Journal of Engineering and Applied Technology
Vol. 5, No. 2, August 2024, pp. 94-103

Online ISSN 2716-2265
Printed ISSN 2716-2257

Smart longline: a tool to help fishermen detect fish and location with smartphone integration

Kamarudin[1,*], Muhammad Ragil Hidayatullah[1], M. Abizar Novaris[1], Riska Derliana Purba[1]

[1]Politeknik Negeri Batam, Indonesia
E-mail: kamarudin@polibatam.ac.id *
*Corresponding Author

ABSTRACT

Longline is widely used by fishermen in Indonesia. The use of longlines, which require fishermen to go back and forth periodically to check the catch, creates problems of time and fuel. This research aims to develop a fishing tool for fishermen that will be more efficient in terms of time and fuel. The method used is a literature study related to the components to be used, the design of electrical, mechanical, interfaces and microcontroller programs, as well as the assembly of components and testing tools. The research was conducted from March to July 2022 at the Batam State Polytechnic with the test site at Nongsa Beach, Batam City. The result of this research is a smart longline prototype that can detect fish pulls using accelerometers as vibration detectors on each hook, and locate them using GPS features processed by the Mappi 32 microcontroller using LoRa communication. The information is displayed on the fishermen's smartphones. This allows the fishermen to monitor their catch without having to regularly check the longline. This tool is also equipped with a solar panel as a power source allowing it to operate for 25 hours above sea level. A future proposal for this research includes making a smart longline capable of detecting the species of fish caught. This would help fishermen analyze the species of fish in the water.

ARTICLE INFO

Article history
Received:
15 March 2024
Revised:
23 August 2024
Accepted:
25 August 2024

Keywords
accelerometer
fishermen
fishing tool
LoRa
longline
smartphone

1. Introduction

Indonesian marine resources are rich in demersal fish. Therefore, fishing gear is important to support the sustainability of demersal fisheries. Bottom longlines are the most effective demersal fishing gear [1].

In terms of construction, the basic longline consists of a main rope, which is attached to the branch ropes in a row at a certain distance from each other, with a hook at each end, and then a float and sinker at certain points from the tip to the base [2]. The operation of the longline is carried out using a vessel equipped with mechanical equipment that functions to lower and raise the longline to the ship. The waiting phase is carried out after the longline gear has been lowered. The duration of this drift phase is 3 to 4 hours [3], [4].

This system remains quite rudimentary, as fishermen cannot ascertain whether all the bait on the longline has been consumed by the fish. Consequently, it lacks time efficiency, with fishermen relying on estimates to raise the longline to the boat, without prior knowledge of the catch quantity. Besides its inefficiency in time management, this traditional method is also fuel-inefficient. Typically, after completing the lowering process, fishermen leave the longline and return approximately 3 to 4 hours later.

This research will result in a system that allows fishermen to monitor how much bait has been associated with fish via smartphone, making it easier for fishermen to determine the right time to pull the longline onto the boat.

This system uses an accelerometer sensor as a fish-pull detector on each hook [5], [6]. The data from the sensor is processed on the Mappi 32 microcontroller, which is able to differentiate the sensor reading when exposed to waves and fish pull [7]. There is also a GPS to mark the position of the longline in the middle of the sea. All this information is sent by LoRa communication from Mappi 32 on the longline to Mappi 32 in the fisherman's house, which is connected to the Internet network.

The data is stored in the Firebase cloud database. It is then displayed in the application on the fisherman's smartphone. This system also uses a solar panel as an energy source with a capacity of 10 WP with a battery voltage of 12 volts. The two components above are connected using a solar charger so that the solar charger can power the microcontroller [8].

2. Method

The method and stages of research implementation for making smart longline can be depicted in Fig. 1

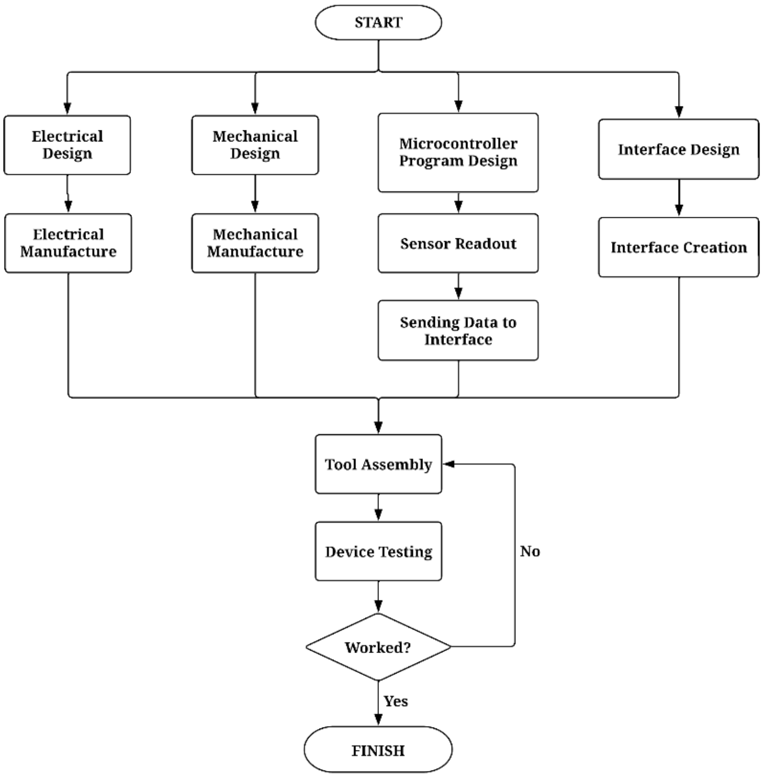


Fig. 1. Flowchart of implementation method

The implementation flow begins with a literature study of the system to be used, how the longline works, the determination of the sensors needed, and how to display the sensor readings on a smartphone. Then the research phase continues with the design process, which consists of 4 points, to the process of making, assembling and testing the results.

2.1. Electrical Design and Manufacture

In the electrical design as shown in Fig. 2, several components are used in the system. First is the power supply module, where there are solar panels as the power source and batteries as the energy storage from the solar panels, as well as solar chargers as the link between the two components that will provide power to the microcontroller through the power USB connector. In the control module, there are 4 accelerometer sensors attached to each branch rope of the longline as a vibration detector when the fish eat the bait, and the GPS module as a marker of the location of the longline in the middle of the sea [9]. Each sensor is connected to the microcontroller on specific pins so that the microcontroller can read the data from each sensor and the value of the GPS module [10].

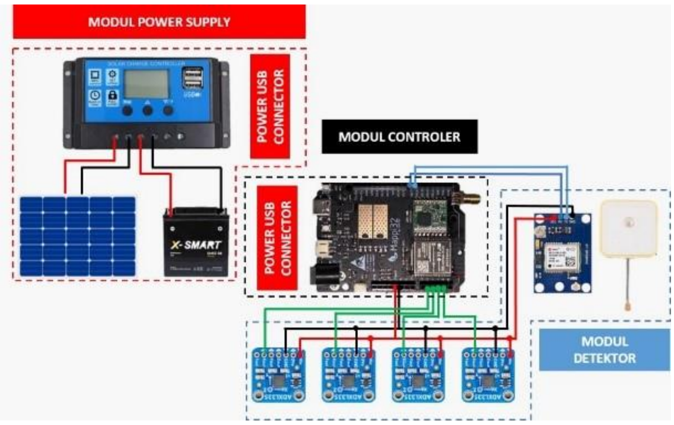


Fig. 2. Electrical design

2.2. Mechanical Design and Manufacture

The mechanical design uses a circular buoy with a diameter of 50 cm and a height of 20 cm as shown in Fig. 3. Inside the buoy are components such as the Mappi32 microcontroller, battery, DC-DC buck converter, step-down module and GPS, as well as solar panels and acrylic for the top cover. The main cable of the smart longline is 4 m long, and every 1m a branch cable is installed to attach the hook and the accelerometer sensor.

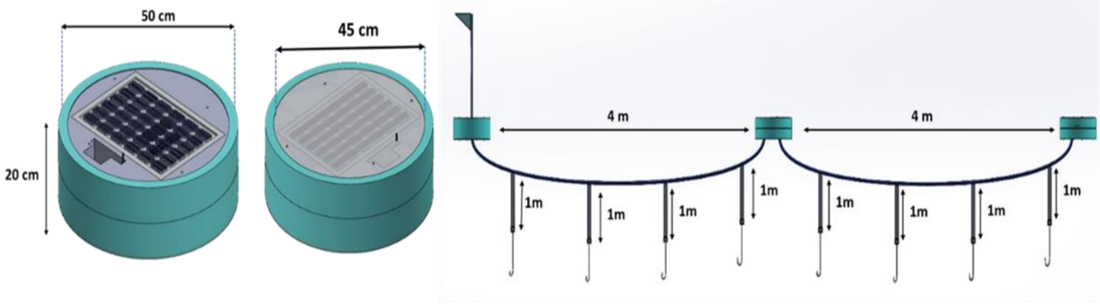


Fig. 3. Mechanical design

2.3. Microcontroller Program Design

As shown in Fig. 4, design and build microcontroller programs using Arduino IDE to calibrate and read sensors [11]. The data is sent from the Mappi transmitter to the Mappi receiver using LoRa communication to overcome the problem of network failures at sea [12], then the Mappi receiver connected to the Internet network sends the data to the Firebase cloud database, which is then displayed on the smartphone application [13].

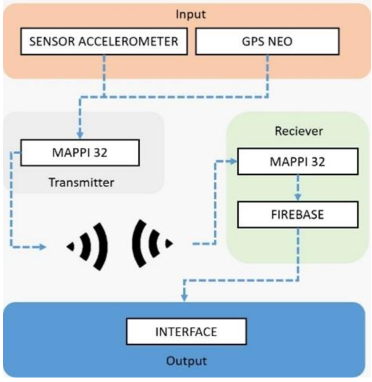


Fig. 4. Microcontroller program design

2.4. Interface Design and Creation

There are several menus such as register, login, longline position and today's catch in the interface design. All the menus have an attractive appearance and make it easier for fishermen to use the application. The creation of interfaces using the Android Studio application [14], with the API: 18 using the Java programming language as a base. In Fig. 5 you can see the database design in this system:

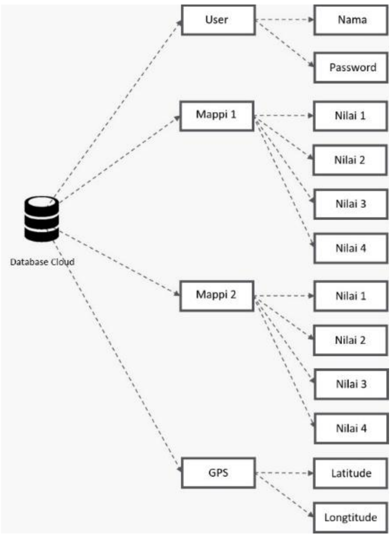


Fig. 5. Android studio database design

2.5. Device Test

The test was installing the smart longline prototype in the middle of the sea at Payung Beach, Nongsa, Batam City. In this test, data was collected from 8 sensors to measure the difference in value between the current vibration in the sea and the vibration when fish catch the bait. From the data, it is determined the maximum limit of the sensor reading value when it is in the sea without any fish pulling. It also calculates the efficiency of the tool in terms of fuel consumption, testing time and the data transmission distance that can be covered between the Mappi32 transmitter and the Mappi32 receiver.

3. Result and Discussion

3.1. Functional Products

Fig. 6. Functional products smart longline

The functional product of the smart longline as shown in Fig. 6 consists of a round dummy with a diameter of 50 cm and a thickness of 20 cm, with a solar panel at the top as an energy source connected to a battery at the bottom of the solar panel, as well as a battery charger and Mappi32 as a microcontroller to send sensor readings to the Mappi32 receiver at the fisherman's house.

The surroundings of the dummy are covered with stickers and the upper and lower sides are covered with acrylic in the shape of a circle, which is connected with a 52 cm long thread iron. The two dummies are connected with a 4 m long hose, in which there is a rope as a place to hook the fishing line, as well as cables to connect the microcontroller to the sensors. The purpose of the hose is to prevent the cable from short-circuiting when exposed to seawater. Every 1 meter of the hose is connected to a branch cable wrapped in heat shrink tubing, with a cable and sensor on the inside and a fishing line connected to the hook at the end.

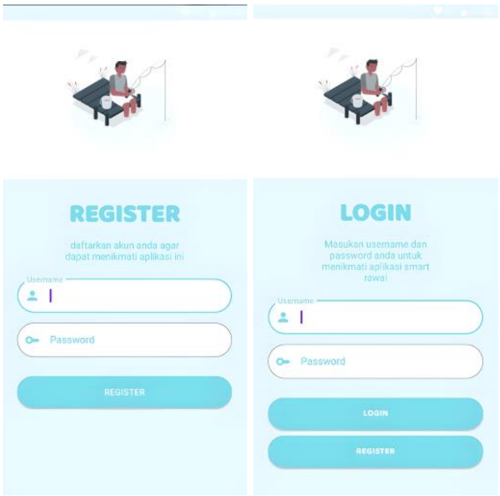
This smart longline is designed to withstand the marine environment, which is prone to short circuits caused by water, and the use of dummies aims to keep all components stable on the rough sea surface.

The process of sending sensor data uses the same node address, so 2 Mappi32 transmitters will send 4 data values each, which are then parsed programmatically on the Mappi32 receiver. After parsing, the data is sent back to the Firebase cloud database in the format of 2 main nodes of the rawai with each node having a branch in the form of 4 sensor data which are then displayed in the application so that the sensor reading process can be monitored by the fishermen. This tool is also installed with GPS as a marker of the position of the longline, which produces output in the form of latitude and longitude of the position of the longline. The process of sending GPS data is also the same as the previous 8 sensors.

The operation of the Smart Longline begins with the deployment of the longline in the sea. When the fish eat the bait, the application displays the catch status along with the position of the longline on the map.

3.2. Interface Display

There are several menus in the Smart Longline application as shown in Fig. 7. These include Register, Login, Today's Catch and Longline Position. The Register menu prompts the fisherman to enter a username and password that will be used to access the login page. In the login menu, fishermen are asked to enter the username and password data that has been registered. Fishermen can press the Register button below the Login button if they do not have an account.

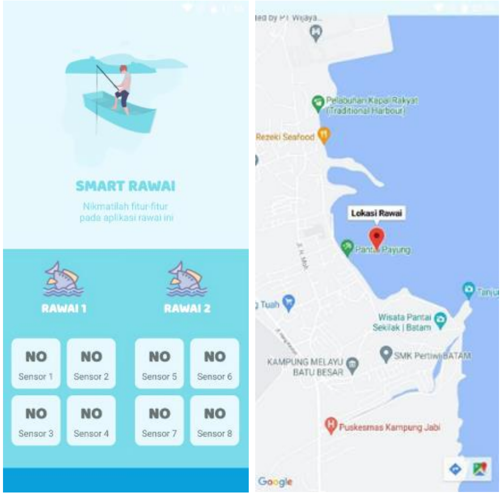


daftarkan akun anda agar dapat menikmati aplikasi ini

Masukan username dan password anda untuk menikmati aplikasi smart rawai

Fig. 7. Register and login page views

In the "Today's catch" menu as shown in Fig. 8, there are 8 fields with indicators in the form of YES or NO. The YES indicator means that the bait was eaten by the fish and the NO indicator means that the bait was not eaten by the fish. Creating 8 boxes divided in two on the application screen represents 2 dummies on the longline, each dummy having 4 hooks and sensors. In the Longline Location menu, the interface displays the location of the longline using GPS latitude and longitude.



Nikmatilah fitur-fitur pada aplikasi rawai ini

Fig. 8. Today’s catch and location page view

3.3. Sensor Reading Result

The accelerometer sensor test is carried out by placing the sensor on each branch rope. The results of the sensor tests are plotted on a graph as shown in Fig. 9.

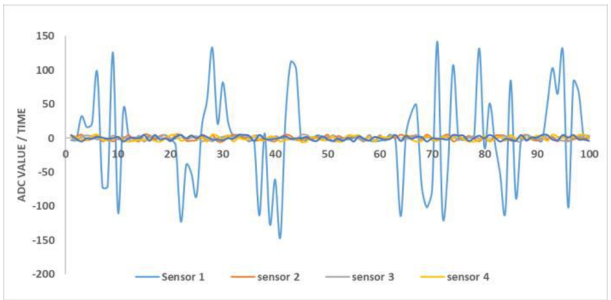


Fig. 9. Graph of sensor readings when the lure is pulled by fish

It can be seen in Fig. 9 that when the bait is eaten by fish (fish on) there is a very contrasting fluctuation in the accelerometer sensor graph. As for the results of the sensor readings on Mappi 1 and Mappi 2 when not eaten by fish, the results are as shown in Fig. 10 and Fig. 11.

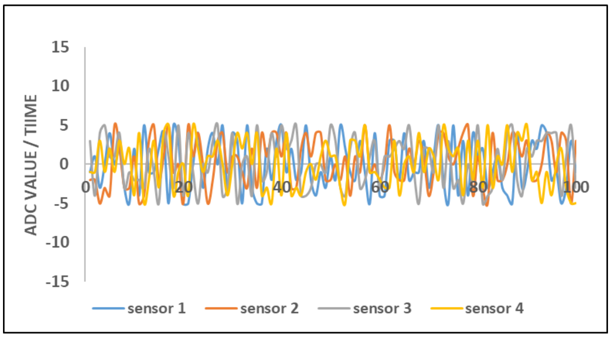


Fig. 10. Graph of sensor readings on Mappi 1 when bait is not eaten by fish

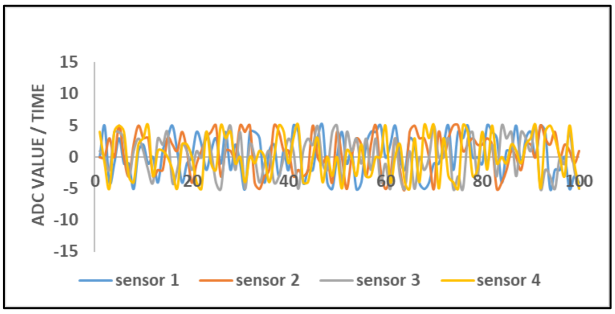


Fig. 11. Graph of sensor readings on Mappi 2 when bait is not eaten by fish

For sensor readings that are only exposed to ocean waves without the pull of fish, the average maximum value of the sensor readings will be obtained. This value is the maximum detection limit for a sensor in an unfished condition. If the sensor reads the vibration value above the maximum limit of the sea wave value, Mappi will read the data as fish on data or the hook has been eaten by fish.

In testing the Neo 6M GPS tracking sensor, the Neo 6M GPS tracking device is placed on the dummy and its accuracy is compared with the GPS on the smartphone in the form of reading the latitude and longitude [15]. From the experiments carried out, we obtained the results shown in Table 1.

Table 1. Tests the accuracy of GPS NEO readings

GPS NEO 6M		GPS Smartphone		Distance Difference (m)
Latitude	Longitude	Latitude	Longitude	
1.100464	104.0554	1.100529	104.05545	8
1.119176	104.0578	1.119299	104.09997	5.5
1.104920	104.0533	1.199299	104.08897	11
1.154827	103.9978	1.145299	104.06057	7
1.098991	104.0534	1.199088	104.07057	11

3.4. LoRa Communication Test

The LoRa communication test is performed outdoors, with data being sent from the 4 sensors, which are combined into one packet and sent to the LoRa receiver. The test results as presented in Table 2 show that the farthest LoRa data was sent at a distance of 2.2 km.

Table 2. LoRa communication distance test

Distance (m)	Data Transmit					Data *Receiver*	RSSI
	Data 1	Data 2	Data 3	Data 4	Packet Transmit		
200	10	15	30	35	#10#15#30#35&	#10#15#30#35&	-96
400	15	20	35	40	#15#20#35#40&	#15#20#35#40&	-92
600	20	25	40	45	#20#25#40#45&	#20#25#40#45&	-97
800	25	30	45	50	#25#30#45#50&	#25#30#45#50&	-92
1000	30	35	50	55	#30#35#50#55&	#30#35#50#55&	-93
1200	35	40	55	60	#35#40#55#60&	#35#40#55#60&	-93
1400	40	45	60	65	#40#45#60#65&	#40#45#60#65&	-82
1600	45	50	65	70	#45#50#65#70&	#45#50#65#70&	-94
1800	50	55	70	75	#50#55#70#75&	#50#55#70#75&	-102
2000	55	60	75	80	#55#60#75#80&	#55#60#75#80&	-118
2200	10	65	80	85	#60#65#80#85&	#60#65#80#85&	-115
2400	15	70	85	90	#65#70#85#90&	#@$#6$$@#8&	-143

3.5. Battery Power Capability

With a 12V 10Ah battery and a voltage of 3.6V, the Rawai Pintar can operate for 25 hours when not powered by the solar panel. With Table 3, the calculation is as follows:

Battery Power 12v 10 Ah = 120 wh; $\text{Usage time} = \frac{\text{Battery Power}}{\text{Total Load}} = \frac{120\ \text{wh}}{4.69\ \text{wh}} = 25.58\ \text{h}$

The operating time of the "Smart Longline" with the use of a 12 V 10 Ah battery is 25 hours and 58 minutes.

Table 3. Smart longline power calculation

Component	Unit	Current (A)	Total Current (A)	Total Power (W)
ADXL 335	4	0.00035	0.0014	0.00504
GPS NEO	1	0.01	0.01	0.36
Mappi 32	1	1.2	1.2	4.32
		Total Load		4.69

3.6. Product Advantages

The advantages of a smart longline over a conventional longline are shown in Table 4.

Table 4. Smart longline advantages

Features	Conventional Longline	Smart Longline
Know the coordinates of the location of the longline	✕	✓
Detect catches in real time	✕	✓
Monitor the longline remotely	✕	✓

Optimizing sensor performance and incorporating advanced technologies to address current limitations should be focused on the next research. Investigating alternative communication methods, such as satellite or cellular networks, could offer more reliable data transmission over greater distances. Moreover, examining the economic impact of the Smart Rawai system on fishermen's operations and assessing its potential for scalability to other fishing regions would be advantageous. Ongoing field testing and user feedback will be essential for further refinement of the system and to ensure its practical applicability.

4. Conclusion

Through extensive research and testing, a Smart Rawai prototype has been successfully developed so that it performs effectively. This device operates in maritime environments and transmits sensor data via LoRa communication technology. Fishermen can utilize a smartphone application to monitor both the catch and the position of the longline, facilitating remote observation without the need for direct inspection. This system is designed to improve time and fuel efficiency, with the potential to enhance overall catch yields. However, the Smart Rawai prototype does face several limitations. The accuracy of sensor data may be affected by environmental factors such as sea conditions and signal interference. Furthermore, the dependence on LoRa communication could result in a restricted data transmission range in certain locations. The prototype also necessitates regular maintenance to ensure optimal performance, which may be challenging for fishermen with limited resources. To mitigate these issues, it is recommended to refine sensor calibration to enhance data accuracy across varying environmental conditions. Additionally, exploring alternative or supplementary communication technologies could extend the effective range of data transmission. Improving the user interface and providing maintenance training for fishermen could also bolster the system's effectiveness and sustainability.

References

[1] Dinas Perikanan Dan Kelautan, “Pengguna rawai dasar list data dasar | Aplikasi Dataku,” Jogjakarta: Jogjaprov.go.id, 2022. [Online]. Available: https://jogjaprov.go.id. [Accessed: 20 Mar. 2022].

[2] Muis, M., “Produktivitas rawai dasar yang dioperasikan di perairan Pulau Makarangana Kabupaten Pangkep,” 2020.

[3] W. L. Franjaya, Z. Zamdial, and A. Muqsit, “Analisis produktivitas dan teknis penangkapan rawai dasar di desa Kota Bani Kecamatan Putri Hijau Kabupaten Bengkulu Utara,” Jurnal Enggano, vol. 3, no. 2, pp. 261–274, 2018. DOI: 10.31186/jenggano.3.2.261-274.

[4] Setianto, “Pengoprasian rawai hanyut E-learning PUSDIK KP,” 2018. [Online]. Available: https://pusdik.kp.go.id. [Accessed: 19 Mar. 2022].

[5] A. Ferreira, S. Ruiz, and L. Carvalho, “Real-time detection of fish motion in aquaculture tanks using accelerometer sensors,” Aquacultural Engineering, vol. 86, pp. 1-10, 2019. DOI: 10.1016/j.aquaeng.2019.102068.

[6] C.-C. Yang and Y.-L. Hsu, “A review of accelerometry-based wearable motion detectors for physical activity monitoring,” Sensors, vol. 10, no. 8, pp. 7772-7788, 2010. DOI: 10.3390/s100807772.

[7] Michael, “Uji jarak LoRa Mappi to Mappi di Yogyakarta,” KM Tech, 2021. [Online]. Available: https://www.kmtech.id/post/uji-jarak-lora-mappi-to-mappi-di-yogyakarta. [Accessed: 8 Feb. 2022].

[8] F. T. Lee, P. R. Wilson, and M. C. Adams, “Efficiency analysis of solar-powered energy systems with battery storage,” Applied Energy, vol. 259, article 114223, January 2020.

[9] E. J. Martinez and R. C. Thomas, “Development of an automated longline monitoring system using GPS and sensor technology,” IEEE Trans. Oceanic Eng., vol. 45, no. 2, pp. 260-272, April 2020.

[10] H. Chen, Y. Wang, Z. Li, and X. Zhang, “Design of a long-distance IoT communication system based on LoRa and GPS for oceanic fishery,” Sensors, vol. 18, no. 5, pp. 1661, 2018. DOI: 10.3390/s18051661.

[11] A. Brown and L. Green, “Arduino-based real-time monitoring system for sensor calibration,” IEEE Sensors J., vol. 20, no. 12, pp. 6632-6640, June 2020. Available: https://doi.org/10.1109/JSEN.2020.3012243.

[12] H. Li, X. Yu, P. Zhang, and W. Xu, “LoRa-based monitoring system for fishery applications,” IEEE Access, vol. 6, pp. 67860-67869, 2018. DOI: 10.1109/ACCESS.2018.2879468.

[13] L. B. Clark and M. E. Stevens, “Design and implementation of a microcontroller-based data acquisition system for environmental monitoring,” J. Sensors, vol. 2021, article 8912345, December 2021.

[14] N. Walker, S. Lee, and T. Brown, “User interface design for mobile applications: Improving usability with Android Studio,” J. Softw. Evol. Process, vol. 32, no. 11, pp. e2264, Nov. 2020. Available: https://doi.org/10.1002/smr.2264.

[15] S. F. Armitage and K. J. Williams, “Integration of GPS and sensor networks for marine environmental monitoring,” Mar. Technol. Soc. J., vol. 53, no. 4, pp. 58-67, August 2019.