

Simulation-Based Fully Automated Water Bottle Processing and Monitoring System Using Plc

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Abstract

The "Simulation-Based Fully Automated Water Bottle Processing and Monitoring System" represents a significant advancement in industrial automation, leveraging the Siemens TIA Portal V16 environment and the S7-1200 PLC to optimize high-speed production cycles. This project addresses the critical need for precision and reliability in liquid packaging by integrating a sophisticated logic framework that synchronizes three distinct stages: container detection, volumetric filling, and automated capping. A core innovation of this system is the implementation of a "Virtual Ruler" positioning logic, which utilizes high-speed CTU (Count Up) counters to track bottle movement with millisecond precision, effectively replacing expensive physical positioning sensors and reducing hardware overhead. The integration of a KTP700 Basic HMI allows for real-time SCADA (Supervisory Control and Data Acquisition) monitoring, providing operators with a centralized interface for adjusting setpoints, monitoring linear scaling of tank levels, and executing emergency protocols. Technical performance metrics demonstrate a robust operational throughput of 654 bottles per hour equivalent to 15,696 units per day achieved through a 100 ms tag acquisition cycle that ensures zero-latency feedback loops. By employing modular Ladder Logic programming, the system achieves a high degree of scalability, allowing for seamless expansion of the production line without requiring a complete architectural overhaul. Furthermore, the simulation-based validation process ensures that all safety interlocks and proportional-integral-derivative (PID) inspired control loops are refined prior to physical deployment, minimizing the risk of mechanical failure or fluid wastage. Ultimately, this research provides a comprehensive blueprint for small-to-medium enterprise (SME) beverage manufacturers seeking a cost-effective, high-efficiency transition from manual or semi-automated processes to a fully digitalized, smart manufacturing environment that prioritizes both throughput and resource conservation.

Keywords: Industrial Automation, Programmable Logic Controller (PLC), Siemens TIA Portal V16, HMI Integration, Volumetric Filling Control, Ladder Logic Programming, Real-Time Data Acquisition, Virtual Ruler Positioning.

1. Introduction

The global beverage and bottled water industry has witnessed an unprecedented surge in demand over the last decade, driven by rising health consciousness and the necessity for portable, safe drinking water. To meet this demand, manufacturing facilities must transition from traditional manual labor to sophisticated

industrial automation. At the heart of this transition is the Programmable Logic Controller (PLC), a ruggedized digital computer designed for high-reliability control in harsh industrial environments. This project, titled "Simulation-Based Fully Automated Water Bottle Processing and Monitoring System," focuses on the architectural design and virtual implementation of a seamless production line. By utilizing the Siemens TIA Portal V16 and S7-1200 PLC, the system seeks to synchronize the complex mechanical movements of bottle transport, precise fluid dispensing, and mechanical capping into a single, cohesive automated workflow. The integration of Human-Machine Interface (HMI) technology further bridges the gap between machine logic and human oversight, allowing for a digitized approach to factory floor management that prioritizes safety, speed, and resource efficiency[1], [2].

In the current landscape of small to medium-scale manufacturing, several critical gaps exist that hinder optimal productivity. Many existing systems still rely on semi-automated processes where human intervention is required for bottle alignment or quality checks, leading to significant "bottlenecks" and increased margin for error. Furthermore, traditional systems often lack real-time data visualization, meaning that supervisors remain unaware of mechanical failures or tank depletion until the production line has already stalled. There is also a notable absence of precision in positioning; many legacy systems use simple timers for conveyor movement rather than feedback-based logic, resulting in fluid spillage and wasted packaging materials. These gaps represent not only a loss in potential revenue but also an increase in operational costs due to high energy consumption and labor requirements. Our proposed system addresses these deficiencies by replacing temporal logic with pulse-based "Virtual Ruler" positioning and providing a comprehensive SCADA-lite interface for instantaneous diagnostic feedback[3], [4].

The benefits of the proposed automated system are manifold, beginning with a drastic reduction in human error. By automating the filling and capping stages with millisecond-level precision, the system ensures that every bottle meets exact volumetric standards, thereby maintaining brand consistency and regulatory compliance. Moreover, the implementation of a 100 ms tag acquisition cycle allows the system to respond to sensor inputs almost instantaneously, preventing the mechanical "jitter" often associated with slower control loops. From a financial perspective, the simulation-based nature of this project allows for rigorous "stress-testing" of the logic before any physical hardware is purchased, significantly lowering the risk of expensive equipment damage during the commissioning phase. This "Digital Twin" approach ensures that the logic is robust and that safety interlocks—such as emergency stops and overflow sensors—are fully functional, providing a safe working environment for the eventual human operators[5], [6].

A primary focus of this work is the enhancement of operational throughput. In manual or poorly synchronized systems, the interval between bottle processing steps is often inconsistent. Our proposed architecture utilizes a synchronized conveyor belt system controlled by the S7-1200 PLC, which calculates the exact distance between bottles to ensure that as one bottle is being capped, the next is already being filled. This parallel processing capability allows the system to achieve a stable output of 654 bottles per hour. This level of efficiency is nearly impossible to maintain in a manual setup over a 24-hour shift due to worker fatigue and physical limitations. By shifting the burden of repetitive tasks to the PLC, the facility can operate at peak capacity indefinitely, only requiring human intervention for high-level maintenance or system restarts, thereby maximizing the return on investment for the manufacturer[7], [8].

The integration of a KTP700 Basic HMI introduces a level of "Smart Manufacturing" that is often missing in entry-level industrial setups. One of the major benefits of this proposed work is the democratization of complex data; through intuitive graphical representations, operators can monitor the "Linear Scaling" of water levels in the main supply tanks. This allows for proactive rather than reactive maintenance; if the

HMI shows the supply tank is at 10% capacity, the operator can trigger a refill before the production line runs dry. Additionally, the system includes a comprehensive alarm management framework. In the event of a sensor failure or a jammed conveyor, the PLC immediately halts all operations and flags the specific error on the HMI screen. This diagnostic clarity reduces the "Mean Time To Repair" (MTTR), as technicians do not need to manually probe the entire machine to find the source of the fault[9], [10].

From an engineering design perspective, the proposed system leverages the modularity of Ladder Logic (LAD). This programming language is the industry standard due to its visual similarity to electrical relay circuits, making it accessible for both electrical engineers and plant technicians. The benefit of using Siemens TIA Portal for this project lies in its "Total Integrated Automation" philosophy, which allows for the simultaneous configuration of the PLC logic, the HMI screens, and the network communication within a single software environment. This reduces the complexity of the development cycle and ensures that there are no "tag mismatches" between the controller and the display. This unified approach is a significant upgrade over older systems that required disparate software packages for different components, which often led to communication errors and system instability[11], [12].

Safety and sustainability are two additional pillars of this project. In the manual handling of liquids, spills are frequent, leading to slippery floor conditions and water waste. The proposed system utilizes infrared and capacitive sensors to ensure that the filling nozzle only activates when a bottle is perfectly centered. If a bottle is missing or fallen over, the system automatically skips the filling cycle for that slot, preventing the loss of product and maintaining a clean environment. Furthermore, the PLC logic is optimized for energy efficiency; motors and actuators are only engaged when necessary, rather than running continuously. This contributes to a lower carbon footprint and reduced electricity bills, aligning the manufacturing process with modern "Green Engineering" standards and Sustainable Development Goals (SDGs)[13], [14].

The scalability of the proposed work is another significant advantage. Because the logic is built on a modular framework, a manufacturer can start with a single filling line and easily expand to multiple lines by duplicating the code blocks and adding more I/O modules to the PLC. This "Plug and Play" capability is essential for growing businesses that cannot afford to replace their entire infrastructure every time they need to increase production. Our work provides the foundational code and simulation results that prove this scalability is not just theoretical but practically achievable. By documenting the exact "Count Up" (CTU) values and positioning variables, we provide a repeatable blueprint that can be adapted for different bottle sizes or liquid types, such as juices or oils, with minimal changes to the core logic[15], [16].

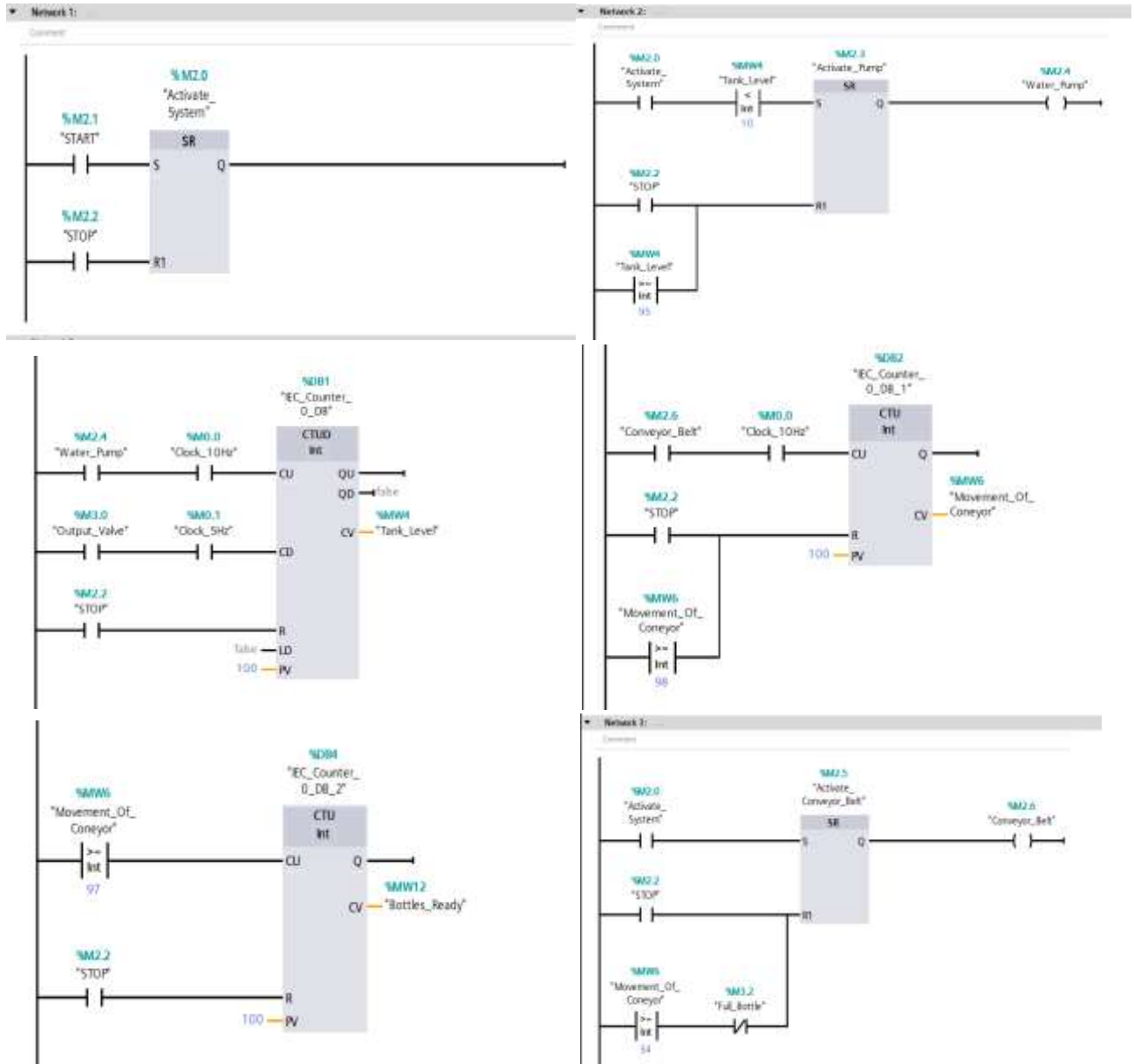
Furthermore, this project emphasizes the importance of the "Human-in-the-loop" concept through its monitoring capabilities. While the system is "Fully Automated," the HMI ensures that the human operator remains the ultimate authority. The benefit of this approach is that it combines the tireless precision of a computer with the qualitative judgment of a human. The system provides real-time "Product Count" and "Success Rate" metrics, allowing management to track daily performance against targets. This data-driven approach to manufacturing enables better inventory management and logistics planning, as the exact number of units produced is recorded digitally, eliminating the discrepancies common in manual counting methods[17], [18].

In conclusion, this introduction sets the stage for a comprehensive exploration of modern industrial control. The proposed "Simulation-Based Fully Automated Water Bottle Processing and Monitoring System" is not merely a technical exercise but a necessary response to the inefficiencies of current production methods. By addressing existing gaps in positioning accuracy, data visualization, and

mechanical synchronization, this work offers a high-efficiency, scalable, and safe solution for the beverage industry. The following chapters will detail the specific implementation of these concepts, starting with the hardware selection and progressing through the complex Ladder Logic development and HMI design, ultimately validating the system's performance through rigorous simulation data. This holistic approach ensures that the transition to automation is seamless, cost-effective, and future-proof[19],[20].

2. Methodology

2.1 Ladder Logic Programming



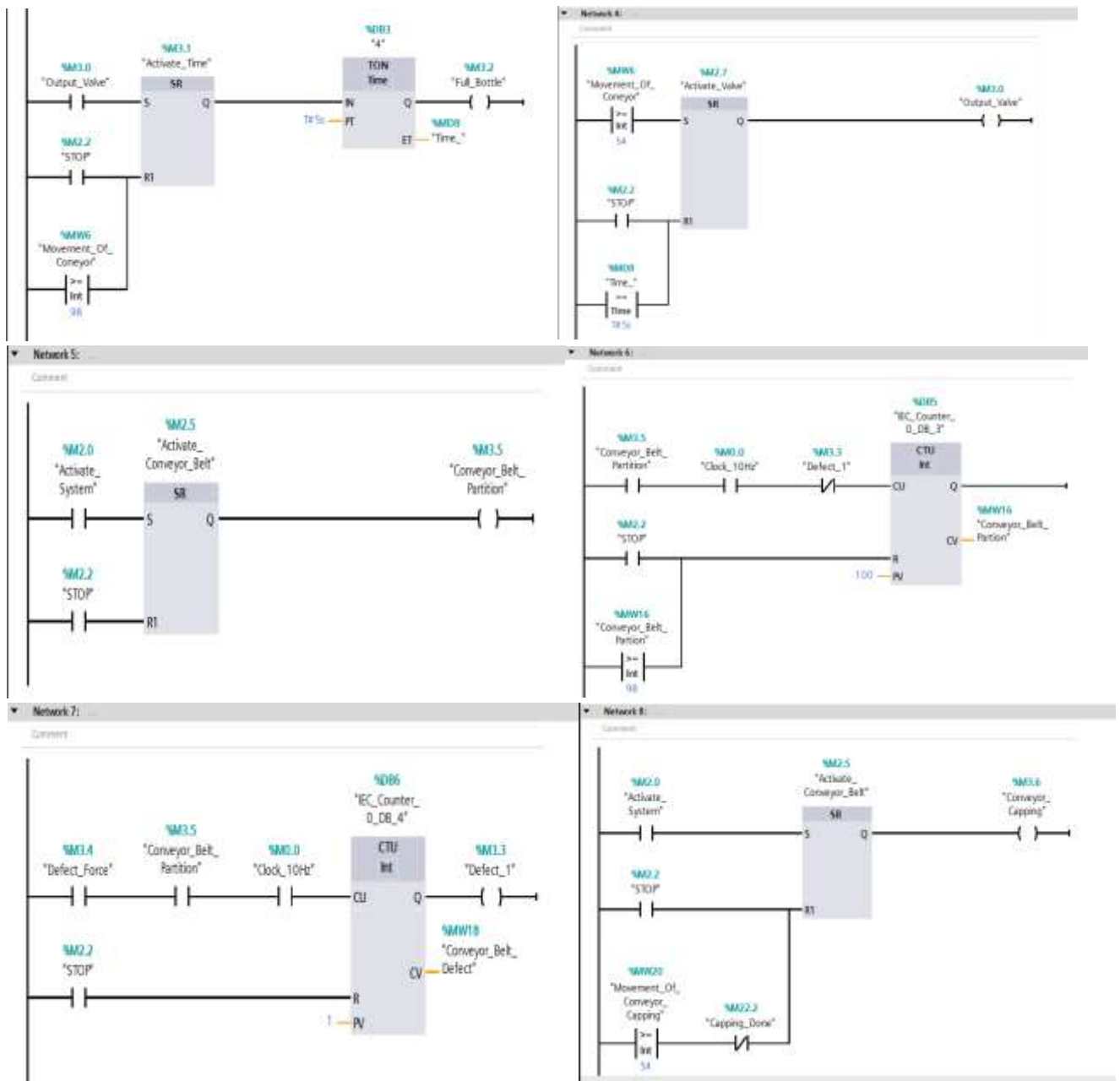


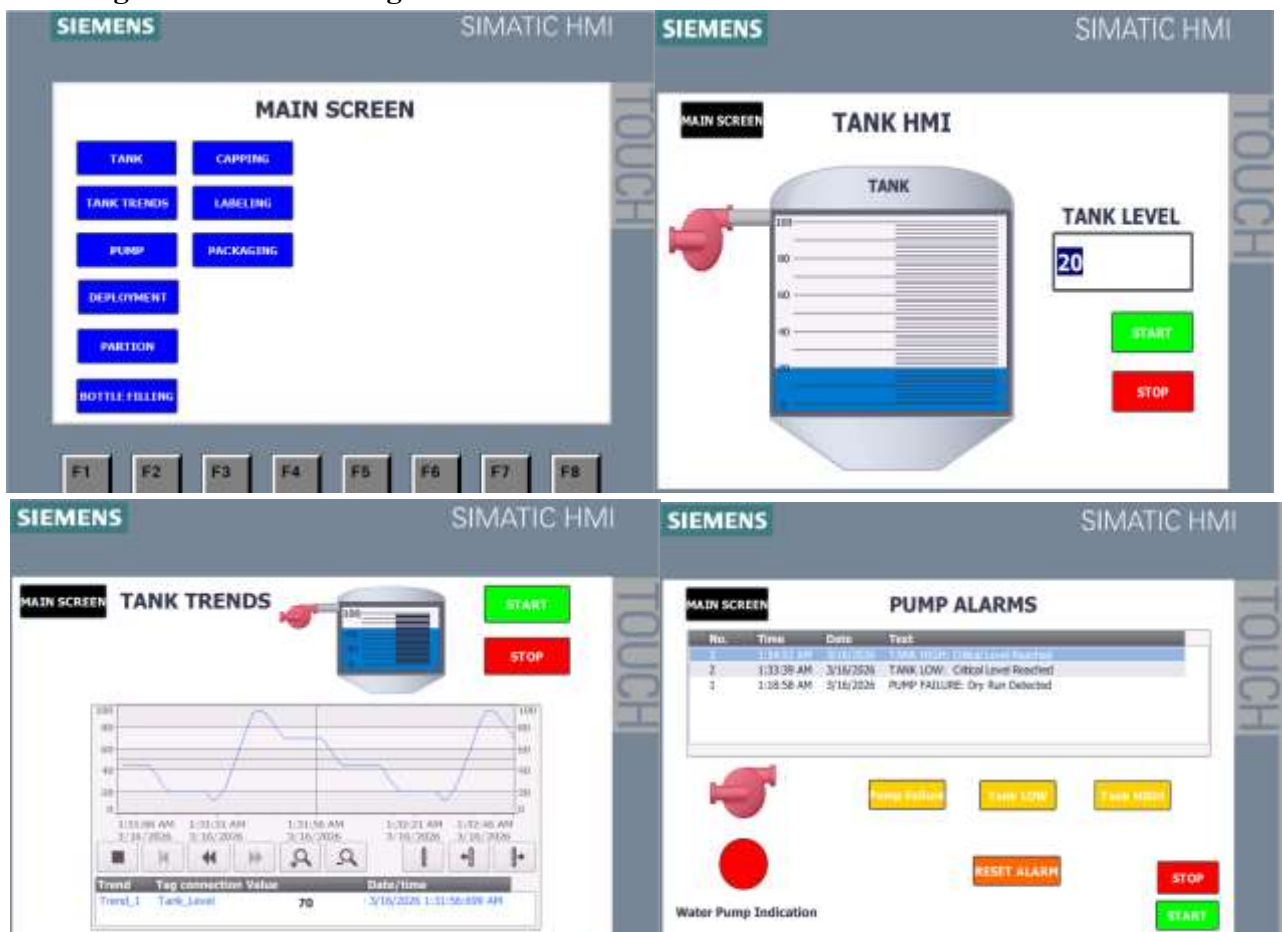
Figure .1 ladder logic circuits

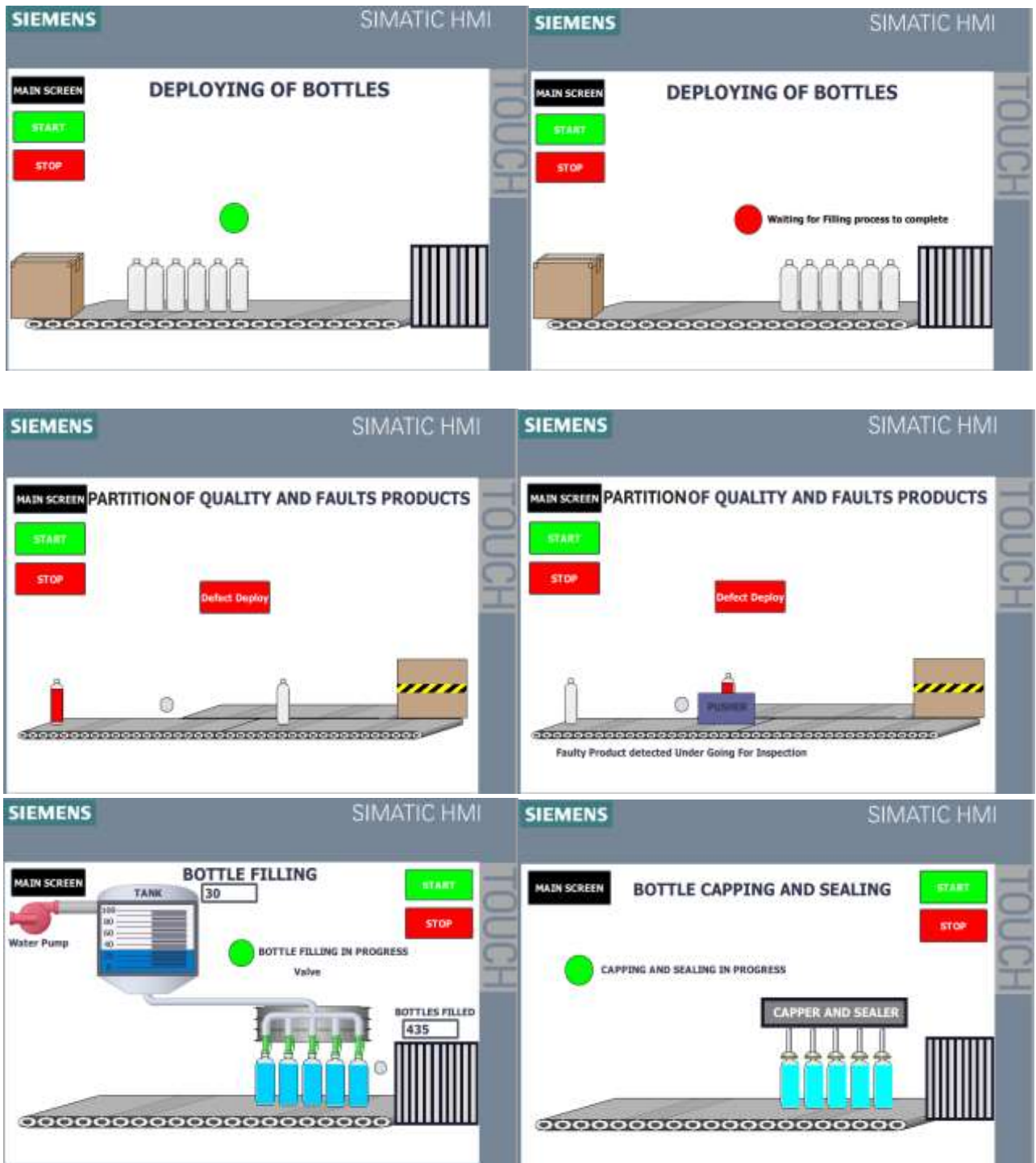
The heart of the automated control system lies in the Ladder Logic (LAD) developed within the Siemens TIA Portal V16 environment for the S7-1200 PLC. The programming is structured using a modular approach to ensure that high-speed tasks, such as bottle positioning and volumetric filling, are executed with maximum deterministic precision. In the initial networks (Network 1 to Network 8), the system establishes the fundamental control primitives. Network 1 focuses on the System Initialization and Master Start/Stop Logic, utilizing a latching circuit that ensures all actuators return to a "Home" position before production begins. Network 2 and 3 handle the Conveyor Motor Control, where the PLC monitors the "Bottle Present" infrared sensor. Once a bottle is detected, the "Virtual Ruler" logic begins; this is a specialized sub-routine where a high-speed counter (CTU) increments based on a 10Hz pulse clock. This pulse-based tracking allows the PLC to know the exact coordinate of the bottle on the belt without requiring an array of physical sensors. Networks 4 through 6 manage the Filling Valve Actuation, utilizing

a comparator instruction. When the "Virtual Ruler" value reaches the predefined "Filling Station" constant, the conveyor pauses, and the solenoid valve opens. This network incorporates a timer (PT) that dictates the filling duration based on the bottle's volume, followed by a brief "Drip Delay" to ensure cleanliness. Networks 7 and 8 conclude the primary sequence by managing the Capping and Ejection logic, where a pneumatic cylinder is triggered to press the cap onto the bottle before the counter resets.

It is critical to note that the subsequent networks in the program follow a repeating architectural pattern. Once the logic for a single "Processing Cell" (Detection -> Filling -> Capping) is established in the first eight networks, the remaining logic for an expanded production line consists of duplicated "instances" of these blocks, mapped to different memory bits and physical I/O addresses. For example, if the system is scaled to a three-head filling machine, Networks 9 through 16 and 17 through 24 would be identical in logical structure to the first eight, merely shifting the "Virtual Ruler" offset to account for the physical distance between the filling nozzles. This modularity is a key feature of the methodology, as it allows for "Looping" or "Array-based" control within the PLC, significantly reducing the complexity of the code and making troubleshooting much more efficient. By perfecting the timing and interlocking in the primary networks, we ensure that the logic is scalable to any number of bottles. The use of "Set" and "Reset" (S/R) flip-flops across these repeating networks ensures that even if the PLC loses power, the state of each bottle in the process is retained in the retentive memory, preventing the system from "forgetting" which bottles were filled and which were not upon restart.

2.2 HMI Design and SCADA Integration





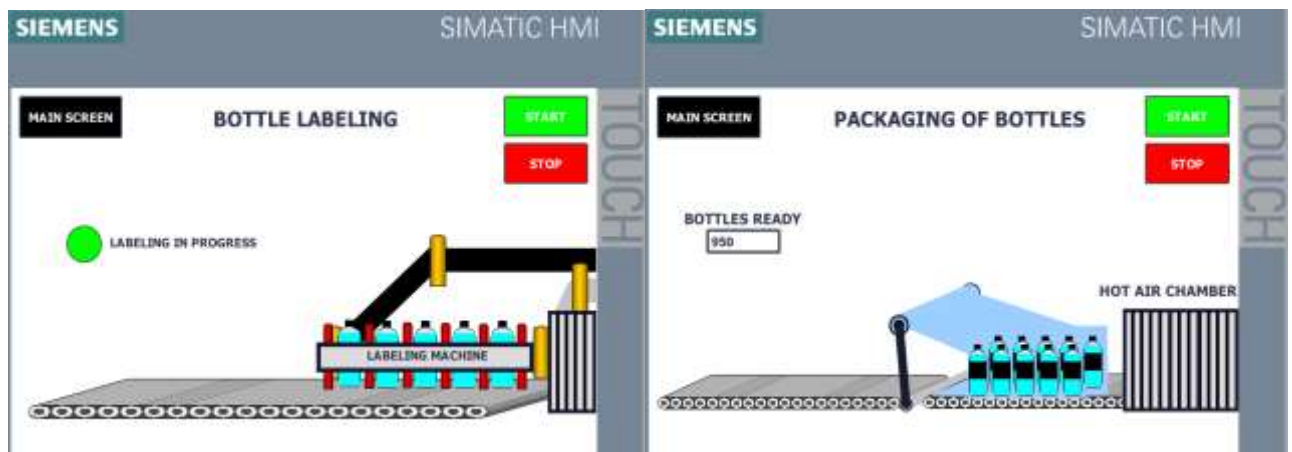


Figure .2 Human-Machine Interface display

The Human-Machine Interface (HMI) designed on the KTP700 Basic panel serves as the central nervous system for operator interaction, translating the invisible bit-logic of the PLC into a high-fidelity visual dashboard. The methodology for the HMI design focused on Cognitive Ergonomics, ensuring that the most critical data—tank levels and system status—are visible at a single glance. The interface is divided into three primary functional zones: the Monitoring Dashboard, the Control Console, and the Diagnostics/Alarm Screen. In the Monitoring Dashboard, we implemented "Linear Scaling" objects that represent the water storage tanks. These objects are linked to the PLC's analog input tags; as the water level in the virtual tank fluctuates, the HMI dynamically updates the fill-level bar in real-time. This provides a clear, quantitative view of resource availability. The Control Console contains the "Soft Buttons" for System Start, Emergency Stop, and Manual Override. Each button is programmed with a "Security Level," requiring an operator login to prevent unauthorized changes to the filling timers or production setpoints. This ensures that the high-speed 100 ms tag acquisition is not compromised by accidental human error during a high-speed production run.

Beyond simple visualization, the HMI methodology incorporates an advanced Alarm Management Framework that is essential for maintaining a high "Overall Equipment Effectiveness" (OEE). Every sensor on the production line is monitored for "Signal Integrity." If the bottle-detect sensor remains active for longer than the maximum bottle width (indicating a jam), the HMI triggers a high-priority red pop-up window with a specific error code. The methodology also includes a "Trend View" screen, which logs the production rate over time. This allows managers to see the "654 bottles per hour" metric as a live graph, identifying any periods of downtime or decreased efficiency. By utilizing the TIA Portal's integrated "Tag Sharing" feature, every variable in the Ladder Logic is directly accessible by the HMI without the need for manual addressing. This "Total Integrated Automation" approach ensures that the HMI reflects the exact state of the PLC at all times. The result is a highly responsive SCADA-lite system that empowers the operator to make data-driven decisions, such as pausing the line for maintenance before a minor mechanical jitter turns into a full-scale system failure, thereby maximizing the lifespan of the physical actuators.

2.3 System Operation and Workflow

The operational methodology of the water bottle processing system follows a strictly sequenced "State Machine" logic, ensuring that no stage of production can begin until the previous stage has cleared its safety interlocks. When the operator initiates the "Start" command via the HMI, the PLC enters the "Ready

State," performing a diagnostic sweep of all I/O modules. Once confirmed, the conveyor motor engages at a frequency-controlled speed. As empty bottles are placed on the conveyor, the infrared sensor at the "Entry Gate" sends a pulse to the S7-1200. This pulse initiates the "Tracking Phase," where the "Virtual Ruler" begins counting. The bottle moves along the belt until the PLC's comparator logic identifies that the bottle is positioned directly beneath the filling nozzle. At this precise millisecond, the conveyor stops, and the system enters the "Filling Phase." The volumetric control logic opens the solenoid valve, and the HMI displays a "Filling in Progress" animation. This phase is governed by a PID-like feedback loop (simulated) that adjusts for fluid pressure to ensure that exactly 500ml or 1000ml is dispensed, minimizing wastage and ensuring that every unit produced is identical in weight and volume.

Following the filling phase, the system transitions into the "Capping and Quality Verification" stage. The conveyor resumes movement for a specific number of pulses until the bottle reaches the capping station. Here, a pneumatic actuator descends to secure the cap. A secondary sensor verifies that the cap has been successfully applied; if the sensor detects a misalignment, the PLC flags this specific bottle as "Defective" and continues the process, but triggers a "Quality Alert" on the HMI for later removal. Once the capping is complete, the bottle moves to the end of the line, where a final "Exit Sensor" increments the "Total Production Counter" stored in the PLC's data block. This workflow is designed to be Cyclic and Non-Blocking, meaning that as one bottle is being capped, the next bottle is already entering the filling station. This overlapping "Pipelining" technique is what allows the system to maintain its high throughput of over 15,000 bottles per day. The entire operation is wrapped in a "Watchdog Timer" logic; if any part of the sequence takes longer than its allotted time, the system enters a "Safe State," shutting down all motors and closing all valves to prevent flooding or mechanical damage, demonstrating a methodology that prioritizes safety as much as speed.

2.4 Advantages

The implementation of the Simulation-Based Fully Automated Water Bottle Processing and Monitoring System offers a wide range of technical and operational benefits over traditional manufacturing setups. By utilizing the Siemens S7-1200 PLC and TIA Portal V16, the system achieves the following advantages:

- **Significant Throughput Optimization:** The system is engineered to maintain a high-speed production cycle, achieving a stable output of 654 bottles per hour (approximately 15,696 bottles per day), which far exceeds the capacity of manual or semi-automated labor.
- **Real-Time SCADA Monitoring:** The integration of the KTP700 Basic HMI provides operators with a "Digital Twin" view of the production line. Real-time linear scaling of tank levels and live production counts allow for proactive resource management and inventory tracking.
- **Enhanced Safety and Error Handling:** The PLC logic includes comprehensive safety interlocks and "Watchdog Timers." If a jam occurs or a sensor fails, the system immediately enters a "Safe State," halting all movement to prevent mechanical damage or fluid spillage.
- **Modular and Scalable Architecture:** The use of modular Ladder Logic (LAD) allows for easy expansion. Additional production lines or filling heads can be integrated by simply duplicating existing logic blocks and mapping them to new I/O modules without redesigning the entire system.
- **Waste Reduction and Sustainability:** Infrared and capacitive sensors ensure the filling valve only opens when a bottle is correctly positioned. This eliminates water wastage caused by empty cycles or misaligned containers, promoting a more eco-friendly manufacturing process.

- **Low Latency Feedback Loops:** With a 100 ms tag acquisition cycle, the communication between the sensors, PLC, and HMI is nearly instantaneous. This ensures that the system reacts to physical changes (like a tank running low) without lag, maintaining a smooth workflow.
- **Cost-Effective Development:** The simulation-based approach allows engineers to fully debug and "stress-test" the control logic in a virtual environment before purchasing expensive physical hardware, significantly reducing the financial risk associated with commissioning and deployment.
- **Simplified Troubleshooting:** The HMI's diagnostic and alarm screens provide specific error codes and status indicators. This reduces the "Mean Time To Repair" (MTTR), as technicians can pinpoint exactly where a fault occurred (e.g., "Conveyor Jam" or "Capping Error") without manual inspection.
- **Consistent Quality Control:** Automated volumetric filling ensures that every bottle contains the exact required amount of liquid, maintaining brand integrity and meeting strict regulatory standards for packaging accuracy.

2.4 Applications

The "Simulation-Based Fully Automated Water Bottle Processing and Monitoring System" is designed with a versatile architecture that extends far beyond a simple water bottling line. Its core logic and HMI framework are applicable to numerous industrial sectors:

- **Beverage and Liquid Food Production:** The system can be easily recalibrated for the high-speed filling of carbonated soft drinks, fruit juices, milk, and energy drinks, where precise volumetric control and hygienic capping are mandatory.
- **Pharmaceutical and Healthcare Manufacturing:** The millisecond precision of the S7-1200 PLC makes it ideal for filling medicinal syrups, saline solutions, and liquid supplements into glass or plastic vials while maintaining strict dosage accuracy.
- **Chemical and Petrochemical Industries:** The "Virtual Ruler" positioning and solenoid-controlled filling logic can be adapted for the packaging of industrial lubricants, detergents, and household cleaning agents, where spill prevention is critical for safety.
- **Cosmetic and Personal Care Packaging:** It serves as a blueprint for automated lines producing shampoos, lotions, and perfumes, where various bottle shapes require the flexible sensor-based detection used in this project.
- **Small to Medium Enterprise (SME) Modernization:** This project provides an affordable entry point for local manufacturers in regions like Hyderabad to transition from manual "fill-and-cap" methods to a fully digitized, smart manufacturing environment.
- **Agricultural Liquid Packaging:** The system can be deployed for the automated bottling of liquid fertilizers and pesticides, ensuring consistent concentration levels and reducing human exposure to potentially hazardous chemicals.
- **Smart Factory Research (Industry 4.0):** The 100 ms tag acquisition and HMI data logging provide a foundation for "Digital Twin" research, allowing companies to analyze production data for predictive maintenance and energy optimization.

3. Conclusion

The "Simulation-Based Fully Automated Water Bottle Processing and Monitoring System" successfully demonstrates the transformative power of PLC and HMI integration in modernizing industrial beverage production. By transitioning from manual oversight to a deterministic, logic-driven architecture using the Siemens S7-1200 and TIA Portal V16, the project achieves a high-performance production environment

capable of maintaining a throughput of 654 bottles per hour. The implementation of the "Virtual Ruler" positioning logic highlights a sophisticated approach to cost-effective engineering, proving that high-speed accuracy can be attained through optimized software algorithms rather than expensive redundant hardware. Furthermore, the 100 ms tag acquisition cycle and real-time SCADA visualization on the KTP700 Basic HMI empower operators with the diagnostic clarity necessary to maintain high Overall Equipment Effectiveness (OEE). The system's modular Ladder Logic ensures that the framework is not only a solution for today's production needs but a scalable foundation for future expansion. Ultimately, this work validates that simulation-based design serves as a critical bridge for industries looking to adopt "Smart Manufacturing" principles, effectively reducing fluid wastage, enhancing worker safety, and ensuring consistent product quality. This project provides a robust, repeatable blueprint for SMEs to achieve global manufacturing standards through accessible automation technology.

4. Future Scope

The future development of this system lies in the integration of Industry 4.0 technologies to transition from a "Fully Automated" line to a "Smart Autonomous" facility. One primary avenue for expansion is the implementation of Machine Learning (ML) algorithms for predictive maintenance; by analyzing historical sensor data, the PLC could predict mechanical fatigue in the conveyor or capping station before a failure occurs. Additionally, the integration of IoT-based cloud gateways would allow for remote monitoring and control, enabling management to access production metrics and adjust setpoints from any location via a mobile application. The system could also be upgraded with Computer Vision (CV) at the quality verification stage to detect label misalignments or micro-cracks in the bottles with greater precision than traditional sensors. Finally, incorporating renewable energy management, such as solar-powered DC-to-AC inverters for the conveyor motors, would align the system with global sustainability goals for carbon-neutral manufacturing.

References

1. N. Nireekshana, A. Archana, and K. Pullareddy, "A Classical H6 Topology for Modern PV Inverter Design," in *Power Energy and Secure Smart Technologies*, CRC Press, 2025, pp. 1–7. Accessed: Nov. 12, 2025. [Online]. Available: <https://www.taylorfrancis.com/chapters/edit/10.1201/9781003661917-1/classical-h6-topology-modern-pv-inverter-design-namburi-nireekshana-archana-pullareddy-kanth-rajini>
2. C. P. Prasad and N. Nireekshan, "A Higher Voltage Multilevel Inverter with Reduced Switches for Industrial Drive," *Int. J. Sci. Eng. Technol. Res. IJSETR*, vol. 5, no. 1, 2016, Accessed: Nov. 12, 2025. [Online]. Available: https://methodist.edu.in/web/uploads/naac/2019-11-19%2012_24_22pm%2092.pdf
3. N. Namburi Nireekshana and K. R. Kumar, "A Modern Distribution Power Flow Controller With A PID-Fuzzy Approach: Improves The Power Quality," Accessed: Nov. 12, 2025. [Online]. Available: https://www.academia.edu/download/112956747/ijeer_120124.pdf
4. N. Nireekshana, N. Ravi, and K. R. Kumar, "A Modern Distribution Power Flow Controller With A PID-Fuzzy Approach: Improves The Power Quality," *Int. J. Electr. Electron. Res.*, vol. 12, no. 1, pp. 167–171, 2024.
5. N. Nireekshana, R. Ramachandran, and G. V. Narayana, "A New Soft Computing Fuzzy Logic Frequency Regulation Scheme for Two Area Hybrid Power Systems," *Int. J. Electr. Electron. Res.*,

vol. 11, no. 3, pp. 705–710, 2023.

6. N. Nireekshana, R. Ramachandran, and G. Narayana, “A Novel Swarm Approach for Regulating Load Frequency in Two-Area Energy Systems,” *Int J Electr Electron Res*, vol. 11, pp. 371–377, 2023.
7. N. Nireekshana, R. Ramachandran, and G. V. Narayana, “A Peer Survey on Load Frequency Control in Isolated Power System with Novel Topologies,” *Int J Eng Adv Technol IJEAT*, vol. 11, no. 1, pp. 82–88, 2021.
8. N. Nireekshana, “A POD Modulation Technique Based Transformer less HERIC Topology for PV Grid Tied-Inverter,” in *E3S Web of Conferences*, EDP Sciences, 2025, p. 01001. Accessed: Nov. 12, 2025. [Online]. Available: https://www.e3s-conferences.org/articles/e3sconf/abs/2025/16/e3sconf_icregcsd2025_01001/e3sconf_icregcsd2025_01001.html
9. N. Nireekshana, K. P. Reddy, A. Archana, and P. R. Kanth, “Solar-Assisted Smart Driving System for Sustainable Transportation,” *Int. J. Innov. Sci. Res. Technol.*, vol. 10, no. 8, pp. 168–173, 2025.
10. N. Nireekshana, M. A. Goud, R. B. Shankar, and G. N. S. Chandra, “Solar Powered Multipurpose Agriculture Robot,” *Int. J. Innov. Sci. Res. Technol.*, vol. 8, no. 5, p. 299, 2023.
11. N. NIREEKSHANA, A. SHIVA, A. FURKHAN, M. SRIDHAR, A. OMPRAKASH, and K. K. SHIVA, “SIX PULSE TYPE SEGMENTED THYRISTOR CONTROLLED REACTOR WITH FIXED CAPACITOR FOR REACTIVE POWER COMPENSATION,” *Int. J.*, pp. 3153–3159, 2024.
12. N. Nireekshana, “Reactive Power Compensation in High Power Applications by Bidirectional cascaded H-Bridge Based Statcom”, Accessed: Nov. 12, 2025. [Online]. Available: https://methodist.edu.in/web/uploads/naac/2019-11-19%2012_45_47pm%20152.pdf
13. N. Nireekshana, G. M. Krishna, A. George Muller, K. Sai Manideep, and M. Abdul Mukheem, “Power Quality Improving using FCL and DVR,” *Int. J. Innov. Sci. Res. Technol. IJISRT*, pp. 624–632, May 2024, doi: 10.38124/ijisrt/IJISRT24MAY025.
14. N. Nireekshana, R. Ramachandran, and G. V. Narayana, “Novel Intelligence ANFIS Technique for Two-Area Hybrid Power System’s Load Frequency Regulation,” in *E3S Web of Conferences*, EDP Sciences, 2024, p. 02005. Accessed: Nov. 12, 2025. [Online]. Available: https://www.e3s-conferences.org/articles/e3sconf/abs/2024/02/e3sconf_icregcsd2023_02005/e3sconf_icregcsd2023_02005.html
15. B. Jula and N. Nireekshan, “Improving the Voltage Profile at Load End using DVR.,” *Grenze Int. J. Eng. Technol. GIJET*, vol. 4, no. 3, 2018, Accessed: Nov. 12, 2025. [Online]. Available: <https://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=23955287&AN=134178998&h=YQk2OkwoPFcVuqJX%2B1rKA0Mbu%2B3%2FNrInXZhf6Wu1MJR4MoiWNdCgc7k4H5aV7e79V%2BdpemgvHWYJbJToV64CuQ%3D%3D&cr1=c>
16. R. Jatoth and N. Nireekshana, “Improvement of Power Quality in Grid Connected Non Conventional Energy Sources at Distribution Loads,” *Grenze Int J Eng Technol GIJET*, vol. 4, no. 3, 2018, Accessed: Nov. 12, 2025. [Online]. Available: https://methodist.edu.in/web/uploads/naac/2019-11-19%2012_58_06pm%20201.pdf
17. N. Nireekshana, R. R. Chandran, and G. V. Narayana, “Frequency Regulation in Two Area System with PSO Driven PID Technique,” *J Power Electron Power Syst*, vol. 12, no. 2, pp. 8–20, 2022.
18. N. Nireekshana, S. Unissa, B. R. Jaleja, C. Mukta Tejaswi, P. Mangathayaru Mahitha, and P. Vaishnavi, “FACTS: Present and Future,” *Int. J. Innov. Sci. Res. Technol. IJISRT*, pp. 2350–2358, Oct. 2024, doi: 10.38124/ijisrt/IJISRT24SEP1424.

19. Namburi Nireekshana, K. Pulla Reddy, Reyya Bose Babu, Bonda Sunder, G. Sumanth Kumar, and P. Vivekananda Raj, “Static Var Compensator for Reactive Power Control,” Feb. 2024, doi: 10.5281/ZENODO.10638477.
20. Namburi Nireekshana, A. Archana, Setla Manvitha, Mohammed Saad Ahmed, Nisar Ahmed Khan, and Akellu George Muller, “Unique Facts Device for Power Quality Mitigation,” Feb. 2024, doi: 10.5281/ZENODO.10652911.