Electric Current Controller Subsystem for Automatic Socket Control of Portable Water Ionizer

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ABSTRACT

The control of electrical current is a crucial element in the development of automatic outlets, especially in the context of the Portable Water Ionizer. The ability to regulate and manage electrical current is a key aspect in ensuring optimal and efficient performance. Testing was conducted when the water temperature exceeded the established threshold of 29°C (Value of 29°C was set as the threshold based on test results, with the initial water temperature before electrolysis process being room temperature). Test results indicated that when the temperature reached or exceeded the threshold, the relay effectively cut off the electrical current by activating the NO terminal, which was originally connected to electrical current. Testing also involved voltage measurements using AVOmeter on the electrode rod, indicating the presence of electrical current (24.7V) on the electrode rod under normal conditions and no electrical current (0V) when the relay functioned. Results demonstrated that the relay operated effectively in controlling electrical current as per the provided commands. Testing confirmed that the relay could disconnect electrical current when the conditions were met, and the electrode had no electrical current when the relay functioned correctly. This system provides a reliable solution for maintaining optimal water conditions within the PWI.

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1. INTRODUCTION

Alkaline water has garnered significant attention in the field of Health. It refers to water with a higher pH level compared to regular drinking water. Alkaline water, rich in hydroxide ions (OH^-), is known to help increase the body's alkalinity levels. To produce alkaline water, individuals can utilize machines or electrolysis devices such as the Portable Water Ionizer. This device functions to separate ions within water with the aim of elevating its pH. The Portable Water Ionizer (PWI) is an electrolysis device comprising two sides of varying sizes. The larger side serves as the cathode, while the smaller side acts as the anode. A perforated membrane is positioned between the boundaries of these two sides, allowing the current of ions during the electrolysis process. The PWI is used to generate two types of water, namely alkaline water and acidic water, by altering the ion composition in mineral water [1].

Water ionizer technology is one of the latest breakthroughs in the field of water purification. This is a method that uses electrodes to produce certain ions in water, which can then remove contaminants and improve water quality. There are interesting and innovative achievements in efforts to improve the quality of water consumed by the community. This research plays an important role in understanding and developing technologies that enable the provision of cleaner, safer and healthier water. Currently, "portable water ionizer" technology has experienced development through various research. Some research have adopted different approaches to power sources, including the use of solar cells/solar-hydrogen as a power source or rechargeable lithium batteries as a power source, and some research make of electrolyzed water for renewable energy storage systems, as well as other innovations. Although much research has been done in this area, there is still room for further development and increased efficiency [2]-[5].

In previous research, the PWI device had been developed using a pH measurement method involving a pH meter. However, this method was deemed impractical and cumbersome due to the need for repeated pH measurements. Additionally, determining when alkaline water was ready for consumption was challenging, often relying on visual cues such as changes in water color. Furthermore, manual intervention was required to unplug the device when the desired conditions were reached. Therefore, an innovation was developed based on previous research, namely creating a special Automatic Socket for Portable Water Ionizers. The working principle of this contact stop is to stop the electric current automatically with a relay as a current load controller, then the relay itself is connected to a microcontroller which is also connected to a temperature sensor. This solution is tested and data is collected at what temperature the pH of the water reaches the desired pH, then the average data is taken to become a threshold which will later be used as a parameter for the electricity circuit breaker. The main objective of this research is to develop the previous PWI model and minimize human intervention in use/automation and increase the efficiency and ease of PWI control.

The control of electrical current is a crucial aspect in the design of automatic socket, especially in the context of developing a Portable Water Ionizer (PWI). The ability to regulate and control electrical current is a key component to ensure optimal and efficient performance. One of the advancements in this regard is the use of Internet of Things (IoT) technology, which has enabled more sophisticated automation in controlling electrical current. In previous PWI models, human intervention was relied upon to decide when to turn off the device after reaching desired parameters. In an effort to enhance electrical current control and minimize human intervention, the concept of an automatic power outlet using IoT technology and temperature sensors is employed as a solution. In this context, temperature sensors serve as thresholds used to activate and deactivate relay devices, thereby allowing for more precise and automatic control of electrical current.

Testing was conducted on the electrical current controller to ensure that the relay functions as intended. The primary goal was to verify the relay's capability to interrupt the electrical current when receiving a signal from the microcontroller. In other words, this testing ensures that the relay can effectively control the electrical current in accordance with the commands given by the microcontroller. Initial testing involved checking the presence of voltage on the electrode rods to ensure that during the electrolysis process, there was electrical current flow, and when the process concluded, there was no electrical current flow. Further testing was carried out on the implemented automatic outlet, which incorporated a temperature sensor into the PWI device. This testing aimed to evaluate the device's performance during the electrolysis process. Throughout the testing, we examined whether the device functioned correctly according to the predetermined threshold settings and whether the temperature sensor could detect the appropriate threshold during the electrolysis process. When the threshold was reached, the relay was expected to function correctly. The results of this testing have significant implications for ensuring the reliable performance of the automatic power outlet.

2. METHOD

The system will work as shown in Figure 1 below, initialization of the temperature sensor is carried out as the first step in this process. The temperature sensor connected to the microcontroller is set to read the temperature periodically and continuously. When the data read by the temperature sensor reaches or exceeds the threshold number, the microcontroller will respond by sending commands to the relay to cut off the electricity. In this system, the type of microcontroller used is ESP32, and for relays, 2 channel relays are used, but only one relay will be used [6]-[7].

The relay terminals used in this system are NC (Normally Closed) and COM (Common). The NC terminal is where the power supply is usually located. With HIGH logic, the socket will conduct electricity, and vice versa, with low LOW logic, the socket will cut off electricity. The NC terminal will be connected to the load so that it can control the current or disconnection of the electric current for the Portable Water Ionizer (PWI) [8]-[9].

Meanwhile, the COM terminal will be connected to the power source. In this context, the COM terminal will be connected to the adapter. By connecting the COM terminal to a power source, the relay allows control of the amperage coming from the adapter to the PWI, so that the relay can control the current of electricity required for the PWI [10]. System implementation is shown in Figure 2(a) wiring diagram of the system and Figure 2(b) implementation of the tools that have been assembled. The pins used to connect ESP32 to the relay are as follows:

- Pin GND relay connect to pin GND ESP32
- Pin IN relay connect to pin 5 ESP32 as controll

- Pin VCC relay connect to pin Vin ESP32

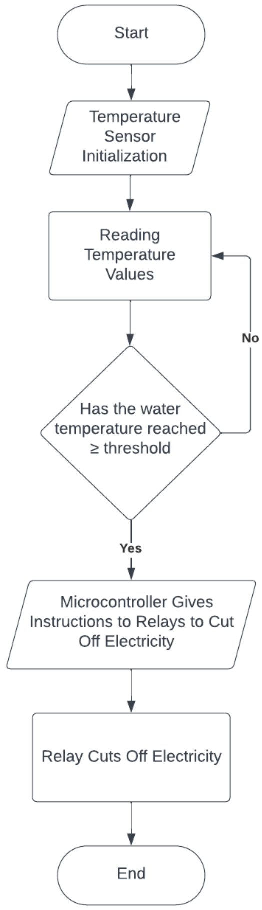
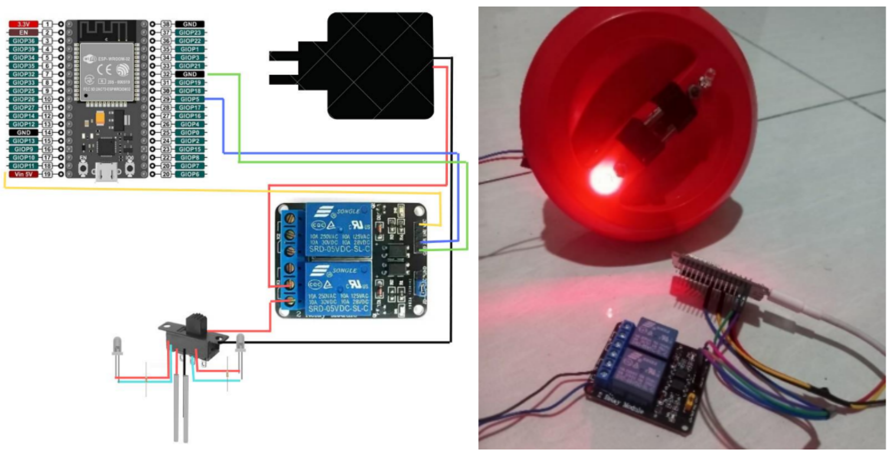


Figure 1. Electric Current Control System Currentchart



(a) (b)

Figure 2. (a) Electric Current Control System Wiring Diagram, (b) Implementation of an Electric Current Control System

In this system, the configuration is set via the Arduino IDE or program code. The program code is designed if the sensor detects a temperature that exceeds a predetermined threshold, then the relay will carry out a command to set the LOW status, which will result in a disconnection of the electricity supply. In Figure 3 below, it can be seen that the system will automatically cut off electricity if the temperature exceeds 29°C. This value of 29°C is set as a threshold based on test results, with the initial temperature of the water before the electrolysis process being room temperature.

```
    bot.sendMessage(chat_id, suhu, "");
  }

  if (text == "/OFF") {
    digitalWrite(RELAY_PIN, LOW);
    bot.sendMessage(chat_id, "Aliran Listrik Telah Dimatikan\n>>> Tidak

  }

  if (text == "/ON") {
    digitalWrite(RELAY_PIN, HIGH);
    bot.sendMessage(chat_id, "Aliran Listrik Telah Dinyalakan\n>>> PWI S

  }
if (temperature >= 29.0) {
    digitalWrite(RELAY_PIN, LOW);
    bot.sendMessage(CHAT_ID, "Air Alkali Telah Siap Untuk Dikonsumsi");
  } else {
    digitalWrite(RELAY_PIN, HIGH);
  }
  delay(1000);
```

Figure 3. Program Code to Set Relay

3. RESULTS AND DISCUSSION

3.1 Testing the electric current control system

Testing is carried out to ensure that the pins between the microcontroller and relay are connected properly and programming runs smoothly. Testing will be carried out with a functionality test to check that the socket functions according to the detected temperature. If the temperature is ≥ 29°C, the socket must be deactivated via relay control (the LED on the gallon lid turns off and measuring the voltage using an AVO meter ensures that there is no voltage currenting). During the test, monitor the temperature carefully and verify that the outlet functions according to the specified conditions. For additional features, the relay can be controlled via a Telegram bot.

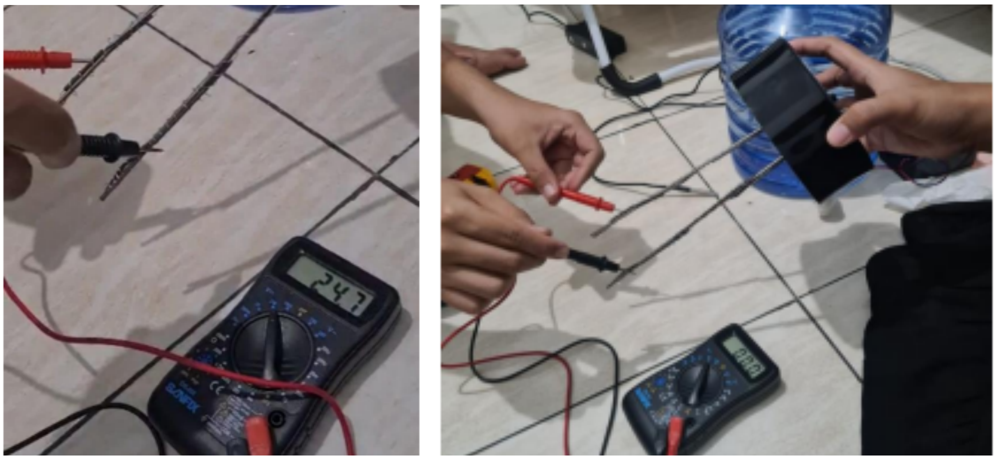
The system will run in a condition where, if the LED is found to be lit on the PWI cover, this indicates that there is electricity currenting and it is carrying out an electrolysis process, whereas if it is found that the LED is not lit on the cover, it indicates that the electricity is no longer currenting to the PWI and the electrolysis process is not being carried out. To check the presence and absence of electric current, two conditions will be checked, the first is when the LED lights up on the PWI cover, measurements are made using an AVO meter on the electrode to see if there is electric current, and the second check is carried out when the LED is not lit on the cover, measurements are made using an AVO meter to see whether It is true that there is no electricity currenting.

Further testing is conducted on the implementation of the automatic outlet, which is connected to a temperature sensor and integrated into the PWI device. This testing will be carried out four times using different types of mineral water, although all of them will be at room temperature around 25°C - 27°C. The primary focus of the testing is on the increase in water temperature. If the water temperature rises and reaches ≥ 29°C, the relay is expected to function properly as per the predefined instructions (indicating a successful electrolysis process). After the water reaches ≥ 29°C, the testing will involve evaluating the changes in water quality using the following parameters: the pH level should be within the range of 8.5 – 9.5, and the Total Dissolved Solids (TDS) value should be ≤ 200. This complies with the regulations specified in the Ministry of Health No. 492/Menkes/Per/IV/2010 regarding the Requirements for Drinking Water Quality.

3.2 Result Testing The Electric Current Control On Electrode

In Figure 4 below, a check is carried out on the electrode when the LED is on or during the process of electric current to see whether electricity is actually currenting through the electrode rod. Based on measurements produced by the AVO meter, it was found that the voltage currenting was 24.7 volts, this refers to the use of a DC power source of 24 volts. A difference of 0.7volts indicates that the voltage value has a tolerance value. This test is carried out when the electrolysis process is to be carried out which can be used as a reference if the temperature is detected ≥ 29°C. The test is carried out again on the electrode rod which requires that the rod has no voltage or no electric current currenting on the electrode rod.

The test was carried out again on the electrode rod when the temperature was ≥ 29°C. Testing is carried out to ensure that the relay can truly deactivate the current of electricity when the condition is reached. From the measurement results above, it can be seen that the electrode rod has a value of 0, which indicates that there is no longer any electric current currenting through the electrode rod.



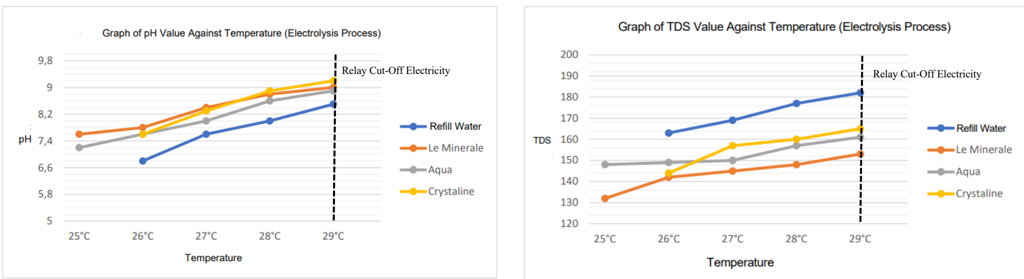
(a) (b)

Figure 4. (a) Testing Voltage Elektrode (LED On), (b) Testing Voltage Elektrode (LED Off)

3.3 Result PWI testing that has connect to automatic socket

The testing commenced with data collection during the electrolysis process. Below are the results depicting the changes in pH, temperature, and TDS at the cathode section. Testing began from the initial water temperature (room temperature) until it reached 29°C, at which point the PWI automatically shut off. Changes in water quality were observed and recorded in the form of graphs. pH measurements were conducted using a pH meter, while TDS values were measured using a TDS meter.

- Mineral Water Type 1: Refill Water
- Mineral Water Type 2: Le Minerale
- Mineral Water Type 3: Aqua
- Mineral Water Type 4: Crystaline



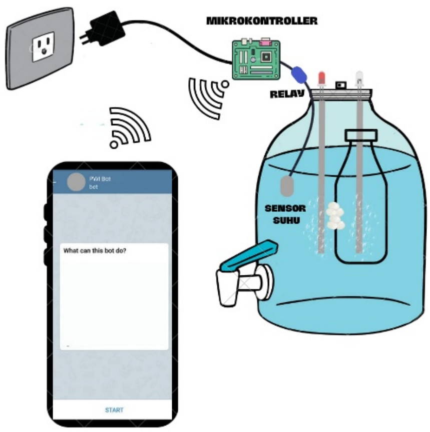
(a) (b)

Figure 5. (a) Graph of pH value Against Temperature, (b) Graph of TDS value Against Temperature

The testing was conducted repeatedly with varying time intervals for four different types of minerals. Type 1 mineral required 70 minutes to reach the predetermined conditions, Type 2 mineral needed 90 minutes, while Type 3 and 4 minerals took 80 minutes to achieve the desired state. The initial temperature of each water sample ranged from 25 to 27 Celsius degrees, with the final temperature reaching 29 Celsius degrees and then relay cut-off the electrical current. Based on the graphs depicting the increase in pH, temperature, and TDS above, the electrolysis process was able to raise the pH by an average of 22%, while the TDS value increased by 12%. The data obtained from the electrolysis process and the use of the automatic socket indicate that the device has met the established parameters. These parameters include achieving a water pH level between 8.5 and 9.5, having a TDS value of ≤ 200, and the relay automatically cutting off the electrical current, preventing any flow of electricity to the electrodes. Here is a summary of the data from the conducted electrolysis tests.

Table 1. Electrolysis Measurements

Water Type	Before Electrolysis				After Electrolysis			
	Temperature	pH	TDS	Status	Temperature	pH	TDS	Status
Refill Water	26 °C	6,8	163	On	29 °C	8,6	182	Off
Le Minerale	25 °C	7,6	132	On	29 °C	9	153	Off
Aqua	25 °C	7,2	148	On	29 °C	8,9	161	Off
Crystaline	26 °C	7,6	144	On	29 °C	9,2	165	Off



(b)

(b)

Figure 6. (a) System Design Mockup, (b) Final Result PWI System that has an Automatic Socket

3.5 Analysis of Result Testing The Electric Current Control System

The primary focus of this testing is to evaluate the relay's performance in interrupting the electrical current when the predefined conditions are reached. If the electrical current is interrupted, electrode testing is conducted using an AVO meter to ensure that no electrical current is still flowing. As seen in Figures 4(a) and 4(b), when the LED is illuminated, it indicates a voltage current of 24 volts originating from the power source, and when the LED is not illuminated, no voltage flows to the electrode. These results indicate that the relay is functioning correctly. The relay can interrupt the electrical current due to the use of the Normally Closed (NC) terminal, where the NC terminal on the relay is connected to the load, and when given a LOW command, the relay will turn off the electrical current.

This testing represents the final stage in the overall system evaluation, specifically the Portable Water Ionizer (PWI) with the integrated automatic socket. Its purpose is to assess the system's ability to operate effectively. The test results indicate that the PWI's electrolysis process can automatically turn off when it reaches 29 degrees Celsius. The electrolysis process also increases the pH value by an average of 22%, and the Total Dissolved Solids (TDS) value increases by an average of 12%. The data obtained from Table 1 above demonstrates that the device meets the predefined parameters, and the automation system functions effectively by interrupting the electrical current when the water temperature reaches a specific threshold.

4. CONCLUSION

In the context of this research study, the system designed and implemented in the Portable Water Ionizer (PWI) has yielded highly positive results. The automation system applied effectively interrupts the electrical flow according to the predefined parameters, particularly when the water temperature exceeds the set threshold. These findings are substantiated by quantitative data that demonstrate a significant increase in both the pH value of the water and the Total Dissolved Solids (TDS) during the electrolysis process.

The primary conclusion drawn from this research is that the utilization of automation technology, particularly the integration of a temperature sensor with an automated socket, holds substantial potential for enhancing the efficiency and ease of control of the PWI. With continuous monitoring of water temperature and the capability for automated decision-making, the system can reliably maintain optimal water conditions within the PWI.

This conclusion is grounded in quantitative findings revealing an average increase of 22% in water pH and an average increase of 12% in TDS values during the electrolysis process. Thus, the adoption of automation technology has significant potential to enhance the overall performance and functionality of the PWI. Consequently, in the context of providing high-quality alkaline water, the implementation of an automation system within the PWI stands as a promising step toward delivering substantial benefits for users' health and well-being.

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