Potential Readings of Water Turbidity Values Based on Optical Sensors on Fish-Rearing Biofloc Media

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Abstract—An optical sensor-based water turbidity reader has been made with an IR-emitting light source, red LED and a laser.
The tool is made as a solution for reading water turbidity values that are impermeable to light-intensity disturbances. In principle, each light emitter will always shoot toward the sensor. The position of the transmitter and sensor is right between the flowing water pipes. When the water flows, the sensor will read the hardness value of the water (in analog value). Of course, pipes, sensors, transmitting sources, and electronic devices are protected by a casing that is impermeable to light intensity. The casing can be placed outside the pool to facilitate the process of tool maintenance. The tool was made in the SV-IPB University hardware laboratory and tested in the SV-IPB University fish pond from April 2022 to October 2022. Tests for all emitting light sources were carried out on aqueous media which has a flock of 6 ml/l. The results show that the three transmitter sources have analog readings in the same range, namely 2200 to 2300. However, of the three, the red LED transmitter sources have consistent reading values for three replications. Thus, the red LED light emitting source has good potential to be used as an optical sensor to read the value of water turbidity in biofloc media. This was proven again in measurements using variations in flock values (5 ml/l, 6 ml/l, 12 ml/l, and 17 ml/l), indicating that the higher the flock value, the greater the resistance value, so the output voltage value is higher. The output voltage value can be calculated from the analog value measured by the device.

Keywords: optical sensor, bioflock, water turbidity

An alternative to solving wastewater quality problems in catfish farming, bioflock comes from the word bios which means life and flock which means clumps so biofloc is a collection of various types of organisms such as fungi, bacteria, algae, protozoa, worms, and others, which are incorporated in clumps. The microorganisms involved in the biofloc system are bacteria. One of the bacteria in the biofloc method is a type of Bacillus [1–2]. According to [3] the addition of heterotrophic bacteria carbon material can convert inorganic nitrogen from feces and feed into a single-cell protein so that it can be used as a source of food for fish.

However, the high organic waste from the rest of the feed/feces resulting from intensive catfish rearing will cause accumulation and deposition at the bottom of the rearing water media, so a decomposition process is needed [4]. If not decomposed, the rearing media will decompose anaerobically by anaerobic bacteria and then form toxic gases such as sulfide acid, nitrite, and ammonia which hurt the metabolism of cultured organisms to death. To reduce organic waste and waste that will be discharged into public waters, it is necessary to manage water quality so that the maintenance media remains in good condition. One of the efforts is an approach through modern sensor-based technology that can inform the value of water quality and work automatically to maintain the quality of the maintenance media so that it remains in good condition [5–9].

This technology applies a sensor-based water quality reading system. This technology was made in the SV-IPB University hardware laboratory and tested in the SV-IPB University fish pond from April 2022 to October 2022. This technology is the right solution as an instrument that can be used to measure air turbidity values. The principles of the tools/instrumentation made in the testing/data collection process are the sensor will read the level of light received from the transmitter. The transmitters used are red LED, laser, and IR. This technology is designed to be light-resistant during the measurement process. This is done to obtain precise water quality values without interference from outside light, because biofloc is not suitable to be placed in a full indoor room because there are

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microorganisms that photosynthesize, thus requiring sunlight. In addition, the measurement process carried out through the flow of water flowing through a pipe is assumed to make the floc melt first so that the viscosity of the liquid entering the pipe will be uniform.

In this study, a sensor-based device for reading water quality values on catfish-rearing biofloc media has been developed to increase the level of harvest productivity.

The turbidity value sensor can distinguish phytoplanktonic turbidity from sediment turbidity.

The material used as a turbidity reader consists of different light-emitting diodes (LEDs) with different wavelengths: (i) infrared (IR), (ii) red, and (iii) laser; two light detectors are used, a light-dependent resistance (LDR) to detect visible light (180°) and a photodiode to detect infrared light. This light-emitting diode (LED) is powered by a voltage of 4.5 volts.

The light receptors used in the sensor are IR photodiode and Light Dependent Resistor (LDR) which are sensitive to the visible light range, namely NSL 19M51. The LDR changes its resistivity depending on the amount of light hitting the sensitive part. The higher the light intensity, the lower the LDR resistance. The IR photodiode used produces high speed and high beam sensitivity. The sensitivity range is from 790 nm to 1050 nm with the peak appearing at 950 nm. The photodiode used is a photodiode with the code BPW83. The photodiode operation is the opposite of the LDR operation. The photodiode resistance increases with light intensity.

The apparatus is shown in Fig. 1. The light detector is placed at 180° from the light source. The distance between the light source and the light detector is 5.5 cm. A pipe made of non-porous crystal with a thickness of 2 mm and a diameter of 2.7 cm is used for the passage of water. The light source system and light receptors are housed in a light-tight plastic case. More details, on the design of the tool, are shown in Fig. 1.

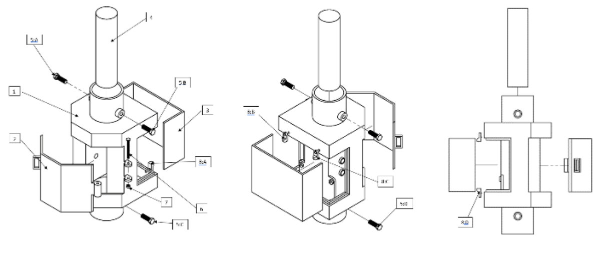

Fig. 1. Design of a Sensor-Based Water Turbidity Value Reader on Catfish Rearing Biofloc Media.

Figure 1 shows the parts of the device casing for the water quality turbidity reading sensor. The front cover (2) is connected to the guard body (1) using a bolt (6) and a nut (7). The front cover also has a holder for a magnet that will connect to the magnet on the shield body (9). This cover serves as a place to see the turbidity of water flowing in a transparent pipe (4). Then, the back cover (3) serves to protect the electronic circuit board and sensors contained in the protective body which can be locked using four keys (8:A, 8:B, 8:C, 8:D). The guard body can also be connected to a water pipe which can be locked with four bolts (5:A, 5:B, 5:C: 5:D).

The size casing for the turbidity sensor has an overall height of 20.6 cm, a length of 10 cm, and a width of 10 cm. The protective body has a height of 12.6 cm. The place for connecting pipes has a diameter of 4.7 cm. The design in Fig. 1 provides potential benefits for fish farming farmers who need to measure turbidity levels instantly because it is practical and efficient. This design presents a very practical improvement, especially for reading the value of water turbidity in the biofloc media for catfish rearing.

The LEDs are powered using a constant output voltage of 4.6 volts. A 330-ohm resistor is used between the fly port and the LED to avoid possible damage. The LDR and photodiode resistor values are measured with a digital multimeter. The LEDs are powered sequentially: IR, red, and laser. The electronic schematic of the circuit which includes all the elements is shown in Fig. 2.

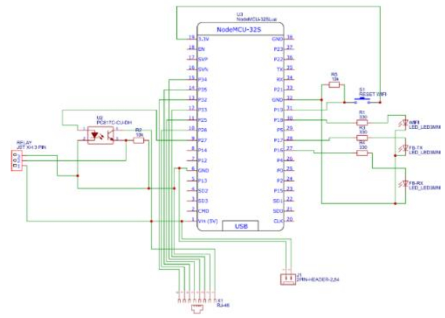

Fig. 2. Electronic Schematic of Sensor-Based Sensor-Based Water Turbidity Reading Devices on Catfish Rearing Biofloc Media.

As shown in Fig. 2, the microcontroller (Esp32) will send a signal to the LED to light up and at the same time the microcontroller also reads the value given by the sensor. The received value will be processed to take the average reading value as long as the sensor receives light. The process is carried out sequentially from the IR, red, and laser LEDs with a reading process for 1 second and a pause for 1 second. The processed data will be uploaded to the database service, namely firebase. Data received from firebase will be read periodically by the website. The website will display the data read from firebase in the form of numbers and graphs. The software used to display the data is the Arduino IDE with the programming language C. The results of reading the value of water turbidity from each light-emitting source are shown in Fig. 3 (IR), Fig. 4 (red), and Fig. 5 (laser). Measurements were carried out in flock conditions of 6 ml/l.

The reading results show that the light-emitting source using a red LED produces consistent reading values on the same media treatment during the measurement. So it can be concluded that the red LED light emitting source has good potential to be used as an optical sensor to read the value of water turbidity in biofloc media.

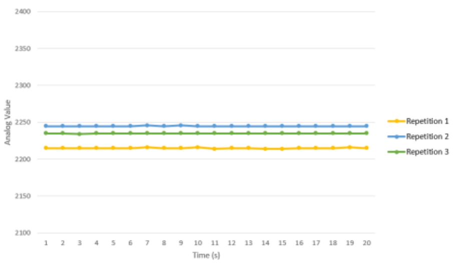

Fig. 3. Graph of Reading the Turbidity Value of Water using IR.

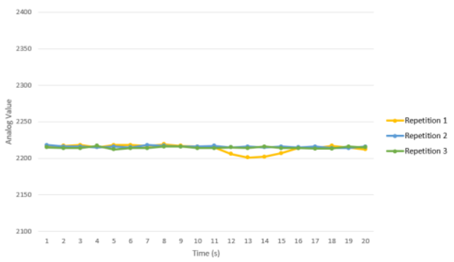

Fig. 4. Graph of reading the value of water turbidity using a red LED.

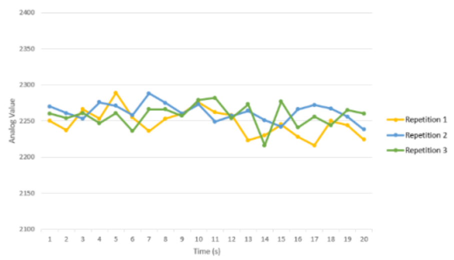

Fig. 5. Graph of Reading Turbidity in Water Using Laser.

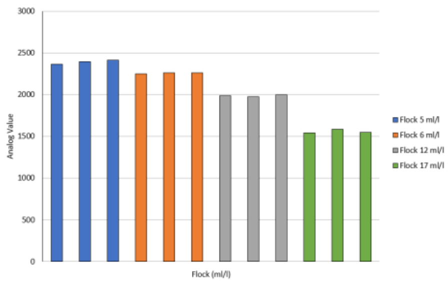

Figure 6. Measurement of the value of water turbidity using the red LED in the flock.

Figure 6 shows the appropriate relationship between the flock and the output voltage value, namely the higher the flock value, the greater the resistance value, so the smaller the output voltage value. The output voltage value can be calculated from the analog value measured by the device. Figure 6 also ensures that the tool/instrumentation made is a tool with innovations for measuring the turbidity value of pool water, where the measurement results are not affected by interference from the intensity of external light, unlike previous studies using conventional turbidity sensors [8–10], where the measurement results which are always changing even though the measurements are made at the same time and media. This tool also has other advantages, name, it is portable, easy to maintain, and does not need to be immersed in the pool, although special maintenance is needed for the pipe (due to mud or moss adhering to the pipe wall).

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