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Liquid Tank Automatic Off Controller Using Low Current Triggered Sensor

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A liquid tank automatic off controller is designed to turn off the electric motor when the water tank reaches its total capacity. The device uses a low-current-triggered sensor to detect the water level, which can be attached to overhead and underground tanks. It operates without standby power and has no metal or corrosive parts attached directly to water. The design includes a supply unit, water sensor unit, device circuit unit, magnetic contactor unit, and pump drive unit. The power unit powers the entire circuit, while the sensor unit senses the water level and transfers the current position to a magnetic switch. The magnetic contactor switch balances the motor's frequency and is a device protector in case of overload. Planning Development Auxiliary Services (PDAS) personnel at Iloilo Science and Technology University (ISAT U) tested the device's functionality, usability, efficiency, maintainability, and portability. The respondents to the study strongly agree that by using the above parameters, the developed device conforms to the needs of the target users.

Keywords: Low current triggered sensor, Low current sensor, Relays, Liquid tank, Automatic off

1. INTRODUCTION

The Liquid Tank Automatic Off Controller Using Low Current Triggered Sensor (LTAOC-LCTS) is designed to manage liquid level overflow situations. Addressing the increasing need for innovation, automation, and sustainability, this gadget prevents tanks from being overfilled or drained unnecessarily. It reduces power consumption and resource waste. This device benefits most industries, agriculture, and household communities.

According to the World Health Organization and United Nations Children's Fund (2023), over 2 billion people live in countries experiencing high water stress. Conversely, the energy sector is responsible for 72% of all global greenhouse gas emissions (Johnston, C. 2021). To generate efficient water management systems, industries and agricultural sectors worldwide rely heavily on them to maintain operations, avoid resource wastage, and reduce costs. In this context, to align with sustainability goals and resource efficiency, developing low-current triggered sensors into liquid tank devices offers a global solution to address the needs of the abovementioned sectors.

Water management and energy efficiency are priorities in developing countries. According to Kerry Turner et al. (2004), efficient water use is crucial in every country. The agriculture, manufacturing, food processing, and energy generation sectors require reliable and automated systems to manage water resources effectively. To contribute to national economic growth and environmental protection, developing and implementing low-current triggered sensor devices in the sectors above can help control the overuse of resources and manage energy consumption and costs of the operation.

Cosgrove and Loucks (2015) state that different areas face unique water and energy resource challenges. A concrete example is areas or regions with limited access to fresh water. These regions can operate effectively with minimal energy input and use gadgets from low-power solutions to manage water resources efficiently. The development of a liquid tank automatic off-controller in certain regions can provide a cost-effective and sustainable solution, specifically in rural or remote areas where traditional power sources are scarce or unreliable.

Manual monitoring and control of liquid tank levels are usually applied in most industries and agricultural setups today. Overfilling the tank with liquids can lead to resource wastefulness, which can damage equipment. Moreover, utilising low-level power sensors is much more beneficial than traditional high-power sensors and controllers, contributing to higher operational costs and increased carbon footprints. The lack of automation can result in a lack of real-time data, making it difficult for operators to make informed decisions.

Developing and implementing an LTAOC-LCTS device is the answer to the abovementioned problems. The gadget utilised a low-current-triggered sensor to detect the tank's liquid level at its maximum capacity. This gadget can operate with minimal power and provide accurate and reliable liquid-level detection. Furthermore, the standard strategy for monitoring the water level in a water tank is to start the electric motor pump at a low level and allow it to run until a higher water level is reached. This study found that LTAOC-LCTS controls and conserves the water level in the overhead and underground tanks. It ensures water flow without considering the overflow of water from the tank. Switching off the water tank saves time, effort, and energy.

2. PURPOSE OF THE STUDY

This study aimed to design, develop and evaluate the LTAOC-LCTS device. Specifically, this study aimed to:

1. Automatically turn off the motor if it reaches the whole tank level;
2. Design a gadget that has no standby power for the device;
3. Utilise a low-current-triggered sensor for the water tank; and
4. Evaluate the study regarding the device's functionality, usability, efficiency, maintainability, and portability.

3. FRAMEWORK

Figure 1 shows the block diagram of the project. This includes the device circuit powered by 5V, a magnetic contactor switch driven by 220 V, an electric water pump, a water sensor and a water tank. First, the device circuit and the magnetic switch are turned.

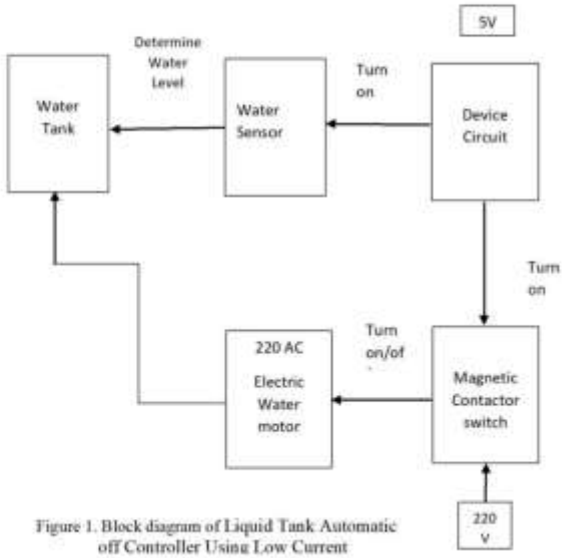

Figure 1. Block diagram of Liquid Tank Automatic off Controller Using Low Current

The device circuit activates the water sensor if the tank reaches its total capacity. On the other hand, the magnetic contactor will turn on until the water reaches its total capacity. The sensor signals the device circuit to switch off the electric motor once it reaches the tank's total capacity.

4. METHODOLOGY

4.1. Research Design

This study used the developmental-descriptive research method. The prototyping-based model was utilised as project methodology in designing an LTAOC-LCTS device. A prototyping-based model comprises planning, designing, construction, testing, and evaluation. It performs the designing, building, and testing phases concurrently until the end users complete and evaluate the hardware prototype.

According to Kendal (2014), a prototyping model is a working model that will be reanalysed, redesigned, and retested until all the system specifications have been met. Moreover, this study used a low-current-triggered sensor that automatically turns the overhead and underground water tanks off. The switching device was intended to use electronic control to refill the water without human intervention. The water tank had no standby high voltage/current compared to the commercially available floater switch. There is no possibility of electric shock.

4.2. Respondents and Sampling Plan

The researchers used the purposive sampling technique to identify the number of respondents to be included in the study. According to Etikan, Musa, and Alkassim (2016), Purposive sampling chooses the study's respondents based on their qualities and willingness to provide data for the research. Purposive sampling is nonrandom and thus allows the researchers to select respondents without underlying theories when selecting the number of participants. The thirty-five respondents from Iloilo Science and Technology University-Planning Development and Auxiliary Services (ISATU-PDAS) personnel were selected based on their willingness to participate in the study and their knowledge and experiences to assess the study objectively.

4.3. Instrument and Data Gathering Procedure

The study was evaluated by the International Standardization Organization (ISO) 25010. ISO 25010 is the international standard in software/hardware evaluation that consists of eight standard quality characteristics, which include functionality, efficiency, compatibility, usability, reliability, security, maintainability, and portability (ISO/IEC 25010, 2022). However, the researchers used five parameters from ISO 25010: functionality, efficiency, usability, maintainability, and portability. According to Panovski (2008), the standard parameters can be revised to suit the needs of the study. The instrument underwent content validation and review by industry experts and professionals in information technology. The device was tested according to the parameters above. These parameters are as follows: functionality refers to the degree to which a product provides functions that meet stated and implied needs; Efficiency is the performance relative to the number of resources used. Usability is the extent to which specified users can use the product to achieve goals effectively, efficiently, and satisfactorily. Maintainability is the ease with which a product can be modified. Portability is the software's ability to be transferred from one environment to another.

In this study, the data-gathering procedure involved both developmental and descriptive methods. Initially, the prototype of the LTAOC-LCTS device was developed based on its framework. Field tests assessed its functionality, efficiency, usability, maintainability, and portability in real-world conditions. Descriptive data was gathered through user surveys and questionnaires to capture feedback on the parameters as mentioned above and overall satisfaction. This combination of developmental and descriptive data comprehensively evaluated the system's effectiveness.

4.4. Data Analysis

Microsoft Excel 2021 was used to process the data for this study. The weighted mean was used to assess the study's acceptability and satisfaction. The Likert scale rating systems used by the respondents are as follows: 1.0-1.8: poor; 1.81-2.60: sound; 2.61-3.40: satisfactory; 3.41-4.20: very satisfactory; and 4.21-5.0 outstanding.

4, 5 Ethical Considerations

This study was conducted following ethical guidelines to ensure the integrity and welfare of all participants. Informed consent was obtained from all participants before data collection. Participants were informed about the study's purpose, procedures, and potential risks.

Confidentiality was strictly maintained by anonymising data and securely storing all information. No harm or discomfort was expected or reported., ensuring compliance with ethical standards throughout the research process. (Fleming, Zegwaard,2018)

5. RESULTS AND DISCUSSION

5.1. Participants' Demographics

Table 1. Participant's Demographic Profile

Participant's Information		Total (N=35)	Percentage (100)
Sex			
	Male	22	63 %
	Female	13	37%
Age			
	20-30	10	29%
	30-40	14	40%
	40-50	7	20%
	50 over	4	11%
Educational Background			
	Engineering Program	4	11%
	Technical/Vocational Program	21	60%
	High School Graduates	10	29%
Years of Service			
	1-10 years	21	60%
	11- 20 years	11	30 %
	21-30 years	3	10%

The study included 35 participants, as shown in Table 1; the majority were male with 63%, but with a significant representation of females with 37%. The age range was diverse, with 40% aged 30-40 years old, 29% aged 20-30 years old, 20% aged 40-50 years old, and the remaining 11% over 50 years old. Regarding educational background, 60% held technical degrees, 11% had engineering qualifications, and 29% had high school diplomas. The participants' professional experience varied from 1 to 10 years, with 60%, 11 to 20 years, 30% and 10 % having more than twenty years of experience in fields related to industrial operations, which are relevant to the study of liquid tank automatic Off controller using low-current triggered sensor.

5. 2. Results of Evaluation

The researchers tested the system in Table 2 to determine its performance and conformance with the specified user requirements.

Table 2 Overall results of the respondents.

Parameters	Obtained Mean	Interpretation

Functionality	4.15	Very Satisfactory
Usability	4.21	Outstanding
Efficiency	4.04	Very Satisfactory
Maintainability	4.13	Very Satisfactory
Portability	4.12	Very Satisfactory
Total	4.13	Very Satisfactory

The respondents rated the device's functionality as very satisfactory, with an average mean of 4.13. According to Ramnath (2012), the device's functionality is a set of attributes or device functions that specify the project's properties that satisfy the stated or implied needs of the users. The system's functionality includes the user requirements as well as its user objectives. For the project to be functional, the device should provide the correct or agreed-upon results or effects, and the device should interact with the specified components of the project. The result of the study implies that the project was able to automatically turn on/off when the water motor reached the full tank level. The device also utilised a low-current triggered sensor for the water tank. Moreover, the gadget was designed to have no standby power. The study conforms to what Antonia Stefani, Eleni Vamvatsikou and Bill Vassiliadis (2023) have stated that the project, to be functional, should provide all the requirements as specified by the users.

The respondents rated the project's usability very satisfactory, with an average mean of 4.21. According to Sruthy (2024), the project usability means that the device enables the user to understand whether the gadget is suitable or appropriate and how it can be used for particular tasks and conditions of use; the project allows the user to learn its applications, the project enables the user to operate and control the gadget. Overall, the result implies that the project functions and is designed to be easily understood by different users. The result conforms to Falco M and Robiolo G. (2020), who said that to design a user-friendly user interface that is easy to learn and use, project developers must consider the importance of project usability. These quality characteristics have shown the highest interest because they are more receptive to the end user.

The respondents rated the efficiency of the project as very satisfactory, with an average mean of 4.03. According to Hamilton and Thomas (2024), the device's efficiency is the project's attributes that determine the level of project performance and the amount of resources used to maintain the project's desired performance. This performance implies that the device could provide appropriate response and processing times and throughput rates when performing its function under stated conditions. The project uses appropriate resources at a proper time when the device performs its function under stated conditions. This result also implies that the project can quickly and efficiently utilise resources.

The respondents rated the project's maintainability very satisfactory, with an average mean of 4.13. According to Bhanushali and Amit (2023), maintainability of the system means that the system can accept the necessary effort needed to make specified modifications, which may include corrections, improvements, or adaptions of the project to environmental changes. The project was able to diagnose itself for deficiencies or failures in all its parts or components that needed to be modified. The project is also changeable, meaning the gadget can be modified to be implemented efficiently. Moreover, the project can also minimise unexpected effects from gadget modifications. The project result also implies that the end users can easily modify and test the system.

The respondents rated the project's portability very satisfactory, with an average mean of 4.12. According to Darwin Mena and Marco Santórum G.(2021).", the portability of the project refers to the ability of the gadget to be transferred from one platform to another, which may include the organisation, hardware or software environment where the project is installed. Moreover, the result implies that the project can be modified for different specified environments without applying actions or means other than those provided for this purpose for the hardware considered. The study can also be modified for different specified components without applying actions or means other than the project offers. It can also coexist with independent hardware in an everyday gadget, sharing common resources. This also means the project can be attached to one environment. The respondents rated the study very satisfactory, with a mean value of 4.13. This evaluation means the project conforms to functionality, usability, efficiency, portability, and maintainability.

6. CONCLUSIONS AND RECOMMENDATIONS

Based on the results presented, the researchers concluded that the developed gadget can automatically turn off the motor if it reaches the full tank level. The project utilised a low-current-triggered sensor for the water tank to detect the water capacity. The gadget has no standby power if it is not activated.

Moreover, the project has no metal or corrosive parts attached directly to water. If there is trouble in the sensor or the circuit, the water motor still operates and functions the same as in the original setup and has returned to manual operation.

Based on the results and conclusions drawn, the researchers present the following recommendations: The project can be implemented and utilised in agriculture, industry, and domestic consumption. It can be further enhanced or modified by applying software applications to control and manage water level capacity easily.

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