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Evaluation of GY271 and GY273 Sensor Performance in Measuring Ocean Current Direction

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Abstract

This study compares the performance of the GY271 and GY273 compass sensors in measuring ocean current direction at Dompak Lama Pier, Tanjungpinang, Riau Islands. The system utilizes an ESP32 microcontroller to record real-time data, store it on an SD card. Two days of testing revealed an average accuracy of 97.9% for GY271 and 98.29% for GY273, with ANOVA analysis indicating no significant differences in most measurements. Both sensors remain reliable for ocean current direction measurements with proper maintenance and calibration.

Keywords: GY271**,** GY273**,** Compass Sensor**,** Ocean current neasurement, Oceanography

INTRODUCTION

Waters, which are part from area maritime the largest in the world, has very big potential in matter source Power nature and transportation sea [1]. One of the aspect important in utilization potential This is understanding about pattern current the sea, which affects various sector like navigation, ecosystem sea, and mitigation disaster [2] [3]. Region Riau Islands, especially at the Old Dompak Pier, Tanjungpinang City, the current sea own role significant in support activity shipping, fishing and life public coast.

Old Dompak Pier is located in the waters strategic with characteristics current sea influenced by tidal factors and conditions geographical local [4]. Accurate understanding about direction current the sea in this region is very important For increase safety shipping, support activity economy, as well as to preserve ecosystem local [5]. However, the measurement current sea face various challenges, such as dynamics complex environment and needs will have consistent data [6] [7].

ESP32 is A innovation technology that can used. Microcontroller This own Wi-Fi and Bluetooth connectivity in One the module [8]. In addition, the ESP32 can used in various applications , such as in study [9], [10]. In addition, the ESP32 can used in system measurement direction current sea using the GY271 [11] and GY273 [12] compass sensors.

Sensor technology has become solution main in measurement of environmental parameters, including direction current sea [13]. Compass sensor, which is used For measure direction in a way precision, offering superiority in efficiency and portability [14]. However, in condition environment dynamic sea, no all sensors have optimal performance. Therefore that's important For do comparison to various compass sensor type use determine the most suitable tool For condition local at Old Dompak Pier [15].

Study This aiming for comparing two types of compass sensors in measure movement direction current sea. With existence study This expected can add outlook related the reliability and accuracy of each sensor, so that can used as guide in choose technology measurement current the right sea. In addition, it is expected study This can give meaningful contribution in support water area management Old Dompak Pier in general efficient.

RESEARCH METHODS

This study adopted a comparative experimental design to evaluate the performance of two compass sensors in measuring ocean current direction. Data collection was conducted at Dompak

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Port, Tanjungpinang for 2 days. The research methodology consists of three main stages: tool design scheme, system design, and sensor calibration.

1.1. Tool Design Schematic

Design scheme tool used for understand How all over component electronics integrated in system. Design scheme the give description about connection between components used in tools. Schematic details design tools shown in Figure 1 and Figure 2.

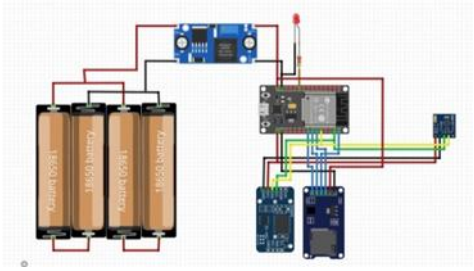

Figure 1. GY271 Schematic

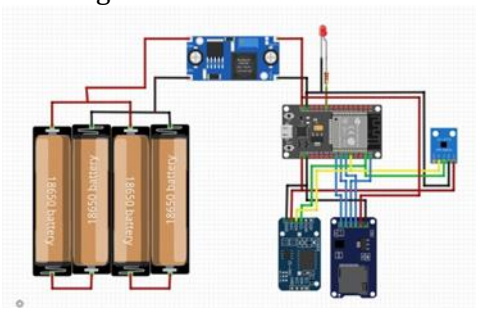

Figure 2. GY273 Schematic

ESP32

ESP32 is A microcontroller the latest designed by *Espressif System*. With merge feature WiFi 2.4 GHz and *Bluetooth* in one chip, which allows application *Internet of Things* (IoT) with easy [16]. ESP32 is often used with the ESP32 DEVKIT V1 development board. Here is an ESP32 that can seen on Figure 3.

Figure 3. ESP32
Source : (https://shorturl.at/lcxUO)

GY271

The GY-271 sensor operates at 3-5V DC and uses I2C interface for data communication. This sensor capable do 3- *axis magnetic field* reading with a measurement range of ±1.3 Gauss and a resolution of up to 5 milligauss. In operation, this sensor use four main pins namely VCC for voltage, GND for ground, and SDA and SCL for data communication. Function This sensor is the main one is measure magnetic field and determine orientation direction, with feature addition in the form of integration accelerometer and gyroscope that allow reading motion in a way simultaneously [17]. The following is the GY271 Sensor shown in Figure 4.

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Figure 4. GY271 sensor
Source : (https://shorturl.at/UIVzE)

GY273

The GY-273 sensor is working magnetometer module measure the earth's magnetic field and determine direction orientation [12]. This sensor module communicate through I2C protocol with four track main, namely Ground (GND) as track grounding, Power Supply Voltage (VCC), Serial Data Line (SDA) and Serial Clock Line (SCL), which facilitates integration with various microcontroller and system electronics. Ability 3-axis reading allows the sensor to detect movement and orientation with precision . Characteristics main sensor covers ability measure acceleration, speed angles, and directions with accuracy high. Here is the GY273 Sensor shown in Figure 5.

Figure 5. GY273 sensor
Source : (https://shorturl.at/DDf1R)

RTC DS3231

RTC (*Real-Time Clock*) is A device hard working for track time in a way *real-time*. RTC is equipped with battery reserve to remain walk although Power main dead. RTC device is used in various applications that require recording accurate time, such as in system computers, IoT devices, and tools electronic others. RTC can also used For arrange time in the process of automation, data logging, and synchronization time between device [18]. Following is the DS3231 RTC shown in Figure 6.

Figure 6. DS3231 RTC Module
Source : (https://shorturl.at/HBwIQ)

Micro SD Card Module

The Micro SD Card module has function main as data storage in digital format. Components This equipped with ability for read and record information on the SD Card storage media. Data communication between module with other devices use Serial Peripheral Interface (SPI) protocol. This module own six pin path consisting of from Ground (GND) as track grounding

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, Power Supply Voltage (VCC), Chip Select (CS), Master Output Slave Input (MOSI) for sending data from master to slave, Master Input Slave Output (MISO) for receive data from slave to master, and Signal Clock (SCK) as data transfer synchronization [19]. The following is the SD Card Module Sensor shown in Figure 7.

Figure 7. SD Card Module
Source : (https://shorturl.at/wQmFk)

1.2. Design System

In system design, it is created with form flowchart. Flowchart is tools used for visualize and understand work processes from tools that have been designed. Flowchart can give channel or system step Work tools that can explained with a systematic and structured way, so that reader can more easy understand stages carried out by the tool. Workflow complete from tool shown in Figure 8.

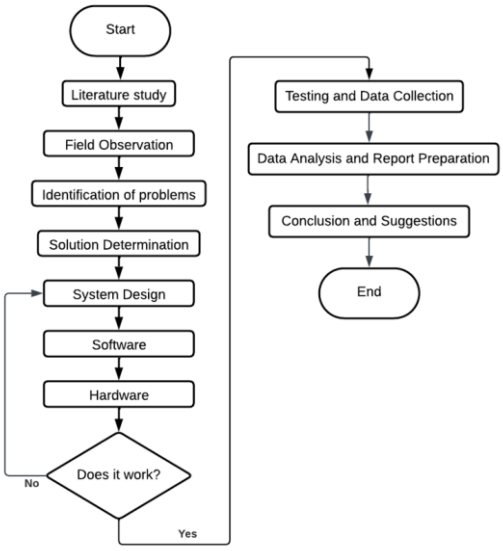

Figure 8. Research Flow Diagram

1.3. Sensor Calibration

Internal sensor calibration study use method linear regression for evaluate performance of the GY271 and GY273 sensors in measure direction current sea. Calibration steps done with record data from the sensor, then compare results measurement with mark reference. Linear relationship between results sensor measurements and values reference stated with form equality the following linear regression this:

$$y = mx + b$$

Where:

- y is mark sensor measurement,
- x is mark reference,
- m is slope which represents sensor sensitivity,
- b is the intercept or offset value.

Calibration results show that mark coefficient determination of R^2 approaching 1, which indicates level compatibility tall between results sensor measurement with mark reference.

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Average accuracy measurement obtained of 97.9% for the GY271 sensor and 98.29% for the GY273. This is show that both sensors have reliable and accurate performance for used in measurement direction current sea, with condition done maintenance and calibration routinely.

RESULTS AND DISCUSSION

The results of the sensor calibration are analyzed use method linear regression for measure connection between sensor data and values reference, while comparison performance both of them tested in a way statistics using ANOVA to determine significance differences in measurement data.

3.1 Sensor Calibration

Based on results calibration of GY271 and GY273 sensors, obtained high accuracy in measurement direction current sea. Calibration done use method linear regression for evaluate conformity between sensor measurement data and mark References. Analysis results regression show mark coefficient determination of R^2 which is close to 1 on both sensors, indicates strong linear relationship.

On Day 1 and 2, both sensors showed results consistent measurement without significant difference in a way statistics (P-value > 0.05). Average accuracy measurements obtained is 97.9% for the GY271 sensor and 98.29% for the GY273 sensor. This is show that both sensors are capable give results reliable and accurate measurements.

In general overall, results calibration prove that Both GY271 and GY273 sensors can reliable in study measurement direction current sea, as long as done routine maintenance and calibration for ensure performance remains optimal. The calibration of the GY271 sensor is shown in Figure 9 a) and b), linear regression in Figure 10, while GY273 in Figure 11 a) and b) and linear regression in Figure 12.

a

No	Kompas manual	Kompas GY271	kalibrasi GY271	Eror	Akurasi
1	30	21	33	9,1	90,9%
2	60	54	63	4,8	95,2%
3	90	87	91	1,1	98,9%
4	120	124	120	0,0	100,0%
5	150	149	146	2,7	97,3%
6	180	174	181	0,6	99,4%
7	210	204	216	2,8	97,2%
8	240	226	241	0,4	99,6%
9	270	264	267	1,1	98,9%
10	300	297	302	0,7	99,3%
11	330	328	332	0,6	99,4%
12	350	348	353	0,8	99,2%
Nilai Rata-Rata					97,9%

b

Figure 9. a) Measurement direction compass Device, b) GY271 measurement results

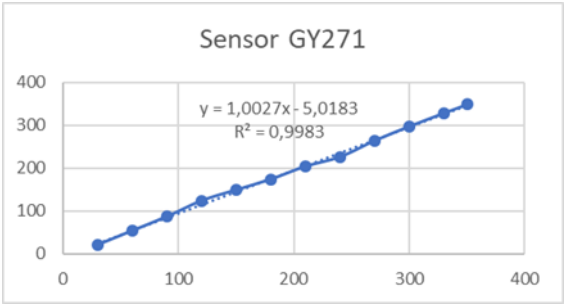

Figure 10. Linear Regression GY271

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No	Kompas Manual	Kompas GY273	Kompas GY273	Error	Akurasi
1	30	26	28	7,1	92,86%
2	60	53	62	3,2	96,77%
3	90	88	90	0,0	100,00%
4	120	114	120	0,0	100,00%
5	150	143	151	0,7	99,34%
6	180	170	184	2,2	97,83%
7	210	204	213	1,4	98,59%
8	240	231	243	1,2	98,77%
9	270	270	274	1,5	98,54%
10	300	301	300	0,0	100,00%
11	330	328	331	0,3	99,70%
12	358	351	348	2,9	97,13%
Nilai Rata-Rata					98,29%

(a) (b)

Figure 11. a) Measurement direction compass Device, b) GY273 measurement results

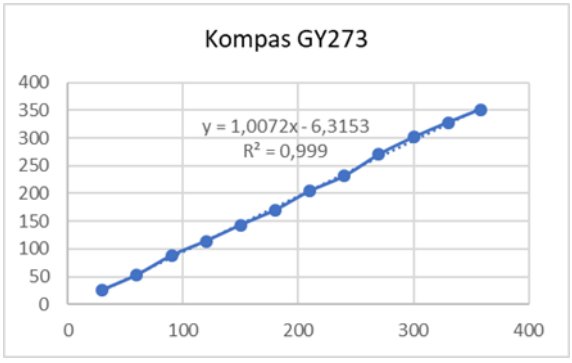

Figure 12. Linear Regression GY273

3.2 GY271 and GY273 Sensor Performance

Table 1 and 2 presents results measurement direction current the sea that is done with using GY271 and GY273 sensors for two days observation. On day 1, data collection was carried out every five minutes, starting from at 13:25 to 15:47. While that on Day 2, data collection took place from at 11:38 to 13:59 with the same interval. Measurement results from both sensors show consistent and interrelated patterns approaching, which reflects reliability in detect movement direction current sea. Even though there is variation small between both sensors, difference the still is at within reasonable tolerance limits.

Table 1. Compass Data Day 1

Compass Data		Day 1	
No	Hours	GY271	GY273
1	13:25	141	142
2	13:30	145	142
3	13:35	149	143
4	13:40	159	155
5	13:45	165	163
6	13:50	176	176
7	13:54	178	177
8	13:59	176	176
9	14:04	176	176
10	14:09	173	170
11	14:14	172	172
12	14:19	172	172
13	14:24	174	169
14	14:29	175	169

Table 2. Compass Data Day 2

Compass Data		Day 2	
No	Hours	GY271	GY273
1	11:38	195	190
2	11:42	194	187
3	11:47	194	187
4	11:52	196	188
5	11:57	196	187
6	12:02	194	185
7	12:07	195	186
8	12:11	195	187
9	12:16	195	186
10	12:21	199	191
11	12:26	197	188
12	12:31	196	188
13	12:36	199	189
14	12:41	195	188

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15	14:34	174	173	15	12:46	196	188
16	14:39	174	172	16	12:51	197	191
17	14:43	180	178	17	12:56	195	186
18	14:48	180	179	18	13:00	195	185
19	14:53	178	179	19	13:05	196	187
20	14:58	178	175	20	13:10	196	188
21	15:03	178	177	21	13:15	198	190
22	15:08	179	176	22	13:20	195	189
23	15:13	177	174	23	13:25	195	189
24	15:18	182	183	24	13:30	197	189
25	15:23	179	179	25	13:35	198	189
26	15:28	179	180	26	13:40	198	188
27	15:32	180	177	27	13:45	199	191
28	15:37	182	184	28	13:50	201	193
29	15:42	183	183	29	13:54	197	190
30	15:47	187	188	30	13:59	198	191

Based on the data that has been collected for two days measurement from both compass sensors (GY271 and GY273), we can to hook results observation with analysis variance (ANOVA) for see whether there is difference significant between the data obtained from both sensors on each day. ANOVA is a technique statistics that can used as comparison more than average from two groups for determine whether there is significant differences. Comparison of current data sea can seen in Figure 13, and the results ANOVA analysis is presented in Table 3.

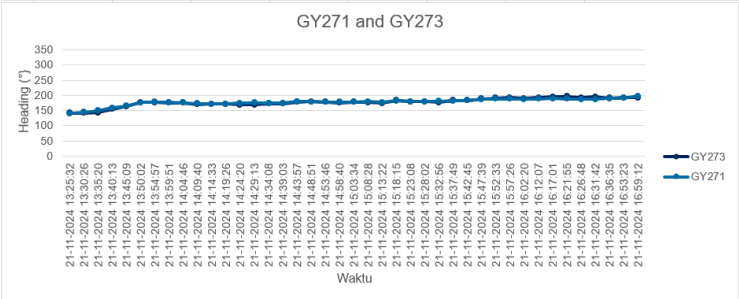

Figure 13. GY271 and GY273 Sensor Line Graph

Table 3. One -Way ANOVA of GY271 and GY273 Sensors Day 1

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
GY271	41	7284,52082	177,671239	143,548644
GY273	41	7278,13251	177,515427	186,429194

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0,49768908	1	0,49768908	0,0030165	0,956337	3,960352

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Within Groups	13199,11358	80	164,9889198
Total	13199,61127	81	

On **day 1**, the data was obtained from both sensors show very consistent results. Reading from GY271 and GY273 are in very similar range. The difference small between both of them can considered as normal fluctuations in sensor reading. Therefore that, based on the ANOVA test, the possibility big no will found difference significant between the data generated by both sensors on the day this. ANOVA results for **Day 1** show **F = 0.0030165** and **P-value = 0.956337**, indicating that mark more big from 0.05. So from That there is difference between GY271 and GY273 which is not significant in a way statistics. Both sensors are working with good day first and can used for measurement direction current sea. Comparison of current data sea during day second shown in Figure 14 and Table 4.

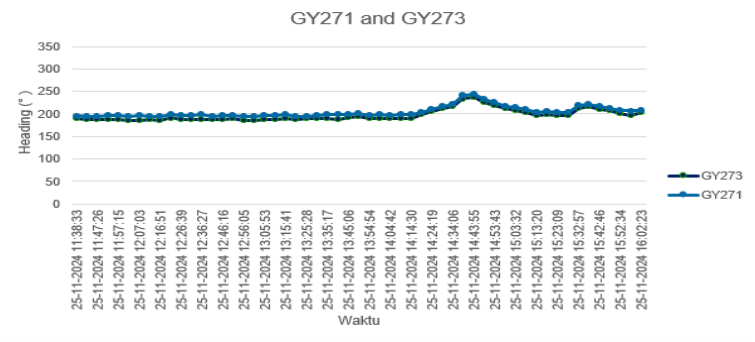

Figure 14. GY271 and GY273 Sensor Line Chart Day 2

Table 4. One -Way ANOVA of GY271 and GY273 Sensors Day 2

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
GY271	55	11225,70016	204,1036393	141,1701758
GY273	55	10823,65504	196,7937285	162,1873945

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1469,457077	1	1469,457077	9,687953896	0,002374	3,929012
Within Groups	16381,30883	108	151,6787831			
Total	17850,76587	109				

On **Day 2**, the data was obtained from both sensors show consistent and stable results. Although Still There is difference small, the difference no significant. Data from both sensors look very similar throughout days, and fluctuations direction Still is at within reasonable tolerance limits. Based on results **ANOVA for Day 2**, which shows **F = 9.687953896** and **P-value = 0.002374011**, where value < 0.05, we can conclude that existence difference significant between the data generated by the two sensors. However, because This P- value Enough small, this show that although There is difference significant in a way statistics, the difference still Enough small and maybe is at in normal tolerance for use of sensors.

CONCLUSION

Based on the analysis of ocean current measurement data using GY271 and GY273 sensors for three days, it can be concluded that both sensors have good accuracy and reliability in local water conditions. On Day 1 and 2 , both sensors showed consistent results with no significant difference (P- value > 0.05), indicating optimal performance. Then , on Day 2 , although there was a significant difference (P- value < 0.05), minor factors such as sensor sensitivity or calibration may affect it. Overall, both sensors can be used effectively for ocean current measurement, provided that proper maintenance and calibration are carried out.

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