A Review on PLC-Based Automatic Level Regulation for Interconnected Two-Tank System

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***Abstract*—logic and artificial neural network (ANN) controllers. 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. This study delves into the intricate dynamics of a multi-tank level control system, encompassing both interacting and non-interacting configurations. Through meticulous analysis, we scrutinize three tanks of equal cross-sectional areas, each representing a first-order system interconnected in diverse modes. Our primary goal is to maintain the level of the third tank at a predefined set point, irrespective of fluctuations in inflow to the first tank. To accomplish this objective, we advocate for the integration of modern artificial intelligence techniques, notably fuzzy**

***Index Terms*—Multi-tank system, Level control, Fuzzy logic, Artificial neural networks, Feed-forward controller, Transfer.**

I. INTRODUCTION

The project "PLC-Based Automatic Level Regulation for Interconnected Multi-tank systems are extensively utilized in chemical and petroleum industries for controlling the liquid level in tanks. Effective level control is critical, as it directly influences both pressure and flow within the process, thereby ensuring process stability, product quality, and operational efficiency. Maintaining the liquid level at a specified set point in multi-tank systems is a challenging task due to the complex dynamics and interactions between the tanks. Various types of feedback controllers, such as Proportional-Integral-Derivative (PID) controllers, are commonly used to control the liquid level in tanks. However, these controllers often face significant challenges when disturbances enter the system. Disturbances can originate from various sources

II.EXISTING SYSTEM

Manual Operation and Visual Monitoring In a manual system, the liquid level in the two-tank setup was typically monitored using sight glasses or external transparent tubes attached to the side of the tanks. Human Oversight: An operator had to physically observe the level markers to ensure the fluid did not overflow or run dry. Valve Control: Flow regulation between the primary and secondary tanks was managed by manually turning gate valves or globe valves. Inconsistency: Because human reaction time varies, maintaining a precise "set point" was nearly impossible, especially when the outflow demand changed suddenly. Mechanical Float Systems Some systems utilized purely mechanical float valves, similar to those found in traditional toilet tanks. Mechanism: A buoyant float connected to a lever arm would physically close the inlet valve as the liquid rose. Interconnection Challenges: In a two-tank system, mechanical floats struggled to account for the interaction effect (the pressure and flow dynamics) between the tanks. Adjusting the level in Tank 1 often caused an unpredictable surge or drop in Tank 2 that the mechanical system could not anticipate.

III. PROPOSED SYSTEM

such as changes in inflow rates or variations in process conditions, and can disrupt the stability and accuracy of the control system. To nullify the effect of disturbances, implementing a feed-forward controller becomes essential. Feed-forward control anticipates disturbances by measuring them directly and applying corrective actions before they affect the system. However, feed-forward control alone is often insufficient. Therefore, a combination of feedback and feed-forward control-known as a feed-forward-feedback controller is employed to maintain the liquid level at the desired set point. This hybrid approach leverages the strengths of both control strategies: the feedback controller corrects any deviations from the set point, while the feed-forward controller preemptively addresses disturbances.

Block Diagram

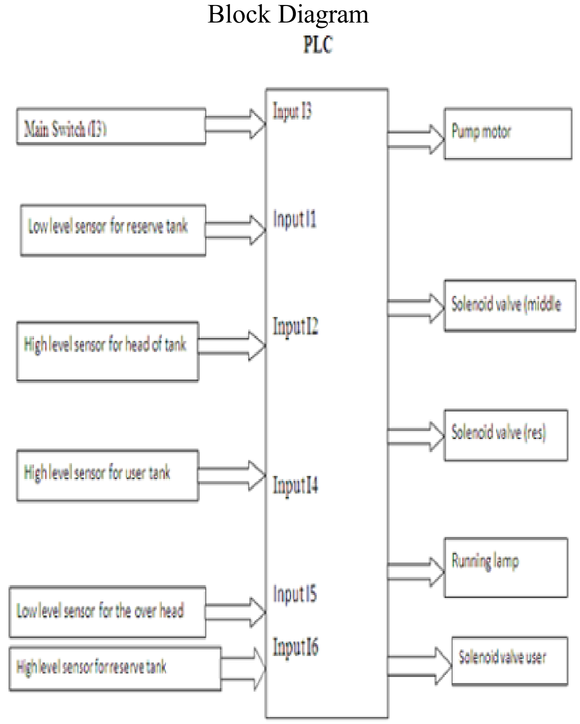

Fig A. PLC-Based Automatic Level Regulation.

3.1 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)

3.2 Arduino Uan Rev2

Arduino Uno WiFi REV 2 is an Uno Microcontroller Board with an integrated WiFi module. The Uno WiFi Rev2 is based on the Microchip Technology ATmega4809 8-Bit Microcontroller. WiFi 802.11b/g/n connectivity is provided by an onboard u-blox NINA-W13 Module. The NINA-W13 Module is a self-contained System-on-Chip (SoC) with an integrated TCP/IP protocol stack, enabling access to a WiFi network. The device can also act as an access point. The Uno WiFi REV 2 also features OTA (over-the-air) programming support, either for the transfer of Arduino sketches or WiFi firmware.

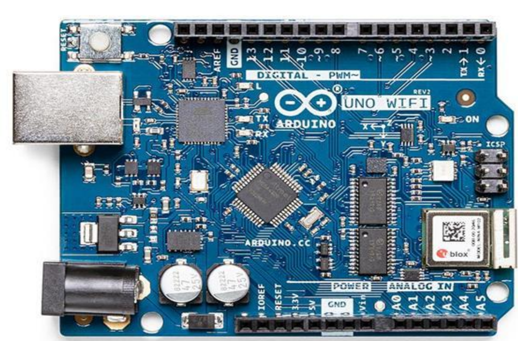

Fig C: Arduino REV2

3.3 Water Level Sensor

The REL-35 sensor features a high-sensitivity detection plate, easy wiring, and stable performance for accurate level sensing. Its durable PCB design ensures long-term reliability even in demanding environments.

Depth of Detection – Accurately senses water level or presence High Sensitivity – Responds quickly to changes in water levels Durable PCB – Long-lasting, corrosion-resistant design Versatile Applications – Ideal for water tanks, automatic pumps, DIY electronics, and smart irrigation A perfect choice for hobbyists, students, and professionals who need a dependable water level sensing solution. Operating voltage: dc3-5v Operating current: less than 20ma Sensor type: analog Detection area: 40mmx16mm Production process.

Fig D: Water Level sensor

3.4 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

3.5 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. Electrical Isolation and Protection The most vital function of a relay is galvanic isolation. Circuit Separation: It separates the sensitive.

3.6 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 F: LCD (16x2)

IV. AUTOMATIC LEVEL REGULATION

The methodology for this study focuses on the design, simulation, and analysis of a three-tank level control system. The system comprises both interacting and non-interacting tanks, and our objective is to regulate the liquid level in the third tank under varying inflow conditions and disturbances. This section details the system setup, mathematical modeling, controller design, and simulation approach.

1. Performance Analysis of Three-Tank Level Control

In this section, we conduct a performance analysis of a three-tank level control system using feedback and feed forward-feedback controllers. Liquid level control in process industries is crucial due to its direct impact on pressure and flow rates, necessitating the maintenance of levels at desired set points.

2. Non-Interacting Three-Tank System

In the non-interacting three-tank system, the manipulated variable is the input flow rate to the first tank, while the controlled variable is the level in the third tank. To minimize the effect of disturbances, a feed-forward controller with suitable tuning parameters is implemented. In this system output flow of the first tank is the input flow of the second tank and similar way second tank is connected to third tank.

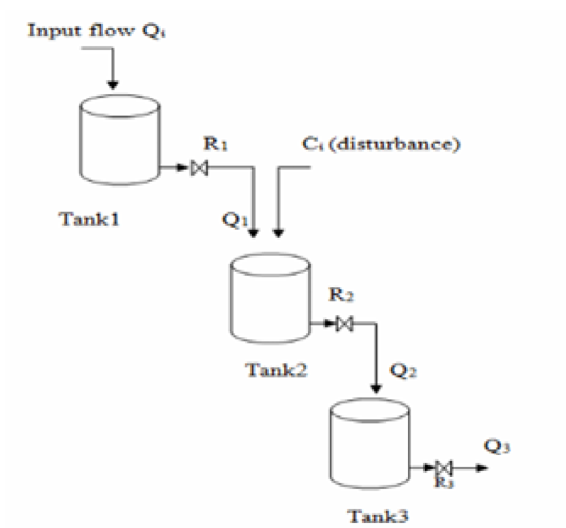

Fig G: Three Interconnected Tank

V. FEATURES

The PLC-based automatic level regulation for an interconnected two-tank system is a fundamental application in industrial automation and a key educational tool. It offers significant advantages over manual or traditional relay-based systems, primarily driven by the need for enhanced efficiency, reliability, precision, and safety in managing liquid levels. The interconnected tank system serves as a common and important benchmark for industrial processes involving liquid storage and transfer, such as chemical processing, wastewater treatment, and food/beverage manufacturing. In these environments, maintaining precise liquid levels is critical for: Ensuring Process Stability: Consistent levels directly impact flow rates, pressure, and chemical reaction times, which are all vital for product quality and operational safety. Optimizing Resource Usage: Automation prevents material wastage due to overflows and ensures efficient use of energy (e.g., controlling pumps and valves only when necessary). Enhancing Safety: By eliminating manual operation and integrating automatic alarm systems, the risk to human workers is greatly reduced in potentially hazardous environments (e.g., refineries or chemical plants). Meeting Quality and Efficiency Standards: Industries require high levels of precision and repeatability, which manual control or simple on-off switches often cannot provide, especially when dealing with the non-linear dynamics and interactions of coupled tanks.

VI. 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.

REFERENCES

[1] Ms. Sarabjeet Kaur, Mrs. Linkan Priyadarsini "Automatic Level Control for Cascaded Water Tanks using PLC" (IRJET)

[2] Y. Kondratenko, O. Korobko, O. Kozlov, O. Gerasin, and A. Topalov, "PLC based system for remote liquids level control with radar sensor," in 2015 IEEE 8th International Conference on Intelligent Data Acquisition and Advanced Com puting Systems: Technology and Applications (IDAACS), vol. 1. IEEE, 2015, pp. 47–52. 48)

[3] P. Panchal, A. Patel, and J. Barve, "PI control of level control system using PLC and LabVIEW based SCADA," in 2015 International Conference on Industrial Instrumentation and Control (ICIC). IEEE, 2015, pp. 1196–1201.)

[4] R. E. Samin, L. M. Jie, and M. A. Zawawi, "PID implementation of heating tank in mini automation plant using programmable logic controller (PLC)," in 2011 International Conference on Electrical, Control and Computer Engineering (INECCE). IEEE, 2011, pp. 515–519

[5] V. R. Segovia and A. Theorin, "History of Control History of PLC and DCS," 2012. Wikipedia, "Serial communication — wikipedia, the free encyclopedia," 2017. [Online]. Available

[6] Miorandi, D.; Sicari, S.; De Pellegrini, F.; Chlamtac, I. Internet of things: Vision, applications and research challenges. Ad HocNetw. 2012, 10, 1497–1516. [CrossRef]

[7] M. D. Schwartz, J. Mulder, J. Trent, and W. D. Atkins, "Control system devices: Architectures and supply channels overview," Technical Report SAND2010-5183, Sandia National Laboratories, 2010.