

## ARDUINO-BASED MONITORING OF ACIDITY AND BASICITY IN MINERAL WATER, WELL WATER, AND DEPOT WATER

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### ABSTRACT

*The quality of drinking water is strongly influenced by its pH value which shows the acidity or basicity of water. This study aims to design and test an Arduino Uno-based water acidity and basicity monitoring tool, which can be used to measure pH in three types of water sources: Le Mineral Water, Well Water, and Depot Water. The system uses a pH sensor to measure water acidity and basicity, comparing the results with the WHO's safe range of 6.5-8.5. The experimental results show that all water samples have pH values that are within the neutral range and safe for consumption: 7.71 - 7.76 for Le Mineral Water, 7.55 - 7.56 for Well Water, and 7.67 - 7.81 for Depot Water. This system is proven effective for real-time monitoring of water pH and can be used as a simple and economical solution in maintaining the quality of household consumption water.*

**Keywords :** Water pH, Arduino Uno, pH-4502C Sensor, Water Content Monitoring



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## I. INTRODUCTION

Water is a basic need that is very vital for human life [1]. The availability of clean water is a top priority, especially for people who depend on water sources from the surrounding environment such as rivers, boreholes, or dug wells. However, the quality of water from these various sources has not been monitored effectively and sustainably, especially in terms of acidity and alkalinity (pH), which are the main indicators of the suitability of water for consumption [2].

The main problem faced is the unavailability of an efficient, practical and accurate water quality monitoring system for use by the community and local government [3]. Manual examination of water quality generally requires experts and laboratory equipment, making it inefficient for daily monitoring in the field. As the concept of smart environment develops, the need for technology-based water quality monitoring systems is increasing. This is driven by global awareness of the importance of maintaining environmental sustainability and public health through the use of efficient and accessible technology. One relevant and applicable solution is the application of microcontrollers in water monitoring systems, which allows real-time measurement of important parameters such as pH [4].

A pH sensor is a device used to measure the acidity and basicity of a solution [5]. This component is very important in water quality measurement systems by reading and providing accurate data. One important parameter in determining water quality is acidity or pH. The pH scale ranges from 0 to 14, where a pH value of 7 is considered neutral, values below 7 are acidic, and above 7 are alkaline [6]. In the context of drinking water, pH balance is very important to maintain the stability of the body system and prevent health problems. Water with a low pH (acidic) can cause corrosion of pipes, damage tooth enamel, and make the kidneys work harder. Conversely, water with a high pH (alkaline) can also cause indigestion and disturb the body's balance if consumed in excess.

Drinking water quality standards according to the World Health Organization (WHO) and the Regulation of the Minister of Health of the Republic of Indonesia state that the pH of drinking water suitable for consumption is in the range of 6.5 to 8.5, this value is considered safe and does not cause negative effects on health [7]. The

development of information technology and electronics, the use of microcontrollers such as Arduino Uno is an essential solution for designing an integrated water monitoring system. With the help of a pH sensor, the system can automatically monitor and display water quality data. This innovation not only provides technical benefits, but also has the potential to support government policies in providing clean water and increasing public awareness of the importance of water quality [8].

Based on this background, this study aims to design and test an Arduino Uno-based acidity and basicity monitoring system for Mineral Water, Well Water, and Depot Water that is reliable, economical and easy to use by the general public.

## II. METHOD

This research was conducted in May 2025 at the Physics Laboratory of Padang State University with the aim of designing and testing an Arduino Uno microcontroller-based water acidity and basicity system. The research method used is the experimental method, where the system device is assembled using a pH sensor connected to the Arduino Uno, and is equipped with a 16x2 LCD and buzzer as an indicator. The water samples used include Le Mineral Water, Well Water, and Depot Water, each of which is tested to determine the level of acidity and basicity (pH).

The pH sensor functions to read the pH value of the tested water sample, then sends the analog data to the input pin on the Arduino Uno. This analog data is then converted into digital values that can be processed by the program to determine the category of water based on drinking water pH standards. After the Arduino Uno receives and processes the pH value, the system will classify the water condition into three main categories, namely acidic, neutral, and alkaline [9]. Based on the pH value range as follows: Acid Category  $\text{pH} < 6.5$  if the detected pH value is smaller than 6.5, the system will activate the buzzer as a warning indicator. This indicates that the water is in an acidic condition that can contain corrosive substances and heavy metals, making it unfit for consumption. The buzzer sound serves as a danger sign so that users immediately stop using the water. The Neutral category if the pH value is in the range of 6.6 to 8.4, the system will detect that the water is neutral and suitable for consumption. This range is in accordance with the drinking water quality standards set by WHO and the Indonesian Ministry of Health. And the Alkaline category  $\text{pH} > 8.5$  if the pH value exceeds 8.5 the system will also activate the buzzer as a warning indicator. Although water in alkaline conditions is not corrosive, it can affect the taste of water and cause imbalances in the body if consumed in excess. Therefore, the buzzer is turned on as a form of warning that the water is outside the neutral range and needs to be reviewed for suitability before consumption.

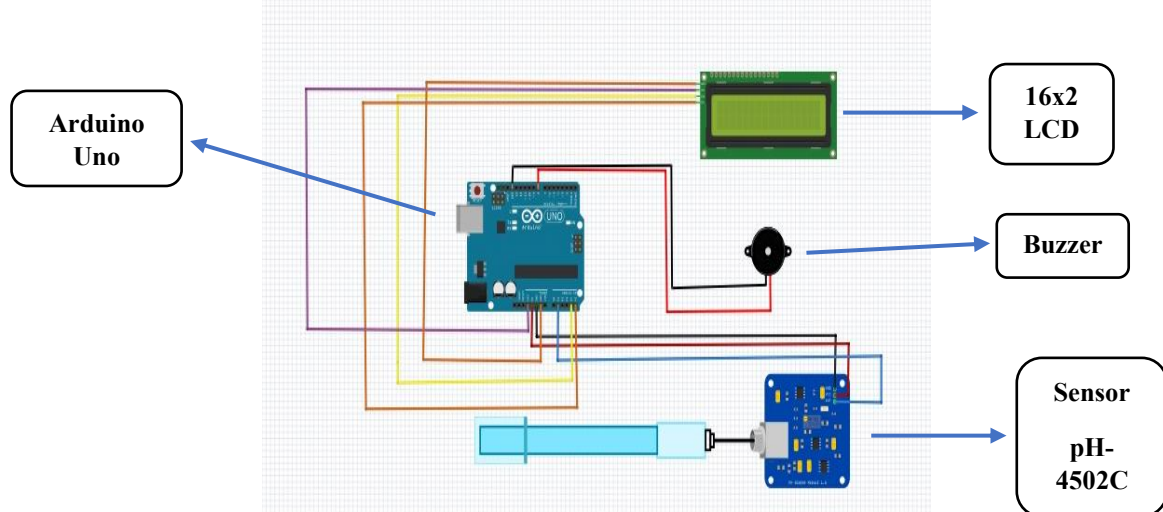


Figure 1. Software Design

The software design in figure 1, is designed to read the pH-4502C sensor data, then process the value, display the results on the 16x2 LCD, as well as provide a warning via a buzzer, sending a warning via a buzzer. This software also plays an important role in the overall system of tools on the pH sensor because it connects sensor readings, data processing, results display; as well as alarms in an integrated manner. With the support of the Arduino Idea, the system becomes easy to develop and modify according to the needs of various types of water tested, such as Mineral Water, Well Water, and Depot Water.

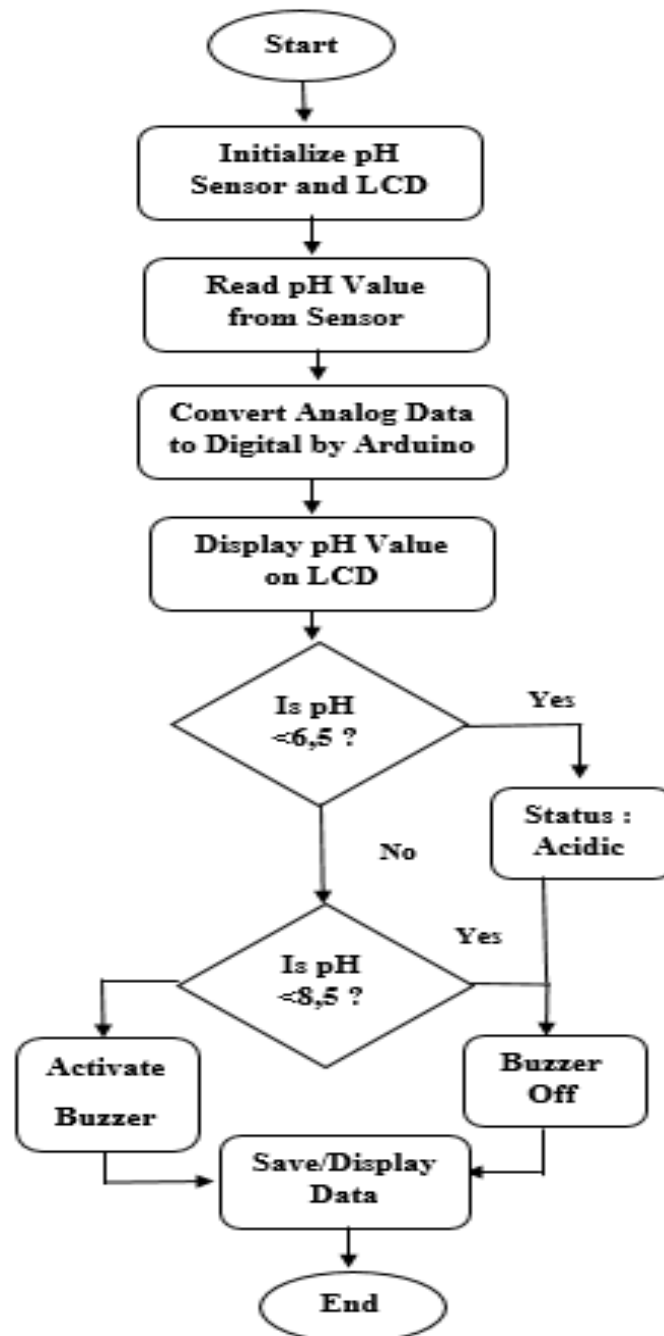


Figure. 2. Tool Flowchart

Designed with the workflow of the Arduino Uno-based system automatically. Starting with the initialization of the sensor and LCD module, reading the pH value from the sensor, converting analog data to digital by Arduino Uno, to displaying the results on the 16x2 LCD screen. Once the pH value is displayed, the system automatically evaluates whether the value is below 6.5 (acidic), between 6.5 to 8.5 (neutral), or above 8.5 (alkaline). If the pH value is detected to be outside the neutral range, the system activates a buzzer to warn that the water is not fit for consumption. Conversely, if the value is within the safe range, the buzzer remains off and the water is declared fit for consumption. This process is continuously repeated, allowing users to monitor water quality directly and efficiently without the need for additional devices. The system is designed to provide a practical, responsive, and economical solution in daily water quality monitoring, especially in household and community settings.

### III. RESULTS AND DISCUSSION

The pH measurement results that have been processed by the Arduino Uno will be directly displayed on the 16X2 LCD module connected to the microcontroller. This data display allows users to monitor the pH value of water in real-time without the need for additional devices such as computers or external communication modules. The results of the Hardware system display can be seen in Figure 3.

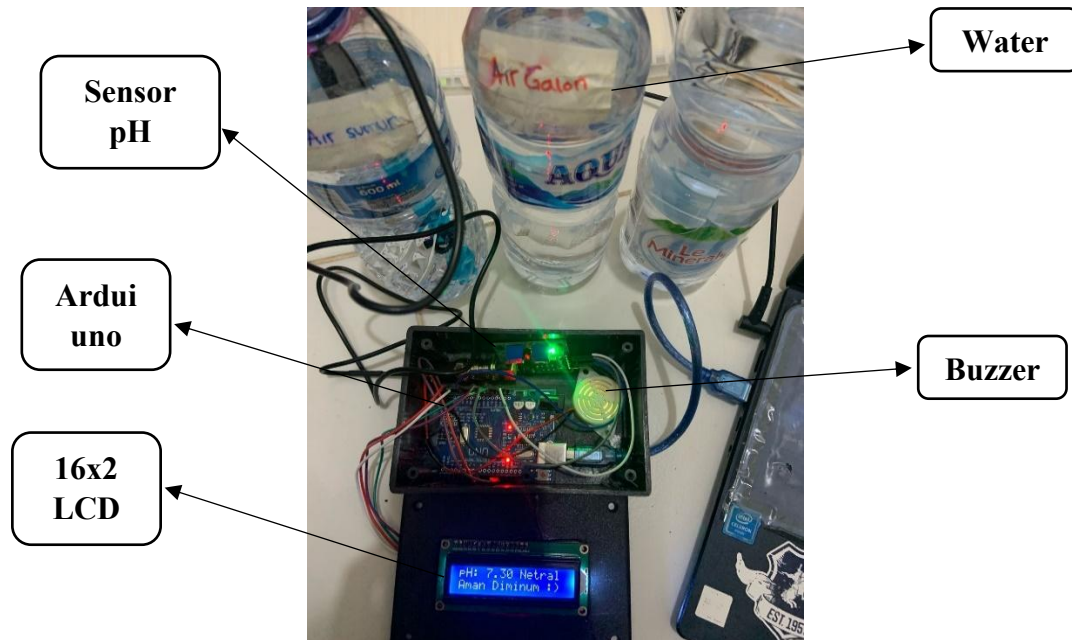


Figure 3. (a) Hardware Design

In Figure 3. shows the hardware circuit of the Arduino Uno-based monitoring system for acidity and basicity in three different waters [10]. which has been functionally assembled and tested on three types of water: Well Water, Gallon Water, and Mineral Water. The system consists of a pH sensor connected to an Arduino Uno to read the acidity and basicity values of the water, with these results displayed in real-time on a 16x2 LCD screen, as shown above. In addition, there is a Buzzer Indicator that functions to provide sound notification if the water is outside the normal pH threshold [11]. This system is designed with a protective box (Electronic Box) to keep components safe and neat.

The pH measurement results that have been processed by Arduino Uno will be directly displayed on the 16x2 LCD module connected to the Microcontroller. This data display allows users to monitor the pH value of water in real-time without the need for additional devices such as computers or external communication modules. In this system, data transmission is done locally through the LCD display, making it quite simple and efficient. In addition, if the pH value is detected to be outside the predetermined safe limits, namely below 6.5 (acidic) or above 8.5 (alkaline) Arduino will automatically activate the buzzer as a warning alarm. This alarm serves to notify users to immediately take the necessary action against water quality that is not suitable for consumption.



**Figure. 4.** Hardware System

Testing on the system is done by taking water samples, namely: Le Mineral Water, Well Water, and Depot Water. Each sample will be tested using the monitoring system and compared with the measurement results using a standard tool, namely the pH Meter [12]. Testing is carried out in several trials to ensure accuracy and consistency in the measurement results [13]. Then the test results will show how accurate the monitoring system is in measuring the pH of water from several samples. The data obtained will be analyzed to determine whether the system meets the established water quality standards. If the measurement results of the monitoring system are close to the standard measurement results, then the system can be considered effective and feasible to use for water quality monitoring. In addition, a comparative analysis of the pH values of the three types of water using the designed system and standard measuring instruments was carried out. The measurement results show that all water samples are in the neutral pH range, in accordance with WHO, which is between 6.5 and 8.5. The level of measurement error between the design tool and the standard tool ranged below 1%, indicating a high level of accuracy and good measurement consistency [14]. The highest difference in values occurred in the measurement of well water, which is thought to be caused by the variability of mineral content and chemical compounds in it. Meanwhile, depot water, well water and le mineral water showed stable pH values and low errors, which can be attributed to the previous treatment and filtration processes. Thus, the system is not only able to provide accurate measurement results, but also offers ease of use, quick response through the buzzer indicator, and efficiency in terms of being applied in households and community environments that require regular and independent monitoring of water quality.

In this system, data transmission is carried out locally through the LCD display, making it simple and efficient [15]. In addition, if the pH value is detected to be outside the predetermined safe limits, namely below 6.5 (acid) or above 8.5 (base). Arduino Uno will automatically activate the buzzer as a warning alarm. This alarm serves to notify users to immediately take the necessary action against water quality that is not suitable for consumption. The measurement accuracy of the system was evaluated by comparing the results obtained from the system with those from a standard digital pH meter, as shown in the following graph:

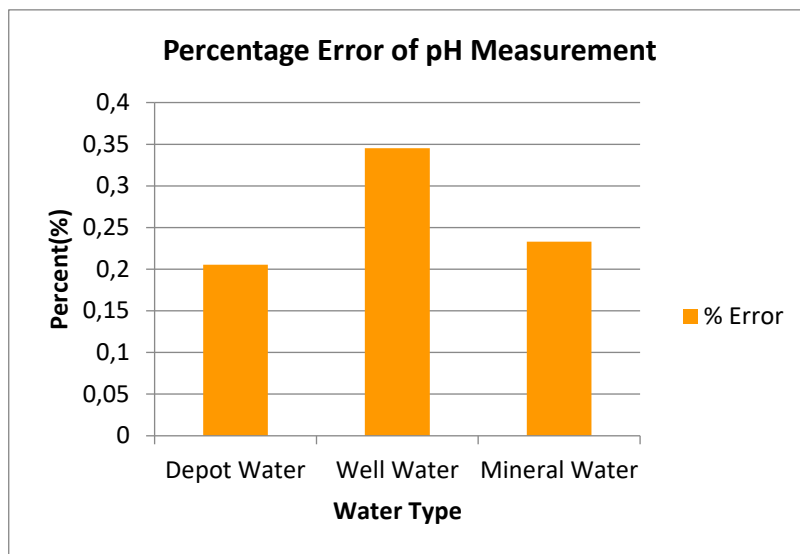


Figure. 5. Graph of pH Measurement Error Percentage

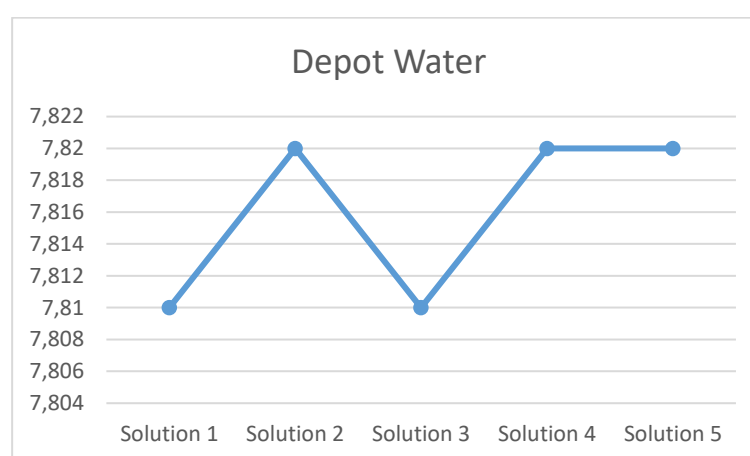
Table. 1. Percentage Error of pH Measurement

Water Type	pH standard	Avarage	%Error
Depot Water	7.79	7.806	0.20539
Well Water	7.53	7.556	0.3453
Mineral Water	7.72	7.738	0.23316

Show the graph in the image and table the percentage error between the measured pH value and the measured pH value and the measured pH value and the standard pH value for three types of water, namely Depot Water, Well Water, and Mineral Water, has a % error that can be seen in the graph above, it identifies that the tool is quite accurate and reliable in measurement. It can be seen that Well Water has the highest error rate, which is around 0.34% compared to Depot Water and Le Mineral Water which have errors of around 0.2% and 0.23% respectively. This could be due to the chemical composition and mineral content in well water which is more variable and unstable, causing the pH sensor reading to be slightly more accurate. Meanwhile, Depot Water and Le Mineral Water have generally gone through a more controlled filtering process and quality standards, so the sensor is able to provide more consistent measurement results and is closer to the reference pH value. Although there are differences in error between water types, the error values shown are still very low <1%, which means that the designed measurement system is reliable and accurate enough to be used in daily water quality monitoring.

**Table. 2.** Measurement results of acidity and basicity in Depot water

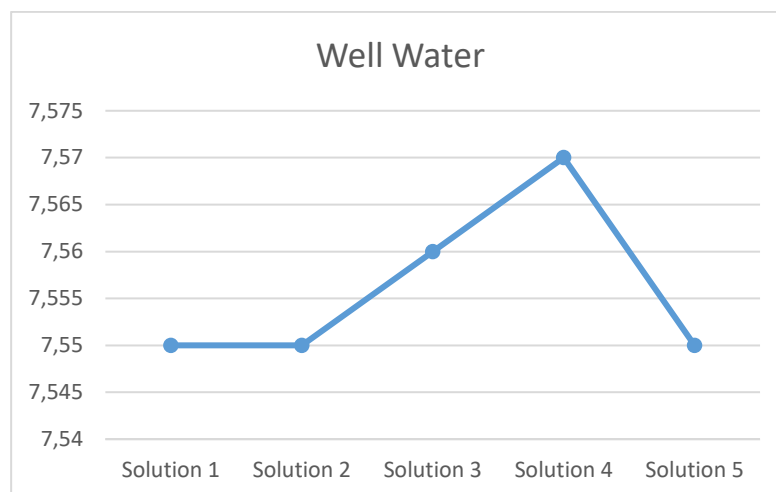
Ph	Status	Description	Buzzer
7,81	Neutral	Safe to drink	Off
7,82	Neutral	Safe to drink	Off
7,81	Neutral	Safe to drink	Off
7,82	Neutral	Safe to drink	Off
7,82	Neutral	Safe to drink	Off

**Figure. 6.** Graph of acidity and basicity measurements of depot water

Depot water shows significant fluctuations. In solution 1, the measured water content was 7.822 then decreased in solution 2 to 7.818 after that, there was another decrease in solution 3 to 7.814 before finally increasing again in solution 4 to 7.818 and slightly increased again in solution 5 to 7.804. The results of pH measurements on the five depot water samples show that the water quality is in neutral to slightly alkaline conditions, with very small fluctuations and still within safe limits. This identifies that the depot water is suitable for consumption and does not require further pH adjustment.

**Table.3.** Measurement results of acidity and basicity in Well Water.

Ph	Status	Description	Buzzer
7,55	Neutral	Safe to drink	Off
7,55	Neutral	Safe to drink	Off
7,56	Neutral	Safe to drink	Off
7,57	Neutral	Safe to drink	Off
7,55	Neutral	Safe to drink	Off

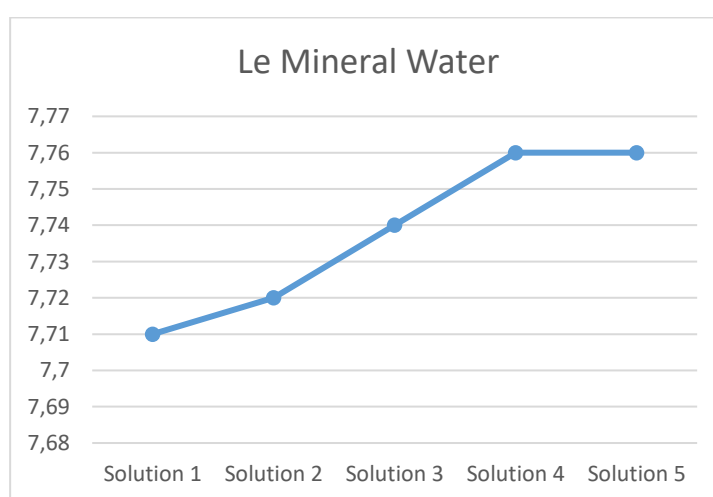


**Figure. 7.** Graph of Acidity and Basicity Measurement of Well Water

Meanwhile, the Well Water showed more stable results. In Solution 1, the water content started at 7.55 then rose gradually until it reached 7.57 in solution 2, and continued to increase until it peaked in solution 5 at 7.575. Despite fluctuations, all pH values are still within the neutral and safe range according to drinking water standards (6.5 - 8.5) so that this well water is considered suitable for consumption without indications of excessive acidity or high alkalinity.

**Table.4.** Measurement results of acidity and basicity levels in Le Mineral Water

pH	Status	Description	Buzzer
7,71	Neutral	Safe to Drink	Off
7,72	Neutral	Safe to Drink	Off
7,74	Neutral	Safe to Drink	Off
7,76	Neutral	Safe to Drink	Off
7,76	Neutral	Safe to Drink	Off



**Figure. 8.** Graph of measurement of acidity and basicity of Le Mineral Water

The graph above shows the changes in the pH value of Le Mineral Water in five different solutions. In solution 1, the pH was recorded at 7.71 which then decreased in solution 2. However, after that, the pH began to increase consistently in solution 3 to solution 5. This identifies better water quality in the last solution compared to the previous solution.

Based on the measurement results of the acidity and basicity of the Depot Water, the pH variation is quite diverse, with the highest pH reaching 7.81 and the lowest 7.67. From the table presented, it can be seen that most of the water samples are at neutral status and are considered safe for use. These measurements indicate that the water from the Depot meets the quality standards expected for consumption purposes. Measurements at the wells showed a slightly lower pH than the Depot Water with a range between 7.55 to 7.56 indicating that the water from the wells is also in the neutral category and safe to drink. All samples tested showed safe status, so it can be concluded that the quality of this Well Water is quite good for health. The measurement results of Le Mineral Water show that the pH varies from 7.71 to 7.76, all water samples have a neutral status and are considered safe for consumers. With a statement stating that this water is safe to drink. The quality of Le Mineral Water based on the results of this test, shows that the water source also meets the standards needed to maintain public health.

#### IV. CONCLUSION

An arduino-based system for monitoring water acidity and alkalinity has been successfully designed and tested. The system integrates an Arduino Uno microcontroller, pH sensor, LCD module, and Buzzer to evaluate water quality from various sources, including Mineral Water, Well Water, and Depot Water. The results show that Depot Water has pH values ranging from 7.67 to 7.81, Well Water from 7.55 to 7.56 and Le Mineral from 7.71 to 7.76 all within the neutral and safe range for consumption. The measurement error was below 1% demonstrating high accuracy and reliable system performance. With its simple, low-cost, and user friendly design, the proposed system offers a practical solution for daily water quality monitoring, particularly for communities relying on local water sources. The inclusion of a buzzer alarm further enhances usability by providing alerts when pH levels fall outside the safe range.

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