Journal of Applied Science, Technology & Humanities
Volum 3, Issue 1, January, 2026, Pages 872-883

ISSN 3032-5765
DOI: https://doi.org/10.62535/sw45r435

Developing an Arduino Uno-Based Water Clarity Assessment Instrument at LIPI-Biotechnology

R. Ramadhan[1]
[1] Vocational School, IPB University

Euis[2], **Siti Farah Fakhirah**[3*], **Asa Yuaziva**[4], **Jonser Steven Rajali Manik**[5], **Icha Maulidya**[6]
[2, 3, 4,5,6] Vocational School, IPB University
[3*]sitifarah@apps.ipb.ac.id, [4]yuazivaasa@apps.ipb.ac.id, [5]jonsersteven@apps.ipb.ac.id, [6]ichamaulidya@apps.ipb.ac.id

Abstract

Visual monitoring of water clarity in closed laboratory reservoirs poses significant challenges and inefficiencies that may compromise equipment sterilization standards. This study aims to develop an automated water clarity monitoring system at the Research Center for Biotechnology-LIPI utilizing an Arduino Uno microcontroller paired with a BH1750 digital light sensor. The device operates on the principle of light transmission, where suspended particles in turbid water obstruct the light intensity detected by the sensor. Data is processed and transmitted via an Ethernet Shield to a web-based interface for both real-time monitoring and database logging. The research results demonstrate that the device successfully classifies water clarity levels based on light intensity readings, defining clear water as >200 Lux, moderate water as 150-200 Lux, and turbid water as <150 Lux. By providing real-time status updates and automated historical data logs, the system eliminates the need for manual physical inspection. This instrument presents a functional and cost-effective solution to ensure adherence to laboratory water quality standards.

Keywords: Water Clarity, Arduino Uno, BH1750 Sensor, Web Monitoring, Internet of Things

INTRODUCTION

Water is an essential element in laboratory operations, particularly for the sterilization and cleaning of testing equipment. The quality of water utilized plays a critical role in the accuracy and reliability of experimental results (Hong et al., 2021; Wysowska et al., 2021). Contaminants or microscopic residues in turbid water can adversely affect delicate chemical and biological reactions, potentially compromising the integrity of the findings (Orlando & Kasoep, 2020). Therefore, it is imperative to ensure that the water used meets stringent clarity and turbidity standards, as emphasized in various water quality management studies (Petrescu-Mag et al., 2024; Susanto et al., 2020). Adherence to these quality standards is fundamental to safeguarding experimental validity and upholding the scientific rigor of laboratory outcomes, a concept that aligns with broader efforts to improve science literacy and competence (Lestari et al., 2019).

At the Research Center for Biotechnology-LIPI, water utilized for cleaning laboratory equipment is stored in closed reservoirs to prevent contamination from environmental pollutants such as dust. However, the enclosed nature of these storage systems impedes effective visual monitoring of the water's physical properties. Traditional monitoring techniques dependent on manual inspections are often inadequate and pose risks regarding reliability. Similar challenges in monitoring efficiency have been reported in various environments, such as lakes, rivers, and aquaculture ponds (Andre et al., 2020; Jais et al., 2024; Kumar et al., 2024; Zuhaida et al., 2024). Delays in identifying shifts in water clarity may result in the inadvertent use of substandard water, thereby jeopardizing the sterility of laboratory instruments and compromising subsequent experimental procedures. Thus, the implementation of real-time monitoring systems is critical to ensure compliance with laboratory standards (Hakimi & Jamil, 2021; Muhsin et al., 2025).

The advancement of the Internet of Things (IoT) and embedded systems offers promising solutions for real-time water quality monitoring (Kelechi et al., 2021; Lakshmikantha et al., 2021). Numerous studies have leveraged microcontrollers, particularly Arduino, to address these challenges, ranging from basic science applications to complex sensor integrations like sensor film materials

(Irzaman et al., 2019; Prabowo et al., 2022). For instance, (Gusri & Harmadi, 2021) and (Saraswati et al., 2025) utilized standard industrial turbidity sensors (SEN0189) to automate water draining and monitor drinking water quality, while (Haslindah et al., 2022) applied nephelometric methods for filtration control systems. Similar implementations using Arduino for turbidity, pH, and TDS monitoring have also been explored in industrial settings, water treatment plants, and filtration tools (Fadhillah & Jenih, 2024; Forhad et al., 2024; Irawan et al., 2021). Low-cost optical approaches utilizing Light Dependent Resistors (LDR) have also been investigated by (Cahyono et al., 2019) and (Siskandar et al., 2023). However, many existing solutions are constrained by their reliance on specialized sensors, which often entail significant implementation costs, whereas simple analog sensors like LDRs require complex signal calibration (Araneta, 2022). Addressing these limitations, this study presents a novel approach by employing the principle of light transmission through a BH1750 digital light sensor. Unlike previous investigations, this method utilizes a high-precision digital light intensity sensor paired with a consistent LED flashlight source as a cost-effective substitute for measuring water clarity. This approach operates on the principle that suspended particles in turbid water obstruct light transmission, leading to a proportional decrease in the intensity detected by the digital sensor, thereby enhancing both accessibility and system affordability (Abiyaksa et al., 2020; Siskandar et al., 2020).

The proposed system integrates an Arduino Uno microcontroller and an Ethernet Shield to transmit data to a web-based interface. This configuration allows laboratory technicians to directly monitor water clarity status in real-time, where the condition is categorized as clear, moderate, or turbid. Furthermore, the system provides access to historical data logs without requiring physical contact with the water reservoir (Jamroen et al., 2023; Kusumah et al., 2021). The primary objective of this research is to design and build an affordable automated water clarity monitoring system, implement web-based data communication for information accessibility, and provide a historical database for long-term water quality analysis in the Biotechnology-LIPI environment.

METHODS

This study employs an experimental design approach focusing on the development of an automated water quality monitoring system. The research procedure was structured systematically to ensure the seamless integration of hardware and software components tailored to the laboratory's operational requirements (Hakimi & Jamil, 2021; Susanto et al., 2020). The specific phases of this methodology are detailed in the subsequent sections.

1. Requirement Analysis

This phase is conducted to align the institution's operational needs with the proposed technical solution. It involves a detailed description of the necessary hardware specifications and the definition of the system workflow to ensure the device functions according to monitoring targets.

2. Web Application Design and Development

Software development initiates with the identification of functional requirements for the web-based system. This process encompasses designing the user interface for data visualization and structuring an efficient database schema for water quality logging (Abiyaksa et al., 2020; Widiasari & Zulkarnain, 2021).

3. Device Design

This stage focuses on hardware architecture design, commencing with the creation of system flowcharts and block diagrams. Furthermore, it involves developing electronic circuit schematics and writing the firmware logic for the microcontroller to ensure accurate sensor data processing.

4. Device Assembly

Journal of Applied Science, Technology & Humanities
Volume .., Issue .., Month, Year, Pages

ISSN 3032-5765
DOI:

Assembly constitutes the process of integrating separate input-output modules into a unified, functional device unit. This process is executed by manufacturing a Printed Circuit Board (PCB) based on the designed schematics, serving as a stable interface connection between the sensor, communication modules, and the microcontroller.

5. Testing

Functional testing is performed to verify the device's performance conformity with the initial design objectives. This procedure involves executing all device functions according to the system flowchart to validate data accuracy prior to full implementation. Calibration and validation techniques are applied to ensure the sensor readings are linear and accurate relative to the actual water conditions (Jais et al., 2024).

6. Device Implementation

Implementation represents the final stage of the water clarity monitoring device development cycle. This phase is carried out by physically installing the hardware unit onto the water reservoir infrastructure at the Research Center for Biotechnology-LIPI laboratory to commence actual operational monitoring (Andre et al., 2020; Siskandar et al., 2022).

RESULTS AND DISCUSSION

1. Requirement Analysis

The workflow of the water clarity determination tool at Biotechnology-LIPI is explained in the block diagram shown in Figure 1. Physical data is read by the sensor, processed by the microcontroller, sent via the Ethernet Shield to the router, and finally displayed on the server computer.

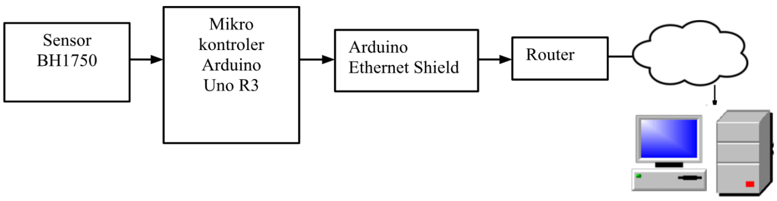

Figure 1. Block Diagram

The devices used in the design of the water clarity determination tool are explained in this stage. A microcontroller is a chip packaged in a single piece where its parts are required for a controller. The microcontroller module used is Arduino Uno. Arduino Uno is a module based on the ATMega 328 microcontroller. This module has 14 digital input/output pins, 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, and a reset button. The image of the Arduino Uno can be seen in Figure 2.

Figure 2. Arduino Uno

The Ethernet Shield is a module that allows the Arduino Uno to connect to the internet to become a web server or communicate with other network devices using the TCP/IP protocol. The image of the Ethernet Shield can be seen in Figure 3.

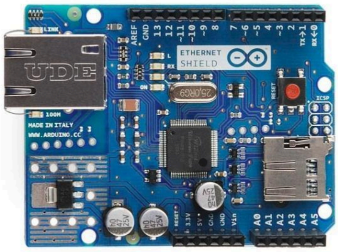

Figure 3. Ethernet Shield

A sensor is basically a device that functions to convert a physical quantity into an electrical quantity, so its output can be processed with electrical circuits or digital systems. The BH1750 digital light sensor has a 16-bit AD converter that directly produces a digital signal output, requiring no complex calculations. This sensor is more accurate and easier because it uses a simple photoresistor version that only calculates voltage output to get the actual data. The image of the BH1750 digital light sensor can be seen in Figure 4.

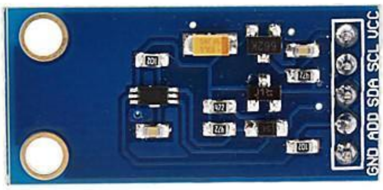

Figure 4. BH1750 Sensor

Additionally, an adapter is a tool used to step down electrical voltage and convert AC (Alternating Current) voltage into DC (Direct Current) voltage. A 9V 1A adapter circuit is used as the voltage for the microcontroller.

2. Web Application Design and Development

The working principle of the Arduino Uno-based water clarity determination tool design begins with reading the value from the BH1750 digital light sensor, which functions as the determinant of water clarity levels. The value obtained is sent to the database as a data storage location. After that, the value is compared with the conditions determined on the web. Then, the compared value can be categorized by its clarity level. The water clarity level category is displayed on the web to make it easier to monitor water clarity. This process repeats continuously starting from the water clarity measurement again. The flowchart of this system can be seen in Figure 5.

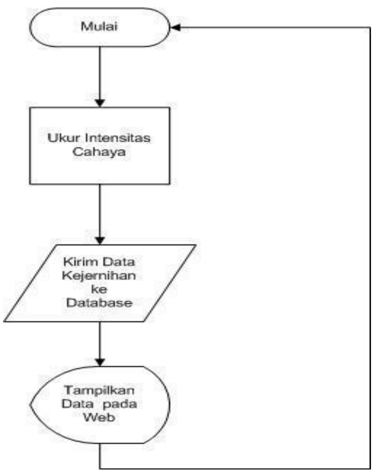

Figure 5. Water Clarity Tool Flowchart

Journal of Applied Science, Technology & Humanities
Volume .., Issue .., Month, Year, Pages

ISSN 3032-5765
DOI:

Journal of Applied Science Technology & Humanities

In the hardware design and program creation stage, the Arduino Uno module is connected to the Ethernet Shield so that it can communicate with the server, as illustrated in Figure 6.

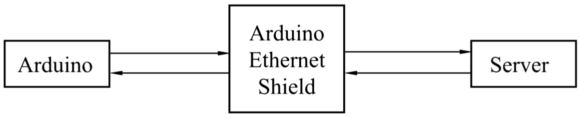

Figure 6. Arduino and Ethernet Shield Connection

Tool programming is done on the Arduino 1.5.2 software using C language. The program begins by writing the library for the Ethernet Shield and setting the server and client IP addresses. The program code can be seen in Figure 7.

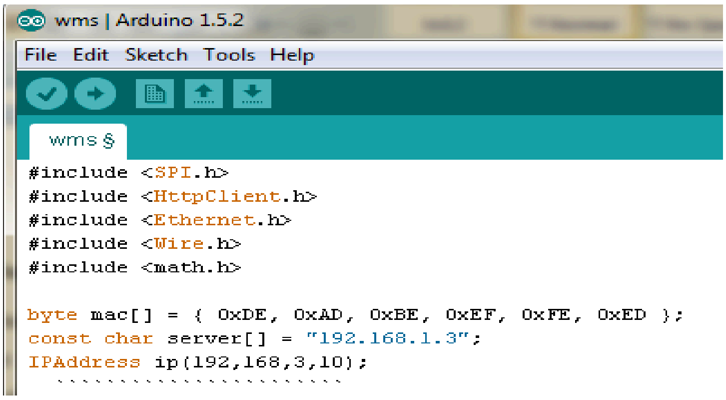

Figure 7. Ethernet Shield Library

The connection between the Arduino Uno and the BH1750 digital light sensor is explained in Figure 8.

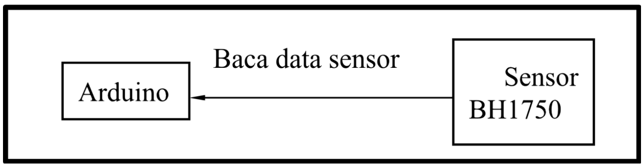

Figure 8. Arduino and Sensor Connection

The initialization of the BH1750 digital light sensor on the Arduino Uno analog pins can be seen in Figure 9.

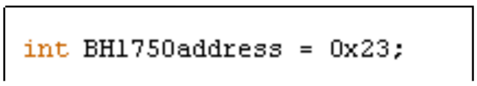

Figure 9. Ethernet Shield

The result of the water clarity measurement from the BH1750 sensor is stored in the var2 variable. The measurement data is given a condition: if the light intensity value obtained is greater than 200 lux, the water is categorized as clear; if the value obtained is greater than 150 lux and less than 200 lux, the water is categorized as moderate; otherwise, the water is categorized as having a turbid clarity level. The conditions explained above were obtained from experimental results with water samples provided by the institution. The categorized data is saved into the database located on the web; in addition, the data will be displayed on the preview to facilitate monitoring. The code snippet can be seen in Figure 10.

```
public function wms_insert_log(){

    if($this->input->post('var2') > 200){
        $turbidity = 'Jernih';
    }else if($this->input->post('var2') > 150){
        $turbidity = 'Sedang';
    }else{
        $turbidity = 'Keruh';
    }
    $old_turbidity = read_file("assets/device/wms/lux.txt");
    write_file("assets/device/wms/lux.txt", $turbidity);
    if($old_turbidity != $turbidity){
        $data = array(
            'turbidity' => $turbidity
        );
        $this->db_wms_log->insert($data);
    }
}
```

Figure 10. Water Clarity Level Categorization

Next is the interface design stage on the web to display the data results from the water clarity determination tool. The web preview design can be seen in Figure 11.

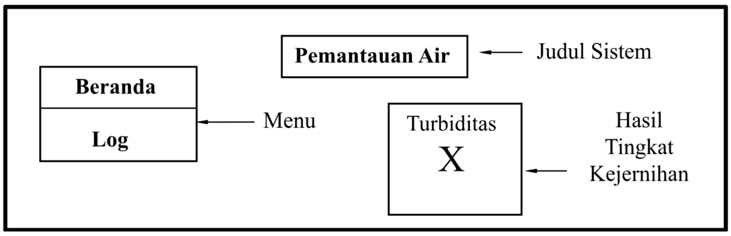

Figure 11. Web Preview Design

The home page display is filled with a table of water clarity level results along with measurement times. The measurement time in the table is recorded on a daily basis. The web home page design can be seen in Figure 12.

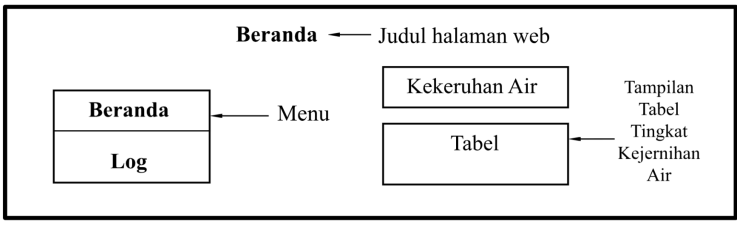

Figure 12. Web Home Page Design

The display on the log menu is a database that records changes in water clarity sorted by recording time. The web log display design can be seen in Figure 13.

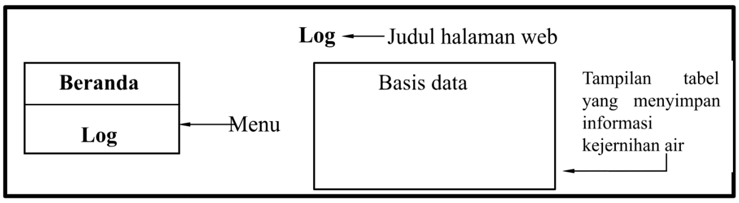

Figure 13. Web Log Design

3. Device Design

Device assembly is the activity of uniting separate input-output modules into a single unit suitable for the purpose. Device assembly is done by creating a PCB circuit according to the circuit schematic used as a connector between the input-output modules and the microcontroller. The

Journal of Applied Science, Technology & Humanities
Volume .., Issue .., Month, Year, Pages

ISSN 3032-5765
DOI:
Journal of Applied Science Technology & Humanities

configuration of the BH1750 sensor legs to the Arduino Uno microcontroller can be seen in Figure 14 and Table 1.

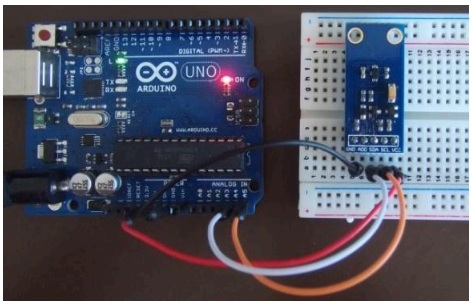

Figure 14. Arduino and BH1750 Sensor Pin Connection

Table 1. Arduino and BH1750 Sensor Pin Connection

Arduino Uno	Sensor BH1750
VCC	VCC
GND	GND
A4	SDA
A5	SCL

The Ethernet Shield is connected to the Arduino Uno module according to the existing pins as shown in Figure 15.

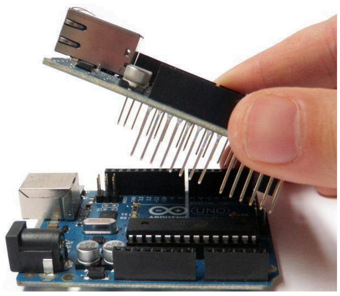

Figure 15. Arduino and Ethernet Shield Pin Connection

4. Device Assembly

Testing is conducted to determine if the results obtained are as desired. Device testing is done by running the device functions according to the flowchart. The test results of the BH1750 digital light sensor with turbid water conditions displayed on the serial monitor in the Arduino 1.5.2 software are shown in Figure 16.

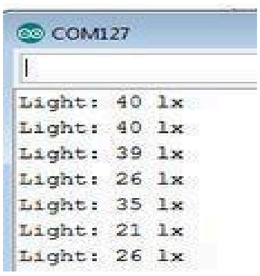

Figure 16. BH1750 Sensor Test on Arduino Serial Monitor

The test results of the water clarity determination tool displayed on the web in turbid water conditions can be seen in Figure 17.

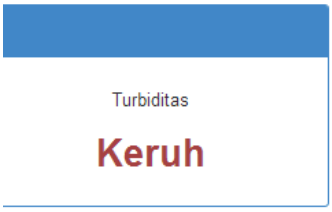

Figure 17. Turbid Water Display Test on Web

The test results of the water clarity determination tool on the web in clear water conditions are shown in Figure 18.

Figure 18. Clear Water Display Test on Web

The test results of clarity level determination in the database along with the time and date. Such data will be recorded every time a change in the water clarity level determination result occurs. It can be seen in Figure 19.

Kejernihan Air	Waktu	Tanggal
Jernih	02:23:41	10 April 2014
Sedang	02:24:02	10 April 2014

Figure 19. Database Display Test on Web

5. Testing

Device implementation is carried out as the final stage of making the water clarity determination tool. Figure 20 and Figure 21 shows the installation of the tool above the water reservoir at the Biotechnology-LIPI laboratory.

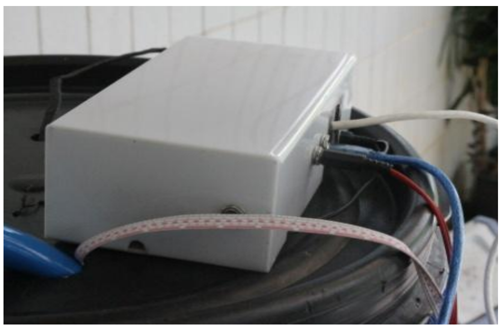

Figure 20. Tool on Water Reservoir 1

Journal of Applied Science, Technology & Humanities
Volume .., Issue .., Month, Year, Pages

ISSN 3032-5765
DOI:

Figure 21. Tool on Water Reservoir 2

The placement of the BH1750 digital light sensor under the water reservoir lid can be seen in Figure 22, and a light source is provided at the bottom of the water reservoir to help the sensor work according to the function of the tool.

Figure 22. Sensor under Reservoir Lid

The tool is connected to the server so that it can be accessed via the web. Figure 23 shows the web display being accessed on a laptop. The web application is installed on the Biotechnology-LIPI web server and can be accessed at http://prakom.lipi.go.id/BiotechWeb.

Figure 22. Web Display

CONCLUSION

This study successfully developed an automated water clarity monitoring system using Arduino Uno and a BH1750 sensor, effectively overcoming visual monitoring limitations in closed reservoirs at Biotechnology-LIPI. The system provides real-time web-based monitoring and automated historical data logging, ensuring compliance with water quality standards for laboratory equipment cleaning. While the primary functions operate optimally, future improvements should focus on enhancing stability by replacing battery power with a constant electrical source. Furthermore, integrating an automatic draining mechanism when turbidity is detected is recommended to minimize manual intervention and optimize overall laboratory efficiency.

REFERENCES

Abiyaksa, D., Adi, S. H., & Siskandar, R. (2020). Pembuatan Prototype Smart Budidaya Ikan Mas Koki Berbasis Arduino. *Indonesian Journal of Science*, *1*(1), 45–50.

Andre, D. J., Triwisesa, E., & Siskandar, R. (2020). Rancang Bangun Alat Monitoring Keadaan Air Danau Berbasis Arduino Terintegrasi Web di Limnologi LIPI. *Indonesian Journal of Science*, 106–112.

Araneta, A. A. S. (2022). Design of an Arduino-Based Water Quality Monitoring System. *International Journal of Computer Science and Mobile Computing*, *11*(3), 152–165. https://doi.org/10.47760/ijcsmc.2022.v11i03.017

Cahyono, B. E., Utami, I. D., Lestari, N. P., & Oktaviany, N. S. (2019). Karakterisasi Sensor LDR dan Aplikasinya pada Alat Ukur Tingkat Kekeruhan Air Berbasis Arduino UNO. *Jurnal Teori dan Aplikasi Fisika*, *7*(2), 179–186. https://doi.org/10.23960/jtaf.v7i2.2247

Fadhillah, M. R. N., & Jenih. (2024). Rancang Bangun Sistem Pemantau Kualitas Air Pada PT Abacus Dana Pensiuntama Berbasis Arduino Uno. *Jurnal Teknologi Informasi*, *10*(1).

Forhad, H. M., Uddin, Md. R., Chakrovorty, R. S., Ruhul, A. M., Faruk, H. M., Kamruzzaman, S., Sharmin, N., Jamal, A. S. I. M., Haque, Md. M.-U., & Morshed, A. M. (2024). IoT based real-time water quality monitoring system in water treatment plants (WTPs). *Heliyon*, *10*(23), e40746. https://doi.org/10.1016/j.heliyon.2024.e40746

Gusri, A. J., & Harmadi, H. (2021). Rancang Bangun Alat Penguras Air Pada Wadah Penampungan Berbasis Turbidity Sensor SEN0189. *Jurnal Fisika Unand*, *10*(3), 330–336. https://doi.org/10.25077/jfu.10.3.330-336.2021

Hakimi, I. M., & Jamil, Z. (2021). Development of Water Quality Monitoring Device Using Arduino UNO. *IOP Conference Series: Materials Science and Engineering*, *1144*(1), 012064. https://doi.org/10.1088/1757-899X/1144/1/012064

Haslindah, A., Musrawati, M., Rosida, U., & Sasly Taslim, M. N. (2022). Sistem Kontrol Pendeteksi Kadar Kekeruhan Air Berbasis Arduino Uno. *ILTEK : Jurnal Teknologi*, *17*(1), 47–51. https://doi.org/10.47398/iltek.v17i1.679

Hong, W., Shamsuddin, N., Abas, E., Apong, R., Masri, Z., Suhaimi, H., Gödeke, S., & Noh, M. (2021). Water Quality Monitoring with Arduino Based Sensors. *Environments*, *8*(1), 6. https://doi.org/10.3390/environments8010006

Irawan, Y., Febriani, A., Wahyuni, R., & Devis, Y. (2021). Water Quality Measurement and Filtering Tools Using Arduino Uno, PH Sensor and TDS Meter Sensor. *Journal of Robotics and Control (JRC)*, *2*(5). https://doi.org/10.18196/jrc.25107

Irzaman, Siskandar, R., Yuliarto, B., Zakki Fahmi, M., & Ferdiansjah. (2019). Application of Ba0.5Sr0.5TiO3 (Bst) Film Doped with 0%, 2%, 4% and 6% Concentrations of RuO2 as an Arduino Nano-Based Bad Breath Sensor. *Chemosensors*, *8*(1), 3. https://doi.org/10.3390/chemosensors8010003

Jais, N. A. M., Abdullah, A. F., Kassim, M. S. M., Karim, M. M. A., M, A., & Muhadi, N. 'Atirah. (2024). Improved accuracy in IoT-Based water quality monitoring for aquaculture tanks using low-cost sensors: Asian seabass fish farming. *Heliyon*, *10*(8), e29022. https://doi.org/10.1016/j.heliyon.2024.e29022

Jamroen, C., Yonsiri, N., Odthon, T., Wisitthiwong, N., & Janreung, S. (2023). A standalone photovoltaic/battery energy-powered water quality monitoring system based on narrowband internet of things for aquaculture: Design and implementation. *Smart Agricultural Technology*, *3*, 100072. https://doi.org/10.1016/j.atech.2022.100072

Kelechi, A. H., Alsharif, M. H., Anya, A. C., Bonet, M. U., Uyi, S. A., Uthansakul, P., Nebhen, J., & Aly, A. A. (2021). Design and Implementation of a Low-Cost Portable Water Quality Monitoring System. *Computers, Materials & Continua*, *69*(2), 2405–2424. https://doi.org/10.32604/cmc.2021.018686

Kumar, J., Gupta, R., Sharma, S., Chakrabarti, T., Chakrabarti, P., & Margala, M. (2024). IoT-Enabled Advanced Water Quality Monitoring System for Pond Management and Environmental Conservation. *IEEE Access*, *12*, 58156–58167. https://doi.org/10.1109/ACCESS.2024.3391807

Kusumah, B. R., Jaya, A. K., Siskandar, R., & Rahim, F. F. (2021). E-Ox Level: Sustainability Test of Data Storage System and Performance Test on Closed System Fish Pond. *Aquacultura Indonesiana*, *23*(1), 1. https://doi.org/10.21534/ai.v23i1.267

Lakshmikantha, V., Hiriyannagowda, A., Manjunath, A., Patted, A., Basavaiah, J., & Anthony, A. A. (2021). IoT based smart water quality monitoring system. *Global Transitions Proceedings*, *2*(2), 181–186. https://doi.org/10.1016/j.gltp.2021.08.062

Lestari, H., Banila, L., & Siskandar, R. (2019). *IMPROVING STUDENT'S SCIENCE LITERACY COMPETENCIES BASED ON*. *14*(2).

Muhsin, Z. S., Al-zubaidi, L., & Rasheed, M. A. (2025). *A Review of Portable Water Quality Measurement System Using Arduino Sensor*. *29*(06).

Orlando, M., & Kasoep, W. (2020). Sistem Monitoring dan Penjernihan Air Berdasarkan Derajat Keasaman (PH) dan Kekeruhan Pada Bak Penampungan Air Berbasis Internet of Things. *CHIPSET*, *1*(01), 17–22. https://doi.org/10.25077/chipset.1.01.17-22.2020

Petrescu-Mag, R. M., Ivan, A., Pantelimon, C., & Petrescu, D. C. (2024). Mapping environmental perceptions in Romania: A mixed-methods research. *Heliyon*, *10*(23), e40845. https://doi.org/10.1016/j.heliyon.2024.e40845

Prabowo, H., Gaol, F. L., & Hidayanto, A. N. (2022). Comparison of the System Development Life Cycle and Prototype Model for Software Engineering. *International Journal of Emerging Technology and Advanced Engineering*, *12*(4), 155–162. https://doi.org/10.46338/ijetae0422_19

Saraswati, I., Himawan, G., Wiryadinata, R., Ramadhani, A., Haryanto, H., Franata, N., Yudono, M. A. S., & Erlindriyani, R. V. (2025). Prototype system for turbidity and TDS measurement of refill drinking water using Arduino microcontroller. *Teknika: Jurnal Sains Dan Teknologi*, *21*(1), 41. https://doi.org/10.62870/tjst.v21i1.30486

Siskandar, R., Fadhil, M. A., Kusumah, B. R., Irmansyah, I., & Irzaman, I. (2020). INTERNET OF THINGS: AUTOMATIC PLANT WATERING SYSTEM USING ANDROID. *Jurnal Teknik Pertanian Lampung (Journal of Agricultural Engineering)*, *9*(4), 297. https://doi.org/10.23960/jtep-l.v9i4.297-310

Siskandar, R., Wiyoto, W., Hendriana, A., Ekasari, J., Kusumah, B. R., Halim, G., & Nugraha, I. J. (2022). Automated Redox Monitoring System (ARMS): An Instrument for Measuring Dissolved Oxygen Levels Using a Potential Redox Sensor (ORP) in a Prototype of Shrimp

Farming Pond with an Internet-Based Monitoring System. *Journal of Aquaculture and Fish Health*, *11*(2), 238–246. https://doi.org/10.20473/jafh.v11i2.31487

Siskandar, R., Wiyoto, W., Santosa, S. H., Sari, J. E., Darmawangsa, G. M., Hidayat, A. P., Dardanella, D., & Kusumah, B. R. (2023). Potential Readings of Water Turbidity Values Based on Optical Sensors on Fish-Rearing Biofloc Media. *Photonics Letters of Poland*, *15*(1), 1–3. https://doi.org/10.4302/plp.v15i1.1176

Susanto, A., Alimuddin, A., Herjayanto, Muh., Budiaji, W., & Fitria, N. (2020). Rancang Bangun Sistem Monitoring Kualitas Air untuk Pemeliharaan Organisme Laut. *Jurnal Edukasi dan Penelitian Informatika (JEPIN)*, *6*(3), 386. https://doi.org/10.26418/jp.v6i3.42899

Widiasari, C., & Zulkarnain, L. A. (2021). Rancang Bangun Sistem Monitoring Penggunaan Air PDAM Berbasis IoT. *Jurnal Komputer Terapan*, *7*(2), 153–162. https://doi.org/10.35143/jkt.v7i2.5152

Wysowska, E., Wiewiórska, I., & Kicińska, A. (2021). The impact of different stages of water treatment process on the number of selected bacteria. *Water Resources and Industry*, *26*, 100167. https://doi.org/10.1016/j.wri.2021.100167

Zuhaida, A., Widodo, A., Prima, E. C., & Solihat, R. (2024). River Water Quality Analysis Using Arduino-Based Sensor of the Cikapundung River, Indonesia. *International Journal of Online and Biomedical Engineering (iJOE)*, *20*(07), 30–47. https://doi.org/10.3991/ijoe.v20i07.48179