

Prototype River Water Level Detection Tool Using Ultrasonic Sensor with Sound Output Based on Arduino Uno Microcontroller

Yudi Irawan Chandra^{1*}, Diah Rury Irawati², Marti Riastuti³, Kokoy Rokoyah⁴
^{1,2,3,4}STMIK Jakarta STI&K, Indonesia

Email: ¹yirawanc@gmail.com, ²diah.ruri@gmail.com, ³tutimarti67@gmail.com,
⁴kokoyrokoyah65@gmail.com

Abstract

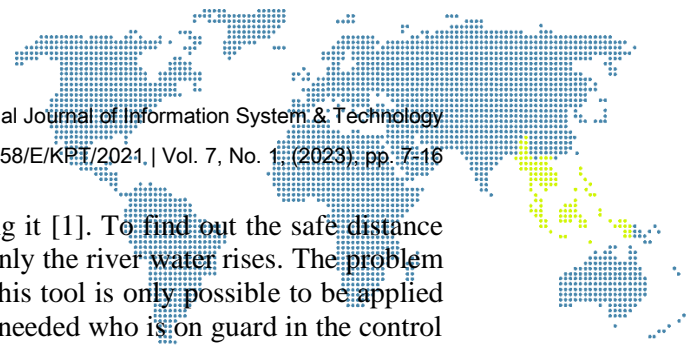
River water that overflows or is at an uncontrolled height can cause flooding and environmental damage. Therefore, the development of a river water level detector that can provide early warning is very important. In this research, we propose a river water level detector using ultrasonic sensor with sound output based on Arduino Uno microcontroller. This device is designed to measure the level of river water by utilizing the principle of ultrasonic wave reflection. The ultrasonic sensor is installed above the river and sends ultrasonic waves to the water surface. The waves are then reflected back to the sensor after reaching the water surface. The travel time of the reflected wave is used to calculate the distance between the sensor and the river water surface. The Arduino Uno microcontroller is used to process the distance data obtained from the ultrasonic sensor. When the water level exceeds the specified limit, the microcontroller will generate a sound output as a warning. A speaker is connected to the microcontroller and will emit different sounds depending on the water level. This tool has advantages in terms of accuracy and responsiveness. By using ultrasonic sensors, measurements can be taken in real-time and provide water level information with high precision. The voice output also allows the information to be delivered directly and effectively to the user. The test results show that this river water level detection device can work well and provide early warning when the water level exceeds the specified limit. The success of this tool is expected to help in flood risk management and environmental conservation.

Keywords: Detection device, river water level, ultrasonic sensor, Arduino Uno microcontroller, sound output.

1. Introduction

Technology has now become a basic need for everyone, especially millennials. With the existence of technology, the community is greatly facilitated in all matters both in the fields of work and education. The existence of technology is certainly very helpful, especially in the field of education because it will be easier to access new knowledge. Technology can also provide benefits if used properly, such as making a tool to detect river water levels to make it easier for officers to know if there will be overflows. With this tool, the community will be greatly helped in detecting water in the river. In this case technology plays a very important role and can also help develop the tools needed for the community as well as in making river water detection devices using ultrasonic sensors with sound output based on the Arduino Uno microcontroller. With this tool, it is not only the floodgate guard who can find out if the water discharge in the river will overflow but the community will also know because of the LED lights up. Keeping the river water discharge monitored but it really takes the help of tools made as a medium in order to send information to officers in the control center room by projecting to the ultrasonic sensor so that it is connected to the Arduino Uno so that the LED lights up and the sound from the speaker gives a danger sign that the water discharge will reach the maximum height limit on the dam so that people around the dam can find out about the danger.

From the background described above, the problem identification is how to find out the water level using LEDs and speakers as a warning sign with the Arduino Uno



microcontroller as the main component in processing it [1]. To find out the safe distance of high river water, and notify river officers if suddenly the river water rises. The problem limitation in this research is that the application of this tool is only possible to be applied to an area that has a control room, then an officer is needed who is on guard in the control room. With a maximum depth of 15 cm, and free of garbage.

The research objectives include: (1) make a device that can provide information if the water discharge rises, (2) issue information with a sound alert, (3) design a river water level detection device using an ultrasonic sensor and (4) make a danger marker device with LEDs.

In previous research Fitri Puspasari (2019) successfully made a prototype tool that aims to measure digital distance based on the Arduino Due microcontroller using the HC-SR04 sensor. The research method used is literature study and direct observation. The measurement results are displayed on a computer device to facilitate reading. This design is controlled through Arduino Due. The results of testing the prototype of the tool can run well and can be accessed in real time [2].

Research conducted by Imam Muklisin (2017) succeeded in designing a water reservoir volume detection device automatically using an ultrasonic sensor based on Arduino Uno R3 designed with simple operations so that it is easy to operate. This tool serves to control the volume in the water reservoir as well as turn on or turn off the water pump engine automatically. This water reservoir volume detection system uses the SRF HRC04 ultrasonic sensor. The arduino uno R3 microcontroller is used as an input and output signal control system and a 16x2 LCD as a data display. Testing is done by varying the distance of the sensor to the water level from 2 cm to 18 cm. the system that has been made is calibrated so that it is suitable for use as a water level measuring instrument. Based on the results of the study it can be concluded that the water reservoir volume detection system can work well as expected, namely it can control the volume of water level in the reservoir automatically with 99.10% accuracy and 0.90% error [3].

Selamet Samsugi (2020) designed and implemented a circuit that functions to open and close irrigation doors automatically. By using an automatic irrigation controller system to make it easier for farmers to control the entry of water in the irrigation flow. With the development of technology, the existence of sensors and microcontrollers, it is easier to make automatic irrigation control devices using ultrasonic sensors. To read the water distance if the water distance is normal, the servo motor will open 180°. And if the water experiences a height within a certain distance, the servo motor will move to close. As a water distance controller, the ultrasonic sensor reads the water distance which will be displayed on the LCD screen. The adapter functions as an AC (220V) to DC (12V) current supplier which is used to supply current to the arduino. In order for the irrigation flow to function automatically, an Arduino UNO R3 microcontroller is needed to receive data sent from servo motors, ultrasonic sensors. So that this tool can be programmed to control the irrigation flow based on predetermined commands [4].

2. Research Methodology

The design and manufacture of tools are grouped into several parts The circuit block diagram describes the input, process, and output blocks in general. The design of the circuit and components explains the stages of the design of the tool, the components needed along with the functions and the overall circuit. The working principle of the circuit contains a detailed description of the work process. The program flowchart describes the work steps of the tool in the form of a diagram. The design of the microcontroller program contains the stages of software programming [5]. Before compiling a program on the Arduino Uno microcontroller, the first step that must be done is to compile a flowchart or flowchart that will be used as a reference for writing program sketches on the Arduino Uno microcontroller as shown in Figure 1.

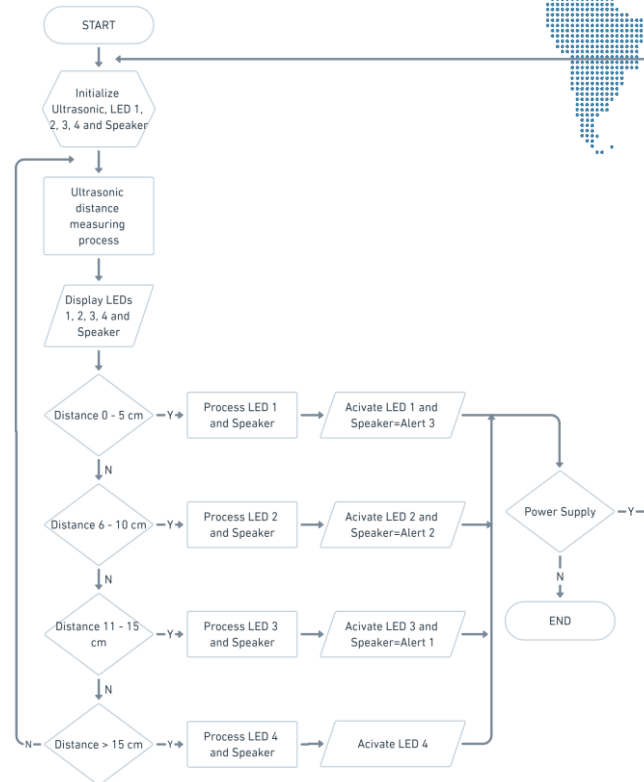
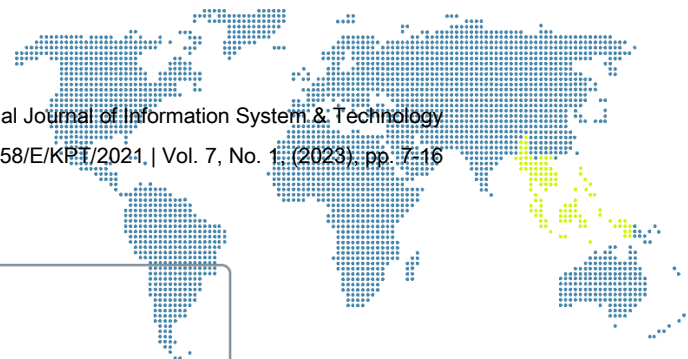


Figure 1. Circuit Flowchart

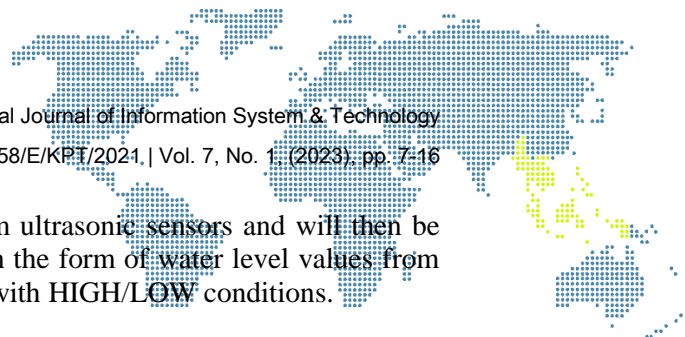
In this research, the manufacture of a surveillance system on the river is made by utilizing the Arduino UNO Microcontroller which is used to process data received by sensors, the microcontroller also functions to control resources and components connected to the microcontroller so that it can perform digital data processing and processing.

The microcontroller can work by connecting it through the USB (Universal Serial Bus) port so that it gets the voltage needed to work at 5 - 5.5V. In this river monitoring system, an ultrasonic sensor is used to detect the water level in the river. The Arduino UNO microcontroller will process the data from the ultrasonic sensor and produce a value that will be used as a reference to determine the safe limit of the river water.

If the water level is less than 15 meters then the green LED light will turn on and make a sound, namely "SIAGA 1!!!, if the water level is less than 10 meters then the yellow LED light will turn on and make a sound, namely "SIAGA 2!!! and if the water level is less than 5 meters then the red LED light will turn on and make a sound, namely "SIAGA 3!!! if the result is HIGH it means that the LED is lit with the speaker.

The next condition is if the water distance is less than or equal to 15 cm, LED 1 will light up. If not, it will run in the next condition, namely if the water distance is less than or equal to 10 cm, LED 2 will turn on and the Arduino Uno microcontroller will send a message to the telegram. Otherwise it will run in the next condition, namely if the water distance is less than or equal to 5 cm, the LED 3 and Buzzer will light up and the Arduno Uno D1 microcontroller will send a message.

The design and manufacture of tools are grouped into several sections. Circuit block diagrams describe input, process, and output blocks in general. The design of circuits and components describes the stages of tool building design, the components needed, their functions and the overall circuit. The working principle of the circuit contains a detailed description of the work process. The program flow diagram describes the tool's working steps in the form of a diagram. Making a microcontroller program contains the stages of software programming [6].



This river monitoring system receives input from ultrasonic sensors and will then be processed by Arduino UNO and produces outputs in the form of water level values from ultrasonic sensors that will activate LEDs, speakers with HIGH/LOW conditions.

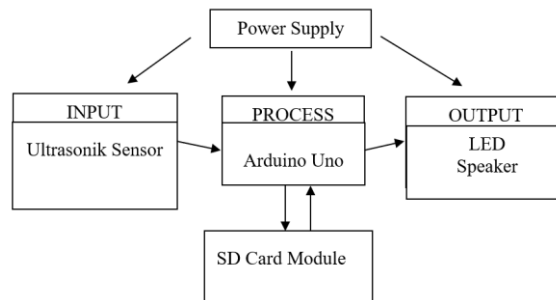


Figure 2. Block Diagram Circuit

The following is a description of the workings of each circuit block in the block diagram in Figure 2:

- a. Ultrasonic Sensor as a water level gauge for the dam.
- b. SD Card as storage.
- c. Arduino UNO as processing of the input block.
- d. Speaker as a notification that the water level has exceeded the safe limit.
- e. LED as notification of water level limits.

3. Results and Discussions

3.1. Ultrasonic Sensor Circuit

In ultrasonic sensors, ultrasonic waves are generated through a device called a piezoelectric with a certain frequency [7]. This piezoelectric will produce ultrasonic waves (generally 40kHz frequency) when an oscillator is applied to the object. In general, this tool will shoot ultrasonic waves towards an area or a target. After the waves touch the surface of the target, the target will reflect back the waves. The reflected wave from the target will be captured by the sensor, then the sensor calculates the difference between the time of sending the wave and the time the reflected wave is received. while the schematic of the ultrasonic sensor circuit can be seen in Figure 3.

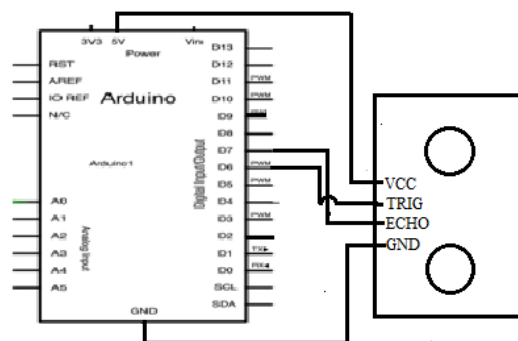


Figure 3. The circuit of the ultrasonic receiver

In this river monitoring system, the pins on the ultrasonic sensor are connected to the pins on the Arduino UNO. The VCC pin on the ultrasonic sensor is connected to the 5V pin on the Arduino UNO, the GND pin on the ultrasonic sensor is connected to the GND pin, the TRIG pin on the ultrasonic sensor is connected to pin D6 Aduino UNO and the ECHO pin on the ultrasonic sensor is connected to pin D7 Arduino UNO. The pin configuration of the ultrasonic sensor can be seen in table 1.

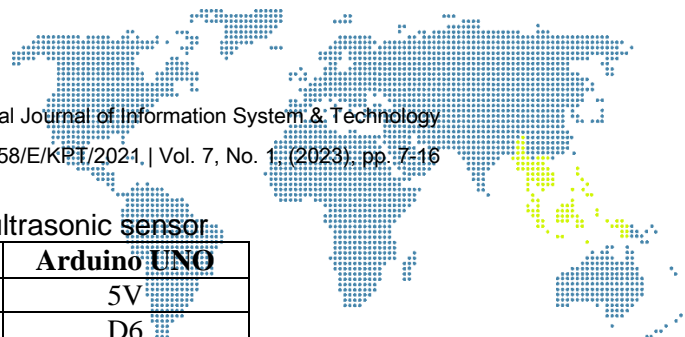


Table 1. Pin configuration of ultrasonic sensor

Ultrasonik HC-SR04 Sensor	Arduino UNO
VCC	5V
TRIG	D6
ECHO	D7
GND	GND

3.2. Speaker Module Circuit

Speakers are hardware that functions to emit sound. The sound produced comes from the processing of electrical signals to audio frequencies (sound) [8]. Speaker module and speaker schematic circuit are shown in Figure 4.

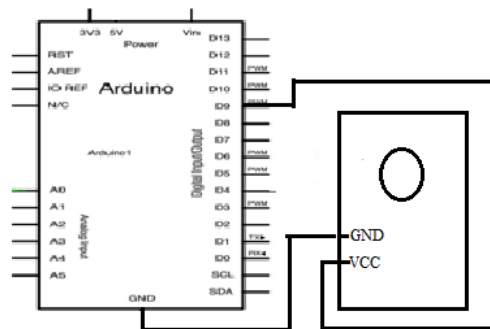


Figure 4. Schematic circuit of speaker module

This river monitoring system, the terminals on the speaker are connected to the pins on the Arduino Uno. Terminal (+) on the speaker is connected to pin D9 on the Arduino Uno, while Terminal (-) on the speaker is connected to the GND pin on the Arduino Uno. The pin configuration of the speaker module can be seen in table 2.

Table 2. Speaker module pin configuration

Speaker	Arduino Uno
VCC (+)	D9
GND (-)	GND

3.3. LED circuit

LED is an electronic component that can emit monochromatic light when given a forward voltage [9]. LEDs are a family of diodes made of semiconductor materials. The colors of light emitted by LEDs depend on the type of semiconductor material used as shown in Figure 5.

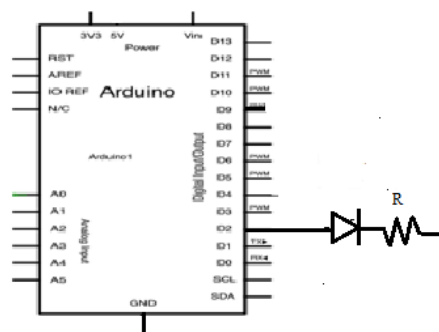
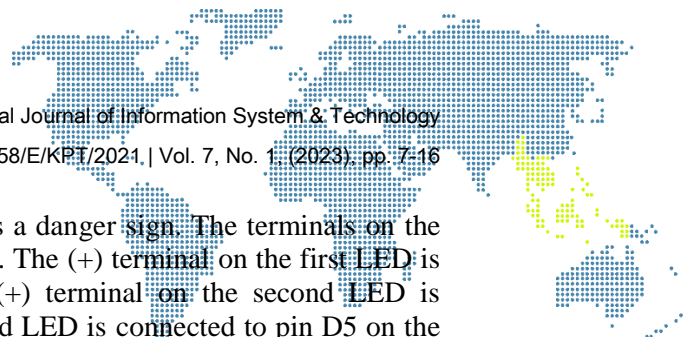


Figure 5. LED circuit



This river monitoring system uses three LEDs as a danger sign. The terminals on the LED are connected to the pins on the Arduino UNO. The (+) terminal on the first LED is connected to pin D2 on the Arduino UNO, the (+) terminal on the second LED is connected to pin D3 and the (+) terminal on the third LED is connected to pin D5 on the Arduino UNO while the (-) terminal on all LEDs is connected to the GND pin on the Arduino UNO through a 1k resistance resistor. The pin configuration of the LED module can be seen in table 3.

Table 3. LED pin configuration

LED (Light Emitting Diode)	Arduino Uno
LED 1	D2
LED 2	D3
LED 3	D5
GND	GND

3.4. Overall circuit

The overall circuit is a combined circuit of the components used in the river monitoring system. This circuit works based on input from ultrasonic sensors and vibration sensors then the input is processed by the Arduino Uno microcontroller so that the results of the process will be obtained. The results of the process carried out by Arduino UNO will be sent to the output, namely the LED and speaker to determine the river water level, if the river water level has exceeded the safe limit, the speaker and LED will light up. The overall circuit of the river monitoring system can be seen in Figure 6.

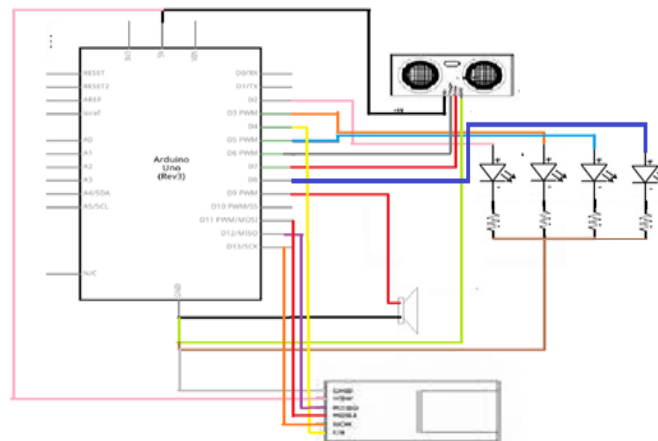
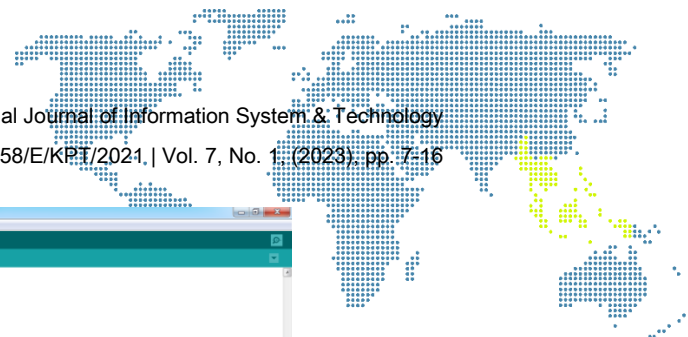
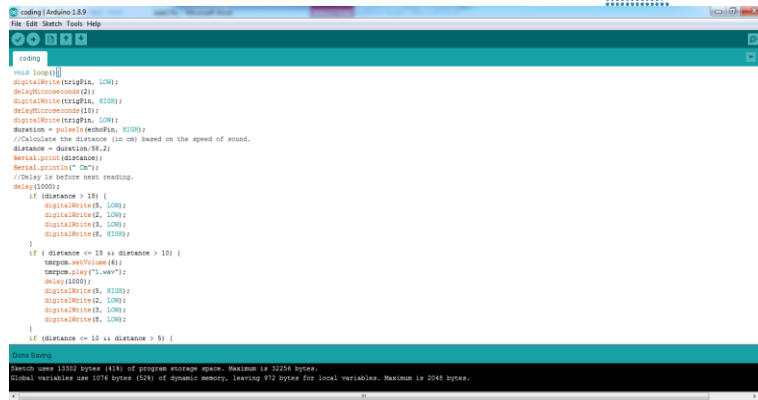


Figure 6. Schematic circuit of the whole device

3.5. Arduino Program Design

In this river safety system simulation tool, microcontroller programming is needed so that the tool can work according to the working principle of the tool. The first step is to open the Arduino IDE application [10]. After opening the Arduino IDE application, the next step is to write the program sketch on the available worksheet. After the sketch program is finished, then compile the program to check whether or not there are any errors in writing the program coding. After the program is decompiled and if no errors occur, the program can be uploaded to Arduino Uno. Before uploading the program, first set the type of board on ESP8266 by selecting tools - board - Arduino Uno and then setting the port settings by selecting tools- port- COM [11]. After the settings are complete, the program is ready to upload. The program upload process can be seen in Figure 7.

```

void setup() {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  //Calculate the distance (in cm) based on the speed of sound.
  distance = duration*34.3;
  Serial.print(distance);
  Serial.println("\n");
  //Delay 1s before next reading.
  delay(1000);
  if (distance > 15) {
    digitalWrite(led, LOW);
    digitalWrite(speaker, LOW);
    digitalWrite(buzzer, LOW);
  }
  if (distance <= 15 || distance > 10) {
    tone(speaker, 440);
    delay(100);
    digitalWrite(led, HIGH);
    digitalWrite(speaker, HIGH);
    digitalWrite(buzzer, HIGH);
  }
  if (distance <= 10 || distance > 5) {

```

Figure 7. Program upload process

3.6. Tool Testing

Testing this surveillance system consists of technical tests and functional tests. Before testing the program must be uploaded first to the Arduino Uno microcontroller. In addition, so that the tool can operate, the tool must be connected to the power supply.

3.7. Technical Test

Technical testing is testing each component in turn by taking measurements in certain parts of the circuit of each block consisting of ultrasonic sensors, LEDs and speakers. The tools used are digital multimeters for LED, speaker and vibration sensor tests and microcontrollers for ultrasonic sensor tests. The digital multimeter is used to measure the voltage passing through the LED, speaker. The microcontroller can function to know how to test the ultrasonic sensor. The first technical test is the measurement of voltage on the LED with the use of a digital multimeter. This test is done by connecting the LED with an adapter. The LED anode pin is connected to the vcc pin on the adapter. The LED anode pin must be connected to the VCC pin through a 1,000 ohm resistor. The function of using a resistor in the LED test is to reduce the voltage value received by the LED so that there is no damage to the LED. The LED cathode pin is connected to the ground pin on the adapter. The initial measurement is to calculate the voltage value of the LED when it is not lit and the next stage is to calculate the voltage of the LED when it is lit. Figure 8 (a) is the display when the LED does not get a voltage and Figure 8 (b) when the LED gets a voltage and the LED is lit.

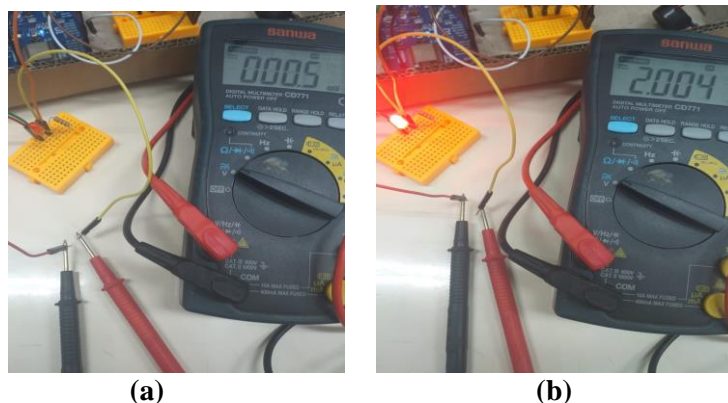


Figure 8. (a) The display when the LED does not get a voltage (b) the LED gets a voltage and the LED is lit

When the LED tool is tested there is a detected voltage value using a multimeter. Can see the test results in table 4.

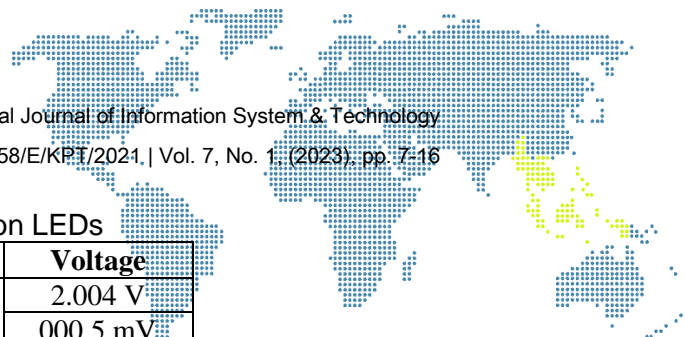


Table 4. Test results on LEDs

Conditions	Components	Voltage
ON	LED	2.004 V
OFF		000.5 mV

The second test is testing the ultrasonic sensor when connected to the Arduino Uno microcontroller. In this ultrasonic sensor test using a ruler to measure the accuracy of the ultrasonic sensor when an object is blocking and comparing with the value generated on the serial monitor. The following are the results of trials on the ultrasonic sensor circuit when obstructed by objects. The first experiment is a trial from a distance of 5cm, the resulting output is a red led that will light up and the speaker will emit a sound in the form of alert 3, shown in Figure 9.

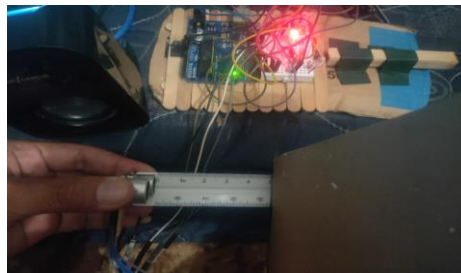


Figure 9. Ultrasonic sensor test run 0 - 5 cm

The second experiment is a test from a distance of 10cm, the resulting output is a yellow led that will light up and the speaker will emit a sound in the form of alert 2, shown in Figure 10.

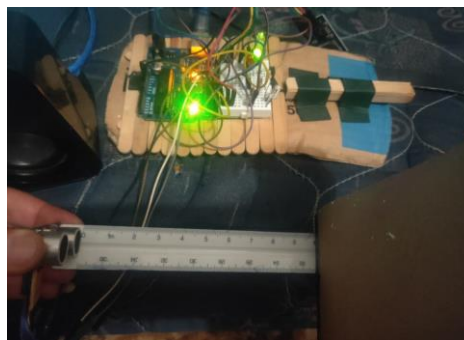


Figure 10. Ultrasonic sensor test run 6 - 10 cm

The third experiment is a test from a distance of 15cm, the resulting output is a white led that will light up and the speaker will emit a sound in the form of alert 1, shown in Figure 11.

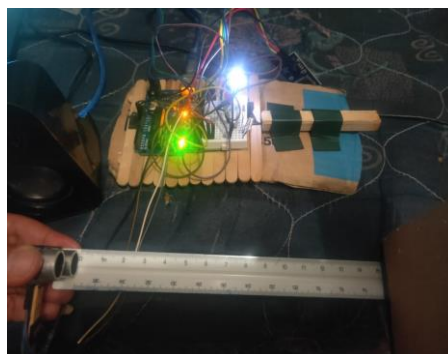
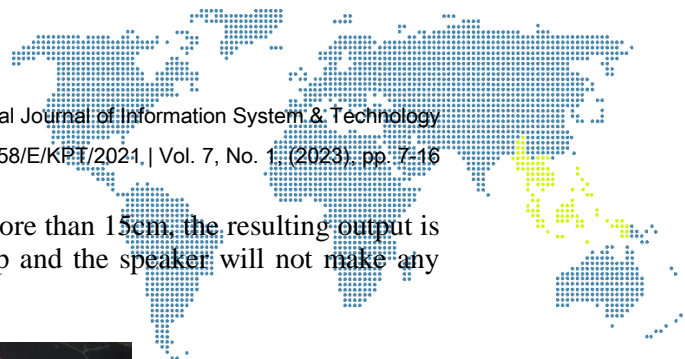


Figure 11. Ultrasonic sensor test run 11 – 15 cm



The last experiment is a test from a distance of more than 15cm, the resulting output is a red and blue led (blink or blink) that will light up and the speaker will not make any sound, as shown in Figure 12.

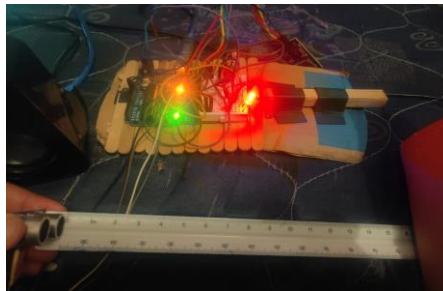


Figure 12. Ultrasonic sensor test run over 15 cm

When the sensor gets a trigger from the microcontroller to generate ultrasonic waves that will be emitted by the ultrasonic sensor. If there is an obstacle in the form of an object, the ultrasonic waves are then reflected back and received by the echo on the ultrasonic sensor. From the data shown in the figure above, it can be seen that the distance between the object and the ultrasonic sensor shown by the ruler is the same as the distance generated by the serial monitor. The overall test results of the circuit can be seen in Table 5 below.

Table 5. Overall test results

Ultrasonic	LED 1 Red	LED 2 Green	LED 3 White	LED 4 Red Blue	Speaker
Distance 0-5cm	High / ON	Low / OFF	Low / OFF	Low / OFF	Alert 3
Distance 6-10cm	Low / OFF	High / ON	Low / OFF	Low / OFF	Alert 2
Distance 11-15cm	Low / OFF	Low / OFF	High / ON	Low / OFF	Alert 1
Distance >15 cm	Low / OFF	Low / OFF	Low / OFF	High / ON	Speaker Not Making Sound

3.8. Functional Test

Functional tests are carried out to find out whether the entire series of dam monitoring systems will function and run as needed or not. Testing begins by connecting the Arduino Uno microcontroller with a 5V voltage to activate the circuit. After the device is active, it will connect the internet connection that has been determined. Then the ultrasonic sensor will be active and read the surface distance with the sensor which will be displayed on the serial monitor. The display can be seen in Figure 13.

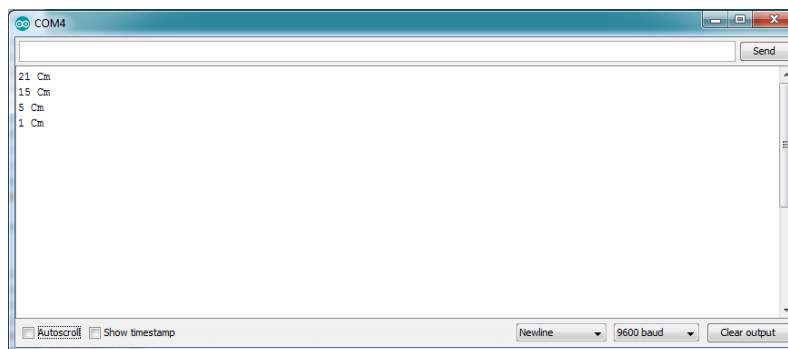
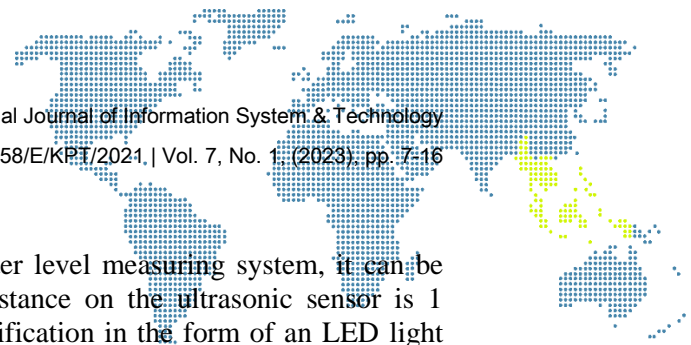


Figure 13. Serial display monitor



4. Conclusion

After analyzing and implementing the river water level measuring system, it can be concluded as follows: The maximum detection distance on the ultrasonic sensor is 1 meter, against the water surface there will be a notification in the form of an LED light and speaker sound, the ultrasonic sensor detects from a height of less than 15cm, 10cm, and 5cm, where the ratio is 1: 100, the LED will light up as long as the water discharge increases and will stop when the water discharge decreases and the speaker provides sound information when the ultrasonic sensor detects an increased water discharge such as alert 1, 2, and 3. For further research development, this tool can be developed by adding an LCD to display the water level, this tool can be developed using a Servo Motor as an opening and closing sluice, besides that it can be developed by adding a button to open and close the sluice.

References

- [1] Y. I. Chandra and K. Kosdiana, "Rancang Bangun Purwarupa Pendeteksi Berat Muatan Bus Transjakarta Menggunakan Metode Incremental Berbasis Mikrokontroler Arduino Uno," *Innov. Res. Inform. Innov.*, vol. 2, no. 1, Apr. 2020, doi: 10.37058/innovatics.v2i1.1477.
- [2] F.- Puspasari, I.- Fahrurrozi, T. P. Satya, G.- Setyawan, M. R. A. Fauzan, and E. M. D. Admoko, "Sensor Ultrasonik HCSR04 Berbasis Arduino Due Untuk Sistem Monitoring Ketinggian," *J. Fis. Dan Apl.*, vol. 15, no. 2, Art. no. 2, Jun. 2019, doi: 10.12962/j24604682.v15i2.4393.
- [3] I. Muklisin, "Pendeteksi Volume Tandon Air Secara Otomatis Menggunakan Sensor Ultrasonic Berbasis Arduino Uno R3," *J. Tek.*, vol. 7, no. 2, Art. no. 2, Sep. 2017, doi: 10.35457/quateknika.v7i2.242.
- [4] S. Samsugi, Z. Mardiyansyah, and A. Nurkholis, "Sistem Pengontrol Irigasi Otomatis Menggunakan Mikrokontroler Arduino Uno," *J. Teknol. Dan Sist. Tertanam*, vol. 1, no. 1, Art. no. 1, Aug. 2020, doi: 10.33365/jtst.v1i1.719.
- [5] Y. I. Chandra, M. D. Lusita, and M. H. Ekasari, "Rancang Bangun Aplikasi Informasi Puskesmas Berbasis Web Mobile (Studi Kasus: Puskesmas Tanah Abang)," *Tekinfo J. Bid. Tek. Ind. Dan Tek. Inform.*, vol. 23, no. 2, Art. no. 2, Oct. 2022.
- [6] Y. I. Chandra, I. Irfan, K. Kosdiana, and M. Riastuti, "Penerapan Metode Prototype Dalam Merancang Purwarupa Pengaman Pintu Kandang Ternak Otomatis Berbasis Mikrokontroler ATMEGA 328P," *Innov. Res. Inform. Innov.*, vol. 4, no. 1, Art. no. 1, Mar. 2022, doi: 10.37058/innovatics.v4i1.4888.
- [7] K. Xie and K. Wang, "Measurement of Wind Speed and Direction with Ultrasonic Sensor Using FPGA," *Energy Procedia*, vol. 12, pp. 837–843, Jan. 2011, doi: 10.1016/j.egypro.2011.10.110.
- [8] S. Yamaguchi *et al.*, "Speaker Identification for Business-Card-Type Sensors," *IEEE Open J. Comput. Soc.*, vol. 2, pp. 216–226, 2021, doi: 10.1109/OJCS.2021.3075469.
- [9] M. Nishikawa, Y. Ishizuka, H. Matsuo, and K. Shigematsu, "An LED Drive Circuit with Constant-Output-Current Control and Constant-Luminance Control," in *INT'LEEC 06 - Twenty-Eighth International Telecommunications Energy Conference*, Sep. 2006, pp. 1–6. doi: 10.1109/INTLEEC.2006.251597.
- [10] J. Dolinay, P. Dostálek, and V. Vašek, "Advanced debugger for Arduino," 2021, doi: 10.14569/IJACSA.2021.0120204.
- [11] J. Mesquita, D. Guimarães, C. Pereira, F. Santos, and L. Almeida, "Assessing the ESP8266 WiFi module for the Internet of Things," in *2018 IEEE 23rd International Conference on Emerging Technologies and Factory Automation (ETFA)*, Sep. 2018, pp. 784–791. doi: 10.1109/ETFA.2018.8502562.