

Modification of the Automatic Control System for Arduino ATmega 328P-Based Water Gallon Cleaner

Kharisma Ramadhan¹, Lutfi Hinda M.², M. Raghil Alashbahanni Mahfudz³,
M. Dafa Dezan Rezaputra⁴, M. Taufiqul Hafizh⁵

^{1,2,3,4,5}Department of Electrical Engineering, Gajah Tunggal Polytechnic, Indonesia

Article Info

Article history:

Received Apr 04, 2021

Revised Dec 21, 2021

Accepted Dec 28, 2021

Keywords:

Water, Quantitative Data, Descriptive Statistics, Gallons, Particles.

ABSTRACT

Humans are living things that have 60 trillion cells to build the body, each cell of the human body contains 70% more water. Humans need water that is suitable for consumption. Water that is fit for consumption is water that has been processed or without processing that has met the requirements and can be drunk immediately. Various factors can cause water quality to decline, one of which is a water container in the form of gallons of water. From the results of a survey of students, 69.2% of students stated that drinking water on campus was not adequate. Meanwhile, 16.9% stated that it was not suitable and 13.8% of the other students stated that drinking water was suitable for consumption. So that the control system is modified on the existing devices so that they can work more effectively and efficiently. Furthermore, the research data was taken using quantitative data analysis techniques with descriptive statistics and the calculation of the average relative error. In the resulting data, the relative error value of the working time variable is 0.51% and 17.2% of the variable delay. And the relative variable error value is 18.3%. For the level of particle content in water in gallon 1 an average of 54 mg / L with an average temperature of 27.44 ° C and in gallon 2 of 52.6 mg / L with an average temperature of 28 ° C.

This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



Corresponding Author:

Kharisma Ramadhan,
Department of Electrical Engineering
Gajah Tunggal Polytechnic,
16 Gajah Tunggal Street, Jatiuwung District, Tangerang City, Banten 15133, Indonesia.
Email: kharismaramadhan8@gmail.com

1. INTRODUCTION

In the human body, there are various kinds of parts, one of which is the body's cells. The human body cells that build this body are as many as 60 trillion, each body cell contains 70% more water. Thus, the human body contains more than 70% water[1]. So that water has an important role in the performance of human cells. Lack of water in the human body will interfere with the biological reactions in the body's cells, this can cause the body to feel sick and can cause death. In general, water in the human body can be reduced through urine, sweat, and feces. To maintain the stability of water in the human body, it is necessary to replace the lost water by diligently consuming drinking water that is fit for consumption.

Water that is fit for consumption is water that has been processed and has met the requirements and can be drunk immediately[2]. Drinking water that meets the requirements is that it has no taste, no smell, no color, no harmful microorganisms, and no heavy metals[3]. So, drinking water treatment is needed to maintain the quality of water so that it is suitable for consumption. Along with current technological developments, drinking water treatment is developing rapidly. This is influenced by the increasing population in Indonesia. The increase in the population of Indonesia in

2010 - 2019 was 1.31%. This means that the average annual population growth of Indonesia increases by 1.31%[4]. Therefore, the need for drinking water also increases. Technological support can make it easier for people to get drinking water suitable for consumption. Besides, the convenience of technology is an alternative to take advantage of existing business opportunities. This can be seen from the fact that water treatment for consumption is not always carried out by large drinking water companies. There have been many refill drinking water depots that treat water for consumption which are operated by themselves.

The refill drinking water depot becomes a place for refilling drinking water using a drinking water filling machine. These machines perform various filtering processes to produce drinking water that is fit for consumption[5]. In addition to community businesses, many other institutions and companies also refill drinking water depots. The technology used in a refill water depot must be qualified. The technology is different for each depot for drinking water refills. This makes it an advantage for each depot. In addition to the filtering process, the refill drinking water depot also needs to pay attention to the condition of the gallon as a container for drinking water. The cleanliness condition of the gallon can also be a determining factor for the quality of drinking water. Usually, water refill operators clean the gallons to be filled with drinking water.

This research is aimed at educational institutions under the auspices of companies that have their drinking water treatment for employees and students. These institutions need a water gallon cleaning tool so that the water quality is better. From the results of a survey of students, 69.2% stated that drinking water on campus was not adequate. Meanwhile, 16.9% stated that it was not suitable and 13.8% of the other students stated that drinking water was suitable for consumption. The lack of proper quality of drinking water is triggered by less clean gallons. Previously, research had been carried out on the design of a gallon cleaner, but it had not worked effectively and the operating system was still working manually. The average gallon cleanliness with this gallon cleaner was obtained data on oral hygiene for 50% gallons, 60% gallon shoulders, 80% gallon body, and 28% gallon bottoms[6]. Thus, from the same survey, 96.9% of students wanted the gallon cleaner to run effectively.

To modify the control system for cleaning refill water gallons, there are 2 elements, namely the material element and the method element. Where the material elements that previously used button components will be changed using ultrasonic sensors. The ultrasonic sensor is a piezoelectric sensor application that can determine the distance of objects and the height of the liquid surface in a non-contact way. This sensor consists of two piezoelectric transducers, where one transducer has a function to send sound waves, while the other transducer will receive the sound waves that have been reflected in the object[7]. This sensor makes use of ultrasonic sound waves. Where the ultrasonic waves are waves with a frequency of more than 20 kHz. The waves are reflected by the first transducer to the object and then received by the second transducer as in Figure 1.

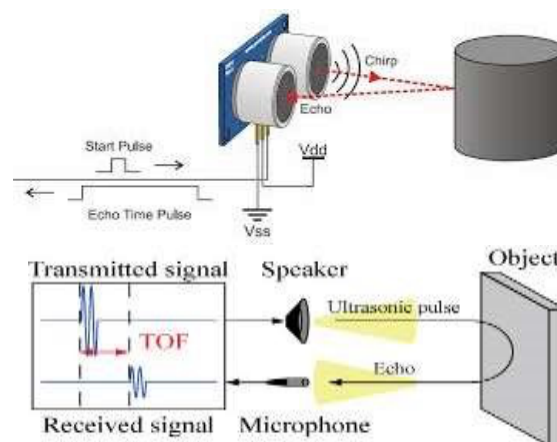


Figure 1. Principles of Ultrasonic Distance Measurement [8]

The HC-SR04 ultrasonic sensor works at a voltage of 5 VDC and a working current of 15 mA. The distance that can be read by the HC-SR04 sensor is from 2 cm to 400 cm. If the object's position is not straight, the HC-SR04 ultrasonic sensor can read the object's position with a 30-degree inclination. The transducer on this sensor will emit sound waves at a frequency of 40kHz[9]. For more details, it can be seen in Table 1.

Table 1. Ultrasonic Sensor Specifications HC-SR04[9]

Parameter	Min	Typ.	Max	Unit
Operating Voltage	4.50	5.0	5.5	V
Quiescent Current	1.5	2	2.5	mA
Working Current	10	15	20	mA
Ultrasonic Frequency	-	40	-	kHz

The work process of the ultrasonic sensor is regulated by the Arduino ATmega 328P microcontroller. Arduino UNO is a microcontroller with IC Atmega 328P which has 28 pins. In Figure 2, Arduino pins consist of 14 digital input/output pins (with 6 outputs for PWM), 6 analog inputs, 2 16 MHz ceramic crystal resonator pins, 2 GND pins, 2 VCC pins, 1pin reference analog, and 1pin reset[10]. This Arduino is the brain of a system to do a job. That is, every operating system requires a brain or processor to work. This processor will receive input commands is then processed and produce output commands to do the work of a system.

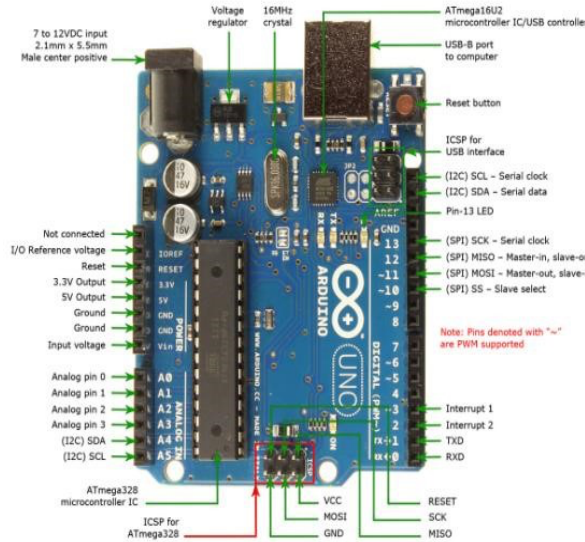


Figure 2. Arduino UNO ATmega 328P[11]

On the Arduino ATmega 328P, there are pins input analog that is named starting from A0 to A5. The analog input can process input values in the form of analog values operating range 0 to 5V. Whereas the pins input/output digital consists of D0 to D13. Digital input can be interpreted as a non-continuous time signal with discrete input pulses represented as 0 and 1[10]. Arduino Uno programming can be done with the Arduino *Integrated Development Environment* (IDE) with a display like a Figure 3. The software works based on the C program on Arduino which is referred to as a sketch[11]. These sketches have their respective functions which will give commands to the microcontroller or IC ATmega 328. Where data is sent from the computer to Arduino using a USB 2.0 type B cable.

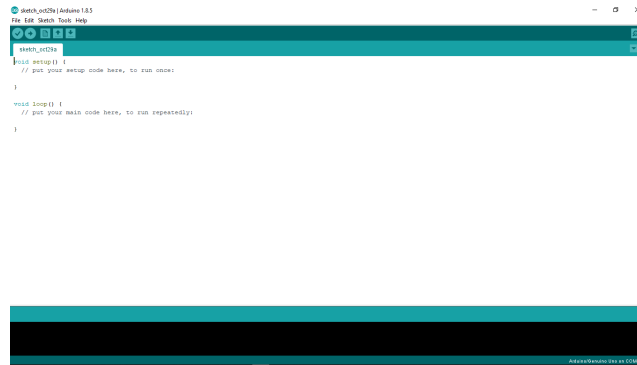


Figure 3. Initial Appearance of Arduino IDE

2. RESEARCH METHOD

The Method used in this research is to modify the control system for cleaning gallons of water. Data is taken by sampling, namely by taking data on the serial print Arduino to find out the distance read by the sensor when the tool is working. Besides, the data was also taken using a *Total Dissolved Solids* (TDS) meter to determine the value of the particle content in the water. Then calculate the accuracy of the distance and time required to operate by looking at its relative error. This research method aims to solve existing problems in a structured manner. Figure 4 shows the flow of the research process that has been carried out.

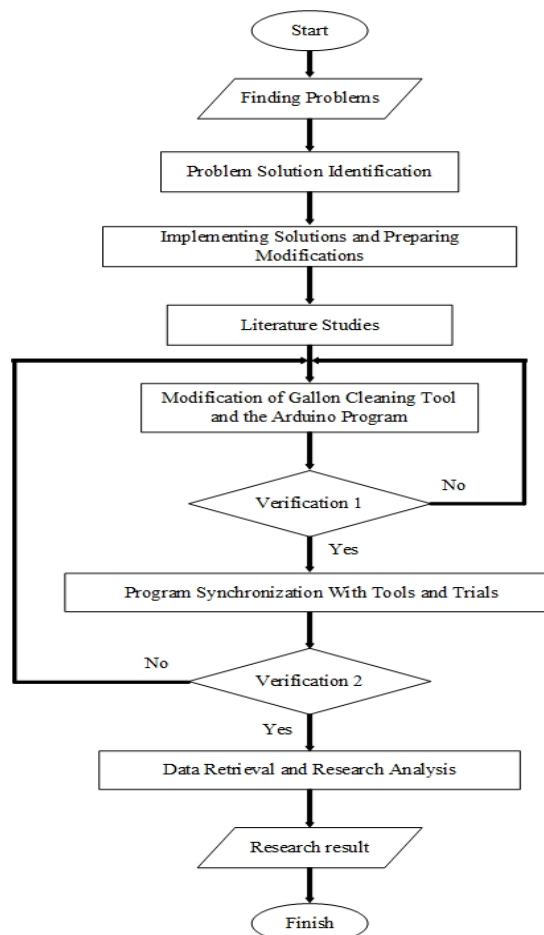


Figure 4. Research Flow Process

2.1. Research Time

Table 2 shows the schedule for conducting the research.

Table 2. Research Implementation Schedule

No	Activities	Week-							
		September			October				
		2	3	4	1	2	3	4	
1	Finding Problems	✓		MID TEST					
2	Problem Solution Identification	✓							
3	Implementing Solutions and Preparing Modifications		✓						
4	Literature Studies		✓						
5	Modification of Gallon Cleaning Tool				✓				
6	Modify the Arduino Program				✓				
7	Verification 1				✓				
8	Program Synchronization With Tools and Trials					✓			
9	Verification 2					✓			
10	Data Retrieval						✓		
11	Research Analysis						✓		
12	Research Result							✓	

2.2. Research Tools

The tools used in this study were (1) screwdriver, (2) cutting pliers, (3) solder, (4) attractor, (5) hammer, (6) nut. While the materials used are (1) Arduino, (2) HC-SR04 ultrasonic sensor, (3) Relay, (4) Push Button, (5) Switch, (6) Electric motor, (7) Jumper cable, (8) Socket, (9) Plug, (10) Gallon cleaning brush.

2.3. Data Collection Techniques

In this study, the research data collection technique used quantitative data analysis techniques with descriptive statistics and the calculation of the average relative error. This test obtains limited data by being presented in tabular form from the trial results[12].

2.4. Equation Analysis

This study uses the calculation of the relative error value in data processing distance and time. Relative error calculation formula[13]:

$$\text{Error}\% = \left| \frac{\text{Measurement} - \text{Actual}}{\text{Actual}} \right| \times 100\%$$

Note:

Error% = Relative error of measurement

Measurement = Value on the test tool

Actual = Value set on the microcontroller

3. RESULTS AND DISCUSSION

3.1. Result of Tool Modification

Figure 5 shows the modified gallon water cleaning tool.



Figure 5. Gallon Water Cleaning Tool

3.2. Tool Testing Analysis

Tool testing is carried out by testing the source code programmed on the Arduino microcontroller, where the tool performance settings with the tool working time for 60 seconds or 1 minute with a delay 5-second hand the sensor reading distance is less from 12 cm. In Table 3 is the data from the testing tools:

Table 3. Testing Results Working

No	Time(s)	Delay(s)	Distance (cm)
1	59,9	8,2	7
2	59,9	8,8	8
3	59,9	5,9	9
4	59,9	5,6	9
5	59,8	5,2	11
6	57,8	5,1	11
7	59,8	5,2	11
8	59,9	4,4	11
9	60	5,2	8
10	60	5	11
Average	59,69	5,86	9,6

Calculation average Error% on the results of the test data:

Error% of the value of the working time of the tool:

$$\text{Error}\% = \left| \frac{59,69 - 60}{60} \right| \times 100\% = 0,51\%$$

Error% on the delay value:

$$\text{Error}\% = \left| \frac{5,86 - 5}{5} \right| \times 100\% = 17,2\%$$

Error% on distance value

$$\text{Error}\% = \left| \frac{12 - 9,8}{12} \right| \times 100\% = 18,3\%$$

From the value of the test results, the relative error value of the variable working time can be calculated delay and sensor reading distance. The value error% obtained from the working time variable is 0.51%. The value error% obtained from the variable is delay by 17.2%. The value error% obtained from the distance variable is 18.3%.

3.3. Analysis of Particle Content Testing

Testing of the tool is carried out by entering a glass of clean water into a gallon then the gallon is cleaned using a *Total Dissolved Solids* (TDS) meter. The water that is in the cleaned gallon is then taken and tested using the tool. The results obtained are as follows in Table 4:

Table 4. Testing Results of Gallon Water Particle Content

No	Gallon 1		Gallon 2	
	Tds (mg/l)	Temperature (°C)	Tds (mg/l)	Temperature (°C)
1	58	26	51	29
2	49	29	53	28
3	55	27,4	53	28
4	53	27,5	53	27,6
5	55	27,3	53	27,4
Average	54,00	27,44	52,6	28

The experiment was carried out 5 times with 2 different gallons. The experimental results obtained at gallon 1, namely the average particle content level of 54 mg/liter with an average temperature of 27.44 ° C and the average particle content level at gallon 2 of 52.6 mg/liter with an average temperature. 28 ° C. The *World Health Organization* (WHO) standard for safe drinking water must have a TDS value of <300 parts per million (ppm)[14]. Meanwhile, the Regulation of the Minister of Health of the Republic of Indonesia states that the maximum TDS standard allowed is 500 mg/liter or 500 parts per million (ppm)[2]. So that from the research results obtained, namely the level of particle content in the water, all gallons tested have met the set standards.

4. CONCLUSION

Modification of the water gallon cleaning tool control system is done by adding an automation system that goes well. The relative error value (Error%) which is obtained from the punctuality of time is when working time is 0.51%, while for the variable delay it is 17.2%. The distance relative error value is 18.3%. And for the level of water particle content after cleaning, an average of 54 mg/liter gallon 1 with an average temperature of 27.44 ° C and an average particle content level of 2 gallons of 52.6 mg/liter with an average temperature average 28 ° C. Thus, the water quality can be declared suitable for consumption and the gallon water cleaner can be declared effective and efficient for use.

REFERENCES

- [1] F. . Winarto, *Manajemen Air Hujan: Sumber Baru Air Minum*. Jakarta: PT Gramedia Pustaka Utama, 2016.
- [2] K. K. Indonesia, "PERMENKES No. 492/Th.2010 Tentang Persyaratan Kualitas Air Minum," *Permenkes No. 492/Th.2010*, no. 492. 2010.
- [3] K. K. Indonesia, "Keputusan Menteri Kesehatan Republik Indonesia Nomor 907/Menkes/Sk/VII/2002 Tentang Syarat-Syarat Dan Pengawasan Kualitas Air Minum," *Keputusan Menteri Kesehat. Republik Indones.*, vol. 53, no. 9, pp. 1689–1699, 2002.
- [4] "Badan Pusat Statistik." <https://www.bps.go.id/statictable/2009/02/20/1268/rata-rata-laju-pertumbuhan-penduduk-menurut-provinsi-1971---2019.html>.
- [5] W. S. P. Imam Suhendra, "Aplikasi Load Cell Untuk Otomasi Pada Depot Air Minum Isi ulang," *Sains dan Teknol.*, vol. 1, no. 1, pp. 11–19, 2015.
- [6] N. Prasojo, A. Setyo, Fajar, A. M. Rasyid., Paramitha, A. Desvi, Fauzi, M., "Rancang Bangun Alat Pembersih Galon Air Isi Ulang Berbasis Mikrokontroler," Tangerang, 2019.
- [7] S. P. Sakti, *Pengantar Teknologi Sensor: Prinsip Dasar Sensor Besaran Mekanik*. Malang: UB Press, 2017.
- [8] K. Manpreet and P. Jai, "Distance Measurement Of Object By Ultrasonic Sensor HC-SR04," *IJSRD-International J. Sci. Res. Dev.*, vol. 3, no. 05, pp. 2321–0613, 2015, [Online]. Available: www.ijssrd.com.
- [9] Cytron Technologies, "Manual Book HC-SR04." pp. 1–10, 2013, [Online]. Available: <http://raspoid.com/download/datasheet/HCSR04>.
- [10] R. H. Sudhan, M. G. Kumar, A. U. Prakash, S. A. R. Devi, and S. P., "Arduino Atmega-328 Microcontroller," *Ijireeice*, vol. 3, no. 4, pp. 27–29, 2015, doi: 10.17148/ijireeice.2015.3406.
- [11] N. Anju Latha, B. Rama Murthy, and K. B. Kumar, "Distance Sensing with Ultrasonic Sensor and Arduino," *Int. J. Adv. Res. Ideas Innov. Technol.*, vol. 2, no. 5, pp. 1–5, 2016.
- [12] J. P. A. Musawwirul Munir Syasmar, Lahming, "Modifikasi Alat Sortasi Gabah (Orizae Sativa L)," *J. Pendidik. Teknol. Pertan.*, vol. 5, pp. 183–188, 2019, doi: 10.32699/ppkm.v7i1.1060.
- [13] B. H. I. Martalia Andayani, Widyaningrum Indrasari, "Kalibrasi Sensor Ultrasonik HC-SR04 Sebagai Sensor Pendeteksi Jarak Pada Ptopie Sistem Peringatan Dini Bencana Banjir," *Pros. Semin. Nas. Fis. SNF2016*, vol. V, pp. SNF2016-CIP-61-SNF2016-CIP-66, 2016, doi: 10.21009/0305020113.
- [14] WHO (World Health Organization), "Total Dissolved Solids (TDS) in Drinking-Water," *WHO/SDE/WSH/03.04/16*. doi: 10.1080/10417943609370625.