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Monitoring System for Hydrophore Tank Onboard Using Micro-controller

Abdul Hakim Joharia, Mohd Zulhilmi Rahadia, Darmaraja Vallasamya*, Muhamad Zulzamzuri Zuhaimia, Ramesh Babu Amathalaib

[a] Faculty of Marine Engineering, Akademi Laut Malaysia, Melaka
[b] Faculty of Business & Management, Akademi Laut Malaysia, Melaka

Abstract - In the maritime industry, the seamless operation of onboard systems is paramount for ensuring both safety and efficiency. Central to this operation is the hydrophore system, which maintains essential water pressure throughout the vessel. The reliable performance of hydrophore units hinges upon the careful management of water pressure, water level, and pH balance. However, ensuring optimal performance necessitates a robust monitoring system capable of integrating these parameters seamlessly. This paper proposes an integrated monitoring system tailored specifically for hydrophore tanks onboard ships. By leveraging real-time monitoring and automation alerts, this system not only enhances operational safety but also streamlines maintenance protocols, thereby ensuring uninterrupted vessel functionality. Through the implementation of such a monitoring system, maritime operators can effectively mitigate risks associated with hydrophore malfunction, ultimately safeguarding both crew and cargo while optimizing operational efficiency at sea.

Keywords: Microcontroller, pH level, Water level, Water pressure

*Corresponding Author. Email address: darma795@gmail.com

1.0 INTRODUCTION

The reliable operation of hydrophore tanks onboard ships is crucial for ensuring a continuous and adequate water supply necessary for various shipboard operations. However, conventional monitoring methods often fall short in providing comprehensive oversight, leading to unforeseen maintenance issues, operational inefficiencies, and potential safety hazards. In this context, local monitoring practices typically involve manual checks of water levels, with limited attention to water quality and pump performance. Consequently, critical factors such as pump runtime, water pH, and potential air lock occurrences remain unrecorded, posing risks to both equipment longevity and crew well-being.

The absence of systematic data recording exacerbates these challenges, leaving ship operators with no insights into pump runtime, frequency of start-stop cycles, or the overall condition of the hydrophore system. Without accurate records, identifying underlying issues such as dry running pumps or water contamination becomes a daunting task, often leading to unpredictable maintenance events and increased machinery wear.

Recognizing these limitations, there arises a compelling need for a proactive solution capable of real-time monitoring, automated alerts, and data-driven insights to mitigate risks and optimize hydrophore system performance. Thus, the concept of Smart hydrophore Monitoring (SHM) emerges as a promising approach to address these challenges.

By implementing SHM technology, ship operators can gain unprecedented visibility into key parameters such as water pH, pressure levels, and water quality in real-time. Moreover, the integration of data storage capabilities enables historical analysis, facilitating trend identification and proactive maintenance planning. This shift towards predictive maintenance not only minimizes downtime and repair costs but also prolongs the lifespan of critical machinery, ensuring operational continuity and safety at sea.

2.0 OBJECTIVE

The primary objective of this system is to enhance the efficiency and reliability of hydrophore tank systems onboard ships by integrating a robust monitoring mechanism. This system aims to reduce unnecessary repair costs through predictive maintenance while ensuring optimal performance of the hydrophore system. Additionally, it seeks to guarantee a consistent and uninterrupted water supply, which is crucial for various onboard operations. By automating monitoring processes, the system significantly reduces the workload on crew members, allowing them to focus on other critical tasks. Furthermore, it emphasizes maintaining high water quality standards to safeguard both human health and the longevity of onboard machinery.

3.0 PROCEDURE

An MCU will monitor changes in the variable resistor to determine the pH level. It is possible to alter the resistance while the simulation is running with a variable resistor. The ADC transforms the analog signals that the MCU receives into digital values. The ADC module is integrated within the microcontroller. An LCD is used to display the digital values. In order to enable serial or parallel data entry into the system, a shift and store bus register were implemented between the microcontroller and LCD. A pressure sensor is employed in pressure measurement to identify variations in the hydrophore tank pressure. The ADC is used by the MCU to transform the signals it receives into digital values. The ADC module is integrated within the microcontroller. LCD is used to display the pressure's digital value.

4.0 SYSTEM PROCESS

The flowchart in Fig.1, represents a systematic process for managing water levels using a motor control system. The process begins by collecting real-time data from water level sensors to monitor the current water level in the tank. This sensor data is then analyzed by a controller, which decides based on predefined water level conditions. If the water level is sufficient, the controller ensures the motor remains powered off to prevent unnecessary operation.

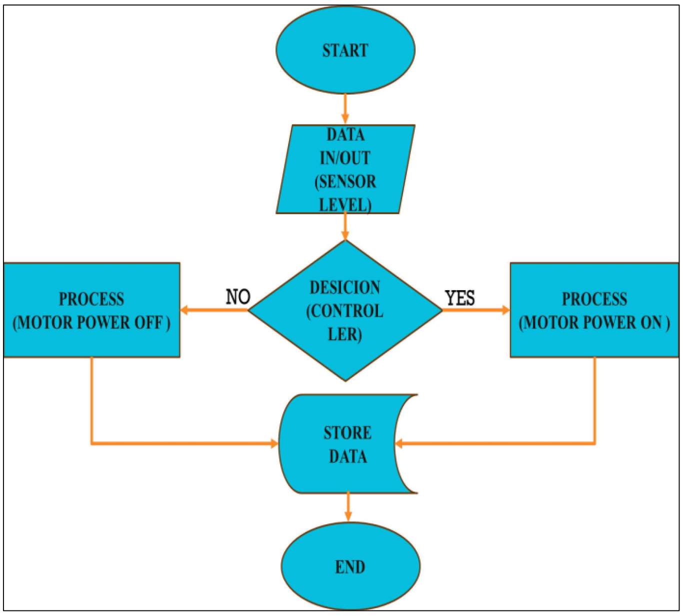

Fig. 1. The flowchart of the water level

However, if the water level falls below the required threshold, the controller activates the motor to refill the tank. Additionally, the system records the sensor data and corresponding motor activity to enable monitoring and analysis for future reference. This process ensures efficient water level management, conserves energy, and supports consistent water supply without manual intervention.

The Table 1 below outlines the system's response based on the inputs from three sensors monitoring water or pressure levels. Each sensor represents a specific level: Sensor 1 (High Level), Sensor 2 (Normal Level), and Sensor 3 (Low Level). The outputs include the Buzzer and Motor, which are triggered depending on the sensor readings.

Table 1. *Truth table for Water level*

Conditions	***Input***			***Output***	
	Sensor 1	***Sensor2***	***Sensor 3***	***Buzzer***	***motor***
A	0	0	0	1	0
B	0	1	0	0	0
C	1	0	0	1	0
D	0	0	1	1	1

Note: the outputs based on the readings from three sensors monitoring different water or pressure levels. Sensor 1 indicates a high level, Sensor 2 represents a normal level, and Sensor 3 signals a low level. These sensor inputs are used to trigger specific actions, such as activating or deactivating alarms (e.g., buzzer) or controlling the motor, ensuring efficient system management and prompt responses to varying conditions.

The flowchart in Fig. 2 below illustrates a process for monitoring and managing pH levels in a system using a sensor-based control mechanism. The process begins with system initialization, followed by data collection from a pH sensor that measures the real-time pH level of the water or fluid. The controller then evaluates the sensor data to determine whether the pH level is within the acceptable range.

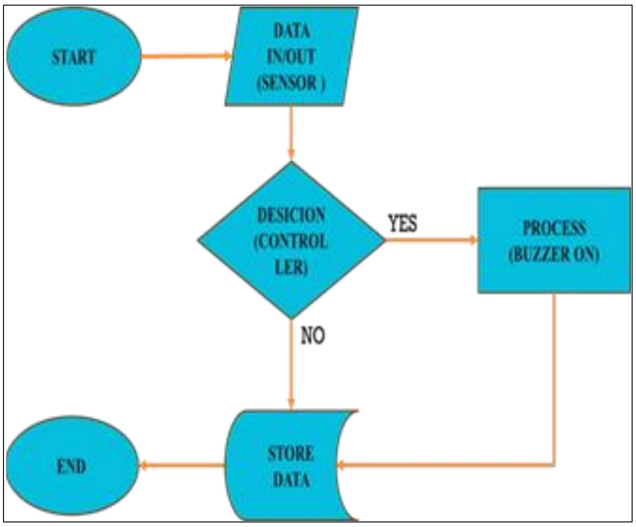

Fig. 2. The flowchart of the pH level

If the pH level is outside the desired range, the controller triggers a buzzer to alert the operator to take corrective action. If the pH level is within the acceptable range, no alert is activated, and the system continues normal operation. Regardless of the outcome, all pH level data is stored for monitoring, analysis, and future reference to facilitate trend identification and proactive maintenance. This process ensures that the pH level is consistently monitored, helping to maintain water quality and safety while enabling timely interventions when necessary. The table 2 shows the system will ensures timely alerts for pH deviations, allowing corrective actions to maintain water quality within safe operational limits.

Table 2. *Truth table for pH level*

Conditions	***Input***			***Output***	
	Sensor 1	***Sensor2***	***Sensor 3***	***Buzzer***	***motor***
A	0	0	0	1	0
B	0	1	0	0	0
C	1	0	0	1	0
D	0	0	1	1	0

Note: The truth table demonstrates the system's behavior based on inputs from three sensors monitoring pH levels. Each sensor corresponds to a specific range: Sensor 1 for high pH levels, Sensor 2 for normal pH levels, and Sensor 3 for low pH levels. The outputs are defined by the Buzzer, which signals an alert, and the Motor, which remains inactive in this pH monitoring system

The flowchart in Fig. 3, represents the process of monitoring and managing water pressure in a system using sensor-based technology. The process starts with the initialization of the system, followed by the collection of real-time pressure data from sensors. This data is analyzed by the controller to determine whether the pressure level is within the desired range. If the pressure exceeds or falls below the acceptable range, the controller activates a buzzer to alert the operator, signalling the need for corrective action.

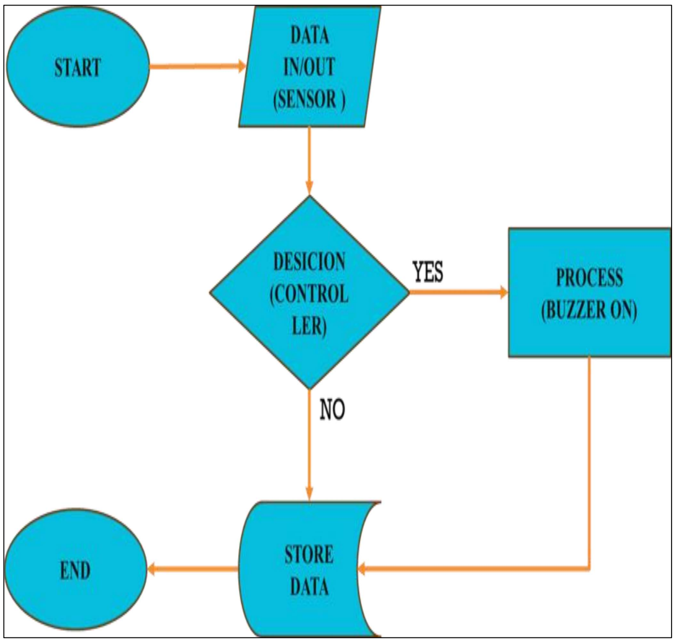

Fig. 3. The flowchart of the water pressure

If the pressure level is within the acceptable range, the system continues to operate without triggering any alerts. In both cases, the collected pressure data is stored for further monitoring, analysis, and trend evaluation. This ensures proactive maintenance and system efficiency. The process concludes once all necessary actions have been executed, preparing the system for continuous monitoring. This approach ensures optimal water pressure levels, enhances operational safety, and minimizes the risk of equipment failure. Table 3 ensures the system responds appropriately to maintain optimal pressure, providing timely alerts and corrective actions when necessary.

Table 3. *Truth table for pressure level*

Conditions	***Input***			***Output***	
	Sensor 1	***Sensor2***	***Sensor 3***	***Buzzer***	***motor***
A	0	0	0	1	0
B	0	1	0	0	0
C	1	0	0	1	0
D	0	0	1	1	1

Note: The table outlines the system's response based on pressure level inputs from three sensors, where Sensor 1 detects high pressure, Sensor 2 indicates normal pressure, and Sensor 3 detects low pressure. The outputs include a Buzzer, which triggers alerts, and a Motor, which activates only under specific conditions

Fig.5 below shows the comprehensive representation of a monitoring and control system designed to measure and manage pH levels, pressure levels, and water levels.

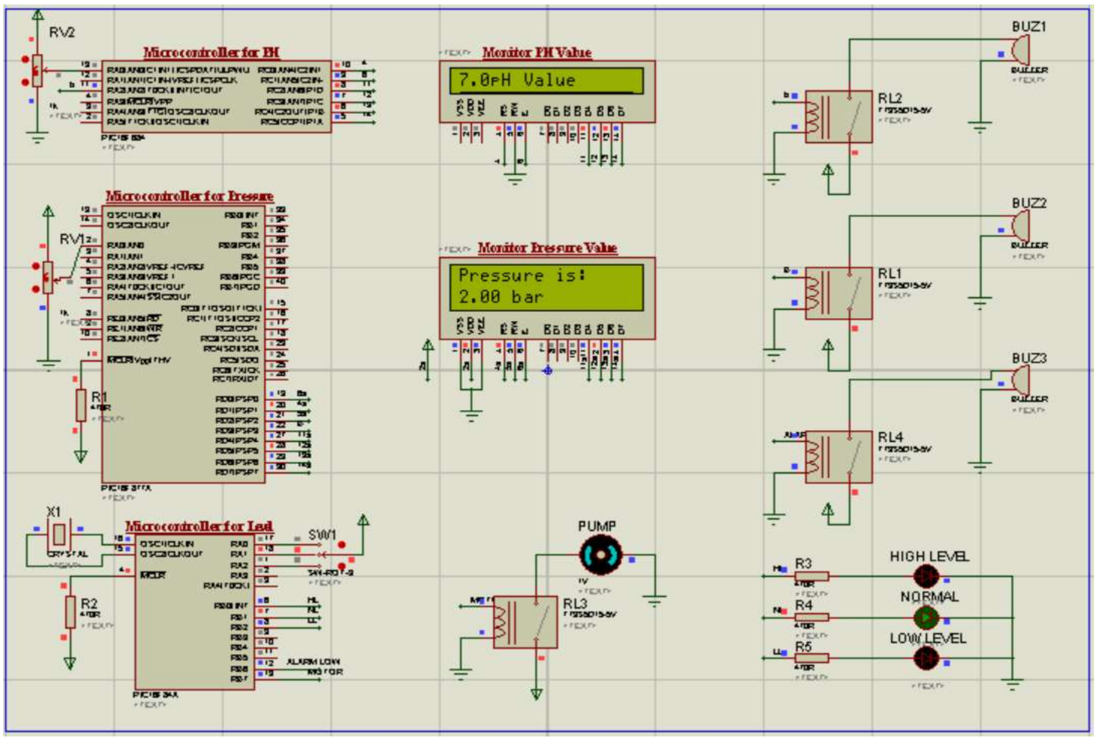

Fig. 5 The layout of circuit

This circuit provides a complete monitoring and control solution for managing pH levels, pressure levels, and water levels in a system. The integration of sensors, microcontrollers, LCDs, relays, and alarms ensures real-time monitoring, efficient control, and timely alerts to prevent failures or damages in the system.

5.0 DISCUSSION AND CONCLUSION

In summary, the monitoring system for hydrophore tanks onboard ships is a game-changer in water distribution system management. By providing real-time insights and enabling proactive maintenance, it enhances operational efficiency and reliability while contributing to sustainability efforts. Its potential applications extend beyond maritime industries, promising advancements in water management practices worldwide. This system represents a significant leap forward in ensuring safe, efficient, and sustainable water distribution systems across various applications and sectors.

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