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Prototype of Greywater Treatment using Arduino Uno

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Abstract

Water is one of our most precious resources and as much as wanted it to be, it is not an infinite resource. Water not only supports human life and activities but also helps to maintain the ecological structure. Water was used for everyday household purposes, such as bathing, dishes, flushing toilets, and washing machine. These activities are producing greywater. This project aims to develop the prototype of greywater treatment to conserve water and convert contaminated water from the washing machine (greywater) into clean water that can be used for watering the plants. Arduino Uno, pH sensor, ultrasonic sensor, solenoid valve, servo motor, and potassium alum are components and materials used in this project. This project was achieved by chemical filtration of the greywater using Arduino Uno. The greywater will be collected and identify the pH level by using a pH sensor. The quantity of potassium alum inserted in greywater was based on the accumulated pH value. The potassium alum was inserted into the greywater to eliminate the detergent in that greywater. The pH sensor was used once again to ensure the greywater are eliminated. The treated water was stored in a tank so that it can be used for the irrigation system, while the ultrasonic sensor was used to determine the level of treated water in the tank.

Keywords Greywater, Arduino Uno, pH sensor, Ultrasonic sensor, Potassium alum

INTRODUCTION

Water has covering around 70% of the surface of the Earth and can be classified as an inorganic, transparent, tasteless, odorless, and nearly colorless chemical substance. Water is the main component of Earth and it is vital for all known life forms, even though it provides no calories or organic nutrients [1]. Water plays a crucial role in the economy and supports human life and activities. It also helps to maintain the ecological structure. Water is needed to keep the continuous availability for humans [2].

Water is essential for human survival on a daily basis, and it is required not only for drinking but also for a variety of other purposes in our daily lives. Water was used for a variety of everyday household activities, including bathing, washing dishes, and flushing toilets. Greywater is generated as a result of these activities. Because of the contamination of ground and surface water by industrial effluents and agricultural chemicals, there is a widespread shortage of water. Industrial pollution is less common in developing countries than it is in urban areas, which is a good thing.[3][4][5].

Water scarcity is a major issue that affects the entire world. Every day, humans produce wastewater [6][7][8]. 85% of the world's water consumption is for agricultural purposes, at a rate of 235 million liters per second, and 70% of this water is wasted [9][10]. When the wastewater is mixed with trash like garbage, household waste, and disposable matters, it will create sewage or wastewater.

Washing machines become the second-largest water waster in the average household [8][11]. The washing machine wastewater should have been recycled, regardless of whether a washing machine is built

using traditional or water-efficient technology, where each load consumes between 15 and 40 gallons of water. The other issue is the scarcity of water. Water scarcity and conservation issues are classified differently by geographic region [12][13][14]. The wise and efficient use of water is becoming a cultural norm. The consumption and the importance of water stewardship need to be emphasized among consumers.

This project aims to develop a low-cost system for water conservation that converts contaminated water from the washing machine (greywater) into clean water that can be used for watering plants. This project can be accomplished through the use of chemical filtration of greywater and an Arduino UNO. Greywater will be collected and the pH of the water will be checked using a pH sensor to determine the amount of potassium alum required to eliminate the detergent from the greywater. The treated water is then stored in a tank until it can be used for irrigation.

METHODOLOGY

The project's flowchart is shown in Figure 1. Firstly, the pH sensor will detect the pH value of the greywater. The soap will then be coagulated with potassium alum, and the sedimentation process will begin. The ultrasonic sensor determines whether the clean water tank is full or not after the two methods are completed. If not, the switch will be turned on to open the gate valve. Water will flow through the cylindrical filter and be stored in a clean water tank. When the tank is full, the ultrasonic sensor will signal to change the servo motor's angle, and then the gate valve will be closed.

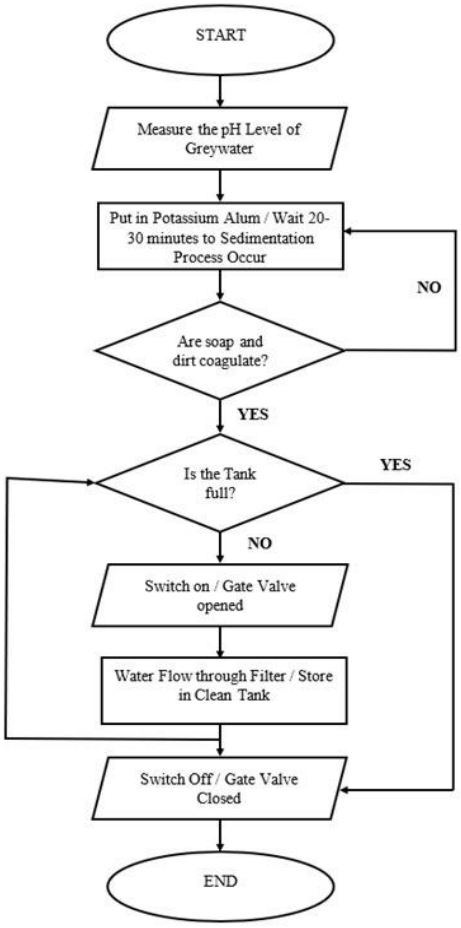

Figure 1 Flowchart of this project

Components and Materials

Figure 2 shows the systems diagram of the greywater recycling process. The components and materials involved in this project are Arduino Uno, ultrasonic sensor, pH sensor Arduino, relay driver, switch, servomotor, gate valve, water pump, and potassium alum. Details explanation for each component and materials are explained below.

An ultrasonic sensor is a device that generates or senses ultrasound energy. It can be divided into three broad categories: transmitters, receivers, and transceivers. Transmitters convert electrical signals into ultrasound, receivers convert ultrasound into electrical signals, and transceivers can transmit and receive ultrasound. So, it can detect the water that flows into the tank.

The most common method of measuring pH is to use an electrochemical pH sensor. Combination pH sensors consist of measuring and a reference electrode. The measuring electrode detects changes in the pH value, while the reference electrode provides a stable signal for comparison.

Arduino Uno board is based on the ATmega328 microcontroller board. It has 14 pins for optical input/output, six analog inputs, a USB connection, a power jack, a serial in-circuit programming header (ICSP), and a reset button. To get going, it is merely connecting to a device with a USB cable or powering it with alternating current (AC)-to a direct current (DC) adapter or battery.

A switch is used to switch on the system and automatically switches off when it receives the signal from the ultrasonic sensor when the tank is almost complete. A servo motor is a rotary actuator or linear actuator that allows for precise angular or linear position, velocity, and acceleration. The servomotor will open the gate valve that allows water to flow throughout the system.

Lastly, Potassium alum is a chemical compound commonly used in water purification, leather tanning, dyeing, fireproof textiles, and baking powder. In this system, it was used to coagulate the soap and dirt from the water. It allows dirt to be filtered through the filtration method that was used in this system.

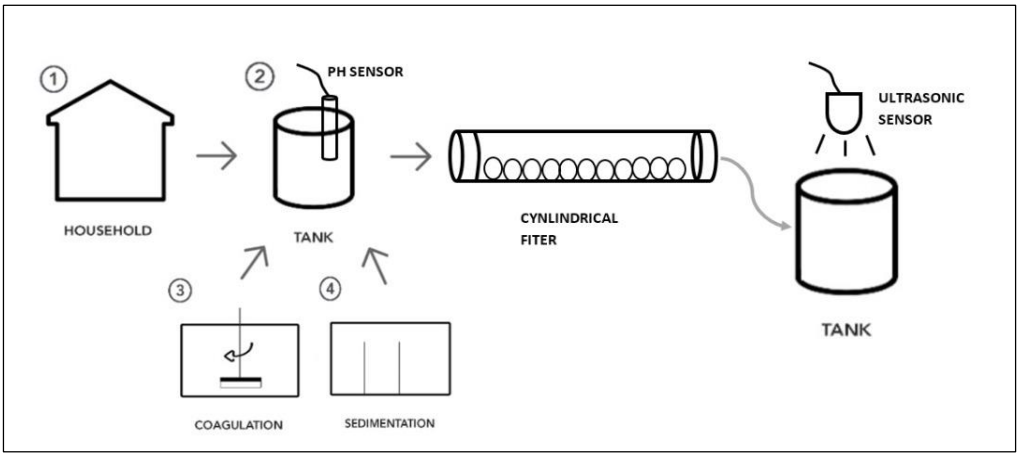

Figure 2 System diagram of the water recycling process

Schematic circuit

Figure 3 shows the example of a schematic diagram for this project. The two potentiometers were used to replace two sensors which are pH sensors and ultrasonic sensors. For the simulation process, the pH sensor will detect the water's pH level, and the value can be shown on the laptop using the Arduino app. Next, when the push-up button is pressed, the servomotor will automatically change its angle. It indicates that the gate valve is opened and allows the water to flow. When the ultrasonic sensor detects the water level in the clean water tank, it will signal the servo motor. After the signal is received, the servomotor will change its angle back to normal. It shows that the gate valve is closed. When the tank is full, the servo motor will not change its angle to open the gate valve although we push the button.

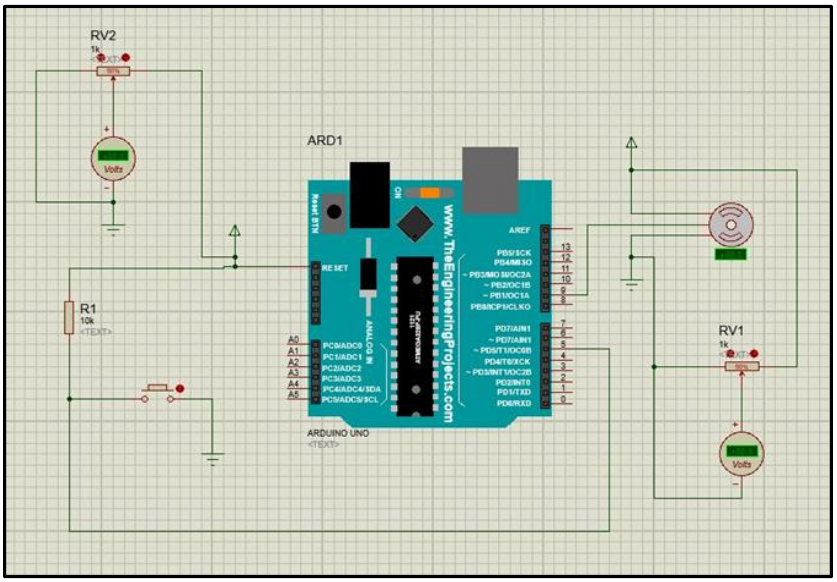

Figure 3 Example of the schematic diagram for this project

RESULTS AND DISCUSSION

Figure 4 shows the hardware connection for this project. Push-button was used to replace the actual pH sensor. This project's complete prototype is shown in Figure 5. The greywater from the washing machine was stored in Tank A. After using a pH sensor to determine the pH level in the washing machine, potassium alum was added to tank A for the coagulation and sedimentation processes. The servomotor will open the gate valve to allow the water to flow once tank A is full and the pH level is neutral. The treated water will be pumped to tank B via the cylindrical filter. The irrigation system can use the treated water from tank B.

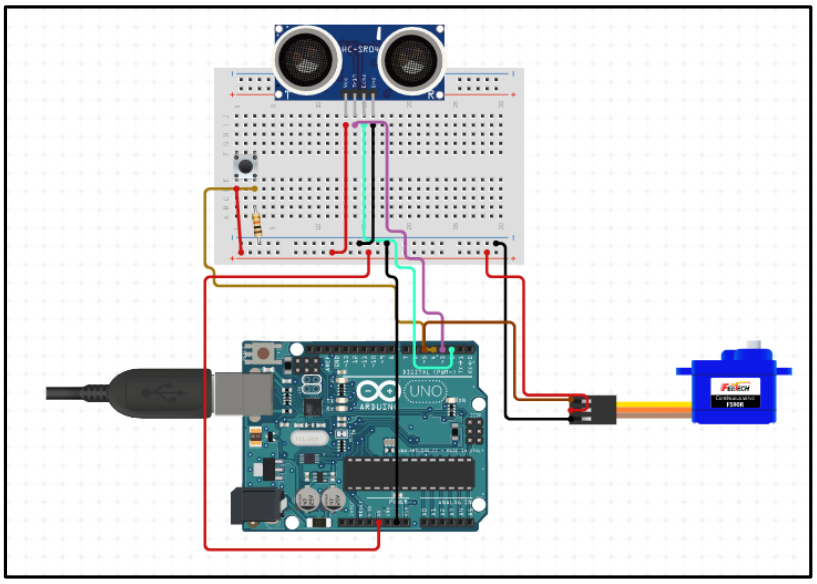

Figure 4 The hardware connection of this project

Table 1 shows the functionality test of the pH sensor. There are three different substances used to test the pH sensor. It shows that the pH sensor was functioning correctly.

Table 2 shows the pH level result as potassium alum was added to greywater. The pH level was measured to identify how much potassium alum need to neutralize the soap. Alkalinity and pH are two essential factors in determining the suitability of water for irrigating plants. pH is a measure of the

concentration of hydrogen ions (H+) in water or other liquids. The pH level of clean water is then measured to recognize if clean water is suitable for irrigation. In general, water for irrigation should have a pH between 5.0 and 7.0.

Table 1 pH sensor functionality testing

Substances	pH level				Functionality
	1	2	3	Average	
Greywater	8.90	8.87	9.06	8.94	YES
Vinegar	3.20	3.10	2.90	3.07	YES
Distill Water	6.98	7.02	6.97	6.99	YES

Table 2 pH level result as potassium alum added

pH Greywater (Before)	Potassium Alum (Tablespoon)	pH Greywater (After)
11.66	1 1/2	6.27
9.83	1	5.92
11.34	1 1/4	6.44

CONCLUSION AND RECOMMENDATION

In conclusion, the prototype for this project was successfully developed. The project was proposed to isolate household water that is being wasted especially water from the washing machine. It found that chemical processes such as coagulation, followed by a filtration or disinfection stage, can reduce the suspended solids, organic substances, and surfactants in low-strength greywater to an acceptable level that can meet non-potable urban reuse needs [15]. However, for medium- and high-strength greywater, the water produced from chemical processes cannot always meet the required reuse standards in all situations unless these processes are combined with other techniques. The additional work that needs to be taken into account is the chemical that needs to be applied to minimize the microbial activity that is taking place in the recycled tank. This prototype needs improvement to build a large-scale model.

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