Development of Environmentally Friendly Urinal Automatic System

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Abstract. The urinal system, with the automatic watering system (flushing), has been widely applied in several public places in Indonesia. Still, the system sometimes does not meet Indonesian habits, especially for a Muslim, as well as less environmentally friendly. For example, it is not fitted with watering facilities (flushing) to clean vital organs and consider the sufficient (not excessive) volume of water. Another essential function is monitoring the availability of water supply and the urinal itself so that it can help the maintenance with simultaneously monitor the availability. Therefore, this research aims to design an environmentally friendly urinal system. In this study, the design and development of IoT-based flushing automation systems employ HC-SR04 ultrasonic sensors, YL-83 as a detector, and ESP8266 wifi module connected to an android-based mobile phone. The urinal flushing automation system is designed with an Arduino Nano Microcontroller capable of detecting someone who will urinate and provide sufficient watering to clean it. The test results are carried out on the effectiveness of distance detection, the adequacy of water discharge, and monitoring of the availability of water. The test results are also compared with a similar type of commercial urinal system. The complete results will be described in the full paper.

Keywords: Please list your keywords in this section.

1. Introduction

Urinal or urinal is one of the sanitation systems created to support human ease in urinating. The use of urinal or urinal with an automatic watering system (flushing) has been widely applied in several public places. But the equipment system is not following Indonesian customs [1]. Not all are equipped with watering facilities (flushing) to cleanse the genitals. This tool is designed with a working system that is adapted to western habits, and many consider this system is not suitable to be applied in Indonesia.

Not all urinal conditions in Indonesia use an automatic flushing system, especially in some public places. Often people are less concerned about urinal hygiene, such as leaving the urinal after urinating, do not close the faucet after urinating, and do not close the faucet even though the water runs out. Therefore the author wants to design an automatic watering system (flushing) that is adjusted to the habits of the Indonesian people, is more environmentally friendly with water-saving, and can maintain the cleanliness of the urinal in the toilet area.

In a previous study by the writer Osathanunkul, et al (2016) [3], that the flushing automation system
that was created had a distance detection system working with infrared and data management with the ESP8266 module, which was sent to the Rasberry pi microcontroller [4-5]. This system works with a distance of under 30 cm and flushing when the object goes after urinating.

Based on previous research, the authors develop this new system by using ultrasound sensors and water detection sensors to determine whether or not there are people who are urinating. Processing is carried out by a microcontroller by regulating the flow of water to flush when urination activities are taking place. The development of the system is further adjusted to do additional watering (flushing) to clean the vital organs of its users. This system will display the status of the LCD on the device and has a recharging system for batteries.

2. Methodology

The following are materials and tools used in the design and development for the urinal flushing automation system. This device consists of 2 parts, hardware, and software.

2.1. Hardware

The following are some of the hardware used for designing this system, including:

- a) Microcontroller 1 and 2 are used Arduino Nano V3, as a processor for the sensor.
- b) Proximity sensor (ultrasonic HC-SR04) and water detecting sensor (YL-83) are for a distance detector for objects and devices sending commands to activate the relay driver.
- c) Water pressure sensor (pressure transducer 5VG1 / 412V12B), used as a detector for the amount of water pressure in the water installation pipe.
- d) An LCD (Liquid Crystal Display) 0.91 inch 128X32 OLED module is to display the measured value by the proximity sensor and to display the equipment status.
- e) Relay module 1 channel SRD-05VDC-SL-C, used to activate electrically selenoid conditions open and close.
- f) Electric valve 3.6Vdc 1 / 2inc MFZ211B-180, used to drain water while the urinal is being used.
- g) 2x 18650 BASEN 3.7 VDC 40A 2600mAh Battery, as a power supply for the microcontroller, LCD, and relay driver.
- h) Battery 2S Charger board module BMS is for recharging the batteries.
- i) Mini generator Gosow F50-12V is to generate electricity from the water flow that is used to fill the current in the battery.
- j) Step down DC converter LM2596, used to adjust the voltage generated by the mini generator to the charger module, which is the voltage 12VDC to 8.4VDC.
- k) The status battery module is to monitor the battery state condition.
- l) Push-button switch on, used as a manual flushing button

2.2. Software

The following are software used to design and build this system, including the following:

- a) Notepad ++, used to write automatic urinal system programs before the program is uploaded to the microcontroller.
- b) Sketch Arduino V 1.8.9, used to upload system programs that have been made to the microcontroller Arduino Nano 1 and Arduino Nano 2.
- c) Solidwork 2014, to draw the prototype.

2.3. The Schematic Diagram

In Figure 1 shows the input that serves to detect objects, namely sensor 1 and sensor 2, while sensor 3 measures the water pressure that exists in the pipe installation. This measurement and detection data is forwarded to the input management section in the form of microcontrollers 1 and 2. The output of the microcontroller system is LCD and relay which is forwarded to the DC valve. The battery is connected to the mini generator as a power supply for the device.
Figure 2 explains the working principle of the system. This circuit has a power supply with a voltage of 3.7 VDC, and 7.4VDC where the voltage of 3.7 VDC is used for electric valves. At the same time, the 7.4VDC voltage is employed for Arduino Nano 1 and 2 voltage supplies. Power supply for an ultrasonic proximity sensor (HC-SR04), pressure sensor, water detection sensor (YL-83), LCD, and relay module using 5VDC power supply on Arduino Nano 2. The working principle of this circuit is that there is data input from the object that is read by sensor 1 (ultrasonic proximity sensor HC-SR04) and sensor 2 (water detection sensor YL-83), namely the distance data between the sensor and the object and data on the presence or absence of water in the urinal. The distance measurement and the detection of the presence of water are changed by a water detection sensor (YL-83) into an electric quantity. The amount of electricity is sent from the input (sensor) to the input manager or signal manager, namely microcontroller. In addition, there is an input in the form of a push-button. This button gives a signal to the microcontroller 2 as a trigger for the activation of the relay module. This button is called the input system for manual bypass.

This input manager is microcontroller 1 and 2. The microcontroller used is Arduino Nano V3. This microcontroller has been programmed with an ultrasonic sensor coding (HC-SR04), water detection sensor (YL-83), pressure sensor (pressure sensor), LCD OLED display 0.91 inc adafruit 128 x 32 and relay module 1 channel. The amount of electricity from the sensor is managed by a microcontroller 1. Data management functions read data and the working status of the urinal and displaying the reading results of the distance to the object to be displayed on the LCD. The results on microcontroller 1 are then forwarded to microcontroller 2 as an advanced data manager to trigger the relay module to respond.
to an available object in front of the urinal.

Valve DC functions as an actuator resulting from the module response while working (ON). The valve will also work (ON) and will drain water into the urinal to flush. When water flows through a mini generator, this mini generator generates a current that is used to recharge the BASEN 18650 battery, which is applied as a power source for this device.

2.4. The Implemented System

![Fig. 3. The final product of the implemented system.](image)

The next step is to implement an automatic urinal flushing system in a prototype. The hardware design of the urinal flushing automation prototype begins with the installation of connecting cables on each component and then attaches it to the body cover that has been made. In this design, the position of the sensor is to detect objects in front of the urinal. The LCD and battery status module is above the body cover, as shown in the figure.

2.5. The Installation of The System

In the installation of a urinal flushing automation system, the body cover is attached to the mechanical part. DC electric valve is connected to the installation of PVC pipe ½ inc contained on the prototype pole. Figure 4 shows that water flowing from a 1/2 inch PVC pipe installation passes through an electric valve. When the status is ON the flow then passes through the mini generator to produce an electric current for charging and flows to the urinal for flushing. The water from the flushing is collected in a tank bottle under the urinal and disposes it manually.

![Fig. 4. The installation of the implemented system](image)
3. Result and Discussion

Following the installation, and the uploaded programming (coding), functional testing was done from the devices. The following picture is the interface displayed on the LCD for the urinal flushing automation system when working.

![Interface of the devices showing various indicators](image1.png)

**Fig. 5.** The interface of the devices showing (1) watering indicator, (2) work status, (3) measured distance (cm), and (4) rated pressure (bar)

![Interface of blynk (IoT) system](image2.png)

**Fig. 6.** The interface of blynk (IoT) system

### 3.1. Testing of The Proximity Sensor HC-SR04

The ultrasonic proximity sensor (HC-SR04) testing was done by placing the object 0 cm to 200 cm from the sensor. Actual distance measurement uses a manual distance meter (meter) against the HC-SR04 sensor readings displayed on the LCD. The data generated in this test was illustrated in the figure below. On reading a distance of 5 cm to 200 cm, it was found that the results are close to the actual distance, i.e., the deviation is around 2.45%. While the distance of the sensor and object is less than 30 cm, the urinal status of wet conditions is "READY" status. Furthermore, if the object is more than 50 cm, the urinal status system changes to "STANDBY" status. The results of this reading can be illustrated in the following curve.

![Distance measurement curve of HC-SR04](image3.png)

**Fig. 7.** The distance measurement curve of HC-SR04
Figure 7 shows that the results read by the sensor have an average difference of 2.45% with a standard deviation of 1.67% of measurements of objects made with a distance of 5cm to 200cm using a meter (manual measuring device).

3.2. Measurement of Charging and Discharging Power

An independent self battery charging system supports this system by connecting the pipe from the valve through a mini supply generator. When the valve is ON, then the flush water flows through a mini generator and produces a voltage to charge the battery.

Figure 8 shows the correlation between charging power and power consumption. In Figure 8, the charging power that is generated from the mini generator changes according to the flowing water and the amount of pressure in the water supply installation. The average power generated when charging is 0.82 Watt, with a standard deviation of 0.07 watts for several tests. The fluctuations are due to the variation of water flow inside the pipe. The discharging is relatively stable at about 0.55 watts with a standard deviation of 0.

![Figure 8](image_url)

**Fig. 8.** The charging and discharging of the power supply

3.3. Comparison with Existing Commercial Equipment

Urinal with an automatic flushing system has been employed in several public places. This study compares the equipment that has been installed in public places such as in the toilet MD place building 2nd floor and Cinema 21 Blok M plaza 6th floor.

| No | Comparison                  | Developed prototype | MD Place Building | Cinema 21 Blok M plaza |
|----|-----------------------------|---------------------|-------------------|------------------------|
| 1  | Average of Flushing         | 4.21 and 5.18 second Flushing every 4 seconds after the user urinates until the user leaves, and 5 seconds when manual flushing | 2.19 dan 5.28 detik | 2.24 dan 8.38 detik |
| 2  | Flushing system             |                     |                   |                        |
| 3  | Power supply                | Battery 7.2V        | Adaptor 6V        | Adaptor               |
| 4  | *Sistem* charging           | Yes                 | N/A               | N/A                   |
| 5  | Manual *Flushing*           | Yes                 | N/A               | American Standard     |
| 6  | Merk                        | prototype           | Lahm              |                        |
| 7  | Sensor                      | Ultrasonic and YL-83 | Infrared          | Infrared              |
| 8  | Distance                    | ON for less than 30 cm dan OFF for | O/N under 25cm and ON | On under 30 cm and ON again for |
Tab. 1 shows performances of the developed prototype with the commercial product in markets and installed in the toilet of MD Setiabudi Building and Cinema 21 Blok M Plaza, Jakarta. The main difference is based on the working system. The MD place and cinema 21 block M plaza toilet urinal works 2 times flushing, i.e., when an object or user arrives, and after the object leaves it. The prototype developed was designed to meet the needs of most Indonesians, i.e., flushing is done immediately after the user urinates.

4. Conclusion

Based on research that has been done, it can be concluded that the urinal flushing automation system designed with Arduino nano microcontroller can detect the presence of someone who will urinate and provide watering to clean it. The sensor response to the urinal flushing automation system to the object has a percentage difference in the reading distance of the sensor by 2.45%, with a standard deviation of 1.67%. The design of the urinal flushing automation system is done by making a prototype of the design with the actual size so that in its application, the system is able to be applied directly. The urinal flushing automation system created using battery resources will be refilled when the urinal is used. This system provides the advantage of being more energy-efficient and environmentally friendly.

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