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PLC-Based Automatic Level Regulation for Interconnected Two-Tank System

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***Abstract*—This project presents the design and implementation of a PLC-based automatic level regulation system for an interconnected two-tank process widely used in industrial liquid-handling applications. The objective is to maintain desired liquid levels in both tanks by employing real-time monitoring and closed-loop control. A Programmable Logic Controller (PLC) is used as the core control unit due to its high reliability, flexibility, and suitability for industrial environments. The precise regulation of liquid levels in interconnected systems is a fundamental requirement in industries such as chemical processing, water treatment, and pharmaceuticals. This project presents the design and implementation of an automated control system for a two-tank interconnected setup using a Programmable Logic Controller (PLC).**

***Index Terms*—PLC, Level Control, ESP 32, Buck Converter, Proportional-Integral-Derivative, Sensors, Actuators.**

I. INTRODUCTION

The project "PLC-Based Automatic Level Regulation for Interconnected Two-Tank System" is designed to monitor the level of liquid in the tank. The system has an automatic pumping system attached to it to refill the tank once the liquid gets to the lower threshold, while offing the pump once the liquid gets to the higher threshold. Sustainability of available water resources in many reasons of the of the world is known dominant issue. This problem is quietly related to poor water allocation, inefficient use and lack of adequate and integrated water management. Water is commonly used for agriculture, industry and domestic consumption.

BLOCK DIAGRAM

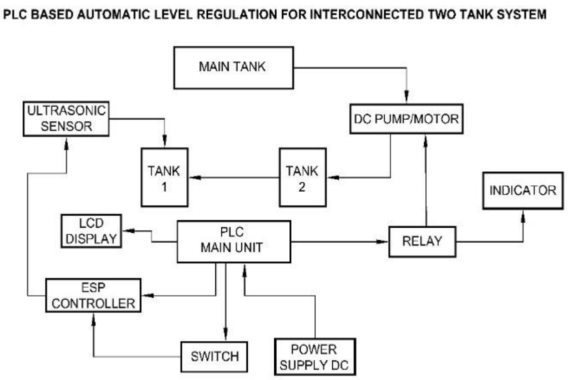

Fig A. PLC-Based Automatic Level Regulation for Interconnected Two-Tank System.

1.1. HARDWARE DESCRIPTION OF PLC

Programmable Logic Controller (PLC) acts as the centralized "brain" that manages the dynamics between fluid inflow, outflow, and the interaction between the two tanks. Its primary function is to maintain the liquid at a desired setpoint by processing real-time data and executing control logic. The PLC continuously monitors the state of the system through sensors. In a two-tank setup, this involves Receiving signals (typically 4-20mA or 0-10V) from ultrasonic or pressure sensors located in both tanks

Fig. B. PLC (Programmable Logic Controller)

1.2. ESP CONTROLLER

Receives Level Data from Ultrasonic Sensor The ultrasonic sensor measures the water/liquid level in the tank by sending sound waves and receiving echoes. ESP controller reads this distance/level data. Processes Sensor Signal Converts raw sensor readings into usable tank level values (%, cm, liters, etc.) Sends Data to PLC Transfers the tank level information to the PLC for automatic pump ON/OFF control. Wireless Monitoring / IoT Function Since ESP (like ESP8266 / ESP32) has Wi-Fi, it can send tank level data to mobile app, cloud, or web dashboard.

Fig C: ESP 32 Controller

1.3. Ultrasonic SENSOR

ultrasonic sensor serves as the "eyes" of the PLC, providing the real-time data necessary to maintain precise liquid levels. Unlike mechanical switches, it offers continuous monitoring, which is critical for managing the dynamics of fluid moving between two different vessels. Continuous Level Feedback Instead of just signaling if a tank is "full" or "empty," the ultrasonic sensor provides a constant analog or digital signal (typically 4-20 mA or 0-10 V) representing the exact height of the liquid. Set-Point Comparison: The PLC compares the sensor's real-time data against a user-defined "Set Point." If the level in the interconnected tanks drops due to outflow or transfer, the PLC identifies the "Error" and adjusts the inlet pump or valve.

Fig D: Ultrasonic sensor

1.4. RELAY:

An electromagnetic switch that allows the low-power PLC signal to control the high-power DC pump safely, acting as an interface between the control logic and the mechanical load. Relay acts as the critical bridge between the "brains" (the PLC) and the "brawn" (the DC pump or valves). While the PLC makes the decisions, it lacks the power to drive heavy industrial components directly. Electrical Isolation and Protection The most vital function of a relay is galvanic isolation. Circuit Separation: It separates the sensitive, low-power control circuit of the PLC (typically 24V DC at low milliamps) from the higher-power.

Fig E: Relay

1.5. BUCK CONVERTER:

A Buck Converter is a DC-to-DC power converter that steps down voltage from its input (source) to its output (load) while stepping up the current. It is highly efficient because it uses switching rather than dissipation (like a linear regulator) to reduce voltage. The circuit primarily consists of a DC input, a high-speed switch (usually a MOSFET), a diode (or a second MOSFET in synchronous designs), an inductor, and a capacitor.

Fig F: Buck Converter.

1.6. DC PUMP

The motor-driven component is responsible for moving fluid from the supply tank into the main tank. Its speed or on/off state is regulated by the controller. The DC pump serves as the final control element within the feedback loop. Its primary role is to manage the mass balance of the system by physically transporting fluid based on the logic processed by the Programmable Logic Controller (PLC). The DC pump converts electrical signals from the PLC into mechanical energy. In a level regulation system, the PLC receives data from level sensors (like ultrasonic or float sensors) and determines if the current level matches the setpoint. An electromagnetic switch that allows the low-power PLC signal to control the high-power DC pump safely, acting as an interface between the control logic and the mechanical load. Relay acts as the critical bridge between the "brains" (the PLC) and the "brawn" (the DC pump or valves). While the PLC makes the decisions, it lacks the power to drive heavy industrial components directly.

II. CIRCUIT DIAGRAM

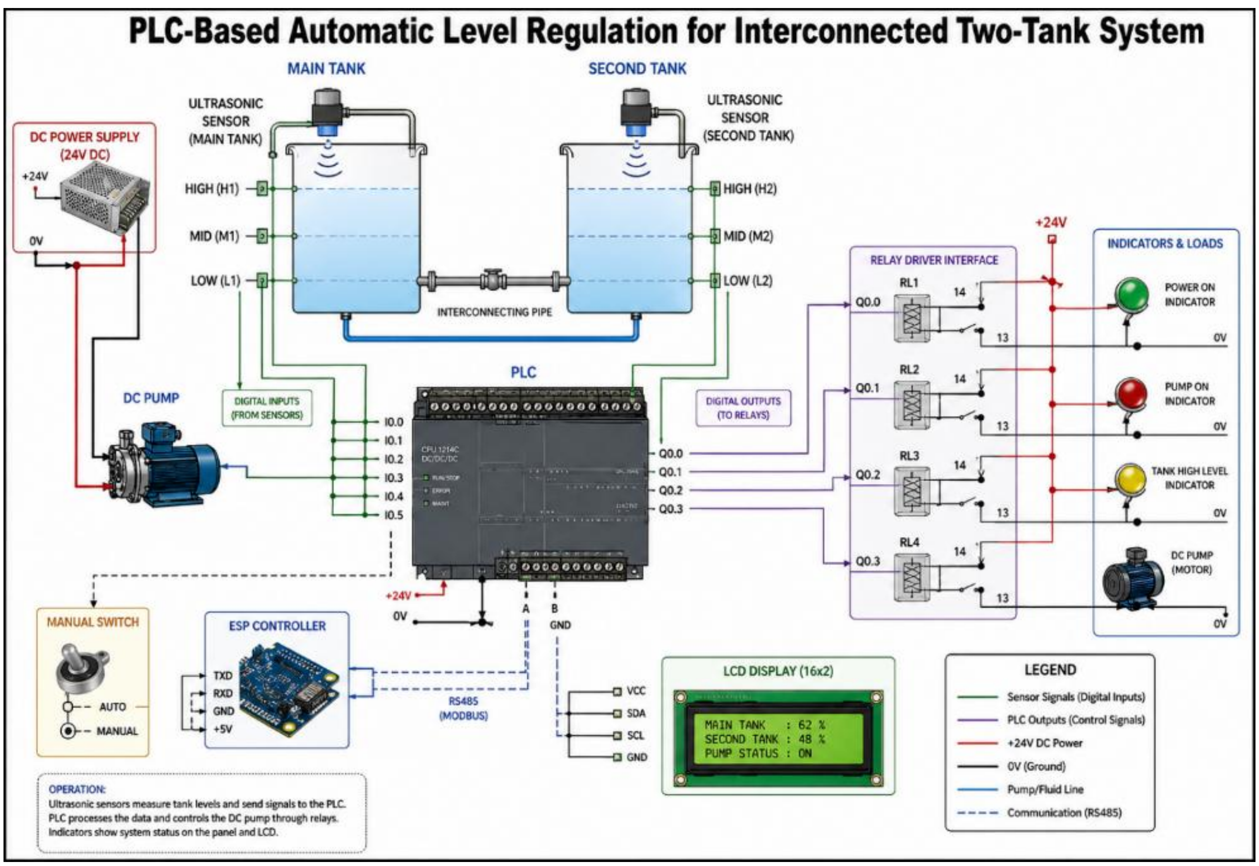

Fig G: Circuit Diagram.

III. LCD DISPLAY

Liquid Crystal Displays (LCD)
An LCD is a small low-cost display. It is easy to interface with a micro-controller because of an embedded controller (the black blob on the back of the board). This controller is standard across many displays (HD 44780).

FEATURES
- 5 x 8 dots with cursor
- Built-in controller (KS 0066 or Equivalent)
- + 5V power supply (Also available for + 3V)
- 1/16 duty cycle
- B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED)
- N.V. optional for + 3V power supply.

Fig H: LCD (16x2)

IV. POWER SUPPLY

A 24V 2A DC Adapter is a power supply unit (PSU) designed to convert high-voltage Alternating Current (AC) from a wall outlet (typically 110V or 230V) into a stable, low-voltage Direct Current (DC). Most modern adapters use SMPS (Switched-Mode Power Supply) technology because it is compact, lightweight, and highly efficient compared to old-fashioned heavy transformers. EMI Filter: The AC mains power first passes through a filter to prevent electrical noise from leaking back into your house wiring. Bridge Rectifier: A set of four diodes converts the AC (sine wave) into "pulsating" DC. Bulk Capacitor: A large high-voltage capacitor smooths the pulses into a relatively steady high-voltage DC (around 310V-325V for a 230V input). High-Frequency Switching (The "Heart") The Switch (MOSFET): Instead of just dropping the voltage, a controller chip flips a MOSFET transistor ON and OFF thousands of times per second (typically 50kHz to 100kHz).

Fig. I. DC Adapter

V. WEB SERVER

Fig J: Web Server

With Web Server, you can create smartphone applications that allow you to easily interact with or even full computers such as Raspberry Pierhead this article to learn about the components that make up the Web Server platform. With Web Server, you can create smartphone applications that allow you to easily interact with microcontrollers or even full computers such as the Raspberry Pathe focus of the Web Server platform is to make it super-easy to develop the mobile phone application. As you will see in this course, developing a mobile app that can talk to Your Arduino is as easy as dragging a widget and configuring a pin. With Web Server, you can control an LED or a motor from your mobile phone with literally zero programming. This is the first experiment that I will demonstrate in this course. But don't let this simplicity make you think that Web Server is only useful, for trivial applications. Web Server is a robust and scalable tool that is used by hobbyists and the industry alike. You can use it to monitor the soil humidity of your vegetable garden and turn on the water, or open up your garage door, with your phone.

You can also use it to control smart furniture that can learn from your routines or embed IoT and AI to traditional industrial products such as a boiler, or for improving the integrity and safety of oilfields. Web Server is free to use for personal use and prototyping. Their business model generates profits by selling subscriptions to businesses that want to publish Web Server-powered apps for their hardware products or services.

VI. MODEL

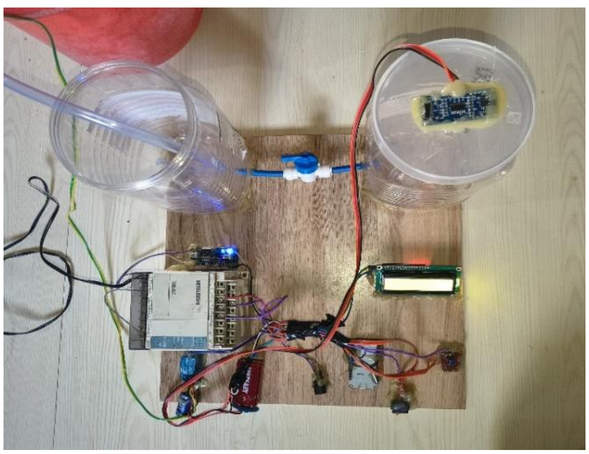

Fig K: Model of PLC-Based Automatic Level Regulation.

The level sensors send a continuous signal (usually 4-20mA or 0-10V) to the PLC's Analog Input Module. The PLC converts this electrical signal into a digital value representing the height in centimeters or liters. The PLC's CPU subtracts the Actual Level (from the sensor) from the Setpoint (entered by the operator via an HMI or PC). If Setpoint > Actual, the PLC triggers the pump to increase the level. If Actual > Setpoint, the PLC stops the pump or opens a discharge valve.

VII. RESULT

Automatic Lavel Regulation

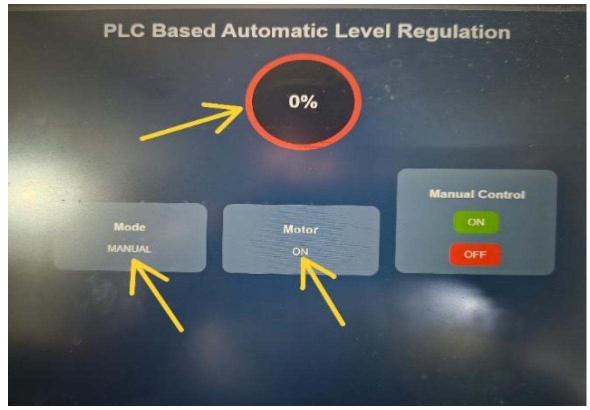

Fig L: Automatic Lavel Regulation.

OUTPUT

Fig M: Output

APPLICATIONS

1. Chemical Processing,
2. Water Treatment Plants,
3. Food and Beverage Industry

VIII. CONCLUSION

The integration of a PLC into a two-tank system effectively addresses the challenges of cross-coupling—where the level in one tank naturally affects the level in the other due to their interconnection. By utilizing automated feedback loops, the system achieves a level of precision and response speed that is unattainable through manual operation. Operational Efficiency Automation significantly reduces the need for constant human intervention, lowering the risk of dry-running pumps or tank overflows. System Reliability The use of industrial-grade PLCs ensures that the control logic remains stable even in electrically noisy or harsh physical environments.

Data-Driven Control The system moves beyond simple "on/off" logic to sophisticated PID control.

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