A Prototype of Solar-Powered Automatic Ablution Tap

Stephan Adriansyah Hulukati¹, Tri Pratiwi Handayani², Risman Jaya³ and Syahrir Abdussamad⁴

¹Electrical Engineering, Universitas Ichsan Gorontalo, Indonesia
²Information System, Universitas Muhammadiyah Gorontalo, Indonesia
³Geography, Universitas Muhammadiyah Gorontalo, Indonesia
⁴Electrical Engineering, Universitas Negeri Gorontalo, Indonesia

Corresponding author: stephanhulukati17@gmail.com

Abstract. Muslims are required to perform ablution before praying. This activity uses water, and can consume a huge amount of it when there are a lot of people who perform ablution at the same time. Conventional ablution taps are unable to control the usage of water. Usually, the tap is left running during this action. Therefore, a lot of fresh water unnecessarily flows to the drain. In order to reduce the usage of ablution water, this research developed a prototype of solar-powered, automatic water ablution tap. The system uses ultrasonic sensors to detect human presence and employs an Arduino microcontroller. It sends the “on” and “off” instructions to the relay to activate the solenoid valve to allow water flow. Water flow from the ablution tap can be more efficient with this system. The sensor detects the presence of human and works only when needed. So, the user does not need to touch the valve to activate water flow. This automatic control system can reduce the excessive water consumption when performing ablution. The testing of the system was conducted in a mosque in Indonesia. The experiment shows that the system is effective for detecting the presence of human in the range of maximum 50 cm above the tap. The used of ablution water is reduced significantly approximately 1900 cc compared to manual tap.

Keywords Selenoide valve, Arduino and Proximity.

1. Introduction

Muslims are obliged to pray five times a day. Ablution is required before praying.[1] Ablution consists of several steps such as washing of hands, face, mouth, nose, arms, swabbing on head, ears and feet.[2] These steps are shown in Figure 1.
These ablutions are shown. This ablution action is water intensive. There are many studies about the volume of water used in an ablution per person. [3] states that the amount of water used in Ablution action is approximately 3-7 L per person [4]. In some mosques, schools and Government buildings the average ablution water used is between 2.5 to 4.5 L per person.

Mosques usually have ablution rooms which use traditional tap. This tap normally can not control water flow automatically and depends on the user to turn it on and off. During ablution, the tap is usually left open by the user, and thus lead to wasting the water used in the process [5]. The amount of wasted water needs to be reduced in order to help the environment and reduce water bill.

Therefore, this research develops the prototype of an automatic water ablutions valve in order to prevent the valve from being opened needlessly during ablution. The system is expected to reduce fresh water wasted in the process of ablution[6].

2. System Design

The feedback control system uses the comparison between input and output. The deviation is used to control the device. The difference between input and output is used as a feed to the control system, which tries to reduce the error and bring the system to an expected state. The prototype is a closed-loop control system which consists of:

1. Ultrasonic sensor
2. Arduino Uno Microcontroller.
3. 10 Wp Solar Panel
4. Solenoid valve
5. Solar Charge Controller
6. 5 Volt DC Relay
7. 12 Volt DC Battery

Schematic diagram of the system is shown in Figure 2.
The prototype utilizes energy from the sun by using solar panel. The solar panel is connected to solar charge controller that regulates the electricity to 12 V battery. This battery is the power supply to the Arduino Uno microcontroller.

The ultrasound sensor, which detects the presence of human, is used as a proximity sensor. The red wire is connected to the 5 Volt DC of arduino, black cable to the ground, yellow cable to ping (7) and blue cable to the Echo (6).

DC relay acts as the switch which is connected to solenoid valve to control the “on” and “off” of the solenoid valve. It is connected to Ground pin and pin 8 of arduino.

The overall component of the prototype is shown in Figure 3.

The prototype that was installed in the wash room is show in Figure 4.
Figure 4. The prototype installed in the wash room

The detail of the tap combined with the ultrasound sensor configuration is shown in Figure 5.

Figure 5. The bottom view of solenoid valve connected to the ultrasound sensor.

The prototype uses ultrasound sensor to sense the presence of human. The current does not flow from voltage DC to ground when the infrared light is hindered by hand or foot of human. The voltage
of the photo transistor is approximately 3.5 Volt. The phototransistor voltage is converted by a comparator circuit to digital logic 0 and 1. The value of logic is 0 when there is nothing hindered it. This signal is processed to trigger the relay to active and thus, activating the solenoid valve. If there is nothing that blocks it, the microcontroller gives 1 second for solenoid tap to turn off.

3 Result and Discussion

The prototype was tested using several distance below the tap as shown in Table 1. This is done to measure the sensitivity of the solenoid to the object below it.

| Distance (CM) | Solenoid valve condition |
|---------------|--------------------------|
| 10 cm         | Active                   |
| 20 cm         | Active                   |
| 30 cm         | Active                   |
| 40 cm         | Active                   |
| 50 cm         | Active                   |
| 60 cm         | Not active               |
| 70 cm         | Not active               |
| 80 cm         | Not active               |
| 90 cm         | Not active               |
| 100 cm        | Not active               |
| 110 cm        | Not active               |

The test result shows that the prototype flow the water at the range maximum of 50 cm below the tap. Therefore when there is no object below the tap, the tap is automatically stop flowing. The flowchart of the system is shown in Figure 6.
The second test was done to know the amount of ablution water saved by using this prototype. Table 2 shows the comparison of traditional valve and the prototype. The amount of the water flows from ablution flows to the container and measure using the measurement glass.

Table 2. The comparison of prototype and manual tap

| Time (second) | Volume of ablution water in the container by prototype | Volume of ablution water in the container by manual valve |
|--------------|------------------------------------------------------|--------------------------------------------------------|
| 10           | 1200 cc                                              | 1800 cc                                               |
| 20           | 2200 cc                                              | 3000 cc                                               |
| 30           | 4700 cc                                              | 8800 cc                                               |
| 40           | 9900 cc                                              | 11500 cc                                              |
| 50           | 12100 cc                                             | 14000 cc                                              |

Table 2 shows that there was approximately 1900 cc water saving by using the prototype. This is because the tap only opened when needed during ablution.

Figure 7. Water consumption comparison using the prototype in comparison with manual tap.

Figure 7 shows the difference between the volume of water used when using prototype and the volume of water when not using the prototype. It shows that the volume of water using manual tap were higher, approximately 2000 cc at the end of ablution action. At the end of the process, the volume of water use by prototype is approximately 12000 which is lower 2000 cc compared to the use of manual tap.

4. Conclusions

4.1. Conclusion
The use of ultrasound sensor, solenoid valve and Arduino Uno microcontroller can reduce the flow of water during the ablution approximately 1900 cc compared to manual tap.

The maximum distance below the tap is 50 cm to allow the flow of water.

Points of style

4.2. Suggestions

- The addition of flow in order to accurately measure water flow.
- The addition of Wi-Fi module to send data online so that the use of water can be monitored real time.

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