.

CIRCUIT AND EXPLANATION:
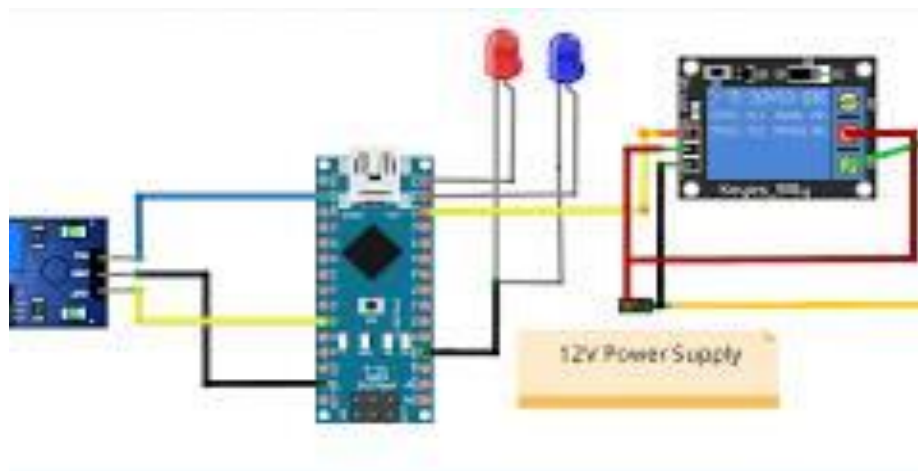
The **Arduino UNO** is a microcontroller board based on the ATmega328P. It is a popular choice for beginners and hobbyists as it is easy to use and has a wide range of available libraries and tutorials. The board has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button.

A **water pump** that operates at 12V is a type of pump that is designed to run on a 12-volt DC power supply.

The pump typically has two wires, one for power and one for ground. These wires can be connected to the **Arduino**'s 12V and GND pins, respectively. Once the connections are made, you can use the Arduino's digital output pins to control the pump. A **relay** is an electronic switch that can be controlled by an **Arduino** microcontroller to turn a **water pump** on and off.

To use a **relay** to control a **water pump** with an Arduino, you will need to connect the relay to the **Arduino**'s digital output pins. The **relay** typically has three pins, VCC, GND, and IN. VCC should be connected to 5V of the **Arduino**, GND to GND, and IN to a digital pin of the **Arduino**. Once the connections are made, you can use the **Arduino**'s digitalWrite function to turn the **relay** on and off, and thus control the **water pump**.

The relay is the intermediate component between the Arduino board and the water pump. It allows the Arduino board to control the water pump.

The role of the relay is to start or stop the pump responsible for filling the bottles.

- We connect the (-) terminal of the relay to the GND pin of the Arduino
- We connect the (+) terminal of the relay to the 3.3V pin of the Arduino
- We connect the terminal (S) of the relay to pin N° 2 of the Arduino

the role of the push button is the activation or deactivation of the relay module.

- We connect the first terminal of the button to the GND pin of the Arduino.
- We connect the second terminal of the button to pin N°1 of the Arduino.

SENSOR UNIT

This block contains the four sensors. The data acquired from the sensors will be transmitted to the control unit. Control unit will then have some logic designed to send corresponding signals to control other blocks of the water fountain. At the same time, the display screen on the water fountain will display the readings along with the determined water quality level and remaining water quantity.

For the PH-value sensor, temperature sensor and conductivity sensor, values will be retrieved and calculated to determine the overall water quality level. When poor water quality is determined, the water replacement procedures will take place. The weight sensor readings will be used to determine the amount of fresh water left in the water tank.

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TEMPERATURE SENSOR:

A water-proof temperature sensor is going to be used. Part number from sparkfun is: DS18B20 [6]. This temperature sensor is compatible with a relatively wide range of power supply from 3.0V to 5.5V. The measured temperature ranges from -55 to +125 celsius degrees. Between -10 to + 85 degrees, the accuracy is up to +-0.5 degrees. This sensor can fulfill all requirements needed for this project.

PH-SENSOR:

PH value is a valued indicator of water quality. This PH-sensor[7] works with 5V voltage, which is also compatible with the temperature sensor. It can 6measure the PH value from 0 to 14 with an accuracy of +- 0.1 at the temperature of 25 degrees.

CONDUCTIVITY SENSOR:

Conductivity sensor is also part of the water quality assessment. The input voltage is from 3.0 to 5.0V. The error is small, +-5%F.S. The measurement value ranges from 0 to 20 ms/cm which is enough for water quality monitoring.

LIQUID LEVEL SENSOR:

This sensor [9] is responsible for reflecting how much freshwater is left in the water tank. When the water level is low, fresh water will be pumped to the water tank to ensure the water fountain keeps running with freshwater. This sensor is 0.5 Watts. For water level from 0 to 9 inches, the corresponding sensor outputs readings from 0 to 1.6. From that, the quantity of freshwater left can be determined.

DISPLAY UNIT:

SCREEN:

The screen will be used to display the readings from the sensors in a real-time manner.[10] In addition, other necessary information will also be displayed. As described in the sensor part, the water quality and remaining water quantity will be displayed. The screen will be programmed so that it makes it easy for users to read information.

This 20*4 LCD display screen is going to be used to display the relevant information. After programming the screen, a conclusion of water quality(Good, Average, Poor) will be displayed along with the remaining water level.

POWER SUPPLY UNIT:

ZN-MN BATTERY:

The Zn-Mn battery must be able to continuously support the functioning of the circuit, display unit, and the mechanical unit.

Requirement: Commercial batteries will be used to maintain a continuous 3.60V power supply for at least 24 hours. If the chosen battery is not powerful enough, 120V power outlets will be considered.

VOLTAGE REGULATOR:

The integrated circuit will regulate the power supply for each module to maintain their functionality. This chip must be able to handle the maximum voltage supplied by the battery (3.60V ± 0.5V) while ensuring the voltage at each module does not exceed their limit.

Requirement: Must maintain thermal stability below 100°C.

MECHANICAL UNIT

FOUNTAIN PUMP

The fountain pump [14] must maintain a continuous water supply through the fountain mechanism. The pump must work 24 hours a day, 7 days a week unless the user manually turns off the power supply.

Requirement 1: The fountain pump must lift a cylindrical water stream of diameter 6mm for a height of 400mm.

Requirement 2: The fountain pump must serve for a duration of 2 years without maintenance or replacement under heavy workload.

Requirement 3: The fountain pump should have an operational condition around 3V, 200mA.

SUPPLY PUMP

The supply pump must function when a low water level alert is raised. While no water supply is requested, the pump must prevent water flow between the main supply and the fountain.

Requirement: The supply pump should have an operational condition around 3V, 200mA.

FILTER

The filter must maintain the water quality through controlling the pH value and conductivity of the water.

Requirement 1: The filter must have a cost less than $5 each for frequent replacement. Each new filter must serve a duration no less than 3 month.

Requirement 2: The filter must be designed for easy removal and installation, while the connection mechanism must have a low degenerate rate when submerged in water.

DRAIN

The drain [13] must be able to hold and release water in the fountain. When water in the fountain should be replaced, the faucet should automatically drain the fountain once instruction is received from the integrated circuit.

CONTROL UNIT

This unit contains the control unit which does the following things:

• When the weight sensor reports a weight less than the minimum weight setting, the control unit will send an alert signal to the user and then control the water supply unit to refill the water fountain with a certain amount of water.

• Computes the water quality with data transferred from the three sensors in the water quality module and sends the result in terms of "Good", "Average" or "Bad" to the user.

• If the water quality is "Bad", the control unit will control the drain module to drain the water in the fountain and then control the water supply to refill.

• Water quality result is sent to the user with wireless connection and screen display as described above in the display unit.(unsure about keeping this function)

CODE AND EXPLANATION:

```c
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <stdbool.h>

// Simulated water level sensor
int getWaterLevel() {
    // Simulate a random water level between 0 and 100
    return rand() % 101;
}

// Simulated pump control
void turnOnPump() {
    // Simulate turning on the pump
    printf("Turning on the pump\n");
}

void turnOffPump() {
    // Simulate turning off the pump
    printf("Turning off the pump\n");
}

int main() {
    // Initialize the random number generator
    srand(time(NULL));

    // Set the desired water level (you can change this value)
    int desiredWaterLevel = 70;
```

```
 // Main control loop
    while (true) {
        int currentWaterLevel = getWaterLevel();

        // Check if the water level is below the desired level
        if (currentWaterLevel < desiredWaterLevel) {
            turnOnPump();
        } else {
            turnOffPump();
        }

        // Delay for a while before checking again (simulate time passing)
        // Adjust the delay based on your system's requirements
        usleep(1000000); // Sleep for 1 second
    }

    return 0;
}
```

In this example, we simulate a smart water fountain system with a water level sensor and a pump. The program generates a random water level between 0 and 100 and compares it to a desired water level. If the current water level is below the desired level, it turns on the pump. Otherwise, it turns off the pump.

Keep in mind that this is a basic simulation, and in a real-world scenario, you would need to interface with actual sensors and pumps and handle more complex control logic and error handling. Additionally, you may need to consider power management, safety features, and communication with other devices or systems to create a fully functional smart water fountain.

BLOCK DIAGRAM:

The block diagram below is a general design of our solution. We divide our design into four modules, including Power Supply, Control Unit, External Control, and Mechanical Unit. Details of each unit is presented in the diagram and described in the next section.