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ENGINEERING PORTABLE UNDERWATER LAMP AS AN AUXILIARY GEAR FOR PURSE SEINE

Rekayasa Teknologi Portable Underwater Lamp sebagai Alat Bantu pada Purse Seine

by:

Taufiq[1], Mulyono S Baskoro[2], Wazir Mawardi[3], Mochammad Riyanto[4]*

[1] *Marine Fisheries Technology Study Program, Graduate School of IPB University. taufiq741988taufiq@apps.ipb.ac.id.*
[2] *Department of Fisheries Resources Utilization, Faculty of Fisheries and Marine Fisheries, IPB University. baskoro.mul@gmail.com.*
[3] *Department of Fisheries Resources Utilization, Faculty of Fisheries and Marine Fisheries, IPB University. wmawardi@gmail.com.*
[4] *Department of Fisheries Resources Utilization, Faculty of Fisheries and Marine Fisheries, IPB University. mochammadri@apps.ipb.ac.id*

* *Correspondence*: *mochammadri@apps.ipb.ac.id*

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ABSTRACT

Lights are common supporting tool in purse seine fishing in Indonesia. Currently, lamps on purse seines use mercury and metal halide (MH) which require very high electrical power. Therefore, there is a need for an effective underwater light technology alternative with low electric power. The aim of this research is to design a portable underwater lamp (PUL) which can be controlled remotely to support fishing operations. The design engineering process in creating the PUL includes light and buoy construction, temperature testing, light distribution, waterproofing, and motion testing. The results show that the PUL design enables the tools to be controlled remotely. The average temperature of the lamp on the PUL is 40 ºC, this temperature is lower than the MH lamp which reaches 250 ºC. The light spreads evenly at an angle of 360º to the horizontal and 180° to the vertical. Meanwhile, the results of the lamp motion test showed that the lamp was watertight and highly stable.

Keywords: *Light emitting diode, Remote control, Waterproof, Electric Power.*

ABSTRAK

Lampu merupakan alat bantu utama dalam perikanan purse seine di Indonesia. Saat ini lampu pada *purse seine* masih menggunakan merkuri dan *metal halide* (MH) yang memerlukan daya listrik sangat tinggi. Oleh karena itu, perlu adanya alternatif teknologi lampu bawah air yang efektif dengan daya listrik rendah. Tujuan penelitian ini adalah merekayasa teknologi *portable underwater lamp* (PUL) yang dapat bergerak otomatis untuk memudahkan operasi penangkapan ikan. Metode rekayasa desain yang digunakan dalam merancang teknologi PUL meliputi konstruksi lampu dan pelampung, uji suhu, distribusi cahaya, tahan air, dan uji gerak. Hasil rancang bangun PUL menghasilkan alat yang dapat dikendalikan jarak jauh. Suhu rata-rata lampu pada teknologi PUL adalah 40 ºC, suhu ini lebih rendah dari lampu MH yang mencapai suhu 250 ºC. Penyebaran cahaya merata pada sudut 360º ke arah horizontal dan 180° ke arah vertikal. Sementara itu, hasil uji olah gerak lampu menunjukkan bahwa lampu sudah kedap air dan memiliki kestabilan yang tinggi.

Kata kunci: *Light emitting diode*, Kontrol jarak jauh, Kedap air, Daya listrik.

INTRODUCTION

Using lighting as auxiliary gear in fishing can increase the effectiveness and efficiency of the fishing operation process (Shen *et al.* 2013; Sofijanto *et al.* 2017; Susanto 2019; Yulianto *et al.* 2014). One fishing gear that utilizes lights is a ring trawl that catches pelagic fish. Along with the times, purse seine fishermen throughout Indonesia have used electric lights. These electric lamps are divided into several types, such as metal halide (MH), halogen, mercury (fluorescent), and light-emitting diode (LED) (Arif *et al.* 2015, Susanto *et al.* 2017). LED lamps have several advantages compared to conventional electric lights, such as energy saving, long service life, harmless, no mercury, affordable prices, and easy to condition as needed (Baumgartner *et al.* 2019; Chepurna *et al.* 2019; Hua and Xing 2013; Lee 2013; Shen and Huang 2012; Shen *et al.* 2013; Zain and Patta 2018;).

Research on lighting auxiliary gear in purse seine fisheries, especially dipping lights in the water, need to be done. So far, purse seine fishermen still use a lot of mercury, neon, and halogen installed on the boat. The use of surface lamps can experience reflection, refraction, interference, diffraction, and polarization, so submerged lights in water are considered more efficient and effective (Sofijanto *et al.* 2019; Wibisono and Baheramsyah, 2016). In recent years researchers discovered a floating light technology. Floating lights are considered more efficient and effective because they are in contact with the water surface so that not too much light intensity is wasted (Bariche *et al.* 2006; Kehayias *et al.* 2016; Maulana *et al.* 2017; Rosyidah *et al.* 2011).

The results of the study of Tamperan fishers in East Java switched to using floating lamps (surrogate lamps) by using fluorescent lamps as a light source (Hartaty *et al.* 2012). Sofijanto *et al.* 2017, also made a floating lamp. The results obtained by floating lamps are considered more efficient than MH lamps. However, for the energy source to turn on these two lights using a generator. These two floating lamps still have shortcomings and weaknesses, such as unsafe construction, short service life, wasteful electric energy, and the light emitted is still need to be improve in the water. Then, a foreign company (Fishing LED Master) also created a floating light construction. A rechargeable battery powers this light. However, these lamps are quite expensive, reaching a price of € 3,500, around 60 million, and the light distribution is still not optimal in water. This lamp is called the Floating LED Light Bouy (Fishingledmaster.com 2021). Based on previous research and the need for appropriate lighting technology as a tool on the purse seine, there is still a need for alternative floating lamp technology that can be operated in water with particular specifications.

Based on the above problems, it is necessary to develop a portable underwater lamp (PUL), a floating lamp in purse seine fisheries that is effective and efficient. The research was conducted by designing a floating lamp construction that can be operated in water. This research aims to create a portable underwater lamp, which involve the design and construction of lamps and buoys, temperature stability tests, light distribution tests, waterproof tests, and motion tests with a remote control system. The results of this study are expected to be used by purse seine fishers to increase fishing effectiveness by using LED light technology, which is effective with lower operating costs.

METHODS

Time and Location of Research

The research was conducted by engineering design on portable underwater lamp (PUL) technology. Design engineering aims to determine the appropriate PUL technology design for purse seine fisheries. Hurst (1999) in Susanto (2019) states that the design process is carried out based on several principles and is divided into four stages, namely the description of the objectives, the preparation of the conceptual design, the preparation of the tangible design, and the preparation of the detailed design.

The research was conducted at the Fishing Vessel and Transportation Workshop at the Department of Fisheries Resources Utilization, Faculty of Fisheries and Marine Sciences, IPB University. The study was conducted from Mei 2020 to August 2022. A drill, electric drill, tank, screwdriver, length measuring instrument, thermo-gun, camera, smoothing machine, scissors, laptop, avo-meter, soldering iron, android, lux meter, and ILT5000 were used in this study. Meanwhile, the following materials have been used: LED HPL 50w white, heatsink, heatsink glue, polyurethane A & B, cable, battery accumulator, fiberglass, resin, catalyst, auto seal glue, rubber seal, acrylic glue, acrylic tube, pipe iron, sandpaper, drill bits, bolts, plywood, step-up, step-down, Wi-Fi modem, NodeMCU, Arduino, spray paint, soldering tin, brushless motor, battery Lippo 4s, ESC Waterproof.

The two laboratory research phases comprise the planning and production phases (Deno *et al*. 2013). This study applied the instrument design and testing research approach. The Data were collected, including temperature stability test data, light distribution, waterproof test data, and maneuverability test data in the laboratory. Data were analyzed using descriptive analysis.

Designing Construction of Portable Underwater Lamp

We are designing the construction of a portable underwater lamp using a tool design method focused on carrying out the design and construction of PUL. In creating the structure of PUL, there are several stages. The first stage is to design the layout using an AutoCAD application in the form of a vertical 6-sided. In determining the shape, many things are considered in determining the shape, especially the lights that can illuminate 360° horizontally. Meanwhile, for lighting in the vertical direction, there are specially designed lamp components, as shown in Figure 1. Stage two is creating an electronic lamp circuit using a parallel electrical circuit (Figure 2). Excess parallel circuit if one lamp is damaged, the other lamps are still lit. The downside is that it consumes many wires. The third stage is to design a lamp protector tube in the form of a vertical cylinder by adjusting the size of the lamp, the material used is acrylic. Acrylic is one of the materials suitable for a protective lamp casing. In addition to being a solid material and has good sinking power and does not reduce the illumination level. According to (Yulianto *et al*. 2014), acrylic material has a compressive strength of 1238.65 kgf and a modulus of elasticity (MOE) value of 130.485-140.097 kgf/cm. The fourth stage is to design the buoy construction as a catamaran. The catamaran has good stability and ample deck space, making it easy to place lighting components and remote controls. Then enter the manufacturing stage. When the construction is complete, a re-check is carried out to ensure everything functions correctly. Data were taken on each construction process step to collect data, which were tabulated using the data tabulation procedure. Moreover, descriptive methods were applied to analyze the data.

The light is powered by a white 50W, 1.5A, 32V HPL LED bulb. Throughout the structure, 12 lights for horizontal illumination and 6 lamps for vertical illumination were used for the parallel electrical circuit that was used in the construction of the light. The use of parallel circuits is fitted to the field settings so that even if one lamp fails, the others will continue to operate. The ultimate NYA 1x2.5 mm cable is used in the electrical circuit, depending on the total number of lights needed. Given that the cable's specifications allow it to carry a current of 2500 W, it is ideal for long-term use.

Measuring Temperature

The lamp temperature test is conducted with and without a lens. Chip LED, PUL construction (without lens (TL) and lens (PL)), and MH were utilized to conduct temperature measurements. The distance between the temperature-measuring instrument and the medium is measured every 10 minutes for two hours at a distance of 1 m. Once collected in the form of notes, each temperature measurement is processed using the tabulation method. In addition, descriptive methods were used to analyze the data.

Measuring Light Intensity and Distribution

Light intensity distribution in the air was measured using the ILT (International Light Technologies) 5000 research radiometer. The measuring of light distribution refers to Susanto (2019). The LED lights are hung on a support pole of about 1.5 m. In the air medium, measurements were taken horizontally and vertically at every multiple of 10° with a distance of 100 cm. Measurements were taken in horizontal and vertical positions to the lamp's direction and the light intensity value with a 10° interval.

Designing a Remote Control System

Lights designed with remote control (RC) system can be moved and adjusted for light intensity remotely. Stage one, the lamp's construction, is driven using a propeller with a power source from the battery with the help of a motion controller in the form of an RC. The lamp's construction can work when the remote control sends data to the microcontroller and translates it to drive a DC motor so it can be controlled by remote control. Stage two, the on/off system and the light intensity can also be controlled remotely. The light can be turned on remotely when connected to Arduino UNO. The light intensity can be lowered through commands from the android, decreasing light intensity slowly when receiving commands. Data were collected from these parameters such as energy power, component specifications, light intensity program data, and drive speed (Bahri and Sudrajat 2015). The PUL technology remote control specifications include the Fly-Sky FS-i10, Receiver FS-ia10b, Esc Fly-monster 150A 2-6s Water-cooling, Servo 35 kg, and Lippo 4s 55000 mAh battery. Other (universal) remote controllers can also power PUL technology construction. According to the specifications of the remote control, the maximum distance that may be traveled or operated is 300 meters.

Designing a Waterproof Lamp Protection System

We are designing a waterproof system on the lamp protector tube using acrylic material. The waterproof test on the protective casing is carried out by dipping the tube into the water at a depth of 1-2 meters for 1-2 hours. The test was carried out for six repetitions with a time difference of 30 minutes. The parameters measured in the design of the waterproof system use a descriptive method by looking at and analyzing the strengths and weaknesses of the acrylic material itself and describing the process of making lamp protection tubes from beginning to end (Suryana 2012).

Designing a buoy construction for portable underwater lamp

Designing a buoy construction for portable underwater lamp technology by using an instrument design method that is focused on the design of the buoy construction form. In creating the structure of the PUL buoy, several stages were passed. The first stage is to design a buoy construction using the max surf application. In determining the shape, we considered especially the level of balance produced by the buoy. The form was designed as a buoy using a catamaran design. The catamaran form has advantages in proportion compared to the monohull form. In addition, the catamaran has a large deck space, which is very helpful in placing the required components (Adietya *et al*. 2013; Romadlon *et al*. 2014). In the second stage, the design form was made on max surf, then transferred to AutoCAD to be re-edited so that the buoy design looks clearer (Figure 9). In the construction design, there are two spaces in front and behind; in the front room, the lighting component is placed, and in the back room, the remote control component is placed. Before designing the buoy length, width, and height, determine how much the overall part weighs so that it is easy to decide on the size of the designed buoy. Stage three, then enter the manufacturing stage; when the construction is complete, a re-check is carried out to ensure everything is functioning properly. All data types are collected as notes in this stage and then processed using the data tabulation method. Furthermore, the data were analyzed using descriptive methods.

RESULTS

Construction Technology Portable Underwater Lamp

According to the analysis, a vertical cylinder is the preferred construction style for modern portable underwater lamps. The types of bulbs used are HPL LEDs, which have the following specifications: 50 watts, 1.5 amperes, 32 volts, white color, up to 12 lamps for horizontal lighting, and 6 lamps for vertical illumination. The design of a portable underwater lamp in the form of a vertical cylinder may cast light equally (360°) in horizontal and vertical directions at an angle of 180°. The lamp's dimensions are 270 mm in height, 230 mm in width, and 70 mm in depth. Figure 1 shows the design of a portable underwater lamp.

The type of bulb utilized is a white 50 watt Hight Power LED (HPL), and the electrical circuit is a parallel circuit (Wardana *et al*. 2011). When it is used in the field, the parallel electrical circuits adapt so that even if one of the lights is broken, the other lamps will continue to work. Additionally, a step-up boost converter is employed in the light circuit to modify the 1800W 40A DC-DC voltage resistance. With a total power of 900W, a current of 27A, and a voltage of 32V, the lamp must have a sufficient current resistance to maintain safety. The light circuit uses cables, namely the Supreme NYA cable 1 x 2.5 mm, which can conduct a current of 2500 watts and is long-lasting.To hold and change the current voltage as necessary, the step-up boost converter adjust voltage serves this function. pertaining to the parallel electrical connections shown in Figure 2.

Temperature Stability

The results of the temperature stability test indicate that the lamp's temperature test is crucial. Longer service life may be determined by the lamp's produced temperature. Longer periods of time can be spent using lights with lower temperatures, and vice versa. The entire lamp structure, including both lamps with and without lenses (TL), is subjected to a temperature test (PL). When a lamp is built without a lens, the temperature it produces in the air is often 50 °C, however when a lens is used, the temperature is typically 40 °C. LED bulbs typically range in temperature from 30 °C to 80 °C (Lu et al. 2011). With regards to the lamp's structure, a lens has not yet been employed. As a comparison to the typical air temperature of 250 °C, temperature tests on metal halide lamps were also conducted. The lamp's architecture also directly contacts water and employs a heatsink cooling mechanism. The distance between the temperature measuring device and the medium, which is measured at a distance of 30 cm with an interval of every 10 minutes for two hours, also affects each measurement (Adli 2017). The study results indicate that LED bulbs have a longer lifespan than MH lamps. Figure 3 shows the overall lamp temperature together with a comparison to the temperature produced by portable underwater light technology using metal halide.

Distribution of Light Intensity in the Air

The distribution of the light produced is influenced by the shape of the lamp construction itself. The form of the distribution of the light produced is presented in Figure 9. Light intensity in the air was measured to determine the pattern of light distribution and the distance of the LED lights made using ILT5000. Measurements were carried out horizontally and vertically at every 10° with different lengths of 25 cm, 50 cm, 75 cm, and 100 cm in the air. The increase influences the occurrence of a decrease in light in the measurement distance analyzed in the form of an exponential equation. Light illumination decreases exponentially according to Barger's law (Nikonorov 1975). Based on the shape of the light distribution, it shows that the construction of the portable underwater lamp can illuminate the fishing area evenly in a horizontal direction of 360. Meanwhile, the vertical light also indicates that the lamp can illuminate at an angle of 180. The lamp's construction shows that the portable underwater lamp's distribution test is suitable for fishing tackle tools for purse seine fisheries.

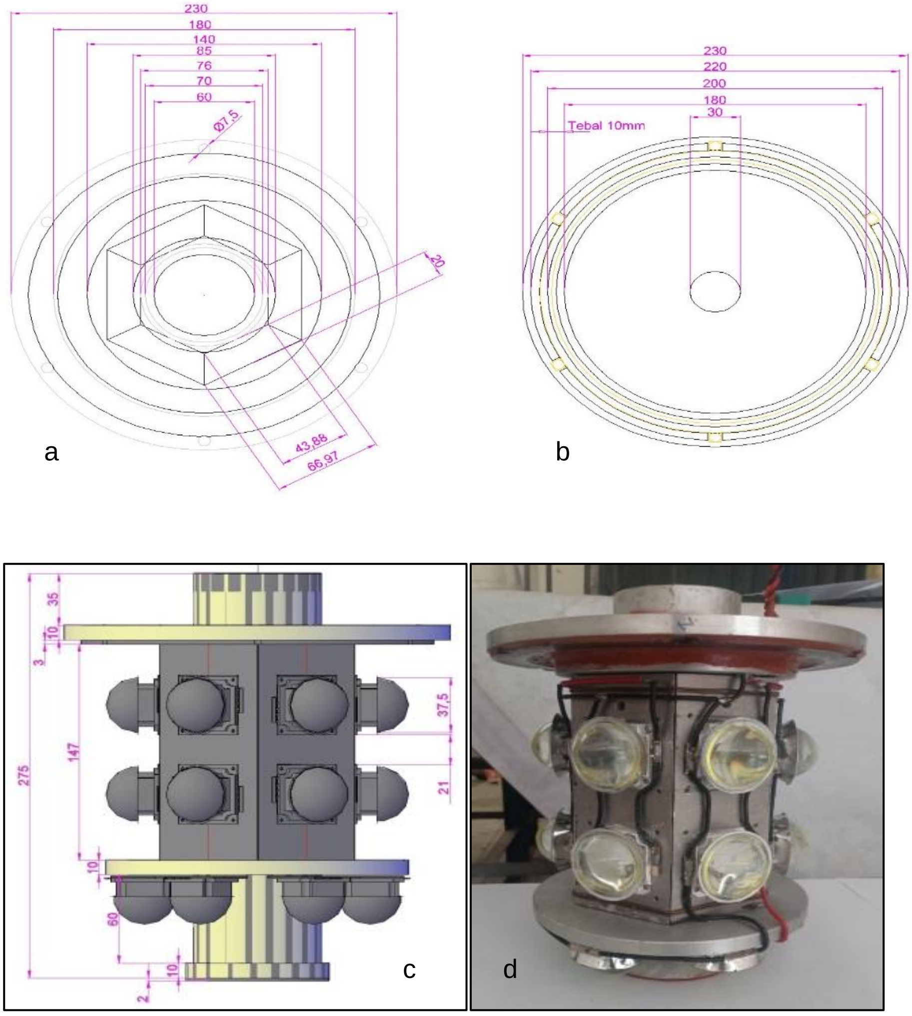

Figure 1 Construction of portable underwater lamp (PUL) technology.

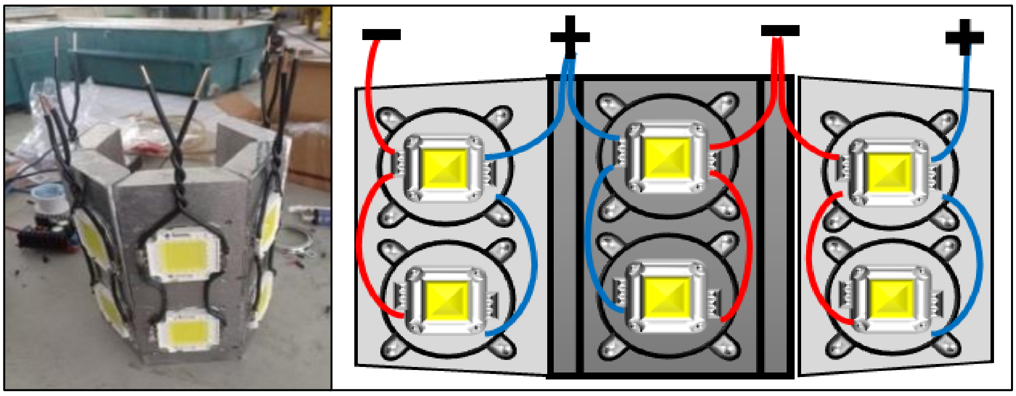

Figure 2 Parallel electrical circuit in PUL technology construction.

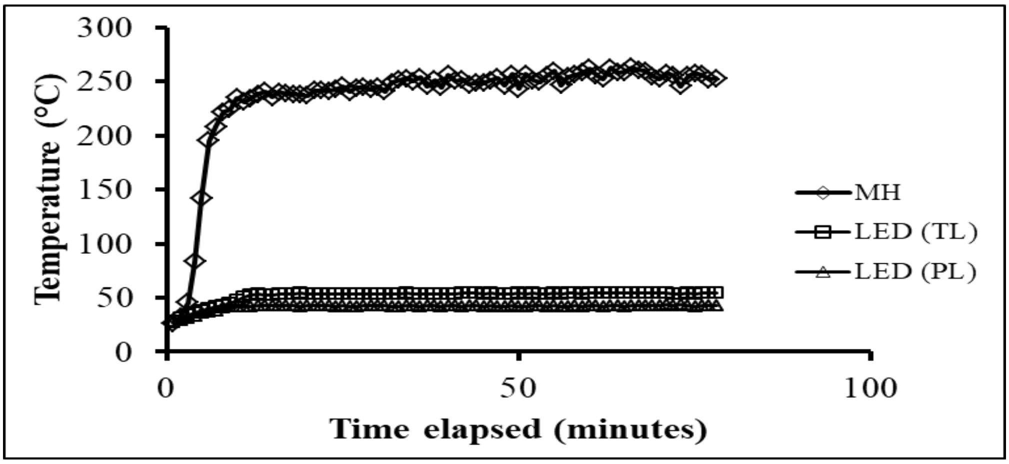

Figure 3 Temperature graph of portable underwater lamp and metal halide technology..

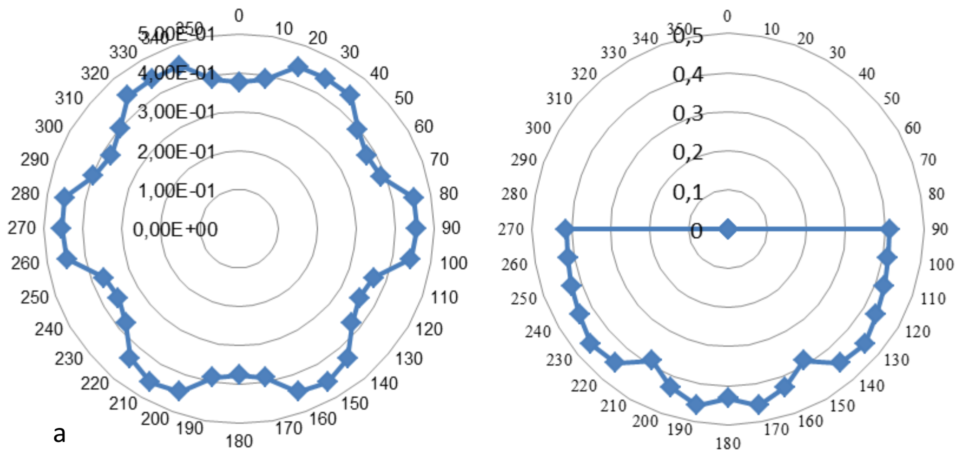

Figure 4 a. The distribution of visible light above (horizontal); b. Side view (vertical) distribution of light.

Remote Control System on Lamp

The remote control system on an object so that it can move using a feedback system. PUL technology can be turned on and off remotely, and the light intensity is adjusted. The lamp has brightness settings of 100%, 75%, 50%, and 25%. The PUL lamp is controlled using an android connected to the NodeMCU / Wi-Fi, so this lamp no longer needs to use a too-long cable connected to a current source (battery). Therefore, the construction of PUL lamps is very safe for users. Meanwhile, lowering the light intensity is controlled by a relay module that is controlled by an android command to the Node MCU. Then, a signal is sent to the relay, which enters and steps up the lamp to turn it on as desired. The flow of the on/off control system and the setting of light intensity are presented in Figure 5.

In addition, the buoy can also be controlled or moved using the remote control (RC). The motion system on the buoy is ordered using the FlySky FS-i10 Transmitter, which is sent a motion command signal to the Receiver FS-ia10b and then enters the Esc Flymonster 150A 2-6s Watercooling to be instructed the Brushless motor to move forward and can turn left and right. Construction propulsion systems can employ remote control system components as universal components or with individual requirements. For more details, the command flow in the RC system is presented in Figure 6.

Waterproof Lamp Protection System

Lamp protector tube (casing) with a vertical cylindrical shape by adjusting the form of the PUL lamp construction. As for the tube size, the inner diameter is 190mm, and the outer diameter is 200mm, 5mm thick, then cut into a length of 230mm. The bottom is permanently closed using an acrylic sheet measuring 10mm wide, 30mm inside, and 220mm outside. Meanwhile, the top of the tube is immediately covered with the lamp (heatsink), which is coated with a rubber seal, uniting the light and tube construction and strengthening the PUL construction. Furthermore, the manufacture of a tube safety casing made of iron functions as a lock between the tube and the lamp's construction. This safety casing is made so that the tube is avoided damage in the event of an impact. The size of the lamp protector tube and safety casing is presented in Figure 7.

In testing the waterproof system on the tube, it is ensured that no water enters. If there is a leak, the test is repeated until the tube has no leaks and is confirmed to be watertight. The waterproof test must be comprehensive because it can be fatal to the lamp circuit; a short circuit can cause the lamp circuit to be damaged. The process of waterproofing the lamp protector casing is presented in Figure 8.

Buoy Construction on Portable Underwater Lamp Technology

Many factors are considered in the design and manufacture of buoy construction using PUL technology, such as the level of stability. The buoy is built in a catamaran type to achieve a high level of stability. Catamarans have excellent stability advantages over monohull boats. In addition, the catamaran also has a wider space/deck, so placing components is quite easy. Based on the results of the buoy construction design, the length overall (LOA) = 125 cm; Breath Hull (B hull) = 20 cm; Breath construction (B) = 65 cm; High (H) = 25 cm; Draft (D) = 15 cm. The results of the design and manufacture of buoys certainly pay attention to the load placed on them. The results of the buoy construction are presented in Figure 9.

It has successfully completed various stages, including the maneuver test, according to the research findings. The performance of the portable underwater lamp has been tested, and the outcomes are excellent. PUL technology, namely the buoy driving system, is appropriately controllable. The catamaran-like design of PUL technology's construction makes it highly stable, and the technology moves very well in straight, zigzag, and circular motions. As shown in Table 1 and with a comparison table in Table 2, some of the features of the portable underwater lamp technology include the following.

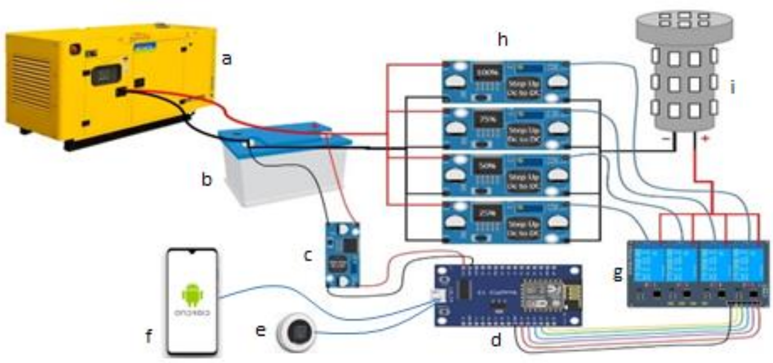

Figure 5 The circuit of the remote control system on the lamp.
Description: a. battery cases; b. accumulator batteries; c. step-down; d. NodeMCU ESP8266; e. Wi-Fi modem; f. Android; g. relay; h. Step-up; i. lamp.

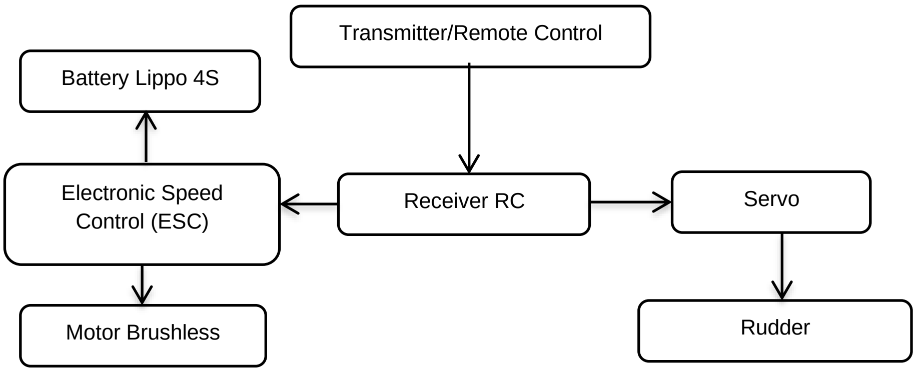

Figure 6 The command system on the remote control.

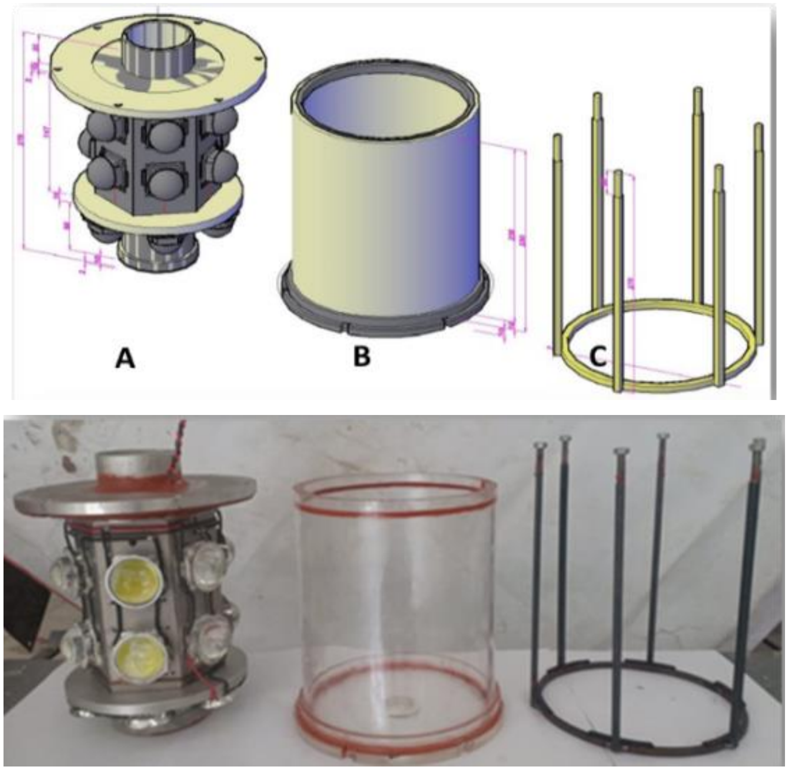

Figure 7 Portable underwater lamp design and construction results; a. PUL lamp; b. Protective tube; c. Safety case.

Figure 8 Waterproof test on portable underwater lamp construction.

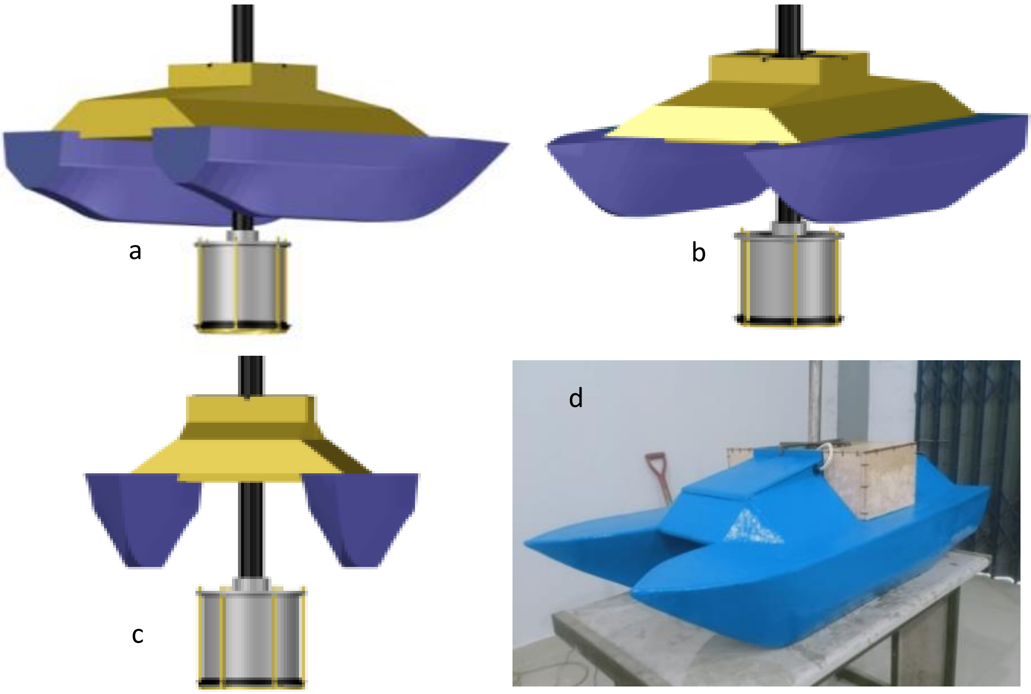

Figure 9 Construction of the Portable Underwater Lamp buoy technology.

Table 1 lists the features of the technology used in portable underwater lamp.

Number	Variable	Description
1	The lamp may be remotely switched on and off.	√
2	Controllable light levels include 100%, 75%, 50%, and 25%	√
3	Remote controls can be used to move constructions.	√
4	The light may be taken apart.	√
5	The light is water-operable.	√
6	The current source is rechargeable.	√
7	For users, secure.	√

DISCUSSION

The results of research that has passed several laboratory trials show that the construction of portable underwater lamp technology can be used as a tool in purse seine fisheries. Such as temperature stability, light distribution, waterproof, and remote control system tests (on/off, light intensity control, drive system). The results of the temperature stability test show that LED lamps are more effective than other electric lamps. The temperature produced by LED lamps is lower than metal halide (MH) lamps. From this, it can be concluded that the use of LEDs can be longer. Normally the normal operating temperature of the LED is from 30 ℃ to 80 ℃.

Meanwhile, the temperature produced by PUL technology is 40 ℃-50 ℃. While the temperature produced by the MH lamp is higher, reaching 250 ℃. The temperature produced by each lamp in a lifetime of 60 minutes and above. These data show that the temperature of the LED chip produced is quite stable, so the LED's lifespan is relatively long. The maximum level of LED temperature stability is 80 ℃, while the temperature value produced by PUL technology is still at a moderate temperature. The heat generated by the LED becomes more stable, and heat can be absorbed by using heat dissipation as a heatsink (Lu *et al.* 2011). The heatsink can absorb heat quite well, which is made of aluminum compared to iron. Therefore, the heatsink is used as an LED chip mounting case to maintain a stable temperature and intensity performance (Sumantri *et al.* 2017; Ziliwu *et al.* 2019).

Furthermore, the results of the distribution of light generated by the PUL construction can illuminate the capture area in a horizontal direction (360°). In addition, the PUL construction can also illuminate the fishing area vertically or the bottom of the water (180°). This construction was deliberately designed with a vertical cylindrical shape to be able to illuminate in a horizontal direction because the purse seine's catch target is pelagic fish. Based on the measurement of the light intensity results, the PUL technology is made to illuminate both horizontal and vertical directions. Meanwhile, the MH lamp has an elliptical graph, which is certainly different from PUL technology. It is influenced because the PUL technology design on the sides and bottom can emit light. Based on the design and general technical analysis, PUL technology can be used in purse seine fisheries. Therefore, further research is needed to test its effectiveness and efficiency by conducting trials of catching using LED boats as a result of research on a field scale. PUL technology can replace MH lamps because LED lamps have less power (Wibisono and Baheramsyah 2016).

PUL technology has advantages compared to lamps produced by previous researchers. The comparison can be seen in Table 2. Using Android, PUL technology can control on/off and reduce and increase light intensity remotely. This tool can be used automatically or controlled remotely, which is different from the previous lights. The intensity of light produced by PUL technology can make schools of fish closer to the catch area.

PUL technology can also be driven by system remote control (RC) where this tool is an innovation by utilizing the internet to obtain a more effective and efficient control system such as controlling, connecting, and exchanging data through other devices while still connected to the internet called the Internet of Things (IoT). The results of this study indicate that there are significant differences with the lamps created by previous researchers. In addition, PUL technology has a buoy construction with a good level of stability so that it is safe to use when operating at sea. The control distance generated by PUL technology for the lamp itself is not limited as long as the lamp is connected to Wi-Fi, while for the self-driving system, the buoy has a control distance of 300 m (Bahri and Sudrajat 2015; Kautsar *et al.* 2014).

Table 2 Comparison of portable underwater lamps with other floating lamps.

No.	Variable	PUL	Pelak Lamp	Floating Lamp	Fishing Light Buoy	Reference sources
1	Light construction can be moved remotely	√	x	x	X	Fishingledmaster 2021; Hartaty *et al.* 2012; Sofijanto *et al.* 2019.
2	The lamp can be on/off and the light intensity can be adjusted (up/down) remotely	√	x	x	X	Fishingledmaster 2021; Hartaty *et al.* 2012; Sofijanto *et al.* 2019.
3	The construction of the lamp can be disassembled if there is a scorched/damaged lamp	√	x	x	X	Fishingledmaster 2021; Hartaty *et al.* 2012; Sofijanto *et al.* 2019.
4	The lamp can be operated in water	√	x	x	x	Fishingledmaster 2021; Hartaty *et al.* 2012; Sofijanto *et al.* 2019.
5	PUL construction has a good level of stability by using a catamaran buoy design	√	x	x	X	Fishingledmaster 2021; Hartaty *et al.* 2012; Sofijanto *et al.* 2019.
6	Current source can be recharged	√	x	x	X	Fishingledmaster 2021; Hartaty *et al.* 2012; Sofijanto *et al.* 2019.

Over time, technology made by humans is growing. Japan introduced a new concept in 2018 where this concept uses modern technology, only relying on humans as the main component. This concept allows us to use modern science-based (AI, Robot, IoT) for human needs with the aim that humans can live comfortably. The main target of this research is portable underwater lamp technology that can operate on its own when released into the water. It means that the previous PUL technology at the IoT level rose to the smart control level (Hendarsyah 2019). Based on the research described above, further research will develop PUL technology equipped with a detection sensor to detect schools of fish and directly operate to control light intensity. The process of decreasing light intensity without being ordered again using a remote control can be called a Smart Portable Underwater Lamp. This technology is useful to make it easier for users when use it (Ellitan 2020). However, it is necessary to conduct further research by making lights in the water that can detect and approach schools of fish directly so that it is easier for users when carrying out fishing operations.

CONCLUSION

Based on the obtained research results, the construction of the portable underwater lamp (PUL) technology can be remotely controlled and utilized in water. The temperature produced by PUL technology is relatively stable, and the lamp is designed to be waterproof. It can make direct contact with water while in operation. The PUL technology is a vertical cylinder that can illuminate the capture area 360° horizontally and 180° vertically toward the water's bottom. By utilizing a catamaran design, PUL buoy construction is highly stable.

SUGGESTION

It is necessary to do further research by making underwater lights that can operate automatically to detect schools of fish directly, making it easier for fishermen to carry out fishing operations.

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