A notification and shutdown system for water pumps using Internet of Things (IoT) technology

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Abstract

This project presents a water pump monitoring and automatic shutdown system utilizing Internet of Things (IoT) technology to prevent potential damage caused by pump malfunctions, such as dry run conditions or excessive power consumption. The system detects the pump's status through a flow switch sensor and a PZEM-004T power measurement sensor, sending real-time alerts to users via the LINE application. Additionally, it can automatically shut down the pump when abnormalities are detected.

The system is designed with configurable settings, including pump shutdown delay, power consumption limits, and a protection mode (Protect Mode), all accessible through a user-friendly interface. Real-time notifications enable users to monitor and control the pump remotely. Testing results indicate that the system effectively reduces the risk of pump damage, minimizes maintenance costs, and enhances water management efficiency.

This project can be applied to water pump systems in households, agriculture, and industrial sectors, improving safety and optimizing water usage.

1. Importance and Problem Statement

Water pumps are widely used in households, agriculture, government sectors, and private organizations. It is undeniable that water pumps are essential and often need to operate continuously. However, a common issue frequently encountered is when the pump runs but does not supply water, a condition technically referred to as a Dry Run. This can result from various causes. Detecting such issues early and resolving them promptly can greatly reduce costs. On the other hand, failure to address them quickly can lead to high repair expenses or even electrical short circuits that may cause fires. Dry Run conditions are common in many areas, leading to damage to the pump and wasted energy. Based on personal experiences with such issues occurring repeatedly in our community, this project was initiated to develop a

system that automatically shuts down the water pump when no water flow is detected or when the pump is consuming abnormal amounts of electrical power. Given these problems, our team decided to create a system that can both alert users and automatically cut off pump operation when a Dry Run or overcurrent condition is detected. Additionally, the system is capable of logging operational data, including unusual power consumption. These features help extend the pump's lifespan, reduce repair and maintenance costs, and lower electricity bills. Moreover, the recorded data can be analyzed to develop strategies for energy savings and to predict potential pump failures in the future.

2. Objectives

To develop a system that automatically alerts and shuts down the water pump when an abnormal condition is detected, such as Dry Run or excessive power consumption, using IoT (Internet of Things) technology. The system integrates sensors for monitoring water flow and power usage, and sends real-time notifications through Blynk Legacy and the LINE application. This solution is designed to prevent pump damage, reduce energy costs, and collect operational data for

further maintenance planning and performance optimization.

3. Concepts and Theories

This project is based on the concept of the Internet of Things (IoT) a technology that enables the monitoring and control of electrical devices via the internet. The developed system aims to enhance the safety and efficiency of water pump operation by providing real-time monitoring and sending alerts to users whenever an abnormal condition is detected.

3.1 Automatic Notification and Shutdown System

Abnormal water pump operations such as Dry Run (where the pump operates without water flow) or excessive power consumption can lead to equipment damage and increased energy costs. This system is designed to detect such conditions using a Flow Switch to monitor water flow and a PZEM-004T sensor to measure electricity usage. When an abnormal value is detected, the NodeMCU ESP8266 sends a command to a relay module to immediately shut down the water pump.

3.2 Communication and Notification via IoT

Sensor data is transmitted to the Blynk Legacy application and alerts are

sent via the LINE API, allowing users to monitor pump status remotely through a smartphone. Additionally, the system can be configured to operate automatically according to preset thresholds.

3.3 Automation and Remote Control

By utilizing a relay module, the system can automatically control the on/off state of the water pump. This reduces the risk of damage due to operational anomalies and improves the overall efficiency of water management. In summary, the core idea of this project is to apply IoT technology to water pump control enhancing safety, energy efficiency, and convenient management via smartphones.

4. Scope of the Research

This project focuses on developing a notification and shutdown system for centrifugal water pumps or groundwater pumps with a power rating of 1 horsepower or higher, operating on 220V electricity, and connected to water pipes with a diameter of at least 1 inch. The system detects water flow using a Flow Switch and monitors power consumption through a PZEM-004T sensor. The NodeMCU ESP8266 serves as the central processing unit. Each system is designed to monitor one pump and is managed via the Blynk Legacy application, allowing users to configure shutdown delay times and power limits. Alerts are sent to users through a LINE group, enabling real-time monitoring and remote control of the water pump.

5. Research Hypothesis

The system will send alerts and shut down the water pump when the pump is operating without water flow or consumes electrical power beyond the defined threshold, thereby preventing potential damage to the pump.

6. Methodology

This project follows a structured process to develop a notification and automatic shutdown system for water pumps using Internet of Things (IoT) technology. The process includes research and data preparation, system design, installation and testing, and system performance evaluation.

6.1 Research and Data Preparation

Initially, the team studied the operating principles of centrifugal pumps and groundwater pumps, as well as components such as the Flow Switch and PZEM-004T, to ensure proper integration into the system. The team also explored the use of the NodeMCU ESP8266 and how it connects with the Blynk Legacy application and LINE API, which serve as

platforms for pump monitoring and control.

6.2 System Design

The system was designed to detect both water flow and electricity consumption using the Flow Switch and PZEM-004T. Data collected from the sensors is processed by the NodeMCU ESP8266 and transmitted to Blynk Legacy, where the pump status is displayed in real time. A Relay Module is used to automatically control the on/off operation of the pump whenever an abnormal condition is detected.

6.3 Installation and Testing

Installation involves connecting the Flow Switch to the water pipe and installing the PZEM-004T for power monitoring. The system is programmed using Arduino C to control the NodeMCU ESP8266, which is then integrated with Blynk Legacy and LINE API. The team tested the system to verify sensor functionality, relay operation, and alert notifications through the applications.

6.4 System Performance Evaluation

Performance was evaluated based on the accuracy of detecting pump abnormalities and the response time in sending alerts and shutting down the pump. Multiple test runs were conducted, with data recorded to ensure that the system operates efficiently and reliably.

7. Research Results and Discussion

This chapter discusses the development and testing of the system to ensure that it operates within the defined scope.

7.1 Hardware Design

Based on the system analysis within the defined boundaries, the hardware was designed using the ESP8266 board as the central processing unit. Input components connected to the board include the Flow Switch and PZEM-004T. The Flow Switch detects whether water flow has stopped, while the PZEM-004T measures the electrical power consumed by the pump. This data is sent to the ESP8266 for processing to determine whether the usage exceeds the set threshold. Additionally, a 4x4 Keypad is used for user-defined settings, and an LCD display is used to show output data.

7.2 Software Design

7.2.1 Data Display via Blynk Legacy

The Blynk Legacy application serves as the control interface for the water pump notification and shutdown system. This screen displays the status of the water pump, system state, time, electricity usage, and shutdown delay

settings, as shown in the figure.
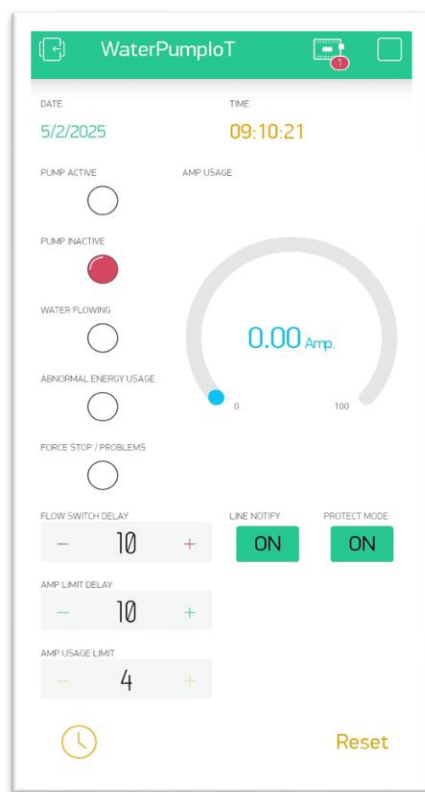
7.2.2 System Display via LCD Screen

The LCD screen displays the real-time electrical current usage of the water pump, as shown in the figure.

8. Conclusion of the Experiment

Based on the research and experimentation, the notification and automatic shutdown system for the water pump functioned effectively according to the defined objectives. The system was able to accurately detect abnormal pump conditions, such as Dry Run operation and excessive power consumption, and successfully notified users via LINE Notify. It also automatically shut down the pump when abnormalities were detected.

The user interface design allowed users to easily monitor the pump status, adjust shutdown delay times, and set power consumption thresholds. The system operated smoothly in conjunction with the Flow Switch and PZEM-004T sensors. Furthermore, the results demonstrated that the system reduced the risk of pump damage, lowered maintenance costs, and improved water management efficiency.

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