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Design of Wastewater Filtration System for Microcontroller and Smartphone-Based Hydroponic Agriculture

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ABSTRACT: The level of water pollution sourced from daily household waste needs to be watched out, especially since the level of awareness of the Indonesian people is still relatively low in water treatment. Waste water treatment plants are always synonymous with high installation costs and the complexity of maintenance and management of the installation equipment.Based on the above background, the authors make a household wastewater treatment installation device in the Lirboyo Al-Mahrusiyah Islamic Boarding School Dormitory, Kediri City, into ready-to-use water for urban agriculture using the hydroponic system method. This device is based on a microcontroller that is connected to the Blynk Web Server which can be operated using a Smartphone.This system is also able to provide results of monitoring the quality of water quality standards resulting from waste treatment in the Lirboyo Al-Mahrusiyah Islamic Boarding School Dormitory. This application can also be applied as a remotecontrol tool by utilizing the internet network to determine the quality of household wastewater quality standards with a water acidity level (pH) of 7.12 and a TDS (Total Dissolve Solid) value of 521 mg/L and turbidity of 5 NTU (Nephelometric Turbidity Units) in real time.

Keywords: *microcontroller, smartphone, water quality standard, water content, hydroponics*

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INTRODUCTION

Water pollution that continues to increase has caused a decrease in the quality of water in the environment. Water pollution is caused by the number of people and various human activities. Water pollution is an unavoidable event, this is due to industrial and technological developments. The development of the industry is also caused by the development of the human population and human needs. This causes the level of environmental pollution to be higher with an alarming quality of pollution. Water that is contaminated by bacteria and microorganisms, as well as harmful chemical substances, causes water unfit for consumption by humans, animals, and plants. Therefore, it is necessary to treat waste in advance so that there is no environmental pollution.

Water is one of the many basic needs of living things that are crucial for their survival. Water treatment is a human effort to provide water that is suitable for use and suitable for consumption, especially in the current condition the level of water pollution has entered a stage that is quite alarming, occurring in groundwater, river water, or seawater.

Wastewater treatment plants are always synonymous with high installation costs and the complexity of maintenance and management of the installation equipment. Based on the background above, the author would make a set of 2 household wastewater treatment plants which were planned to be applied to the Lirboyo Al-Mahrusiyah Islamic Boarding School Dormitory in Kediri City because there was a lot of wastewater from toilet disposal which would become ready-to-use water for urban agriculture systems with a hydroponic system method which could also support the provision of one source of nutritious food in the form of organic vegetables.

The system was designed using a microcontroller and a smartphone. A microcontroller is a control tool for receiving and sending data from sensor readings as well as an IoT platform that could be connected to smartphones.

Water treatment is one of the efforts to provide water that is suitable for consumption. Based on the background above, the author made a system entitled "Design of a Wastewater Filtration System for Microcontroller and Smartphone-Based Hydroponic Agriculture" which could be operated remotely as a final project.

METHODOLOGY

The research was conducted at the Science Laboratory of Al-Mahrusiyah Lirboyo Vocational School and the Al-Mahrusiyah Lirboyo Islamic Boarding School Dormitory. The research flowchart is as follows:

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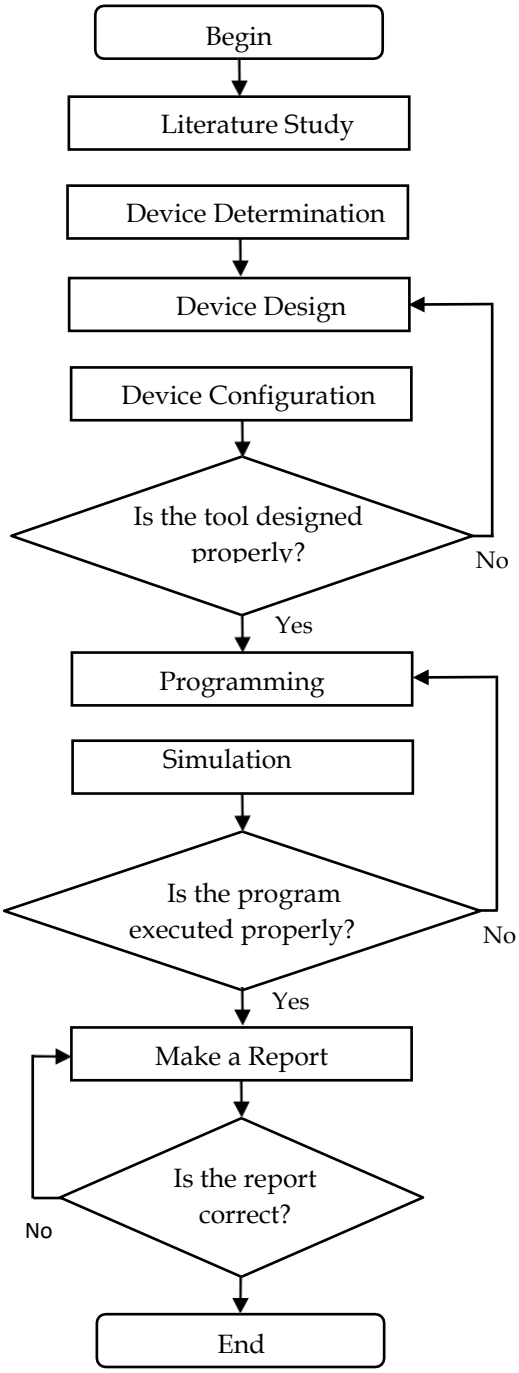


The Figure of Research Flowchart

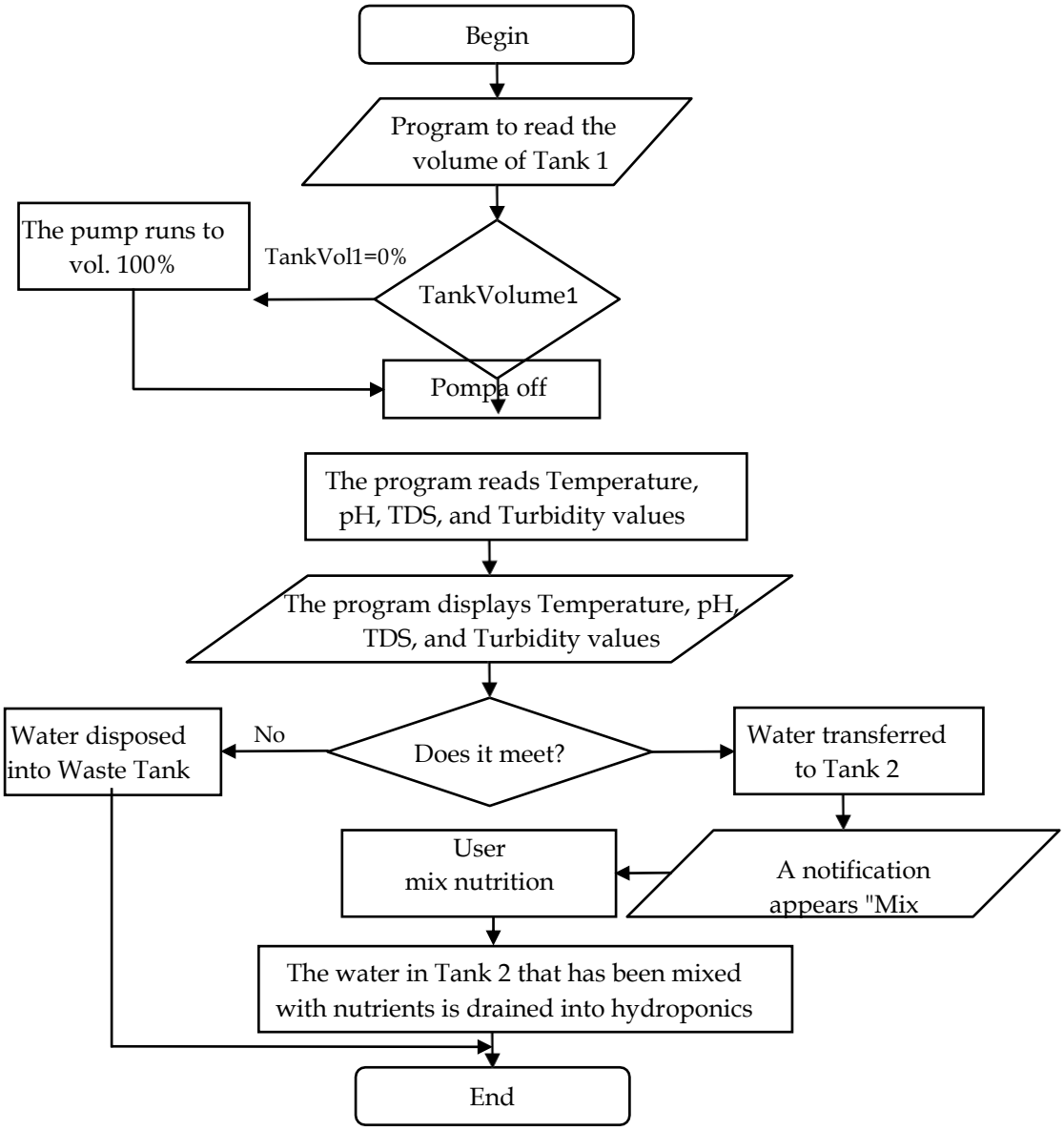
The tools and materials used in the research were hardware and software, namely:

A. Hardware
   1. Arduino Uno
   2. NodeMCU ESP8266
   3. HC-SR04 Ultrasonic Sensor (2 pieces)
   4. DS18B20 Temperature Sensor
   5. pH sensor
   6. TDS (Total Dissolved Solid) Sensor

7. Turbidity Sensor
8. LCD (Liquid Crustal Display) + I2C (3 pieces)
9. Relay module high-level trigger (5 pieces)
10. Power Supply 12v 10A
11. Reverse Osmosis
12. Cable
13. Solder and tin
14. Laptop

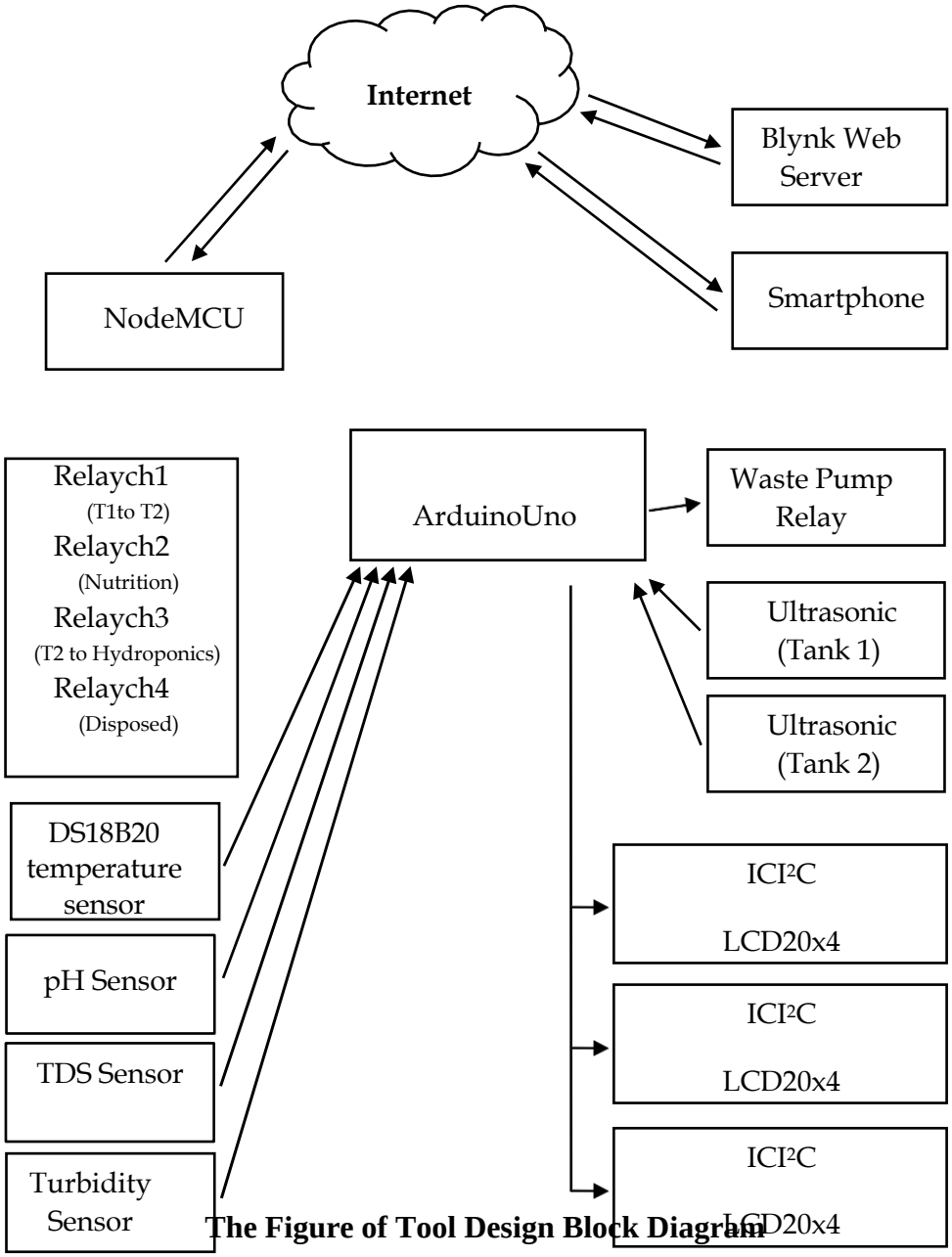
B. Software
1. Arduino IDE
2. Blynk

Before designing the system, the author made a flowchart of the system so that when designing the program it is more focused. The flowchart is as follows:



The Figure of System Flowchart

The tool design block diagram is as follows:



The Figure of Tool Design Block Diagram

Tool design begins after all components are available. The components used were listed on the tools and materials and the system workflow was also listed on the system flowchart. The system designed used 2 ultrasonic sensors connected to the Arduino Uno microcontroller to measure the water level in the two tanks. In addition to measuring the water level in the tank, the ultrasonic sensor in tank 1 was used to give orders to the Relay that cut off the RO (Reverse Osmosis) pump.

Testing of water quality standards used a temperature sensor, pH sensor, TDS sensor, and Turbidity sensor which was also connected to the Arduino Uno microcontroller and connected to the LCD (Liquid Crustal Display) via I2C (Inter-Integrated Circuit) to display the sensor readings. After that, the Arduino Uno microcontroller was connected to the NodeMCU. The goal was that the sensor reading

result could appear on the smartphone screen with the Blynk application that was connected to the Web Server via the internet so that it could be monitored remotely.

The next component used a Relay to cut off the power. Using 5 Relays including the RO (Reverse Osmosis) filter pump, pump tank 1 to tank 2, Solenoid Valve to the nutrient tank, pump tank 2 to hydroponics, and the drain pump to tank 1. The relays were connected to the NodeMCU so they could be controlled on a smartphone in the Blynk application so it could also be controlled remotely. However, the Relay on the RO pump couldn't be controlled so it operated automatically based on the ultrasonic sensor in tank 1 with logic as shown in the system flowchart.

After the design of the tool was complete, then the next step was to design the program using the Arduino IDE application on the laptop by connecting the Arduino Uno and NodeMCU to the laptop using a USB cable. The programming language used was Arduino programming language.

RESULTS AND DISCUSSION

Results and Discussion of Filtration System

The filtration system made in this study involved an RO (Reverse Osmosis) filter and Arduino Uno and NodeMCU microcontroller devices, ultrasonic sensor, DS18B20 temperature sensor, pH sensor, TDS sensor, Turbidity sensor, and relay.

The working mechanism of the system is a water quality standard test parameter measured by a sensor connected to the Arduino Uno, using the C programming language. The sensor value results were sent to the LCD and the Blynk application on the smartphone via the internet.

By using a smartphone, the author could see the sensor reading result wherever he wants.

Results and Discussion of Testing Water Quality Standards

Research has been carried out on the manufacture of systems for appropriate technology for treating household wastewater at the Al-Mahrusiyah Islamic Boarding School Lirboyo Kediri, and then the wastewater treatment products were used in a filtration system for hydroponic growing media for vegetable crops.

The initial stage of this research was to test the quality of groundwater used by a hydroponic irrigation system, which later the data would be used as comparison data for treated wastewater which could be monitored on a smartphone via the internet. The test results data are as follows:

Table 1. of measurement results of water quality standard parameters

Average	Groundwater	Wastewater	Filtered Water
Temperature (^oC)	23	24	23
pH	6.90	8.24	7.12
TDS(mg/L)	511	895	521
Turbidity (NTU)	5	13	5

Based on the table showed that the filtered water was not much different from groundwater. The result of the acidity level of water from the treatment of dormitory household waste was a significant decrease, approaching a neutral pH. While the TDS measurement of wastewater samples before and after treatment there was a significant decrease in the range of 500. These results indicated the TDS value of wastewater

samples that have been subjected to absorption and filtration processes was still higher than the TDS value required by the water quality standards regulated in the Minister of Health of the Republic of Indonesia Number 492/Menkes/PER/IV/2010 which requires the TDS value to be 500 mg/L. The turbidity level of household wastewater also experienced a very significant decrease, equal to the water quality standard value of 5 NTU. NTU (Nephelometric Turbidity Unit) is a unit for the level of turbidity of water. If the water is getting turbid, then the unit level of turbidity is getting higher.

Based on the Regulation of the Minister of Health of the Republic of Indonesia which is regulated in the Minister of Health of the Republic of Indonesia Number 492/Menkes/PER/IV/2010 which requires the maximum limit value of the turbidity level for water fit for consumption to be 5 NTU, the wastewater treatment has shown a value that was in accordance with the requirements.

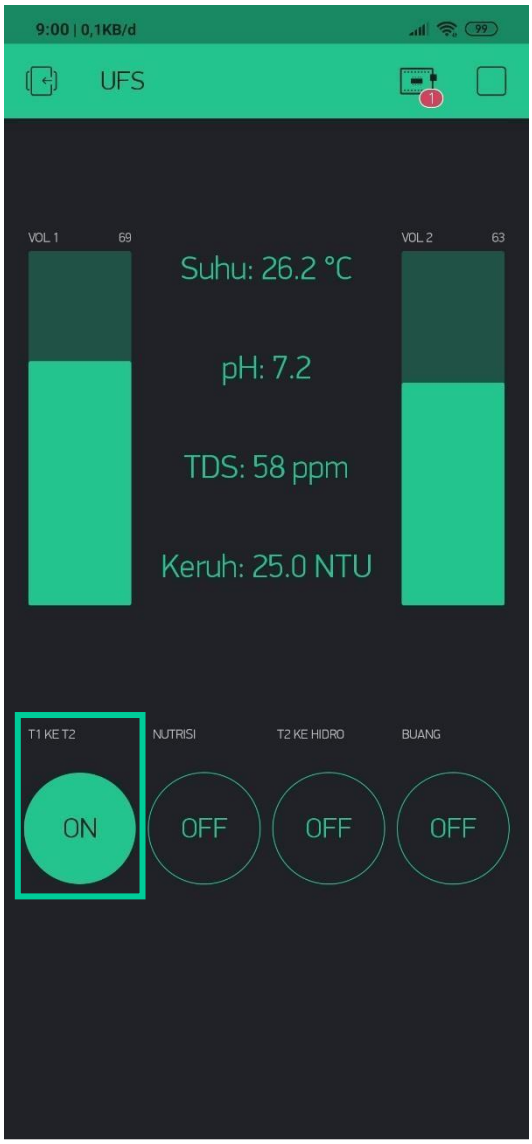
The next stage was the installation of a filtering system on the dormitory wastewater which was connected to a wastewater purification device and a hydroponic system.

Results and Discussion of Control System

The control system is part of the system that controls the filtration system manually after the water passes through the filtering stage. After being filtered, the water was tested for quality standards by observing the results of the quality standard sensor readings on the LCD or smartphone. After the testing phase was complete, then the water was transferred by pressing the button through the Blynk application. The buttons on Blynk have different functions. The following are some explanations of the buttons on the Blynk application.

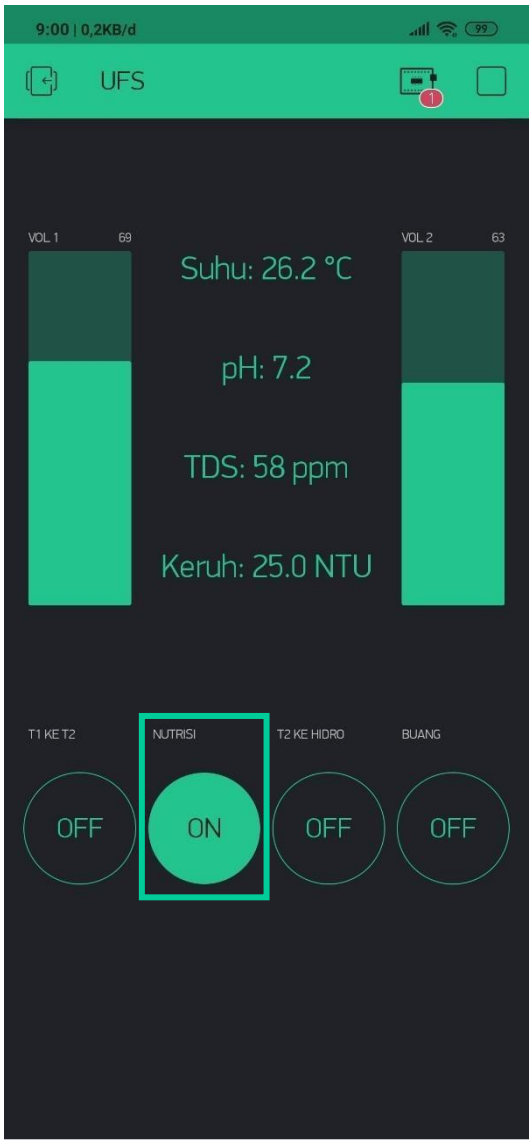
T1 to T2 Button

The T1 to T2 button is a button that functions to transfer water from tank 1 to tank 2 after the quality standard test is complete. However, if the quality standard has met the standard. If it does not meet, then the water would be disposed of using another button. This button controls the pump. The pump used was an aquarium pump and was placed at the bottom of tank 1. T1 to T2 buttons as in the following screenshot.



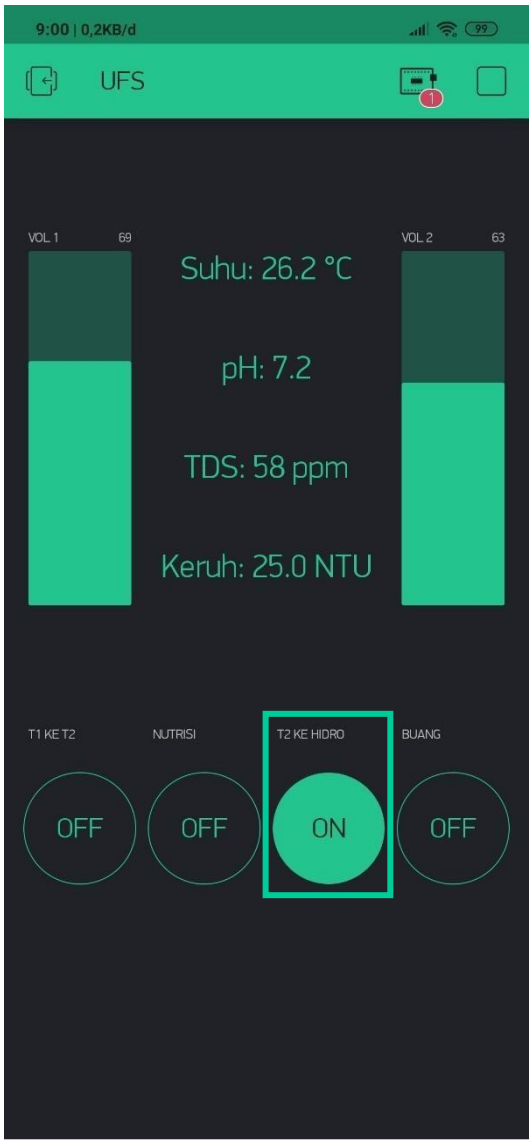
Nutrition Button

The Nutrition Button is a button that functions to drain the hydroponic nutrient liquid in tank 2 after the water in tank 2 is full. This button controls the solenoid valve. It works like a water faucet. It's just that the solenoid valve opens when 12v DC is supplied with electricity. Nutrition button as in the following screenshot.



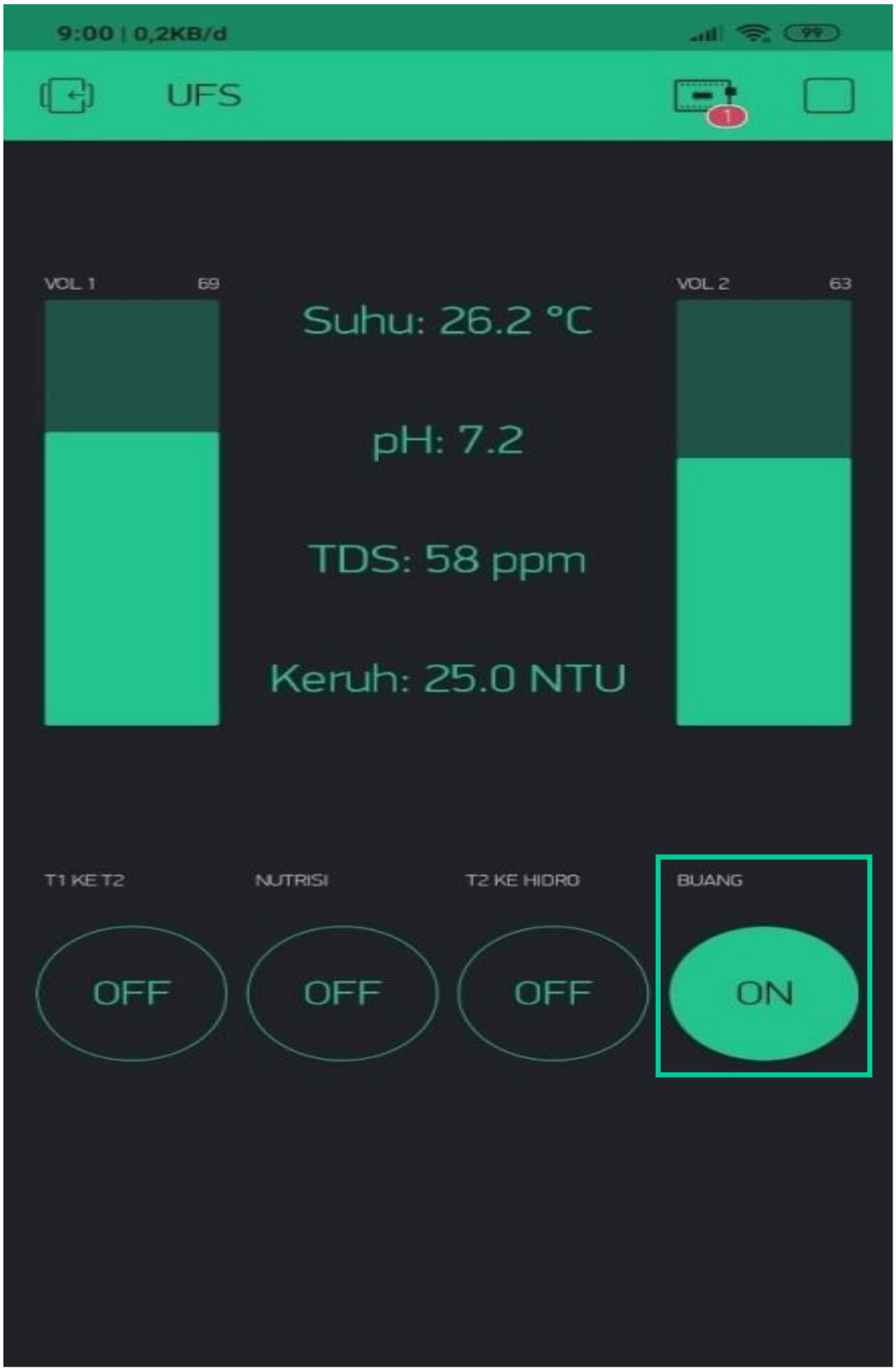
T2 to Hydroponics Button

The T2 to Hydroponics button is a button that functions to transfer water in tank 2 that has been mixed with hydroponic nutrient liquid to the hydroponic growing media. This button controls the 12v DC pump and is placed at the bottom of tank 2. The T2 to Hydroponics button is as shown in the following screenshot.



Disposal Button

The disposal button is a button that functions to dispose of water in tank 1 if the water does not reach the quality standard. This button controls the 12v DC pump and is placed on the outer wall of tank 1. Disposal button as shown in the following screenshot.


9:00 | 0,2KB/d
UFS
VOL 1
69
VOL 2
63
Suhu: 26.2 °C
pH: 7.2
TDS: 58 ppm
Keruh: 25.0 NTU
T1 KE T2
NUTRISI
T2 KE HIDRO
BUANG
OFF
OFF
OFF
ON

CONCLUSIONS AND RECOMMENDATIONS

Based on the research that has been carried out, the following conclusions could be drawn:

1. Design of a wastewater filtration system program using temperature, pH, TDS, and Turbidity sensors. The results of the sensor readings were processed by the Arduino Uno microcontroller and NodeMCU then could display the results of water quality readings with parameters of temperature, pH, TDS, and Turbidity on the LCD. Then the tool that the author made could be run properly according to its function.
2. How to test the results of water quality readings with parameters of temperature, pH, TDS, and Turbidity could be seen on the LCD. The results of water quality readings could also be viewed on a smartphone online. So that water quality readings could be tested anytime and anywhere.
3. Installation of the wastewater filtration system was carried out by programming the microcontroller with other devices, such as temperature, pH, TDS, Turbidity sensors, and LCD screens. The sensors were placed in the storage tank after the water is filtered.
4. Connecting the microcontroller to the smartphone by connecting the NodeMCU to the Wireless Router that is already connected to the ISP and the smartphone is in an active data state, the Blynk application on the smartphone is already connected. In this case, the filtration system could be controlled and monitored remotely.
5. The installation of the device begins from the stage of connecting all sensors to the microcontroller. Then design the program on the Arduino IDE, then upload it to the microcontroller and test the accuracy of the sensor. The next stage is the microcontroller, module, and sensor placed in a box that has been designed in the framework. Installation of RO (Reverse Osmosis) filter and tank on the framework. The last stage is merging with hydroponics.

REFERENCES

Adywater. 2019. 7 Fungsi Membran RO, Mulai dari Pemurnian Air Minum Hingga Filter Air Industri. https://www.membranro.com/2019/03/7-fungsi- membran-ro-mulai-dari.html (accessed on June 28th, 2020).

Asri, Dinda Kurnia. 2019. Rancang Bangun Sistem Pemantau Suhu, Kelembaban, Dan Ph Pada Media Tanam Hidroponik Dengan Nodemcu (Micro Controller Unit) Berbasis Web [Skripsi]. Fakultas Teknik, Universitas Lampung.

Beetrona. 2019. Membahas Cara Kerja Sensor Ultrasonic HC-SR04. https://beetrona.com/membahas-cara-kerja-sensor-ultrasonic-hc-sr04 (accessed on June 28th, 2020).

Febrianto. 2018. Apa itu Arduino Uno?. https://ndoware.com/apa-itu-arduino- uno.html (accessed on June 28th, 2020).

Herwibowo, Kunto, dan N.S. Budiana. Hidroponik Sayuran. 2014. Penebar Swadaya. Jakarta.

Kho, Dickson. 2020. Pengertian Mikrokontroler (Microcontroller) dan Strukturnya. https://teknikelektronika.com/pengertian-mikrokontroler- microcontroller-struktur-mikrokontroler, (accessed on June 28th, 2020).

Kho, Dickson. 2020. Pengertian Relay dan Fungsinya. https://teknikelektronika.com/pengertian-relay-fungsi-relay (accessed on June 28th, 2020).

Ningrum E.S, Susetyo P. W, Putra T.A. 2008. Sistem Sensor Keasaman Air (pH) untuk Aplikasi Pengontrolan Kondisi Air Tambak Udang [Tugas Akhir]. Politeknik Elektronika Negeri Surabaya, Surabaya.

Purba, Michael. 1995. Buku Pelajaran Kimia Kelas XI. Erlangga. Jakarta.

Putera, Gilang Ananda dan Christian D. H. F. M. 2017. Perancangan Alat Ukur Kadar Padatan Terlarut, Kekeruhan Dan Ph Air Menggunakan Arduino UnoI [Skripsi]. Fakultas Teknik, Universitas Hasanudin Makassar.

Saputra, Akip. 2016. Pengukur Kadar Keasaman dan Kekeruhan Air Berbasis Arduino [Skripsi]. Fakultas Teknik, Universitas Muhamadiyah Surakarta.

Saputro, Tedy Tri. 2017. Mengenal NodeMCU: Pertemuan Pertama https://embeddednesia.com/v1/tutorial-nodemcu-pertemuan-pertama, (accessed on June 28th, 2020).

Sitepu, Jimmi. 2019. Sensor Suhu DS18b20 dengan Arduino dan Menampilkan nya di LCD. https://mikroavr.com/ds18b20-arduino (accessed on June 28th, 2020).

Syefudin, 2019, http://indomaker.com/index.php/2019/04/09/memulai-menggunakan-blynk-pada-nodemcu (accessed on June 28th, 2020).

Yusuf, Muhammad, Dede. 2016. Alat Pendeteksi Kadar Keasaman Sari Buah, soft drink, Dan Susu Cair menggunakan Sensor pH berbasis Mikrokontroler Arduino Uno Atmega328 [Skripsi]. Politeknik Negeri Sriwijaya.