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To cite this article: K Karwati and J Kustija 2018 *IOP Conf. Ser.: Mater. Sci. Eng.* **384** 012032

View the article online for updates and enhancements.

Prototype of Water Level Control System

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Abstract. Global climate change and unpredictable rain circle cause uncertainty of water availability. Therefore, the technology which can increase water distribution efficiency is needed. This paper describes prototype water level control system that has an important role in providing convenience in the drainage system. If usually the water gate at the dam is operated manually, this prototype is simulation open and close automatically water gate based on rainfall levels using Arduino. To automatically control open and close the water gate, we use Ultrasonic sensors as input values. The water gate will be driven using a Servo Motor. The output of the water level status is displayed in the form of LCD display and is also followed by sound output for people with visual impairments (blind). The design results of this prototype are expected to be one of the good contributions the drainage system. With this automatic sluice of, the course will minimalize the risk from flood or another risk.

1. Introduction

Global climate and unpredictable rain circle may cause uncertainty of water availability [1]. Recently, a very important problem from all over the world is the management of water resources [2]. Water is commonly used in households, agriculture, and industry [2, 3]. Therefore, we need technology which can increase water distribution efficiency.

In practice are known that many types of water level control system that can be done [2-6]. Such system includes providing flood prediction, environmental protection, water discharge, power plant system, providing water control in industry, simple water level control in the home [7].

The most efficiency of water distribution system to every aspect can be enhanced through dam automation. For that application can be done by designing open and close automatic water gate at the dam for a drainage system. The drainage system efficiency is not more than 40% if manually operated, through some automation, the drainage system efficiency can be enhanced to 50% [5].

This paper design prototype water level control system by open and close automatically the water gate use ultrasonic sensor. Open and close automatically the water gate becomes one of the means of service in an effort to control the distribution of more efficient drainage system to every aspect so as to minimalize the risk of the flood [6].

2. Methods

2.1. Software design

In this paper, the ultrasonic sensor reads the water level in the aquarium as input to the Arduino. As output, the servo would move the door aquarium, and water level conditions would be visible on LCD and led, as illustrated in the following schematic capture by Proteus (Figure 1).
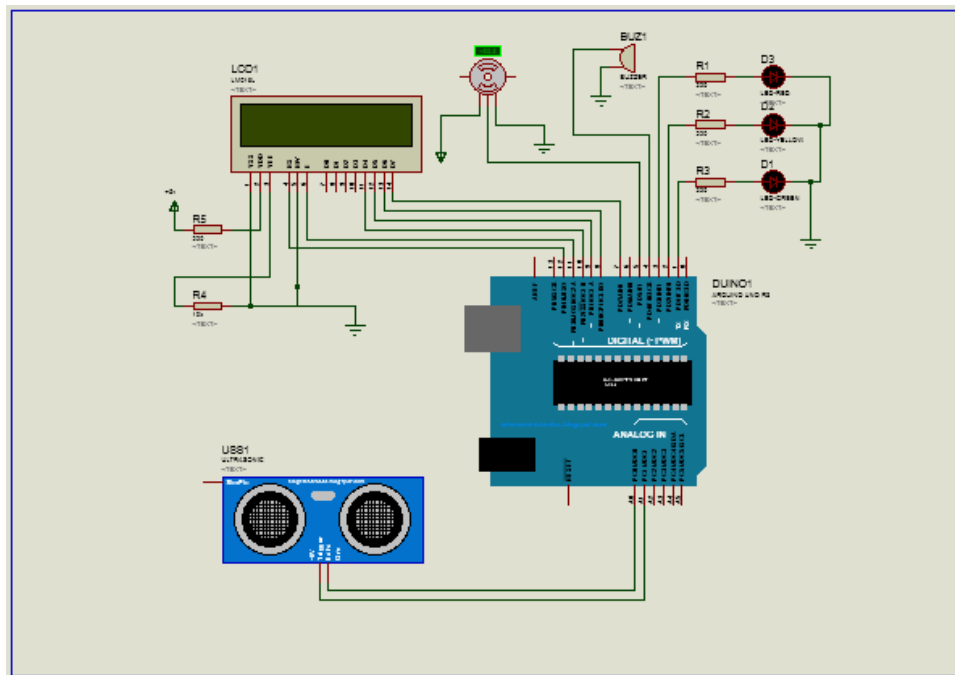

Figure 1. Schematic capture.

The open and close automatically water gate operation is illustrated in block diagram system (Figure 2). The diagram contains several parts, that is, water level detected by the ultrasonic sensor, input data from ultrasonic sensor to Arduino, Arduino set servo motion, the servo for moving the water gate (the door aquarium), and the ultrasonic sensor for making feedback to Arduino. If the water level is low so the door would close.
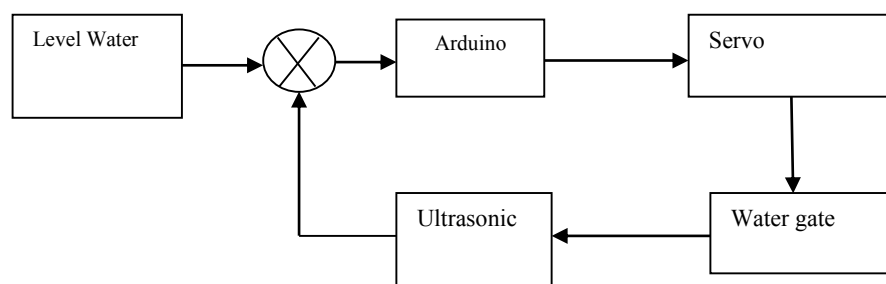

Figure 2. Block diagram system.

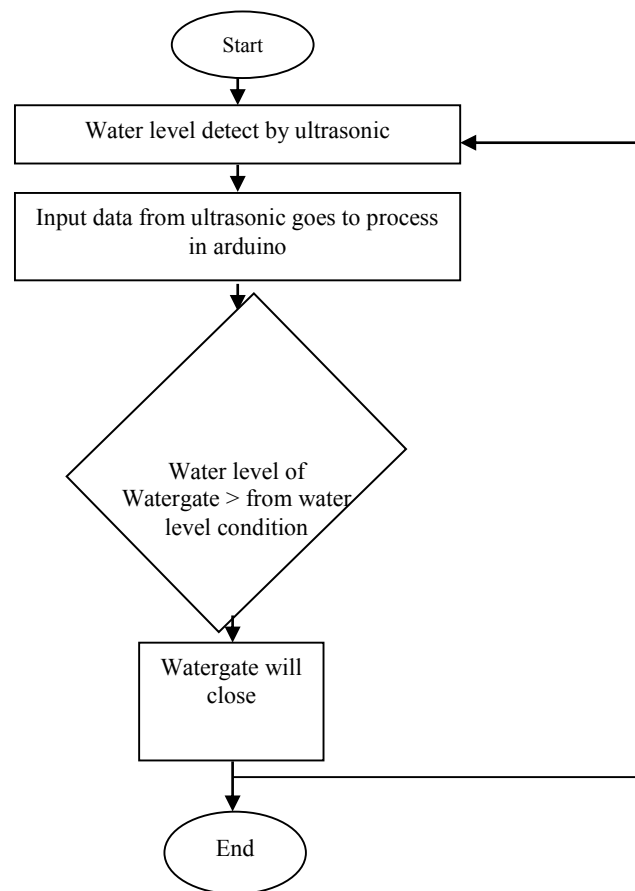The flowchart of system is as follows (Figure 3).

Figure 3. Flowchart system.

The paper programs is set to 3 water level conditions, that is "AMAN" at water level ≤ 5 cm from ultrasonic sensor, "SIAGA" at 5 cm ≥ dist ≤ 10 cm from ultrasonic sensor, and "AWAS" at ≥ 10 cm from ultrasonic sensor. Designing software programs using Arduino software with C programming language.

2.2. Hardware design

Plant uses a glass aquarium with a door hole on the front. Aquarium measuring 50 x 30 x 20 cm. The door opening is 5 x 5 cm in size. The door is used using acrylic material with a size of 7 x 7 cm.

The working principle of the ultrasonic sensor is the transmitter sending ultrasonic waves, then measuring the time required until the arrival of the reflection of the object. Ultrasonic sensor used is SRF-05. The time difference when transmitted to capture returns is used as a reference calculation of how far the distance between the sensors with the object that reflects the ultrasonic waves [8]. Ultrasonic Sensor Devantech SRF-05 with the following specifications:

- Works on a 5 volt DC voltage
- Current load of 30 mA - 50 mA
- Generate a wave frequency of 40 KHz
- The range of detectable distance of 3 cm - 400 cm
- Requires a minimum input trigger of 10 uS

It can be used in two choices of input trigger mode and echo output mounted on different pins or input trigger and echo output mounted in one pin the same [9].

The ultrasonic sensor SRF-05 has the following views (Figure 4).

Figure 4. Ultrasonic SRF-05.

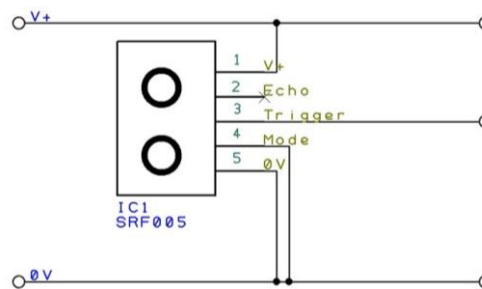The SRF-05 ultrasonic schematic can be seen as follows (Figure 5).

Figure 5. Schematic ultrasonic sensor.

2.2.1. Servo motor. In general there are 2 types of servo motors. Namely servo standard and continuous servo. Standard servo motors are only capable of moving in a semi-circle or 180 degrees, while continuous-type servo motors are capable of rotating by 360 degrees. The servo motor used is a continuous-type servo motor. Continuous types can rotate up to 360 degrees. Servo motors have the following display (Figure 6).

Figure 6. Servo motor 360 degree.

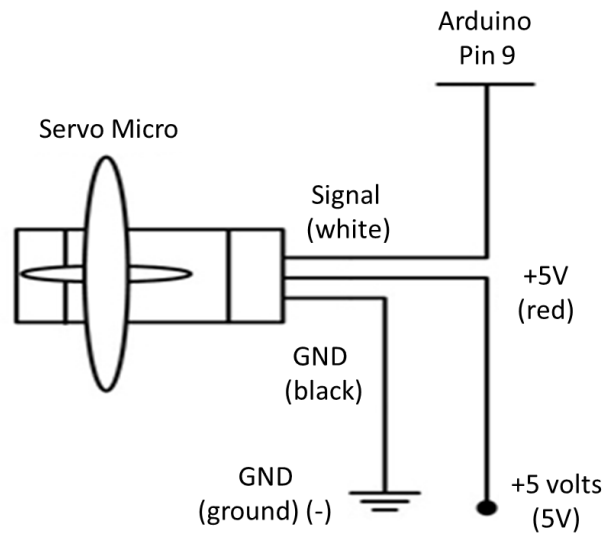The schematic of the servo motor can be seen as follows (Figure 7).

Figure 7. Schematic servo motor 360 degree.

2.2.2. Arduino Nano. Arduino Nano is a microcontroller based on Atmega 328P. Arduino Nano has more or less the same function as Arduino Duemilanove, but with different parts. Arduino Nano has a DC power cable, and works with Mini-USB cable. Arduino Nano has 22 digital pin I / O (consisting of 6 pins PWM output), 8 pin analog I / O, and reset button [12]. Parts of the Arduino Nano have the following appearance (Figure 8).
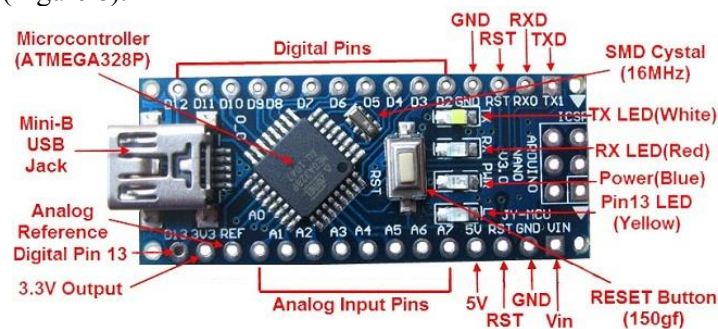

Figure 8. Arduino nano.

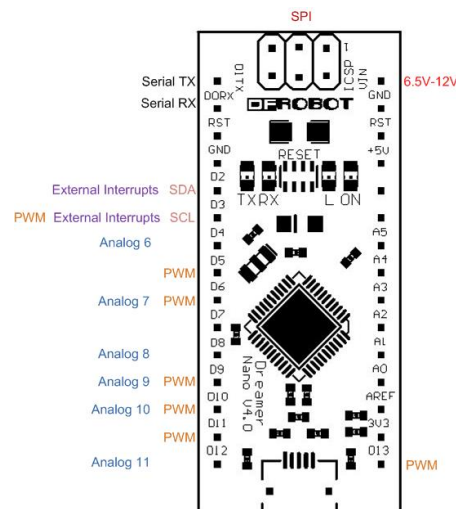The schematic of Arduino Nano can be seen as follows (Figure 9).

Figure 9. Schematic of arduino nano.

2.2.3. LCD 16 x 2. LCD (Liquid Crystal Display0) is a type of display media that uses liquid crystals as the main viewer LCD is already used in various fields such as electronic devices such as television, calculator, or computer screen LCD used dot matrix with character number 2 x 16. The LCD is very functional as a viewer which will later be used to shown working status of the tool. The features presented in this LCD are:

- Consists of 16 characters and 2 lines.
- Has 192 characters stored.
- There is a programmable generator character.
- Can be addressed in 4-bit and 8-bit mode.
- Equipped with back light [2].

The schematic of the 16 x 2 LCD has the following display (Figure 10).
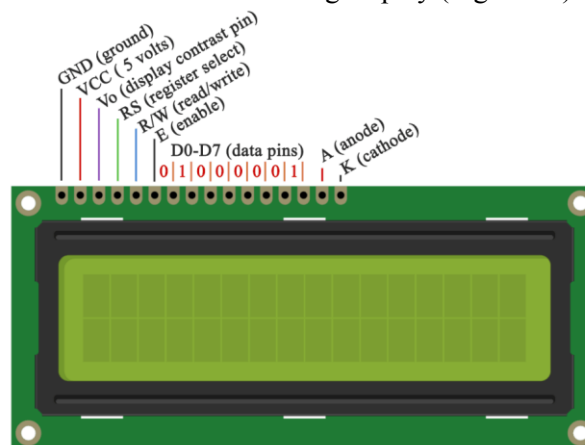
Figure 10. Schematic of LCD 16 x 2.

3. Results and discussion

The SRF-05 ultrasonic sensor is used as the sensor that detects the water level of the plant in 3 states, which is "AMAN" status at water level with distance of ≥ 10 cm from ultrasonic sensor, "SIAGA" at water level 5 cm distance $\geq$ distance ≤ 10 cm of the ultrasonic sensor, and "AWAS" at the water level with a distance of ≤ 5 cm from the ultrasonic sensor.

The results of prototype testing can be seen in Table 1.

Table 1. Testing result.

| No	Distance	Led			Buzzer	Servo
		Green	Yellow	Red		
1.	15,9	On	OFF	Off	Off	Off
2.	12,5	On	Off	Off	Off	Off
3.	8	Off	On	Off	On	On
4.	7,15	Off	On	Off	On	On
5.	2	Off	Off	On	On	On

Based on the test results performed, it can be seen that the prototype succeeded in accordance with the desired. The components used can work properly as desired. Test results in some conditions can be seen as follows.

Figure 11. Test results on "AMAN" status.
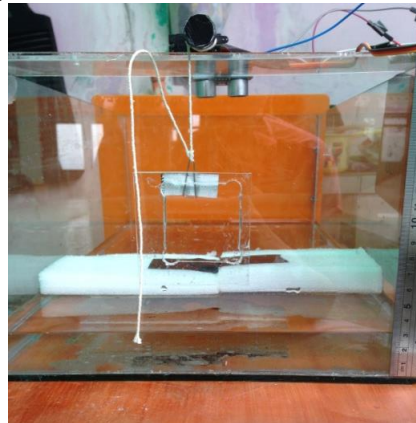
Figure 12. Test results on "AMAN" status.

The test results of Fig. 11. and Fig. 12 produce "AMAN" status with live green LED and the servo motor remains silent.

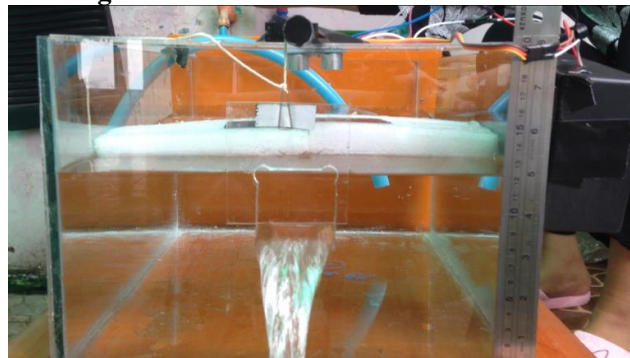**Figure 13.** Test results on "SIAGA" status.

Figure 14. Test results on "SIAGA" status.

The test results of Fig. 13 and Fig. 14 produce "SIAGA" status with live yellow LED and rotating servo motor.

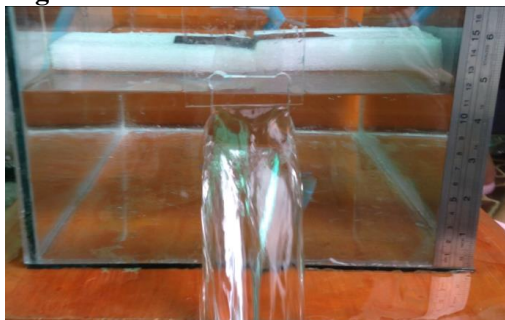
Figure 15. Test results on "AWAS" status.

Figure 16. Test results on "AWAS" status.

The test results of Fig. 15. and Fig. 16. resulted in the status "AWAS" with the red LED on and the rotating servo motor. Based on the test results, ultrasonic sensors can function properly. Testing of ultrasonic sensors can be seen in Table 2 as follows.

Table 2. Ultrasonic sensor test result.

NO	DIST (CM)	SENSOR READING (CM)	ERROR (%)	AVERAGE ERROR (%)
1.	2	1.67	1.6	
2.	3	2.89	3.6	
3.	4	3.80	5	
4.	5	4.90	2	
5.	7	6.84	2.2	
6.	8	7.82	2.25	2.15
7.	9	8.86	1.5	
8.	10	9.86	1.4	
9.	14	13.78	1.5	
10.	17	16.9	0.5	

Table 2 is a comparison test of ultrasonic water distance measurement. Obtained by the comparison result of ultrasonic sensor distance measurement with water got an error of the difference of reading. The following error is obtained by the measurement:

$$\text{Error\%} = \left(\frac{sample\ distance - sensing}{sample\ distance} \right) x\ 100\ \%$$

Based the data of sensor sensing test results showed that the sensor has a precision measurement level with an average error of 2.15%. This project is experiencing some constraints that are not in accordance with the desired process in the process of working in a 360 degree servo motor system. Servo motors are understood to be adjustable rotation using the degree of degree, not working as desired. 360 degree servo motors are the same as continuous motors that can only rotate clockwise and clockwise, so there is no time to stop.

Based on these constraints, this project tries to use 180 degree servo motor. However, because the rotation is only 180 degrees, less appropriate to open the door on this prototype. Constraints on this can be solved by adding TIP components, diodes, and resistors in a 360-degree servo motor circuit. By using TIP, the servo motor can be set to spin and stop.
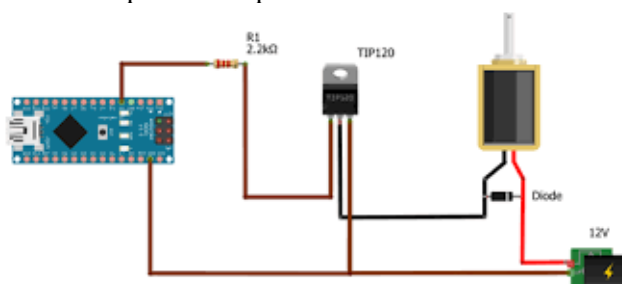

Figure 17. TIP 120 circuit with servo 360 degrees.

4. Conclusions
Our design is in conformity with the intended purpose. The prototype of water level control system works well in distributing water in accordance with the water level, so it can be one of the contributors in the drainage system especially in the dam area to the surrounding environment. Based on the test results, the prototype can function well. From the sensor side, ultrasonic sensor is a good distance detection sensor with error 2.15% based on test results. Constraints in the use of 360 degree servo motors can be handled using the TIP 120, so the 360 servo motor can function as desired.

References

[1]   Kulkarni N K and Shete V V 2015 "Hybrid neuro-fuzzy approach for flood prediction and Dam gate control" *Int. Conf. Inf. Soc. i-Society 2014* pp. 213–218.

[2]   Illes C, Popa G N and Filip I 2013 "Water Level Control System Using PLC and Wireless Sensors" *IEEE 9th Int. Conf. Comput. Cybern.*, pp. 195–199.

[3]   Pratilastiarso J, Tridianto E, Elvian G P H, Budi U E, Vera N and Ika C A 2017 "Simulation water level system with feedback feedfoward control" *Proc. - 2016 Int. Electron. Symp. IES 2016* pp. 42–47.

[4]   Jeswin C J, Marimuthu B and Chithra K 2017 "Ultrasonic Water Level Indicator and Controller Using Avr Microcontroller" *In Information Communication and Embedded Systems (ICICES), 2017 International Conference on* (pp. 1-6). IEEE.

[5]   Bhat S P and Hirekhan S R 2016 "Automation of water discharge process at canals" *Proc. 2015 Int. Conf. Appl. Theor. Comput. Commun. Technol. iCATccT 2015* pp. 609–613.

[6]   Litrico X, Belaud G and Fromion V 2007 "Stability analysis of automatic water level control gates in open-channels" *2007 46th IEEE Conf. Decis. Control* pp. 1591–1596.

[7]   Hy Cao N D 2016 "Design of water tank level PID control based on kingview" pp. 2–5.