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PLC and LabVIEW Convergence for Smart Industrial Automation

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Abstract: *Industrial automation greatly reduces the need for human sensory, human workforce and cost. This research paper presents integrated bidirectional communication architecture for establishing real-time data exchange between the Allen-Bradley MicroLogix 1000 PLC and the National Instruments LabVIEW graphical development environment. The planned solution for industrial automation is achieved by implementing a real-time controlling and monitoring system. This enabling advanced supervisory control and monitoring in industrial automation systems. The main objective of this study is to detect the damage or fault of the product and consistently record those values over the internet with the presence of classic models of plc, and make monitoring and datalogging. In this outline, the MicroLogix 1000 PLC serves as a real-time control unit and sends process variables such as sensor values to LabVIEW for analysis and visualization. This connection allows operators to monitor the performance of the system in real time. LabVIEW generates setpoints and control commands based on processed data, which are sent back to the MicroLogix 1000 PLC for necessary adjustments. This bidirectional communication enhances system, which are written back to the PLC to enable closed-loop control. By enabling the closed loop control system, the features like live monitoring fault detection, data logging over the internet and also ensures a significant leap in operational efficiency, these chows the how classic PLCs can be revitalized and digitally augmented to fulfill the evolving demands of smart industrial needs.*

Keywords: Allen Bardley PLC, LabVIEW SCADA, Industrial Automation, Real-Time Systems

I. INTRODUCTION

Allen Bardley is one of the PLCs that are widely used in industries for controlling. They are grounded well, but the early models are not built for modern SCADA integration or IoT applications. They don't have built-in web servers, no Ethernet/IP-to-cloud flexibility, no native support for easy logging or remote access. That's the crack they are strong at control, but weak at communication with new gen systems.

LabVIEW is a graphical programming language. It incorporates features that make it possible to use LabVIEW as a SCADA systems development environment. LabVIEW supports a real-time database known as a LabVIEW DSC Tag Engine. One of the ap plications of this tag engine called ``device server'' can communicate with a wide range of standard industry I/O instruments through its support for OPC Applications. or uniquely configured custom devices. Unlike other SCADA packages the LabVIEW HMI provides a complete programming environment to support the communications between the HMI and the tag engine (Chattal et al., 2019).

At this stage RSLinx Gateway comes in. It acts as an Object Linking and Embedding for Process Control server - This means in opens internal PLCs data like tags, bit, timer, register external software through a standard format. Using OPC Client functions, can connect to RSLinx, write data, read data, and acts like SCADA

Think of RSLinx as a decoder that observes PLC's internal language and presents it in a form LabVIEW understands. That is the target to attaining the classic MicroLogix PLCs get the power that is efferences like modern Programmable Logic Control. The efficiencies are fast decision-making, real-time relationships between non-PLC devices, and non-

PLC workings like Data logging, storing data to the cloud, periodic report generation, and Mailing activities. Programmable Logic Controllers (PLCs) are indeed often referred to as the brains of industries. LabView Connects the human and machine in one part as well and monitors the process continuously like set point sensors inputs, and sends signals to the actuators, which wait for the signals. That is what LabVIEW computations by reading from the Brain of the industry and makes its computations like processing, analysing, decision making, error handling, take place and Write to the PLC, this is called controlling. LabVIEW uses the Datalogging and Supervisory Control (DSC) Module and the LabVIEW Real-Time Module can be used to develop SCADA applications in LabVIEW.Propagating errors is especially important in embedded processors to ensure a safe shutdown (Monitor and Log Data With LabVIEW Real-Time - NI, n.d.).

Here an application helps to understand the LabVIEW SCADAs efficiency. Vision machines help to make decisions by grabbing visual data. The proximity sensor is connected to the PLC, which senses the presence of the metallic object thus the output is digital signal (0 and 1) binary values. Using this presence, the one camera module can able to grab the object image. LabVIEW Vision Developer Module helps to analyses the image like pattern matching and colour detections using the specifications of the object. (It can also analyse size matching and edge detection). By this evaluation results in the LabVIEW makes to trigger the output module interfaced with the PLC. Thus, the result is logged in the array format for report generation and Emailing takes place. This integration makes them smarter and stronger for industrial operations.

TABLE I - Features

Component Type	**Name/Tool**	**Function/Role**
Programmable Logic Controller	Allen-Bradley MicroLogix 1000	Sensors and actuators are linked to this system.
SCADA System	LabVIEW	Provides real-time control, monitoring, and human-machine interaction (Using and Deploying NI OPC Servers, DSC, and LabVIEW OPC UA Toolkit, n.d.).
Communication Linker	RSLinx Classic Gateway	Acts as an OPC/DDE server to connect LabVIEW with legacy PLCs using DF1 protocol.
Supervisory Control Module	LabVIEW DSC Module	Enables alarm management, historical data logging, and distributed SCADA systems.
Vision Module	LabVIEW VDM	Supports image acquisition and processing for object detection and quality control.

II. METHODOLOGY

Integrating ABB with LabVIEW SCADA details with the setup of hardware components, communication protocols, and software logic required to achieve real-time control, monitoring, and vision-based object validation. The proximity sensor triggers image acquisition, which is processed in LabVIEW using the Vision Development Module. Based on the detection results, control signals are sent to the PLC, and system data is logged, visualized, and uploaded to the cloud with automated reporting.

2.1 PLC Integration Strategy

RSLinx Classic acts as the communication bridge between RSLogix 500 and the PLC. To establish the connection, an **RS-232 DF1 driver** is configured in RSLinx Classic by selecting the appropriate COM port and setting parameters such as baud rate, parity, stop bits, and station address to match the PLC's serial settings. Once the DF1 driver is active and successfully recognizes the PLC, RSLogix 500 can be launched to program and monitor the controller in real time via the established serial link.

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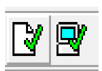
2.2 Driver Configuration for PLC

- Connect the PLC to the power supply.
- Connect the ABB PLC to the COM port of the System (e.g., COM 3).
- First Open the RSLinks Classic – Communications – Configure Driver.
- Configure Driver wizard open – first select all other drivers to stop.
- In Available Driver Type – select RS-232 DF1 devices – click Add New...
- Add New RSLinx Driver Appear – Select the valid Driver (AB_DF1-2) – click OK.
- Configure RS-232 DF1 Device Wizard Appear
- Here now select the COM Port where the Plc is connected.
- Verify the COM Port in device manager in the PC.
- Then Verify Device – SLC-CH0/Micro/Panel/View, Baud Rate – 9600, Parity – None, Stop Bit – 1, Station Number – 1, Error Checking – BCC, Protocol – Full Duplex.
- Now Click Auto-Configure for the Status.
- IF the Status Shown Configuration Successfully. Click OK.

2.3 Programming PLC

- Now Open RSLogix
- Click File - New Write the Ladder logic Program.
- Click For  Error Check. If there is no error.
- Save the Program with the special Title.
- Now Download the program - while downloading the Program, the Program is Download to the PLC Directly.
- And ask to move For Online Mode. Click OK to go to RUN.
- Now The PLC Program, is Downloaded to the MicroLogix 1000 for Integrating with LabVIEW

2.4 Configuring OPC Server

OPC requires an OPC server that communicates with one or more OPC clients. OPC allows "plug-and-play", gives benefits as reduces installation time and the opportunity to choose products from different manufactures (Using and Deploying NI OPC Servers, DSC, and LabVIEW OPC UA Toolkit, n.d.).

RSLinks Configuration: Open RSLinx Classic – DDE/OPC – Topic Configuration – select the program running – add to the Folder as Server

2.5 LabVIEW integration

The OPC items are served from RSLinx, which reads PLC registers. RSLinx (OPC Server) → LabVIEW (OPC Client) LabVIEW subscribes to OPC tags (e.g., RSLinx.OPC_Server\Topic1.Tag1). When the systems are different PCs, data is transferred through DCOM (Distributed Component Object Model).

The connection is achieved in LabVIEW through DataSocket.

2.6 Vision System Integration

2.6.1 Image acquisition using NI IMAQdx

- It involves capturing an image of the object to be analyzed with the help of camera (Fareeza et al., 2018).
- **Camera Selection:** A USB camera was selected through the **IMAQdx device list**, ensuring compatibility with the **NI Vision Acquisition Software**.
- **Frame Capture:** A **single-frame acquisition mode** was used, optimized for accuracy and analysis speed. This frame was passed to the vision module for analysis.

2.6.2 VISA Assistant for Camera Communication

Although not used for image processing itself, the **VISA Assistant module** was configured in the block diagram to:

- Ensure the camera was properly detected and initialized at runtime.
- Manage device-level resource locking to avoid conflicts during live operations.

The VISA module verified the **port enumeration** and established a continuous availability check before executing any image grab sequence.

2.7 Object Detection Algorithm (VDM)

- Capture **pattern features** (edges, geometry, orientation)
- Detect **colour zones** or unique surface tones

2.8 Real-Time Decision Logic

- Thus, the result needed is yes/no. now this is achieved by binary format. By analyzing the object, the decision have been achieved through the Boolean data, it rapidly processed and tell what to do next.

2.9 Control and Monitoring

LabVIEW show that the new system developed would be highly flexible and easy in controlling the level.(Using and Deploying NI OPC Servers, DSC, and LabVIEW OPC UA Toolkit, n.d.)Early, LabVIEW get the signs from the proximity sensor about the presence of object this read by the LabVIEW from the PLC at continuously monitoring. This monitored signal triggers the camera to grab an image. The image is then analyzed efficiently and the decision is lead to control the actuator by write the data to the PLC. This leads in controlling the PLC.

2.10 Visualization and Data Logging

A machine vision system typically consists of machine vision software (machine vision tools) and a camera (image acquisition device). But many other things need to be considered for a machine vision system. Each of the components has its own significance.**(Fareeza et al., 2018)**

Modern industrial automation depends heavily on the capability to visualize and log data during real-time operations for achieving operational excellence. The visual and dynamic features provided by LabVIEW make it play a crucial role in this situation. The visual representation of the graphical interface helps industrial operators and engineers to directly observe how their processes develop in real time.

During process operation the system captures systematic data logs which get stored on cloud infrastructure into a managed accessible database for later examination. This enables:

- Situational decisions making - Process data which enables operational intelligence for tactical adjustments.
- Effective Problem Solving – Rapid identification and resolution of anomalies or faults.
- Deeper Understanding – performance and dynamics.
- Process Improvement - discover performance weaknesses and benefits from optimized procedures.
- Real-Time Awareness – Maintaining continuous, data-driven visibility across the system.

LabVIEW processes sensor and control data points into essential visual pictures that improve human comprehension while promoting elevated supervisory control techniques. The fusion of data logging and visualization creates accessible historical data and live operational status which together form a robust framework for predictive analysis and automated system control. The combination of these integrated features produces a system that enhances its performance to meet Industry needs.

It continuously reads OPC tags (%%MW100, %%I1.0) for process variables (PVs). Updates real-time trend plots (Waveform Chart/Graph). If needed, logs data to file (TDMS, CSV).

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III. MODELING AND ANALYSIS

In this case the Data socket or OPC UA/DCOM libraries connect LabView to the OPC server (RSLinx). Common LabVIEW tools for OPC communication: LabVIEW DSC Module (Data Acquisition & Control) – Provides native OPC support. Shared Variable Engine (SVE) – It can be bound to OPC tags. NI OPC Servers & Clients – For direct OPC DA integration. Fig:1 shows the communication flow for the model of the research which use RSLinks S the OPC Srver Between RSLogix and LabVIEW.

Fig. 1. Communication Flow.

In this context, OPC acts as a tool to facilitate the data flow between the different subsystems. In other words, the data are translated into a common language so every hardware/software element can communicate with the others (Integration of Sensors, Controllers and Instruments Using a Novel OPC Architecture, n.d.). Fig

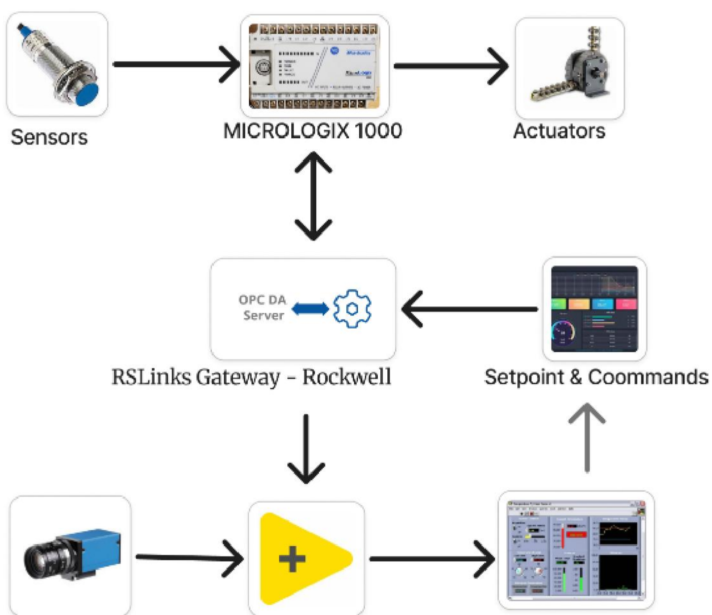

Fig. 2. Data Flow.

The experiment tells the integration between Allen Bradley and LabVIEW SCADA using OPC as RSLogix which seamlessly communication between them. Digital sensor input is actuated in the PLC hardware, were in consistently good acquired in LabView using DataSocker and OPC/io server. Controlling signals issued from LabVIEW where propagated in real time to the PLC, embedding deterministic control industry actuators were connected to PLCs I/O module. Fig.3 results the controlling and the monitoring that is used in the front panel of the LabVIEW SCADA. It is not jest indicator and control it uses DSTP protocol to successfully integrated with the Allen Bradley PLC used here the this protocol used to connect the variety of plc to LabVIEW through the OPC.

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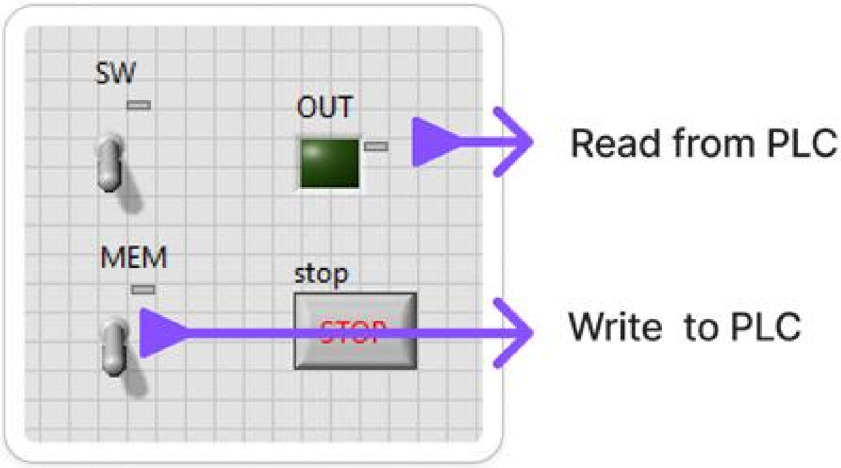

Fig.3. PLC Input and Output in LabVIEW

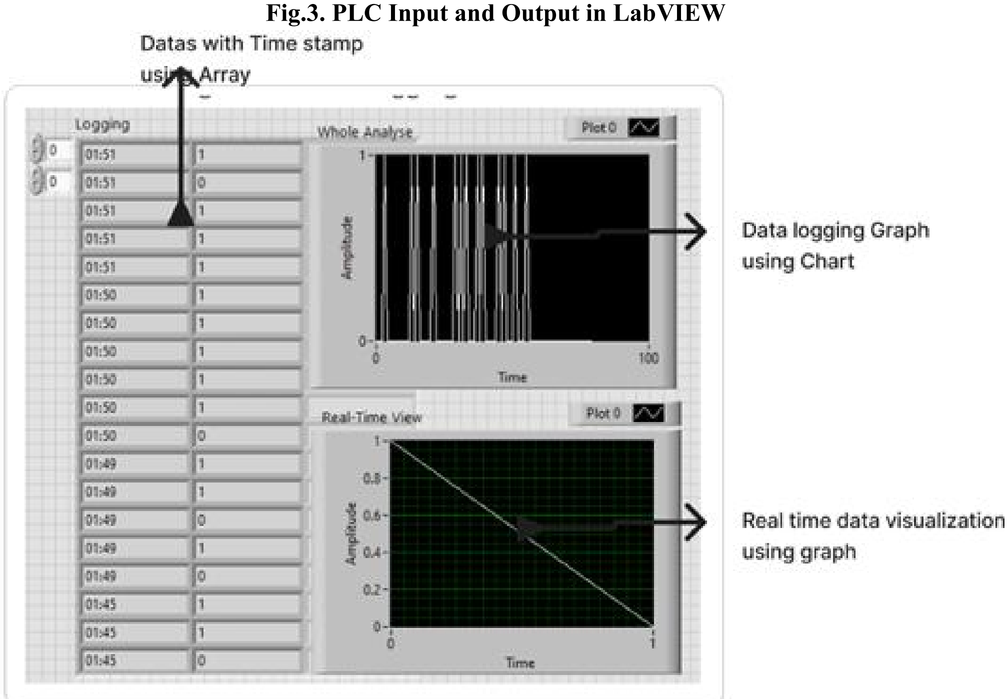

Fig.4. Data logging and Monitoring IN LabVIEW

The modular design of the LabVIEW front panel gives an easy integration of additional Allen Bradley PLC tags without any major reconfiguration. And this Fig.4 shows the are also in the front panel which are the structure and for this efficiency LabVIEW is used as scad that is the unique works like datalogging and mail generations are smarter works that can handled and here the datalogging monitoring array and data logged graph and real monitoring are all the output that can be visually monitored.

Industrial Relevance:

- The implementation tells viable for real-world supervisory control applications and especially in heritage Allen Bradley PLC systems direct IoT capabilities.

- The integration with LabVIEW plays a wide crucial role integrating many more applications for automate the industry even in the case of network and in hardware.

IV. CONCLUSION

This research has closely created an effective way for intelligent communication between LabVIEW and the Micrologix-1000 PLC. By bringing control access into the LabVIEW's world, also enabled more than just basic data acquisition and opened the door to real-time monitoring, automated alarm triggering for enhanced security, and structured data logging for report generation. All this builds to the formation of a complete SCADA application. What matters most now is how this configuration updates the PLC. It has successfully expanded its capabilities with RS-232, with LabVIEW serving as a smart SCADA layer, despite the fact that it lacks native features like Ethernet or sophisticated data handling. This implies that even antiquated gear can now be used in modern automation settings.

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