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THE USE OF A MAGNETIC SENSOR TO DETECT LOBSTER (*Panulirus spp.*) CATCHES ON THE LABORATORY SCALE

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ABTSRACT

Problems in operating trap fish tool are that fishermen do not know the actual condition of the traps. Thus, it causes the effectiveness of time and number of catches to be not optimal. Based on the conditions and problems above, the writer concluded that an innovation in the operation of the trap to design a magnetic sensor-based system/tool to detect lobster catches that can be accessed via smartphone is required. The aim of this study is to design and observe the performance of using a magnetic sensor to detect lobsters' (*Panulirus* spp.) movements on a laboratory scale (in the aquarium). Data analysis in this study used the Confusion Matrix method, where this method divides the test results into 4 common conditions: TP (True Positive), TN (True Negative), FP (False Positive), and FN (False Negative). From the 4 conditions, Recall, Specificity, Precision, Accuracy, and F1 Score can be calculated. From 16 tests with the 16 lobsters of 60-190 grams/individual, it obtained conditions of TP of 25 times, TN of 109 times, FP of 11 times, and FN of 15 times. From the four conditions, it was obtained a Recall value of 0.625 or 62.50%, Specificity of 0.9083 or 90.83%, Precision of 0.6944 or 69.44%, Accuracy of 0.8375 or 83.75%, and F1 Score of 0.6579 or 65.79%. Based on the observations and test results of the actual detection and application system in this study, performance reference for using magnetic sensors was by using Accuracy with a score of 83.75%.

Keywords*: lobster trap, internet of things (IoT), lobster, magnetic sensor.*

INTRODUCTION

One of the marine commodities with high economic value is crayfish or lobster. Lobsters that have a very high selling value on the market are lobsters that are still alive with complete body parts (Miswar *et al.*, 2016). This marine commodity has essential economic value in the trading sector, both local and international. The type and size of lobster greatly determine the price of lobster (local). One of the main fishing businesses for fishing community is lobster catching activities, because with a minimum lobster catch quantity and excellent quality, it will still profitable for the business as well as increase the income (Zulkarnain *et al.*, 2011).

According to the Annual Report of the Maritime Affairs and Fisheries Service of the Kebumen Regency in 2020, the production of marine fisheries, especially lobster, was 58.77 tonnes. The utilization of lobster in the Indian Ocean, especially in the south of Java Island, is relatively still below its sustainable utilization potential (Boesono 2012 *in* Khikmawati *et al.*, 2015). However, in the last 10 years there has been an increase in lobster utilization in the Fisheries Management Area of Republic Indonesia (WPPNRI) 573 namely 2.0 (Ministerial Decree of the Ministry of Maritime Affairs and Fisheries No. 19 of 2022), which means lobster catching efforts must be reduced (Suhana, 2022).

The use of environmentally friendly fishing gear is one of the methods to maintain the sustainability of fish resources, as regulated in the Code of Conduct for Responsible Fisheries (CCRF) (FAO, 1995).

Lobster catching performed by fishermen is included in small-scale capture fishing activities, carried out in coastal water with simple fishing gear (traditional) (Rahman *et al.*, 2015). The types of fishing gear widely used to catch lobster are bottom gillnet monofilament and hoopnet (Zulkarnain *et al*., 2011). These two fishing gears can reduce the quality of the catch because lobsters that are caught are generally entangled or twisted in nets which can cause parts of the lobster's body to be broken or severed limbs, such as legs and/or antennae (Zulkarnain *et al*., 2011). Moreover, if these fishing gears are lost, they will have a role in ghost fishing (Tamarol *et al*., 2012). Meanwhile, based on Eno *et al*. 2001; Groeneveld, 2000; Rizky *et al*., 2018, *bubu* (trap) is a selective and environmentally friendly fishing gear.

Problems in operating trap fish tool are that fishermen do not know the actual condition of the traps. Thus, it causes the effectiveness of time and number of catches to be not optimal, where fishermen need to check one by one (manually) for the trap installed (it cannot be known whether the trap is filled or not). Although lobsters are generally considered to be active at night (Cobb, 1971; Cooper & Uzmann, 1980; Jury, 1999; Karnofsky & Price, 1989; Lawton, 1987; Lawton & Lavalli, 1995; Reynolds & Casterlin, 1979), lobsters evidently do not enter traps with higher speeds at night (Jury *et al*., 2001).

Based on the conditions and problems above, the writer concluded that an innovation in the operation of the trap to design a magnetic sensor-based system/tool to detect lobster catches that can be accessed via smartphone is required. This innovation is expected to help fishermen monitor the condition of the traps spread without checking directly at the sea so that it can improve the effectiveness and efficiency of catching activities using trap fishing gear. This is also one of the steps to prepare and face the digital industry era in the fisheries sector, especially catching fisheries using traps. The aim of this study is to design and observe the performance of using a magnetic sensor to detect lobsters' movements in the aquarium (on the laboratory scale.

RESEARCH METHODS

Experimental Design

The design sensor tool was to detect lobster catches (*Panulirus* spp.). The sensor used to detect lobster catches in trap fishing gear was a magnetic sensor with the specifications as follows:

Material	:	ABS (Acrylonitrile Butadiene Styrene)
Connection way	:	Normally open or normally close
Max switching voltage	:	300 VDC
Max contact rating	:	10 W
Max switching current	:	0.55 A
Electrical life	:	50mV- 10uA - 1x10E6

A sensor was installed or placed on the net door, which divides the aquarium into two parts. The diameter of the door hole was 20 cm. Lobsters that enter or pass the door hole would hit the sensor, and then the sensor would read or detect data. The data were sent to the sensor node on the water surface. Data communication from the magnetic sensor to the sensor node used wires NYMHY 4 x 0.75 mm^2.

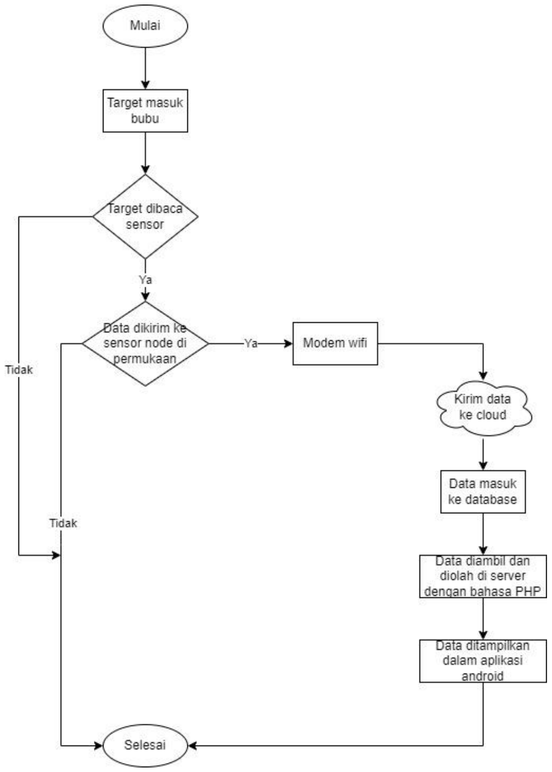

Figure 1. Diagram of System Flow

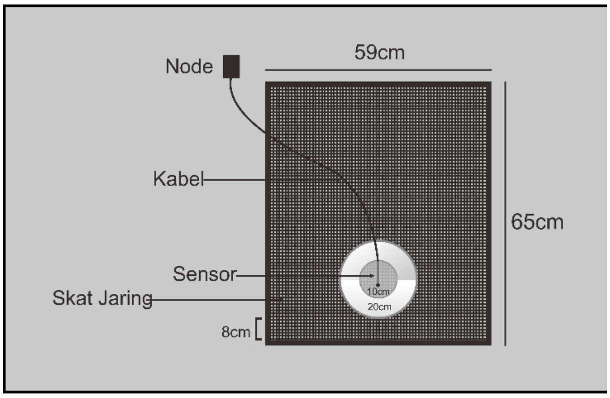

Figure 2. Tool Installation Design

The sensor node has a task to receive and process data from the sensor and then send the data to the Wi-Fi modem. Specification of the sensor node used is as follows:

Processor	:	32-bit 80Mhz
RAM	:	36 Kb
Wi-Fi protocols	:	802.11 b/g/n
Operating current	:	80 mA
Operating voltage	:	3 - 3.6 V
Operating temperature	:	-40 - 125 C
Battery	:	Lithium-ion 3.6 V 5800mAh
Type antenna	:	External Omni directional
Enclosure	:	Waterproof
Input	:	Digital counter max 20 mA

After data is processed in the sensor node, data are sent to the Wi-Fi modem, which will be sent to the cloud (database). The specification of the Wi-Fi modem used is as follows:

Frequency	:	LTE TDD: B38/39/40/41, LTE FDD: B1/2/3/4/5/7/8/20(28), HSPA+/HSPA/UMTS: B1/B2/B4/B5/B8, GSM: 850 MHz/900MHz/1800MHz/1900MHz
Wi-Fi	:	Frequency - 2.4GHz, Protocol - 802.11b/g/n, 20/40M, Channel 1~11, Antenna - Internal Antenna (2x2)
Data Rate	:	4G - 3GPP Cat. 4
Downlink/Uplink	:	Up to 150 Mbps/50Mbps
Card	:	Micro
Users	:	32 users
Product dimensions	:	130 x 100 x 46 mm
Product weight	:	155 grams
Packaging dimensions	:	20.3 x 11.3 x 8 cm
Battery	:	11.000 mAh
Signal range	:	±125 meters

Data in the cloud go to the database. Furthermore, data were taken and processed in the server with PHP (Hypertext

Preprocessor) language. Then, data were displayed in the Android application.

Testing Procedures

This test was conducted on a laboratory scale using an 150 x 70 x 60 cm aquarium with a a water capacity of ±630 liters. The water used was seawater taken from Pasir Beach, Kecamatan Ayah, Kebumen Regency.

A net partition dividing the the aquarium into two parts was installed in the middle of the aquarium. One part is for placing lobsters, and the other is for placing bait. This partition was given a hole (diameter of 20 cm) as an entrance. In the hole, a detector device (magnetic sensor) for lobster catches was installed and filled with seawater, in which the right side was filled with lobsters and the left side was filled with bait to attract lobsters' movement from the right side to the left side of the aquarium. The research object was lobsters that passed or hit the detector device (sensor).

Under the main aquarium (research aquarium), there was an aquarium filter to filter circulating water equipped with UV light (ultraviolet) and a water pump machin.

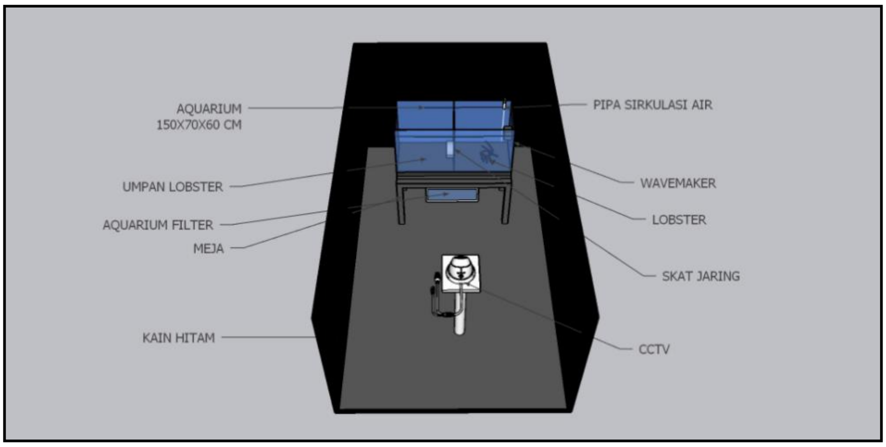

Figure 3. Laboratory Scale Test

In order to form currents and waves similar to or resembling sea-like conditions, a wave maker was installed on one side of the main aquarium (research aquarium). The specification of the wave maker used is as follows:

Voltage : 220-240 V
Frequency : 50-60 Hz
Power : 20 W
Max. Flow Rate : 20.000 L/Hr
Size : 15 x 10 x 14 cm
For aquarium : 150-200 cm

Primary data collection during the research was in the form of actual data of the catch (lobsters passing the door) and data in the application system. Parameters taken from experimental data were the actual catches (filled, empty, and number of catches) and catches based on the reading of the Android application system.

This test was conducted 16 times. Lobsters used were 60 - 190 grams/individual. In one test, 10 lobsters were used, where lobsters were put on the right side of the aquarium, and the bait to attract lobster movement was put on the left sight of the aquarium. Lobsters were soaked for approximately 12-18 hours. They were put in the afternoon and taken the next morning. This is according to the lobsters' habit, which was more active at night (Bakhtiar *et al*., 2014; Donny Prariska *et al*., 2020; Khikmawati *et al*., 2015; Kusuma *et al*., 2012; Sipayung *et al*., 2016; Zulkarnain *et al.*, 2011a). Each test used different lobsters (Miswar *et al.*, 2016).

A camera was installed on one side of the aquarium to record lobsters' movement from the right side to the left side of the aquarium (lobsters passing door equipped with a sensor). A partition or guard rail with a black cloth of 300 x 150 x 150 cm was installed around the aquarium so that the research activity was not disturbed.

Data Analysis

Testing of tool performance was conducted on land or laboratory scale. An aquarium equipped with a detector was used. Then, the aquarium was filled with seawater and lobsters. A camera was installed on one side of the aquarium to record object movements (lobsters). Testing was conducted to find out the suitability of the system with research objectives (Azhari *et al.*, 2021). Tool testing also aims to test the designed functions (Arafat, 2016).

This test was conducted to find out the ability of the system to detect objects. This test was conducted using the Confusion Matrix method, where this method divides the test results into 4 common conditions (Han *et al.*, 2012):

1) TP (true positive): when the actual condition was filled, and the system detected filled
2) TN (true negative): when the actual condition was not filled/empty, and the system detected not filled/empty
3) FP (false positive): when the actual condition was not filled, and the system detected filled
4) FN (false negative): when the actual condition was filled, and the system detected not filled/empty

From the four conditions above, system recall (true positive rate), specificity (true negative rate), precision (accuracy when detecting filled), and accuracy (accuracy in detecting) values could be found. According to Han *et al.* (2012) and Zulma *et al.* (2021), the following equations were used to calculate the values:

$$Recall\ (TPR) = \frac{\mathrm{TP}}{\mathrm{TP} + \mathrm{FN}} \tag{1}$$

$$Specificity\ (TNR) = \frac{\mathrm{TN}}{\mathrm{TN} + \mathrm{FP}} \tag{2}$$

$$Precision = \frac{\mathrm{TP}}{\mathrm{TP} + \mathrm{FP}} \tag{3}$$

$$Accuracy = \frac{\mathrm{TP} + \mathrm{TN}}{\mathrm{TP} + \mathrm{FP} + \mathrm{FN} + \mathrm{TN}} \tag{4}$$

After finding recall, specificity, precision, and accuracy values, the F1 Score was observed. F1 Score is defined as the harmonic mean of the precision and recall(Chicco & Jurman, 2020) with the equation as follows:

$$F1\ Score = \frac{2\ .\ \mathrm{TP}}{(2\ .\ \mathrm{TP}) + \mathrm{FP} + \mathrm{FN}} = 2\ .\ \frac{precision\ .\ recall}{precision + recall} \tag{5}$$

The worst value of the F1 Score was 0, and the best value of the F1 Score was 1. If the F1 Score had a good value, it showed that our classification model had good precision and recall.

RESULTS AND DISCUSSION

The testing results of the actual detection and application system using the Confusion Matrix were shown. From 16 tests conducted using 160 lobsters of 60-190 grams/individual, 4 conditions in Table 1 were obtained.

Table 1. Testing Results of Actual Detection and Application System

No.	Conditions	Number (times)
1	True Positive	25
2	True Negative	109
3	False Positive	11
4	False Negative	15
	Total	160

True Positive is the condition when the actual is filled, and the system detects filled. True Negative is the condition when the actual is not filled or empty, and the system detects not filled/empty. Moreover, False Positive is the condition when the actual is not filled or empty, and the system detects filled. Meanwhile, the condition when the actual is filled, and the system detects that it is not filled or empty is called False Negative (Fibrianda & Bhawiyuga, 2018; Hakim *et al*., 2012; Rafsanjani *et al*., 2022; Septiansyah *et al*., 2023; Yudhono *et al*., 2015).

False Negative obtained in this study was 11 times, and False Negative was 15 times. Based on the observation performed, the condition of False Positive was caused by a lobster stopped in the door (already touched the sensor) for a long time so that catch can be detected by the system for more than 1 lobster. Moreover, after conducting observation, the lobster stopped at the door, which was caused by the design of the entrance in the partition (same as in the trap), which was shaped like a cone with a horizontal position. Meanwhile, to install or place a magnetic sensor, rigid media was required.

In this study, the media used to install the magnetic sensor was a plastic funnel with a diameter of 20 cm (same as the net/trap partition door), with the end cut off (the remaining 9 cm of the horizontal surface). Furthermore, there was ±10 cm conical net (part of the net/trap partition door). Thus, if a lobster enters the door, but the lobster's movements are less agile/aggressive, lobsters become stopped on the surface.

In other words, several factors caused the detection error, especially the condition of False Positive in this study. In line with the research conducted by Hakim *et al*. (2012) regarding Machine Learning in the intrusion detection system, the condition of False Positive is not only due to an incorrect algorithm, but False Positive occurs due to an incomplete algorithm used by the detection system. Moreover, according to Kuruppu & Zou (2021), the mechanical interface used to install the sensor is susceptible to failure due to environmental, manufacture, and operation conditions.

From the observation results, the condition of False Negative was caused by a poor internet signal (down). The internet signal could be seen in the signal indicator in the Wi-Fi modem. Based on the observation, poor internet signal was when the indicator lights up at 1-2 bars, from a 5 bar signal range on a Wi-Fi modem. This is in line with the study conducted by Ardiyanto (2016) regarding Machine Learning in the Network Intrusion Detection System (NIDS), which stated that False Negative can occur due to several factors. One of them is the failure of NIDS to perform packet inspection of data traffic (Salah & Qahtan, 2009).

Sensor Performance

Based on the Confusion Matrix, we can calculate Recall, Specificity, Precision, Accuracy, and F1 Score. From 4 conditions obtained in Table 1, measurement values were obtained in Table 2 as follows:

Table 2. The Measurement Results of Tool Performance

No.	Parameters	Values	Percentage (%)
1	Recall	0.6250	62.50
2	Specificity	0.908333	90.83
3	Precision	0.694444	69.44
4	Accuracy	0.8375	83.75
5	F1 Score	0.657895	65.79

Recall (True Positive Rate)

Recall is the ratio of true positive prediction compared to all true positive data (Sokolova *et al*., 2006). Recall answered question, "What percentage of lobsters are predicted to be entered (filled) than all lobsters that are actually entered (filled)?". According to Arthana (2019), Ghoneim (2019), Nursahid (2022), and Setiawan (2020), we can choose an algorithm with high Recall if we choose False Positif (FP) better than False Negative (FN).

Specificity (True Negative Rate)

Specificity is the ratio of true negative prediction compared to all true negative data (Sokolova *et al*., 2006). Specificity answered a question, "What percentage of lobsters is actually not entered (not filled) than all lobsters that are actually not entered (not filled)?". According to Arthana (2019), Ghoneim (2019), Nursahid (2022), and Setiawan (2020), we can choose an algorithm with high Specificity if we do not want a False Positive (FP) to occur.

Precision

Precision is the ratio of true positive prediction compared to all results predicted to be positive (Sokolova *et al*., 2006). Precision answered the question, "What percentage of lobsters is entered (filled) from all lobsters predicted to be entered (filled)?". According to Arthana (2019), Ghoneim (2019), Nursahid (2022), and Setiawan (2020), we can choose an algorithm with high Precision if we prefer True Positive (TP) to occur and really do not want False Positive (FP) to occur.

Accuracy

Accuracy is the ratio of true prediction (positive and negative) with all data (Sokolova *et al*., 2006). Accuracy answered the question, "What percentage of lobsters is actually predicted to be entered (filled) or not entered (not filled)". Based on Arthana (2019), Ghoneim (2019), Nursahid (2022), and Setiawan (2020), we can choose an algorithm with high Accuracy if our dataset has a very close number of False Negative and False Positive data (Symmetric).

F1 Score

The F1 Score is the average comparison between weighted precision and recall (Sokolova *et al*., 2006). Based on Arthana (2019), Ghoneim (2019), Nursahid (2022), and Setiawan (2020), we can choose an algorithm with a high F1 Score if our dataset has a very different number of False Negatif and False Positive data (Asymmetric).

According to the observation and the results of the actual detection and application system test in Table 1 above, the algorithm performance references the Use of a Magnetic Sensor to Detect Lobster (*Panulirus* spp.) Catches in the Laboratory Scale was by using Accuracy.

Accuracy was chosen because the dataset generated had a close number of FP (False Positive) and FN (False Negative) data (Symmetric). False Positive was 11 data, and False Negative was 15 data. According to Ghoneim (2019), choosing Accuracy is more precise. Moreover, using a magnetic sensor to detect lobster catches was in the environment with many influencing external factors.

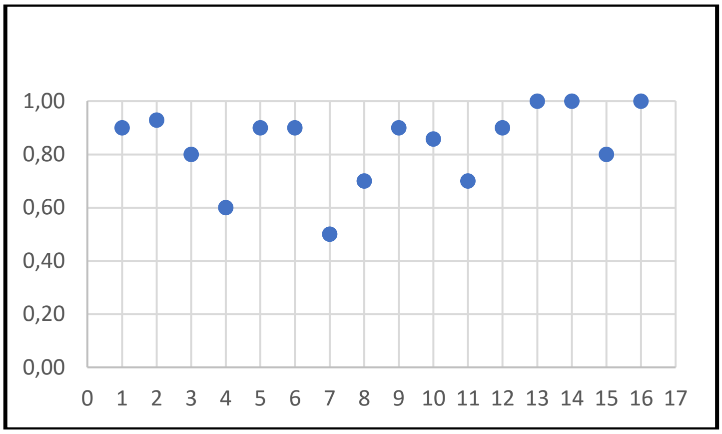

Figure 4. Distribution Graph of Accuracy Value

Figure 4 is a distribution graph of accuracy value generated during 16 tests. From 16 tests, it was obtained the highest accuracy value of 1 or 100%, which was 3 times on the 13th, 14th, and 16th tests. Meanwhile, the lowest accuracy value of 0.5 or 50% was 1 time on the 7th test.

On the 13th test, an accuracy value of 1 was obtained because the test obtained a TP (True Positive) condition of 2 times, TN (True Negative) condition of 7 times, FP (False Positive) condition, and FN (False Negative) of 0 times.

On the 14th test, an accuracy value of 1 was obtained because the test obtained TP (True Positive) condition of 1 time, TN (True Negative) condition of 9 times, FP (False Positive) condition, and FN (False Negative) of 0 time.

On the 7th test, it obtained the lowest accuracy value of 0.5. This was because the test obtained the TP (True Positive) condition of 3 times, TN (True Negative) condition of 2 times, FP (False Positive) condition of 5 times, and FN (False Negative) of 0 times. The condition of False Positive was 5 times according to the observation conducted, in which there were lobsters stopped in the door so that it was detected by the system for more than 1 lobster.

This study used a magnetic sensor to detect lobster catches or, in this case, lobsters' movement from the right side to the left side of the aquarium, in which the consideration is the working principle of a magnetic sensor, which will be affected by a magnetic field. When lobsters touch or hit the magnetic lever, they will approach the sensor so that a magnetic field is formed, and the output of 1 data (lobster enter) is ultimately formed. Otherwise, if a lobster comes out, the magnetic lever will move away from the sensor (move away from the magnetic field) so that this does not affect the output of this tool (incoming lobsters are not counted).

This is in line with the previous study, which stated that a magnetic sensor is a sensor that is easily affected and sensitive to the magnetic field and provides changes in output conditions. The working principle of a magnetic sensor is that it will be active when the conductor affects the magnetic field so that the magnetic is repelled or attracted according to the influence of the conductor provided (Widharma, 2020). Another study also stated that a magnetic sensor is a tool that will be affected by the magnetic field and make changes to a condition in output. This is like a two-state switch (on/off) that is moved by the magnetic field around it. This sensor is usually packaged in empty packaging and free from dust, moisture, smoke, or vapor (I. Setiawan, 2009).

This study used a Wi-Fi modem, not Bluetooth, for data communication because the node required an internet connection to send data to the cloud so that it could be monitored via an application on a smartphone. The modem was used to obtain an internet connection from an internet service provider through a 3G/4G network. No modem is available with Bluetooth connection in the market, so device customization before using the device is required.

This study used an internet network, not an intranet because the node required an internet connection to send data to the cloud so that it could be monitored via application. If using an intranet without the internet, data could not be sent and saved to the cloud so that it could not be monitored via an application on a smartphone.

In this tool, two devices requiring energy sources to work were the sensor node and the Wi-Fi modem. Both energy sources used a lithium battery. Sensor node (5880 mAh) and modem Wi-Fi (11000 mAh). According to the observation conducted, from 100% to 0%, the battery of the sensor node could be used for approximately more than 47 hours 34 minutes. Furthermore, the battery on the Wi-Fi modem could be used for approximately 85 hours. Thus, both were safe to use in lobster traps, where fishermen usually soak the trap for approximately 12 to 18 hours.

Condition on the laboratory scale was actually very different from condition in the field. In the laboratory scale research, a wave maker was installed to form currents and waves that can be similar to or resemble the conditions in the sea. Based on the observation and measurement conducted, the current of surface water generated from the installation of a wave maker was 59.64 cm/second, and the tool is not affected by this condition. The tool was relatively safe to use in the operation of lobster traps. According to BMKG (2023), the surface current in the lobster-catching area in the Kebumen Regency is 20-45 cm/second.

This tool cannot make sure or guarantee that what enters the trap are lobsters. Therefore, to minimize detection error in the tool, the magnetic lever and sensor were set to open, forming the magnetic field for 10 seconds. The sensor will only record if the sensor lever is held for a minimum of 10 seconds. This was according to the observation, which showed that lobster required time to enter the trap door. Thus, based on the experiment, the time was determined to be 10 seconds. The magnetic sensor will send data if the magnetic lever has returned to its original position (closed).

This study must be continued and further developed to improve the deficiencies and weaknesses. One of the weaknesses found in this study is when marine life or other objects are stuck or stop at the tip of the trap, causing the magnetic lever to open for 10 seconds or more, it will be output 1, which states that the lobster enters the trap.

CONCLUSION

Conclusion

This study obtained the design of a Lobster (*Panulirus* spp.) catch detection tool in the trap using a magnetic sensor that can monitor via application in the Android-based smartphone. This sensor tool can work well on a laboratory scale with an accuracy value of 83.75% to detect lobster movements that enter at the tip of the trap in the aquarium.

Suggestion

Further study is required for the trial operation of using a magnetic sensor in detecting lobster (*Panulirus* spp.) catches in the trap conducted at sea. Stronger or sturdier trap construction as media is required for installing a magnetic sensor.

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