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Development of IoT-based Automatic Water Drainage System on Fishing Boat to Improve Operational Efficiency

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Abstract

The profession of fishermen requires a reliable system to remove stagnant water from fishing boats, as manual drainage is time-consuming and inefficient. This study proposes an IoT-based automatic water drainage system without using an inverter or ultrasonic sensor, offering a cost-effective alternative. The system utilizes a water level sensor and a DC water pump, controlled via a smartphone application. The research model used is the Research and Development (R&D) model, through several stages, namely potential and problems, initial data needs, prototype creation, prototype validation, prototype revision, validation, implementation. Problems occur at the prototype stage, problems that must be revised include aspects of wiring, Power Suitability, Water Level Sensor Test, and the configuration of the relay used. The IOT-based automatic water drainage system can function based on the results of white-box testing including Hardware Implementation, Software Implementation, Implementation of Application Usage, and Automatic Drainage System Testing. This is indicated by the results of the Liquid Water Level Sensor Functionality test, DC Water Pump Functionality Test, Solar Panel and Battery Functionality Test, and IOT Functionality Test. IOT-based automatic water discharge systems on fishing boats are more efficient and cost-effective in the long run, although diesel engines offer more reliability under adverse weather conditions or in places with limited access to sunlight.

Keywords: automatic; inverter; IOT; system; sensor

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1. Introduction

The Riau Islands Province, consisting of a variety of large and small islands, is part of the archipelago of Indonesia. With a strategic geographical location on major maritime and aeronautical transportation routes, the province offers important accessibility. As part of the island of Sumatra, the Riau Islands are divided into five regencies, namely Bintan, Karimun, Lingga, Natuna, and two cities, Batam and Tanjungpinang, all of which contribute to the diversity and richness of this region.

Mantang Besar Village is one of the villages located on Mantang Island, Bintan Regency. This village covers several areas, such as Selat Limau, Tanjung Mamboi, Pulau Sirai, Telang Kecil, and Telang Besar. The majority of people in Mantang Besar Village work as fishermen, making fishing activities the main economic sector. As a coastal area, Mantang Besar Village has great potential in the fisheries sector. This is in accordance with the program initiated by the Village regarding the empowerment of sovereign communities in the marine and fisheries sector.

Based on the program that was initiated, important things is the need for transportation, namely the fishing boat. The profession of fishermen requires a means of transportation to support sailing to catch fish. Then, what often becomes a problem is the stagnant water on the fishing boat. This happens when there is no fishing activity, or the boat is on the mooring. On the other hand, the water suction machine does not turn on automatically. So fishermen need to check regularly and drain the water by turning on the water pump machine manually or draining the water using a dipper.

One solution that can be used is to implement an automatic disposal system based on the Internet of Things (IoT) [1]–[3]. The Internet of Things (IoT) is a concept where various sensored devices are connected to each other via the internet to collect and transfer data [4], [5]. IoT can make everyday life easier, reduce operational costs, provide data insight, and provide customer experience [6]. This solution can certainly make it easier for fishermen to carry out their activities because the time wasted on disposing of water can be used for other productive activities.

Since such a system will be used in all conditions, the automatic water drainage system that is to be designed must have at least several basic aspects, one of which is reliability. In other previous studies, automatic water drainage systems were designed using inverters and ultrasonic sensors [7]. The use of water level in automatic water drainage systems is based on considerations from several aspects, namely in terms of price efficiency, power consumption, accuracy, and scale of use. In terms of price, ultrasonic sensors are generally more expensive than water level sensors. Then, in terms of power consumption, ultrasonic sensors require lower power even when used on a large scale [8]. On the other hand, water level sensors have shortcomings in terms of accuracy when compared to ultrasonic sensors [9]. Because the scale of use is still within a small scope, the use of water level sensors is more optimal because these sensors are suitable for simple applications where a high level of accuracy is not required. This is different from ultrasonic sensors where the scope of use will be more efficient if used in a wider area, for example to measure water levels in water channels [10]. This automatic water drainage system is made for fishermen who of course have to consider the economic side and the scope of use. Therefore, the use of water level sensors is certainly more efficient when compared to ultrasonic sensors.

This raises the question of what if the automatic water drainage system is designed without using an inverter, and the sensor uses an automatic water level sensor, in order to cut manufacturing costs while maintaining the performance of the tool to be designed. Based on the problems that have been explained. Researchers need to develop a cheaper automatic water disposal system, of course with reliable performance. Not only that, this system is also designed so that fishermen in Mantang Village can control it by just looking at their smartphones. From a research perspective, the implementation of this technology opens up opportunities to study the integration of IoT and renewable energy in the traditional fisheries sector. Data generated by IoT devices, such as system usage patterns or weather conditions that affect them, can be used to develop similar technologies in other sectors. In addition, this supports sustainability and environmental protection efforts, where research results can contribute to increasing energy efficiency and reducing carbon emissions in the long term.

2. Methods

The research methods and research techniques used describe concisely but stay specific, such as size, volume, replication, and processing techniques. For the new method, it has to be explained in detail so that other researchers can reproduce the experiment. However, the established method can be explained by selecting references.

The research model is adapted from the Research and Development (R&D) model [11]. Meanwhile, the Research and Development to be conducted by researchers is adjusted to the research needs. The Research and Development scheme includes: 1) potential and problems; 2) initial data needs; 3) prototype creation; 4) prototype validation; 5) prototype revision; 6) Prototype recheck 7) validation; 8) implementation. Figure 1 shows the flowchart of the product development process of an automatic water drainage system for pumps.

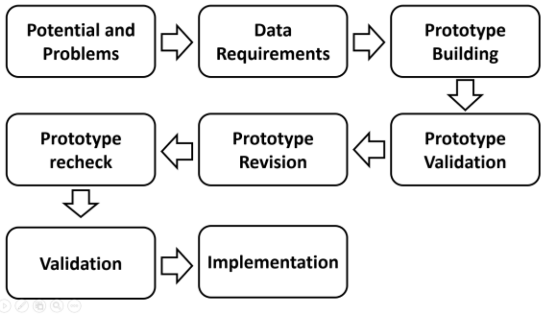

Figure 1. The Research and Development research model that will be planned

2.1 Potential and Problems

Researchers aim to design an IoT-based automatic water drainage system that operates efficiently without the need for an inverter. By eliminating the inverter, the system can potentially reduce energy consumption and simplify its overall structure, making it more cost-effective and accessible for various applications. This approach seeks to enhance the effectiveness of water drainage mechanisms while maintaining a straightforward design that relies on direct power sources.

Additionally, the researchers are committed to retaining the ultrasonic sensor instead of replacing it with a liquid water level sensor. The ultrasonic sensor offers precise distance measurements and can detect water levels without physical contact, ensuring durability and reliability in different environmental conditions. This choice reflects a strategic decision to maintain accuracy in water level detection while optimizing system performance for practical and sustainable use.

2.2 Initial Data Requirements

The initial data collection process involves conducting surveys and observations to assess the condition of a fishing boat in Mantang Besar Village. This boat will serve as a pilot project for the development of an automatic water drainage system. The gathered data will be essential in understanding the boat's physical structure and operational requirements.

Key aspects of the data collection include capturing images of various parts of the boat, such as the front, side, and rear views, as well as the fishing compartment or bulkhead. Additionally, photographs will be taken of the top of the engine house and the interior of the engine house. This comprehensive dataset will serve as the foundation for designing and developing a prototype of the automatic water drainage system, ensuring it is tailored to the specific needs of the fishing vessel.

2.3. Prototype Building

The method used in software development is the Scrum method [12]. At the prototyping stage, it begins with creating a design concept to facilitate the assembly process. At this stage, the researcher also conducted a survey of the needs of what tools will be used to create a prototype of an automatic water drainage system. The automatic water drainage system is designed without using an inverter and ultrasonic sensor. An inverter is not needed in this design because the water pump used is a DC current type, where a pump with this model is a pump that is energy efficient [13]. This is different from the type of pump with an AC type, where the power consumption required is greater. Then, the sensor implemented does not use an ultrasonic sensor type, but uses an automatic water level sensor. In addition, to control the sensor and smartphone, at least a dual core chip is needed. Therefore, ESP32 was chosen to accommodate this task [14].

Figure 2 shows a block diagram for an Automatic Water Drainage System on Fishing Boats using Solar Power based on the Internet of Things.

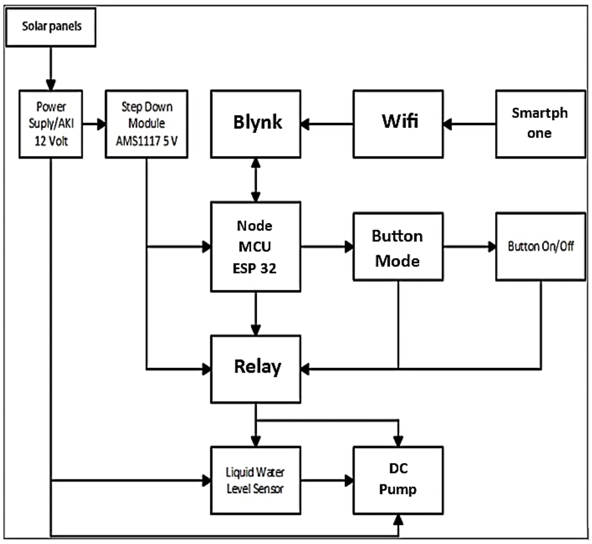

Figure 2. Block Diagram of Automatic Water Drainage System on fishing Ship Based on Internet of Things

The automatic water drainage system on a fishing boat utilizes solar power and is based on the Internet of Things (IoT). Users interact with the system through a smartphone using the Blynk application, which is connected to a Wi-Fi network. The application communicates with the NodeMCU ESP32, a microcontroller that serves as the central processing and control unit. Users can choose between Automatic and Manual operation modes using the Button Mode feature. In Automatic Mode, the system activates a relay that connects to a Liquid Water Level Sensor and a DC pump, enabling automatic control of the pump based on water levels. Meanwhile, in Manual Mode, users manually control the pump through an On/Off button, which then activates the relay and the DC pump.

2.4 Expert Validation

Validation was conducted by four experts. Several aspects and indicators that will be assessed in this study are explained in Table 1.

Table 1. Software and supporting hardware

No	Aspect	Indicator
1.	Cabling	1. Cut the cable as needed by taking into account the maximum cable length standards. 2. Install the connector on the cable according to the standard color sequence.
2.	Power Compliance Test (I/O)	1. Optimal energy input 2. Test battery life during operation 3. Stability of energy released during operation
3.	Water Level Sensor Test	The sensor can tell the control panel to turn the water pump on or off accurately.
4.	Automation system performance	1. The system is able to respond to changes in water conditions. 2. The system can take appropriate action based on sensor data
5.	Safety	The installation of the system on the fishing ship does not endanger the ship's crew in terms of electricity.
6.	Reliability	The system can operate consistently over a period of time.
7.	Pump capacity	The pump capacity is sufficient to drain water quickly.
8.	IOT functionality	1. The system's ability to connect to other devices via a network 2. Have adequate security mechanisms to protect data and prevent unauthorized access. 3. The system is able to collect, store and manage data well. 4. The system must allow remote monitoring and control.

2.5 Implementation

The final product will be implemented on the fishing boat by considering several aspects, namely wiring, power suitability test (I/O), water level sensor test, automation system performance, safety, reliability, pump capacity, and IOT functionality. The implementation of the automatic water drainage system on the fishing boat goes through two stages, namely the installation stage, then the testing stage. At the installation stage, fishermen will be assisted on how to install the product on the fishing boat. Then, the final product testing is carried out to see the performance of the automatic water drainage system without an inverter and ultrasonic sensors experiencing a good level of consistency and reliability.

Before that, it is necessary to test the water pump that functions to pump water out of the ship when activated by the relay and Liquid Level Controller Sensor. This connection is connected via input from the NO Pin on Relay 2 and the NC Pin on the Liquid Level Controller Sensor to the (+) Cable from the DC Pump and Input from the (-) battery cable to the (-) Cable from the DC Pump. This test is carried out before installation on the fishing ship to ensure the pump is functioning properly.

The DC pumps used in this system are described in Table 2.

Table 2. Pump Specifications

DC 12-Volt water pump		
No	Specification	Information
1	Voltage	12 Volt
2	Motor Speed	Max 8500 rpm
3	Motor Current	0.1 Ampere
4	Water flow	12 Litre/Minute
5	Output Diameter	16 mm

After installation is complete, the device will be tested for four weeks to record system reliability and resilience in percentages, as well as total operational time in hours, number of restarts required, and recorded outages. This data is further analyzed using statistical methods such as averages, to see long-term trends and system performance.

Based on the test data obtained, researchers will record in general how the reliability and functionality of the pump after testing for one month. These notes are used to see the advantages and disadvantages which will then be used as evaluation material.

3. Results and Discussions

3.1 Potential and problems

Based on an interview with one of the fishermen, it was found that the manual process of waste water disposal using a pump presents several challenges. The manual method requires more time and effort compared to an automated system. Additionally, relying on human labor for pump operation can be exhausting and inefficient, as it demands continuous monitoring and physical intervention. These difficulties often hinder fishermen from effectively managing their workload and optimizing their time for other essential tasks.

To address these challenges, the introduction of an Automatic Waste Water Pump Control System, particularly one powered by solar energy, is expected to significantly improve efficiency. This system enables automatic pump operation, reducing the dependence on manual labor while ensuring a more streamlined and hassle-free process. With automatic control in place, fishermen can focus on their primary fishing activities without being burdened by the repetitive task of wastewater disposal.

3.2 Initial Data Requirements

Initial data is data collected through a survey and observation process regarding the condition of the fishing ship in Mantang Besar Village, which will be used as a pilot project for the implementation of an automatic water drainage system. Initial data on the fishing ship that was collected includes physical data of the ship in the form of images from the front, side, rear, fishing compartment or bulkhead on the fishing, the top of the fishing engine house, and the inside of the engine house. This data will be used as the basis for designing a prototype of an automatic water drainage system. The physical data of fishing vessels that have been collected are presented in Table 3.

Table 3. Fishing physical data

No	Data	Documentation	Information
1	View from the front		
2	View from the side		
3	View from behind		
4	Fishing boat plot or partition		Fishing boat Plots or Partitions on boat (Height between 30 – 40 cm) a. Location of planned sensor placement for water discharge detection b. Location of placement of 12V DC Pump
5	Top of the pump machine house		Top of the Pump Machine House c. Location of Solar Panel Placement d. Location of 12V Battery Placement
6	Inside the engine house		Inside the Engine House e. Placement Location of Panel Box for Solar Charge Controller and other Equipment

3.3 Prototype Building

Figure 3 is a picture of the architecture of the automatic water drainage system on the IoT-based fisherman's pump and solar power as a whole system. The image shows the integration of various hardware components such as sensors, microcontrollers, communication modules, and electrical energy sources from solar panels. Through the hardware design visualized in the image, it is expected to help identify the needs and technical specifications needed to build a comprehensive system prototype, ensuring that all elements work harmoniously to achieve the desired goals. The design of an IoT-based automatic water drainage system for fishing pumps is presented in Figure 3.

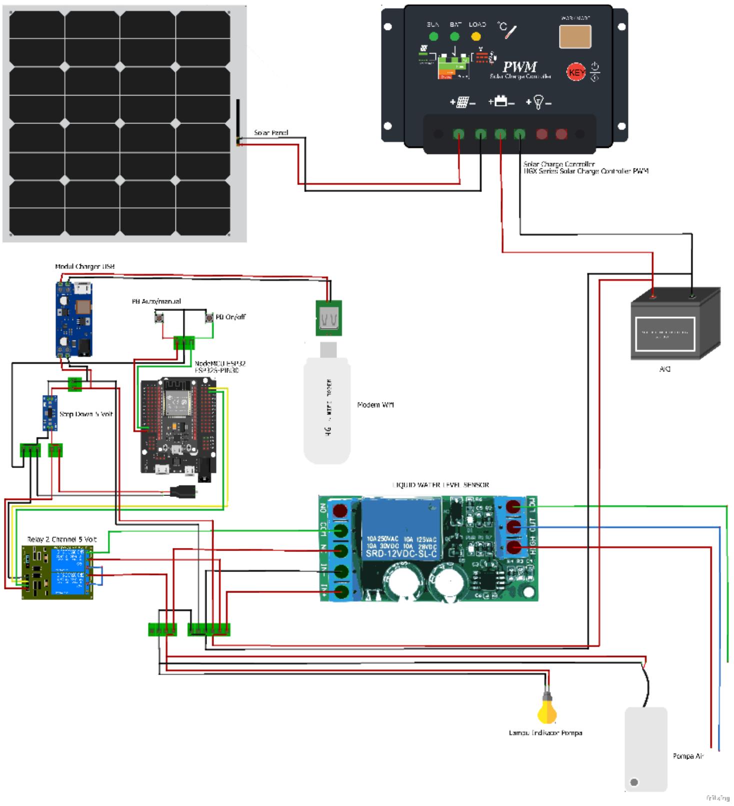

Figure 3. Design of an IoT-based automatic water drainage system for fishermen's pumps

Based on Figure 3, the block diagram of the automatic water drainage system on fishing boats using solar power based on the Internet of Things (IoT) begins with the user operating a smartphone that connects to the Blynk application, which must first be linked to a WiFi network. Through this application, the smartphone communicates with the NodeMCU ESP32 microcontroller, which acts as the main processing and control unit of the entire system. This microcontroller receives input from the application and coordinates the system's responses accordingly.

Once connected, the user can select the desired operating mode by choosing the Button Mode within the Blynk interface. In Automatic Mode, the system activates a relay connected to both a liquid water level sensor and a DC pump, allowing the pump to automatically turn on or off based on the sensor's input. In contrast, when Manual Mode is selected, the user directly controls the system through an On/Off button, which sends signals to the relay and DC pump, enabling manual operation of the pump.

Based on the architectural description of the automatic water drainage system, a prototype can be made which will then be validated by experts. The manufacturing process and form of the prototype are presented in Figure 4.

Figure 4. Prototype building process

3.4 Expert Validation

The first validation by experts was carried out by considering several aspects, including Cabling [15], Power Suitability Test (I/O) [16], Water Level Sensor Test [17], Automation System Performance [18], Safety, Reliability [19], Pump Capacity [20], and IOT Functionality [21]. The validation results are shown in Table 4.

Table 4. Expert Validation Results

No	Aspect	Case	Recommendations /Feedback
1.	Cabling	There is an error in installing the cable on the connector pin, which can cause an electrical short.	Correct the procedure for installing cables on connector pins by paying attention to the length of the cable strip and matching the cable to the pin.
2.	Power Compliance Test (I/O)	5 volt input is unstable	Step Down DC 5 volt AMS 1017 is needed to stabilize the 5v electric current.
3.	Water Level Sensor Test	-	Sensors need adjustment when implemented on pumps
4.	Automation system performance	The automation system does not work due to the use of separate relays, 1 relay per channel connected to each device.	Using 1 relay 2 channels
5.	Safety	-	-
6.	Reliability	-	The use of ESP32 can accommodate manual and automatic defecation operations.
7.	Pump capacity	-	A pump with a 12 volt specification is sufficient to accommodate water discharge at a speed with an average water discharge of 11.92 liters/minute in five tests.
8.	IOT functionality	The wifi modem is not working, caused by an unstable 5 volt input	AMS1017 5 volt DC stepdown is needed to stabilize the 5v electric current.

3.5 Implementation and Testing

System implementation on fishing ship stage includes The implementation of the IoT-based automatic water drainage system on a fishing ship involves testing and integrating both hardware and software to ensure proper function in real conditions. The system uses a 12-volt DC pump motor powered by a solar-charged battery to help fishermen automatically remove bilge water and reduce manual work. The implementation includes testing the pump motor, setting up the NodeMCU ESP32 microcontroller, configuring the Blynk application, and verifying both automatic and manual drainage modes. The following sections explain the results and processes of the hardware and software setup, application usage, and drainage system testing.

The integration process includes several key steps, such as testing the pump motor to confirm its operational reliability, setting up the NodeMCU ESP32 microcontroller as the central control unit, and configuring the Blynk application for seamless user interaction. Furthermore, both automatic and manual drainage modes are verified to ensure the system's adaptability to different scenarios. The following sections provide a detailed explanation of the results, covering the hardware and software setup, application usage, and testing procedures of the drainage system.

several important aspects. Hardware implementation, which involves installing and configuring the physical components needed to run the system. Then, device chain implementation, which refers to the arrangement and configuration of various devices so that they can work in an integrated manner. Followed by software implementation, which includes the installation, configuration, and testing of programs that support the system's functions. This stage is very important because the implemented software must be able to function properly with the hardware that has been installed previously.

Following the hardware setup, software implementation is carried out, which includes the installation, configuration, and rigorous testing of the programs that support the system's operation. The software must be optimized to interact smoothly with the previously installed hardware, ensuring that all automated and manual functions perform as expected. This stage is critical as it ensures that the system operates reliably under real-world conditions, providing fishermen with an efficient solution for water drainage management.

The 12 Volt DC Water Pump Speed Test Dataset used is presented in Table 5.

Table 5. 12 volt DC pump motor test results

No	Testing stage	Water Flow Liter/Minute
1	Testing stage 1	11.7
2	Testing stage 2	11.8
3	Testing stage -3	12.4
4	Testing stage 4	11.8
5	Testing stage 5	12.1

Based on the results from the 12-volt DC water pump speed test dataset, it can be concluded that the actual water discharge rate measured during the trials closely aligns with the pump's specified capacity of 12 liters per minute. Although the average output was consistent with expectations, minor fluctuations were observed throughout the testing process. These variations are considered normal and can be attributed to several possible factors. Small leaks in the piping or connection joints could slightly reduce the effective water flow, while inaccuracies in measurement tools or techniques might introduce some error in the recorded values. Additionally, the performance of the pump may gradually decline due to wear and tear, especially if used continuously over long periods. Obstructions or buildup inside the hoses or pump inlet could also temporarily affect the discharge rate. Despite these minor discrepancies, the pump's performance remains within acceptable operational limits for use on the fishing vessel.

Overall, this DC water pump can be considered to function according to the pump manufacturer's specifications taking into account reasonable variations in water discharge measurements. The thing that needs to be highlighted based on the five tests is the better average water discharge of 11.96 liters/minute. While during expert validation, the average water discharge was only 11.92 liters/minute. This variation cannot be identified directly. However, the factors that cause this can be identified by looking at several previous studies. It is said that one of the causes of inconsistent water discharge coming out through the pump is the influence of the current flowing from the battery to the device [22].

This section will explain the hardware implemented based on the analysis and design that has been done to achieve the research objectives. The following is a list of hardware implemented, including Solar Panel, Accumulator/Battery, Solar Charger Controller, NodeMCU ESP32 Microcontroller, 2 Channel 5 V Relay, Push Button, Liquid Level Controller Sensor, AMS1117 5V Step Down Module, 12 Volt DC Water Pump, USB Charge Module, Wifi Modem, and DC Pilot Lamp. After all devices are properly installed and in good condition. Then conduct initial testing to ensure the system can function as a whole in accordance with the system design so that the system can operate smoothly and integrated between the hardware components. The implementation of the overall hardware circuit in the automatic air exhaust system on the pump is presented in Figure 5.

Figure 5. Implementation of the Overall Hardware Circuit in the Automatic Water Drainage System at the Pump

On the software side, this automatic water drainage system requires a program that is able to integrate all hardware components to create a system that works effectively and efficiently. This program is designed so that fishermen can monitor and control the system remotely via an Internet of Things (IoT) connection [23]. The implementation of this software involves coding that is entered into the NodeMCU ESP32 microcontroller, which functions as the main brain of the system. The NodeMCU ESP32 is responsible for controlling all operations, including activating and deactivating the pump based on data received from the Liquid Level Controller Sensor [24]. The coding process is carried out using the Arduino IDE, which allows for efficient integration and testing. Arduino IDE for coding NodeMCU ESP32 is presented in Figure 6.

Figure 6. Arduino Coding for NodeMCU ESP32

Here is an example of the implementation of the use of the blynk application when selecting automatic or manual operating modes. When operating the system, the user can choose between automatic mode or manual mode. In automatic mode, the system will work independently based on sensor input and control logic to drain water efficiently. Operation on an Android phone is presented in Figure 7.

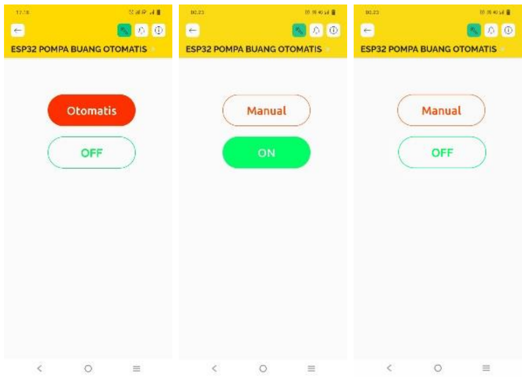

Figure 7. Operation on Android phones

From the implementation of the entire system that produces an Automatic Water Drainage System Series, it is necessary to carry out testing to ensure whether the implemented system has the reliability to drain water as expected.

The liquid water level sensor functionality testing was carried out to ensure the sensor accurately detects both high and low water levels and responds accordingly by sending signals to the system. As shown in Table 6, the test was conducted under the condition that the system was powered on. In the first step, water was added to the fishing vessel until it reached the high-level sensor. The sensor successfully detected the high water level and sent a signal to the system, confirming its functionality. In the second step, water was released from the pump until it reached the low-level sensor. The sensor also correctly detected the low water level and sent a corresponding signal to the system. Both test scenarios were validated and confirmed to be functioning as expected, indicating that the sensor can reliably monitor water levels for automatic drainage control.

Table 6. Liquid Water Level Sensor Functionality Test Results

Pre-Conditions	Testing steps	Test Results	Valid
System On	Put water into the fishing until it touches the high level sensor	The sensor detects high water levels and sends a signal to the system.	[√]
System On	Release water from the pump until it touches the low level sensor.	The sensor detects low water level and sends a signal to the system.	[√]

The DC water pump functionality test was conducted to verify the system's ability to control the pump's operation based on received signals. As presented in Table 7, the test involved two key conditions. First, when the system was turned on, a signal was sent to activate the pump. The pump responded by turning on and successfully pumping water, indicating proper function. Second, while the pump was active, a signal was sent to deactivate it. The pump promptly stopped operating, demonstrating its ability to respond accurately to control commands. Both test scenarios were validated, confirming that the DC water pump operates reliably in accordance with system instructions.

Table 7. DC Water Pump Functionality Test Results

Pre-Conditions	Testing steps	Test Results	Valid
System On	Gives a signal to activate the water pump	The water pump turns on and pumps water.	[√]
Water pump active	Gives a signal to turn off the water pump	Water pump stops working	[√]

The solar panel and battery functionality testing was conducted to verify the reliability of the power supply system, ensuring it can operate both during sunlight exposure and in the absence of direct solar energy. As shown in Table 8, the first test was carried out by exposing the solar panels to sunlight while the system was on. The result showed that the solar panels successfully generated electrical energy and charged the batteries, confirming their proper function. In the second test, after the battery was fully charged, the power supply from the solar panel was disconnected. The system then automatically switched to using the battery as the power source. Both test scenarios were validated, demonstrating that the system can effectively manage its energy supply, making it suitable for continuous use on a fishing vessel regardless of weather conditions.

Table 8. Solar Panel and Battery Functionality Test Results

Pre-Conditions	Testing steps	Test Results	Valid
System On	Exposing solar panels to sunlight	Solar panels generate electrical energy and charge batteries.	[√]
System is on, battery is fully charged	Disconnecting the power from the solar panel	The system switches to using the battery as a power source.	[√]

The Internet of Things (IoT) functionality testing was conducted to evaluate the responsiveness and operational reliability of the system when accessed remotely through the Blynk mobile application. As shown in Table 9, the system was first connected to a WiFi network, and the Blynk app was successfully opened on a mobile device, displaying the current system status. The user could switch between "Manual" and "Automatic" modes, and the water pump responded accordingly by turning on and off based on the selected mode. Additionally, when the "On" button was pressed, the water pump activated and discharged water, while pressing the "Off" button caused the pump to stop working. All test steps were validated, confirming that the IoT integration enables effective and reliable remote control of the water drainage system.

The monthly device testing was conducted to monitor the performance and stability of the system over an extended period. As shown in Table 10, the system was operated continuously for four weeks at a constant voltage of 12 volts. In Week 1 and Week 2, the device operated for 168 and 336 hours respectively, with no restarts or recorded disturbances, indicating stable performance during the initial phase. However, in Week 3, the system operated for 504 hours but experienced 2 restarts and recorded 1 disturbance, suggesting early signs of system stress or environmental interference. By Week 4, after 672 hours of operation, the system encountered 4 restarts and 4 recorded disturbances. This progression highlights the importance of regular system monitoring and maintenance to ensure long-term reliability, especially in field applications such as fishing vessels.

Table 9. Internet of Things Functionality Test Results

Pre-Conditions	Testing steps	Test Results	Valid
The system is connected to a WiFi network	Opening the Blynk app on a mobile device	The application opens and displays the system status.	[√]
Blynk app opens	Press the "Manual or Automatic" button	The water pump turns on and off according to the selected mode	[√]
Blynk app opens	Press the "On" button	The water pump turns on and discharges water.	[√]
Blynk app opens	Press the "Off" button	Water pump stops working	[√]

Table 10. Device Test for a month

Testing Time	Power (volts)	Operating time (hours)	Number of Restarts	Recorded Disturbance
Week 1	12	168	-	-
Week 2	12	336	-	-
Week 3	12	504	2	1
Week 4	12	672	4	4

Based on the results of the four-week trial, the automatic air exhaust system can be said to have quite good noise. In the two weeks of testing, the system can work without interruption and without restarting. However, in the 3rd week, the system began to experience damage to the Switch on/off button. The cause of the damage was due to corrosion. In the 4th week, the system began to experience a decrease in performance which caused the power supply distributed by the battery to weaken. It was identified that the rainy season that occurred caused the energy storage capacity absorbed by the solar panel to the battery to decrease.

This problem may be resolved if the power flow from the battery to the system can be set to be more efficient. [25]. One of the limitations of this study is the absence of power measurements so that it is not identified whether the power flow in the system is efficient or still experiencing power waste. Overcoming the problem of power flow in the system becomes important during the rainy season, solar panels experience a decrease in power input, the battery still has energy reserves to supply power to the system. Other studies state that real-time control using IOT can optimize the power supply to devices [26].

4. Conclusions

Problems occur at the prototype stage and must be revised to include aspects of wiring, Power Suitability, Water Level Sensor Testing, and the configuration of the relay used. At the Implementation stage, the designed automatic water-drainage system exhibited good performance and reliability. This is indicated by the results of the Liquid Water Level Sensor Functionality test, DC Water Pump Functionality Test, Solar Panel and Battery Functionality Test, and IOT Functionality Test.

This research has a weakness, namely the absence of control on the power supply in the automatic water drainage system that has been developed. Therefore, it is not clear whether the power provided is efficient. This is important considering that this device is required to be able to work under any condition, especially during the rainy season, so that control of the power supply must be monitored. In future research, it is hoped that there will be in-depth power output testing so that the development of this device can perform much better.

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References

[1] M. U. Sohag and A. K. Podder, “Smart garbage management system for a sustainable urban life: An IoT based application,” *Internet of Things (Netherlands)*, vol. 11, p. 100255, 2020, doi: 10.1016/j.iot.2020.100255.

[2] J. Li and H. He, “Design of rice intelligent water-saving irrigation system based on agricultural internet of things,” *J. Phys. Conf. Ser.*, vol. 1176, p. 052068, Mar. 2019, doi: 10.1088/1742-6596/1176/5/052068.

[3] B. B. Sharma and N. Kumar, “IoT-Based Intelligent Irrigation System for Paddy Crop Using an Internet-Controlled Water Pump,” *Int. J. Agric. Environ. Inf. Syst.*, vol. 12, no. 1, pp. 21–36, Jan. 2021, doi: 10.4018/IJAEIS.20210101.oa2.

[4] H. Kopetz and W. Steiner, “Internet of Things,” in *Real-Time Systems*, Cham: Springer International Publishing, 2022, pp. 325–341. doi: 10.1007/978-3-031-11992-7_13.

[5] Y. Perwej, K. Haq, F. Parwej, and M. M., “The Internet of Things (IoT) and its Application Domains,” *Int. J. Comput. Appl.*, vol. 182, no. 49, pp. 36–49, 2019, doi: 10.5120/ijca2019918763.

[6] Dwi Nurul Huda, T. Adyatma, and Z. Zulfachmi, “Pengembangan Aplikasi E-Money Dengan Pemanfaatan Payment Gateway Berbasis Android (Studi Kasus Sekolah Tinggi Teknologi Indonesia Tanjungpinang),” *J. Bangkit Indones.*, vol. 11, no. 2, pp. 28–36, Oct. 2022, doi: 10.52771/bangkitindonesia.v11i2.212.

[7] T. Ch. Singh, K. Srinivas Rao, P. Srinath Rajesh, and G. R. K. D. Satya Prasad, “Waste water-based pico-hydro power for automatic street light control through IOT-based sensors in smart cities: A pecuniary assessment,” in *Artificial Intelligence and Machine Learning in Smart City Planning*, Elsevier, 2023, pp. 87–99. doi: 10.1016/B978-0-323-99503-0.00010-7.

[8] S. Kang, D. S. K. David, M. Yang, Y. C. Yu, and S. Ham, “Energy-efficient ultrasonic water level detection system with dual-target monitoring,” *Sensors*, vol. 21, no. 6, pp. 4–6, 2021, doi: 10.3390/s21062241.

[9] R. Tawalbeh, F. Alasali, Z. Ghanem, M. Alghazzawi, A. Abu-Raideh, and W. Holderbaum, “Innovative Characterization and Comparative Analysis of Water Level Sensors for Enhanced Early Detection and Warning of Floods,” *J. Low Power Electron. Appl.*, vol. 13, no. 2, 2023, doi: 10.3390/jlpea13020026.

[10] T. S. R. Pereira, T. P. de Carvalho, T. A. Mendes, and K. T. M. Formiga, “Evaluation of Water Level in Flowing Channels Using Ultrasonic Sensors,” *Sustain.*, vol. 14, no. 9, pp. 1–20, 2022, doi: 10.3390/su14095512.

[11] Sugiono, *Metode penelitian dan pengembangan (research and development/R&D)*, 4th ed. Bandung: Alfabeta, 2019.

[12] D. Asri Yana Vita, R. Raihan, and Z. Zulfachmi, “Implementasi Metode Scrum pada Transformasi Bisnis Lokal UMKM Tanjungpinang,” *J. Bangkit Indones.*, vol. 12, no. 2, pp. 46–52, Oct. 2023, doi: 10.52771/bangkitindonesia.v12i2.249.

[13] F. I. Pasaribu, N. Evalina, and P. Harahap, “Inverator Starting Energy Saver Design For Electric Power Efficiency In Water Pumps,” *J. Electr. Technol. UMY*, vol. 5, no. 1, p. PRESS, Jul. 2021, doi: 10.18196/jet.v5i1.12096.

[14] Zulfachmi, Wanhendra, and D. Saputra, “Sistem Pengendali Otomatis Debit Air Pada Simulasi Bendungan Menggunakan Mikrokontroler Atmega 32 Dan Komunikasi Serial,” *J. Bangkit Indones.*, vol. 9, no. 1, pp. 13–17, Mar. 2020, doi: 10.52771/bangkitindonesia.v9i1.111.

[15] M. MOLENDA and D. PŁONKA, “Application of the indicator analysis to assess and improve the quality of the assembly process of telecommunications installations – a case study,” *Sci. Pap. Silesian Univ. Technol. – Organ. Manag. Ser.*, vol. 2020, no. 148, pp. 511–523, 2020, doi: 10.29119/1641-3466.2020.148.37.

[16] B. A. Bhayo, H. H. Al-Kayiem, and S. I. Gilani, “Assessment of standalone solar PV-Battery system for electricity generation and utilization of excess power for water pumping,” *Sol. Energy*, vol. 194, pp. 766–776, Dec. 2019, doi: 10.1016/j.solener.2019.11.026.

[17] L. Schenato, J. P. Aguilar-Lopez, A. Galtarossa, A. Pasuto,

T. Bogaard, and L. Palmieri, “A Rugged FBG-Based Pressure Sensor for Water Level Monitoring in Dikes,” *IEEE Sens. J.*, vol. 21, no. 12, pp. 13263–13271, Jun. 2021, doi: 10.1109/JSEN.2021.3067516.

[18] Q. Li, D. H. Wu, D. Z. Yang, M. H. Fei, Y. Song, and Y. Liu, “Design and Realization of Fully Automatic Pump Performance Test System,” *Int. J. Eng. Res. Africa*, vol. 69, pp. 109–124, May 2024, doi: 10.4028/p-MX1eNP.

[19] S. Marchal, M. Miettinen, T. D. Nguyen, A.-R. Sadeghi, and N. Asokan, “AuDI: Toward Autonomous IoT Device-Type Identification Using Periodic Communication,” *IEEE J. Sel. Areas Commun.*, vol. 37, no. 6, pp. 1402–1412, Jun. 2019, doi: 10.1109/JSAC.2019.2904364.

[20] S. S. Chandel, M. Nagaraju Naik, and R. Chandel, “Review of solar photovoltaic water pumping system technology for irrigation and community drinking water supplies,” *Renew. Sustain. Energy Rev.*, vol. 49, pp. 1084–1099, Sep. 2015, doi: 10.1016/j.rser.2015.04.083.

[21] M. Suryanegara, D. A. Prasetyo, F. Andriyanto, and N. Hayati, “A 5-Step Framework for Measuring the Quality of Experience (QoE) of Internet of Things (IoT) Services,” *IEEE Access*, vol. 7, pp. 175779–175792, 2019, doi: 10.1109/ACCESS.2019.2957341.

[22] P. P. A. Santoso, D. Mahmuda, and I. Sanubary, “Pengaruh Jumlah Panel dan Aki terhadap Waktu Operasi Pompa Air pada Sistem Hidroponik Tenaga Surya,” *G-Tech J. Teknol. Terap.*, vol. 7, no. 3, pp. 827–836, 2023, doi: 10.33379/gtech.v7i3.2525.

[23] Y. Nurhadryani, W. Wulandari, and M. N. F. Mastika, “Vehicle Detection Monitoring System using Internet of Things,” *J. RESTI (Rekayasa Sist. dan Teknol. Informasi)*, vol. 6, no. 5, pp. 749–760, Oct. 2022, doi: 10.29207/resti.v6i5.4082.

[24] Y. Lianawati, C. Mahendra, G. M. Sugianto, S. J. Mendrofa, A. L. Setiani, and B. Y. Baraga, “Sistem Monitoring dan Controlling ‘Smart waste’ berbasis Internet of Things menggunakan modul ESP 32,” *J. Telecommun. Electron. Control Eng.*, vol. 6, no. 2, pp. 163–175, 2024, doi: 10.20895/jtece.v6i2.1400.

[25] P. K. D. Pramanik *et al.*, “Power Consumption Analysis, Measurement, Management, and Issues: A State-of-the-Art Review of Smartphone Battery and Energy Usage,” *IEEE Access*, vol. 7, pp. 182113–182172, 2019, doi: 10.1109/ACCESS.2019.2958684.

[26] B. Su and S. Wang, “An agent-based distributed real-time optimal control strategy for building HVAC systems for applications in the context of future IoT-based smart sensor networks,” *Appl. Energy*, vol. 274, p. 115322, Sep. 2020, doi: 10.1016/j.apenergy.2020.115322.