

## LIGHT SENSOR BASED AUTOMATIC AQUARIUM LIGHT

**Annisa Hanif Febrianti\*, Bima Pangayoman, M.Ikhsan Nurdin, Qorias Ihsan Musthofa, Wahyu Pribadi, Ricto Yudi Wicaksono**

Madiun State Polytechnic, Madiun.

\*Corresponding author: aissshafrintt@gmail.com

### **Abstract**

Smart Aquarium is a modern technology to automate and optimize its maintenance, especially for individuals who like to keep animals to channel their hobbies. Keeping fish in aquarium certainly different from in the wild which has a higher light intensity than indoor. This will certainly inhibit the photosynthesis process in aquarium plants. This study aims to determine the effect of LDR light sensors are very accurate when measuring the intensity of ambient light. When the light in the room is low or dim, for example at night, the sensor will detect and then it will command the Arduino Uno to activate the aquarium light to turn on. On the other hand, when the room has a high light intensity, the light will automatically turn off. The response time of the LDR light sensor is also relatively fast, and has high accuracy regarding the surrounding light intensity conditions. This system has several benefits, one of which is light manually, as well as optimizing energy use.

**Keywords :** Fish, Light, LDR Sensor, Plant photosynthesis, Sensor.

## **INTRODUCTION**

All living organisms require light to survive, including the life forms in the aquarium. Aquariums feature small aquatic life forms that possess aesthetic appeal within the tank. Aquariums seek to establish a stunning sight within the tank. As a result, the aquarium will appear more stunning and appealing (Hariyanto *et al.*, 2022)). Water plants and fish create an environment for life and growth in the aquarium. (Raharjo *et al.*, 2018). The quality of decorative fish is evaluated based on color and healthy growth. The uniqueness and variety shown by a product are significant commercial traits that can affect how well consumers accept an animal product, thereby impacting its market selling price (Colihueque & Tume *et al.*).

The quality of decorative fish is assessed based on coloration and healthy growth. The variety and distinctiveness exhibited by a product are significant commercial traits that can affect the degree of consumer approval of an animal product, thereby influencing the market value of the product (Colihueque & Tume *et al.*). For aquatic organisms to thrive effectively, ornamental fish need consistent feeding in aquariums, ponds, and similar environments to satisfy their dietary requirements (M. Ghufuran H. Kordi K.). Moreover, we should focus on maintaining ornamental fish; there should also be lighting that serves as an alternative to natural light that sustains the life of ornamental fish. Another role of lighting is to enhance the visibility of the colors of ornamental fish's scales and fins; without sufficient lighting in the aquarium, the fish may look washed out or lifeless (Bambang Priono). A USB LED artificial lighting system capable of automatically adjusting its brightness according to the surrounding light conditions of the aquarium, utilizing a light sensor and an Arduino microcontroller, is essential. Insufficient light can negatively impact the health of the biota within the aquarium and hinder plant photosynthesis (Hutabarat *et al.*, 2022). Conversely, if the light intensity is excessively high, such as from direct sunlight or continuous artificial lighting, it can lead to rampant algae growth, detrimentally affecting the aquarium's aesthetics (Suryadinatha *et al.*,

2022). Moreover, USB LED is highly appropriate for use in aquariums as it supports plant growth better than neon lights (Gupta & Jatothu, 2022). USB LED lights can enhance the visual appeal of the aquarium and offer greater efficiency than other lamp types (Kumari & Kumar, 2022). Multiple factors influence the appearance and viability of aquatic life in aquariums, such as temperature, pH, the composition of aquarium biota, oxygen and ammonia concentrations, filtration systems, lighting, among others (Kumari & Kumar, 2022).

This research utilized a compact aquarium. Consequently, this research employed 1 USB LED that operates at 5 watts. In light of the issues mentioned, a device is required to autonomously regulate the lighting according to the surrounding light intensity around the aquarium, utilizing fuzzy logic with Arduino UNO. This system operates continuously for 24 hours to ensure the aquarium's condition is preserved.

## LITERATURE REVIEW

### System Design

In designing this system, the design of the control device is carried out in accordance with the plan. The control devices include a light sensor device and a fritzing, arduino idea as a command receiver

### Light Sensor (LDR)



Figure 2. 1 Light Sensor (LDR)

Source : Sari Teknologi Robotik

Lamp The light sensor lamp is that the lamp will detect the presence of light. The sensor will capture light during the day, then responded by the transistor and the lights will turn off. Vice versa, the sensor will not capture sunlight at night, so it will be responded to by the transistor and the lights will turn on automatically. The advantages of light sensor lamps are not only related to the automatic function that is carried out. Light sensor lamps are designed as products that can save electricity costs. Using a light sensor lamp, we can cut monthly electricity costs.

Light Dependent Resistor (LDR) sensor is a type of resistor that changes its resistance due to the influence of light. The magnitude of the resistance value on the LDR light sensor depends on the size of the light received by the LDR itself. When the light is dark the resistance value is getting bigger, while the light is getting smaller. LDR is a type of resistor that is commonly used as a light detector or measuring the amount of light conversion. LDR consists of a semiconductor disk that has two electrodes on its surface.

The formula used for light using LDR sensor can stated as :  
ADC conversion of the LDR in the light:

$$\text{Formula : } V_{LDR} = \frac{R_{LDR}}{R_{LDR} + R_1} \times V_{REF}$$

$$DHK = \frac{V_{LDR}}{SS}$$

ADC conversion on LDR when dim:

$$\text{Formula : } V_{LDR} = \frac{R_{LDR}}{R_{LDR} + R_1} \times V_{REF}$$

$$DHK = \frac{V_{LDR}}{SS}$$

ADC conversion of an LDR in the dark:

$$\text{Formula : } V_{LDR} = \frac{R_{LDR}}{R_{LDR} + R_1} \times V_{REF}$$

$$DHK = \frac{V_{LDR}}{SS}$$

## Arduino Uno



Figure 2. 2 Arduino Uno R3  
Source : Wikipedia Bahasa Indonesia

Arduino is an open-source single-board micro-controller, derived from the Wiring platform, designed to facilitate the use of electronics in a wide variety of fields. The hardware has an Atmel AVR processor and the software has its own programming language. The language used in Arduino is not a relatively difficult assembler, but a simplified C language with the help of Arduino libraries. Arduino is an electronic circuit that is open source, and has hardware and software that is easy to use. Arduino is a microcontroller board based on ATmega328. Arduino has 14 input/output pins of which 6 pins can be used as PWM outputs, 6 analog inputs, 16 MHz crystal oscillator, USB connection, power jack, ICSP head, and reset button. Arduino is able to support microcontrollers; can be connected to a computer using a USB cable. (Feri Djuandi, 2011).

## LED



Figure 2.3 LED  
Source : Homeminimalisite.com

LED lights stand for “Light Emitting Diode”. is a semiconductor device that produces light when an electric current passes through the gap between the cathode and anode in the device system. LEDs also have a positive leg polarity on the longer leg and a negative leg on the shorter leg.

## Breadboard

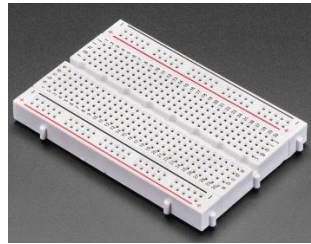


Figure 2.4 Breadboard

Source : sfxpcb.com

Basically a breadboard is a board that is used to create electronic circuits without having to bother the user to solder. Usually this breadboard is used to create temporary electronic circuits for trial or prototype purposes.

## RESEARCH METHOD

### Research Stages

The method applied in this research is a combination of several methods, which begins with observation, literature review, device design, device design, and ends with testing and evaluation of the tool under study.

- a. In the observation phase, observations and data collection related to the problems that occur are carried out.
- b. In the literature review phase, relevant information and sources are collected according to the research topic and used as references for new research.
- c. In the device design phase, modeling is carried out using the Arduino uno microcontroller as the parameter to be designed.
- d. In the design phase, the product device model is made through the fritzing software application.
- e. In the testing and evaluation phase, verification is carried out to ensure that the device and program function properly.

### Flowchart

Flowchart of the LDR sensor work system. Software design, contains programming for the LDR sensor, the room state input process, the menu for the condition input process, the LDR sensor algorithm, and the program for the monitoring system. The program is divided into several sketches or sheets, with one sketch serving as the main program. Each sketch calls each function of other sketches made as needed through the “void” function created in each sketch. This technique is used because it is simple and practical, creating functions that can be called several times as needed.

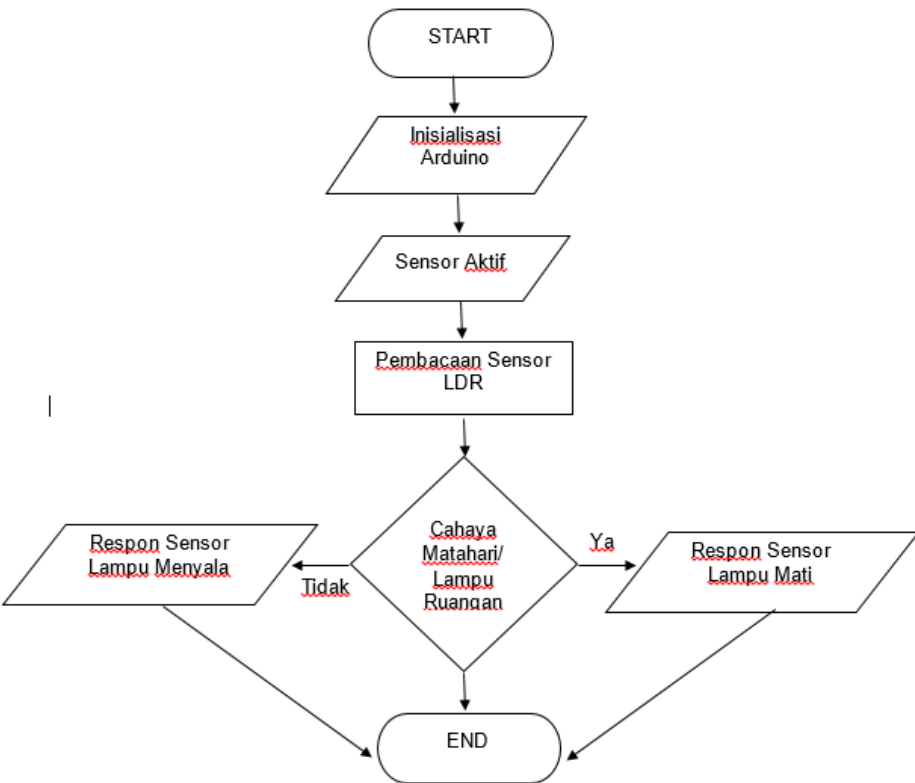


Figure 3.1 Flowchart software light sensor

**Block diagram**

The design of the circuit scheme includes the stages of work that are the core part of the tool. To explain the design of an automatic light system using an Arduino Uno-based LDR sensor, first describe the general block diagram of the working system shown by the Arduino Uno microcontroller as input or output that will process data and store a command or program that has been made. Then the LDR sensor will capture the light and will be responded well by Arduino Uno. The following is a block diagram design of an automatic light system based on Arduino Uno. The picture below is a component design, namely the interface between the Arduino Uno with the LDR sensor as input and output components in the form of LEDs as indicators of monitoring the state of the room. The power supply for each component comes from the 5Vdc Arduino Vout which is assembled in parallel.

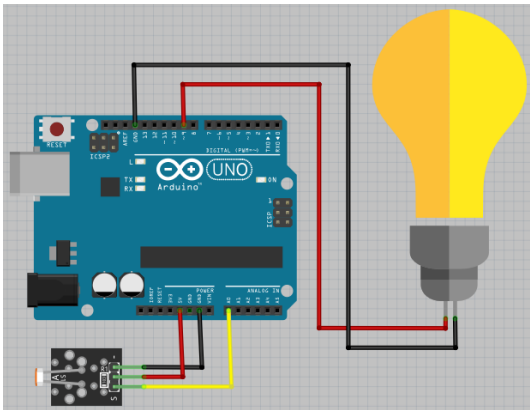


Figure 3.2 Schematic of smart light aquarium

The hardware design is continued by making a smart light design as shown below. Smart light is made with LED lights connected to fittings. Then the Arduino uno circuit, LED, LDR sensor as a detector of the state of the room is at the back of the aquarium.

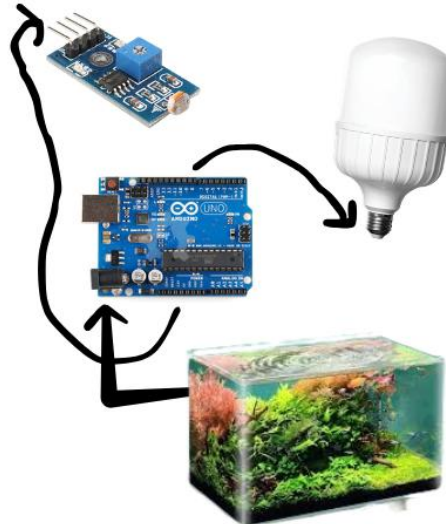


Figure 3.3 Prototype smart light aquarium

### Calculation

LDR is a form of component that has a change in resistance that depends on light. Therefore, it is necessary to convert the ADC value on the LDR. To calculate the ADC conversion on the LDR, the first thing that must be known is the resistance of the LDR. Here is an example of calculating the

ADC of an LDR sensor according to :

Unknown:

$$V_{ref} = 2,56 \text{ V}$$

Resistance LDR:

$$ADC = 8 \text{ bit} = 2^8 = 256$$

$$Bright = 4 \text{ K}\Omega$$

$$Dim = 19 \text{ K}\Omega$$

$$Dark = 1 \text{ M}\Omega$$

$$Step \text{ size} = \frac{V_{ref}}{2^8 - 1}$$

$$Step \text{ size} = \frac{2,56}{256 - 1}$$

$$Step \text{ size} = \frac{2,56}{255}$$

$$Step \text{ size} = 10 \text{ mV}$$

ADC conversion of the LDR in the light:

Unknown: Bright = 4 K $\Omega$

$$Step \text{ Size} = 10 \text{ mV}$$

$$R1 = 10 \text{ K}\Omega$$

$$V_{REF} = 2,56 \text{ V}$$

$$\text{Formula : } V_{LDR} = \frac{R_{LDR}}{R_{LDR} + R_1} \times V_{REF}$$

$$\text{: } D_{HK} = \frac{V_{LDR}}{SS}$$

$$\text{Answer : } V_{LDR} = \frac{4 \text{ K}\Omega}{4 \text{ K}\Omega + 10 \text{ K}\Omega} \times 2,56 \text{ V} = 0,73 \text{ V}$$

$$\text{: } D_{HK} = \frac{0,73 \text{ V}}{10 \text{ mV}} = 73$$

ADC conversion on LDR when dim:

Unknown: Dim = 19 K $\Omega$

Step Size = 10mV

R1 = 10 K $\Omega$

VREF = 2,56 V

$$\text{Formula : } V_{LDR} = \frac{R_{LDR}}{R_{LDR} + R_1} \times V_{REF}$$

$$\text{: } D_{HK} = \frac{V_{LDR}}{SS}$$

$$\text{Answer : } V_{LDR} = \frac{19 \text{ K}\Omega}{19 \text{ K}\Omega + 10 \text{ K}\Omega} \times 2,56 \text{ V} = 1,67 \text{ V}$$

$$\text{: } D_{HK} = \frac{1,67 \text{ V}}{10 \text{ mV}} = 167$$

ADC conversion of an LDR in the dark:

Unknown : Dark = 1 M $\Omega$

Step Size = 10mV

R1 = 10 K $\Omega$

VREF = 2,56 V

$$\text{Formula : } V_{LDR} = \frac{R_{LDR}}{R_{LDR} + R_1} \times V_{REF}$$

$$\text{: } D_{HK} = \frac{V_{LDR}}{SS}$$

$$\text{Answer : } V_{LDR} = \frac{1000 \text{ K}\Omega}{1000 \text{ K}\Omega + 10 \text{ K}\Omega} \times 2,56 \text{ V} = 2,53 \text{ V}$$

$$\text{: } D_{HK} = \frac{0,253 \text{ V}}{10 \text{ mV}} = 253$$

The ADC value conversion calculation of the LDR sensor involves several important steps to obtain the digital value of the resistance change affected by light intensity. With a Vref of 2.56 V and an 8-bit ADC, the step size is calculated to be 10 mV. For bright conditions, an LDR resistance of 4 K $\Omega$  produces a voltage of 0.73 V which is equivalent to an ADC value of 73. In dim conditions, an LDR resistance of 19 K $\Omega$  produces a voltage of 1.67 V which is equivalent to an ADC value of 167. In dark conditions, an LDR resistance of 1 M $\Omega$  produces a voltage of 2.53 V which is equivalent to an ADC value of 253. This process shows how the voltage generated by the voltage divider is calculated and converted into digital form by the ADC, which functions to measure light intensity through changes in resistance on the LDR.

## RESULTS AND DISCUSSION

System Implementation is done to find out the output of each module used. This aims to make it easier when analysing and repairing damage if it occurs in the module. Here are the final results of the Automatic Aquarium Light project.



This automatic aquarium light project is designed to detect the light intensity around the aquarium. This project is controlled by an Arduino Uno microcontroller which is connected to a light sensor and also a usb led lamp. This project is controlled by a programme that has been stored on the Arduino Uno so that it can directly control it. This tool consists of an Arduino uno microcontroller circuit as a control centre, an LDR light sensor as a detector of the intensity of the surrounding light, and a usb led lamp as aquarium lighting. The lights will turn on when the light sensor detects the intensity of the dark light and then forwarded to the Arduino, then the Arduino gives a command to the lights to turn on.

Light sensor testing is done using the intensity of light around the aquarium. The result is if the light around the aquarium is low or dark, the sensor will detect and will send a signal to the Arduino and then proceed to the usb led light. If the light intensity around the aquarium is good or dim, the sensor will not detect it. The Ldr Light Sensor not only detects Light intensity but also detects objects that are  $\pm 5$ cm in front of the sensor. When there is an object that is too close to the sensor, the sensor will detect it and the usb led light will turn on.

In this project Arduino uno functions as a controller for all components, which controls the Ldr Light sensor, and usb led lights. The Arduino processes the input from the sensor and decides whether the lights should turn on or off. This process runs automatically. Arduino also sets a delay of  $\pm 1$  second to ensure the transition when on or off runs smoothly and as needed.

In this project the usb led lamp serves as a light source for the aquarium when the surrounding light intensity is low or dark. This lamp is used to replace natural light and increase the intensity of light around the aquarium. This usb led lamp turns on and off automatically based on the signal from the Arduino after getting data from the Ldr light sensor.

When testing the final results, the system can work well. When the light around the aquarium is less or dim, for example at night, the sensor will detect and then the Arduino will activate the aquarium lights to turn on. Conversely, when the room is bright, the lights will automatically turn off. The response time of the LDR sensor is also relatively fast, with a delay of about 1 second. This light sensor project successfully demonstrates the basic concept of microcontroller-based automation, where the system works well in detecting changes in environmental light and responds by turning the lights on or off as described above. The use of this automated system also contributes to the saving of electrical energy as the lights will only switch on when needed.

## CONCLUSION

Based on the Practicum that has been carried out, it can be concluded that this research aims to optimize aquarium lighting management efficiently and automatically. This system utilizes an LDR

light sensor to measure the intensity of the surrounding light. When the light in the room is less or dim, for example at night, the sensor will detect and then the Arduino will activate the aquarium lights to turn on. Conversely, when the room is bright, the lights will automatically turn off. The response time of the LDR sensor is also relatively fast, with a delay of about 1 second. This light sensor project uses the basic concept of microcontroller-based automation.

## ACKNOWLEDGEMENT

With all due respect, we would like to thank all those who have supported and contributed to the research project of automatic aquarium lights using Arduino Uno R3 based light sensor. We are very grateful to Mr. Ricto Yudi Wicaksono and Mr. Wahyu Pribadi as supervisors who have provided invaluable guidance and support. Thanks also to Politeknik Negeri Madiun for the facilities and resources provided, as well as to the technician staff at the Railway Laboratory Building D who have assisted in the hardware setup. We are grateful to colleagues and friends who have provided input during this research. Thanks also to family and friends who have provided moral support. Finally, we would like to thank the Arduino open source and various sources that have helped develop this system.

## REFERENCES

- Bambang Priono, 2. (t.thn.). Rancang Bangun Sistem Otomatis untuk Pemberian Pakan, Penerangan, dan Pengurasan Air pada Akuarium Ikan Hias. *repository.unipasby.ac.id*, 2.
- Colihueque, 2., & Tume *et al.*, 2. (t.thn.). *repository.unipasby.ac.id*, 2.
- Colihueque, 2., & Tume *et al.*, 2. (t.thn.). Rancang Bangun Sistem Otomatis untuk Pemberian Pakan, Penerangan, dan Pengurasan Air pada Akuarium Ikan Hias. *repository.unipasby.ac.id*, 2.
- Gupta and Jatothu, 2. (2022). Sistem Kontrol Intensitas Cahaya Lampu Aquascape Menggunakan Fuzzy Logic . *Jurnal Teknik Elektro*, 323.
- Hariyanto *et al.*, 2. (2022). Sistem Kontrol Intensitas Cahaya Lampu Aquascape Menggunakan Fuzzy Logic. *Jurnal Teknik Elektro*, 322.
- Hutabarat *et al.*, 2. (2022). Sistem Kontrol Intensitas Cahaya Lampu Aquascape Menggunakan Fuzzy Logic. *Jurnal Teknik Elektro*, 323.
- Kumari and Kumar, 2. (2022). *Jurnal Teknik Elektro*, 323.
- Kumari and Kumar, 2. (2022). Sistem Kontrol Intensitas Cahaya Lampu Aquascape Menggunakan Fuzzy Logic . *Jurnal Teknik Elektro*, 323.
- M. Ghufuran H. Kordi K., 2. (t.thn.). Rancang Bangun Sistem Otomatis untuk Pemberian Pakan, Penerangan, dan Pengurasan Air pada Akuarium Ikan Hias. *repository.unipasby.ac.id*, 2.
- Raharjo *et al.*, 2. (2018). Sistem Kontrol Intensitas Cahaya Lampu Aquascape Menggunakan Fuzzy Logic. *Jurnal Teknik Elektro*, 323.
- Suryadinatha *et al.*, 2. (2022). Sistem Kontrol Intensitas Cahaya Lampu Aquascape Menggunakan Fuzzy Logic. *Jurnal Teknik Elektro*, 323.