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Data Acquisition and Control System Using LabVIEW

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Abstract: The project aims to use LabVIEW, a National Instruments-created graphical programming environment, to design and implement a data acquisition and control system for monitoring and regulating physical characteristics. The system emphasizes automation, modularity, and user-friendly visualization, and is used in various applications such as laboratory testing, prototype creation, and industrial automation. The results demonstrate how LabVIEW's powerful tools can enhance system configuration ease, accuracy, and efficiency.

Keywords: National Instruments, LabVIEW, data acquisition, system, control.

I. INTRODUCTION

Data Acquisition (DAQ) systems are crucial in modern engineering and industrial environments for monitoring and controlling physical parameters like pressure, force, and temperature. They enable engineers to capture real-time data from sensors, process it, and make informed decisions. As industries advance towards intelligent automation and Industry 4.0, the demand for flexible, user-configurable, and scalable DAQ systems has increased.

This project aims to create a software-driven DAQ and control system that mimics real-world applications while being accessible and cost-effective. The system ensures secure access, customizable I/O configurations, real-time signal processing, intuitive data visualization, and persistent data storage for analysis and reporting. LabVIEW was used for simulation, utilizing NI-DAQmx simulated cDAQ modules to simulate analog signal acquisition and external device control. The system generates analog sine wave signals at 1000 samples per second, emulating realistic sensor behavior. The system provides a robust platform for exploring DAQ and control concepts in a simulated environment, serving as a learning tool for understanding system integration and real-time data flow.

II. OBJECTIVES

The objective of the project is:
To design, a user-friendly Data Acquisition & Control System in LabVIEW, using NI-DAQmx's simulated cDAQ modules to generate and sample analog signals, securely configure virtual input/output channels, control virtual external devices, and store data under user-defined test names.

III. METHODOLOGY

A. Block Diagram

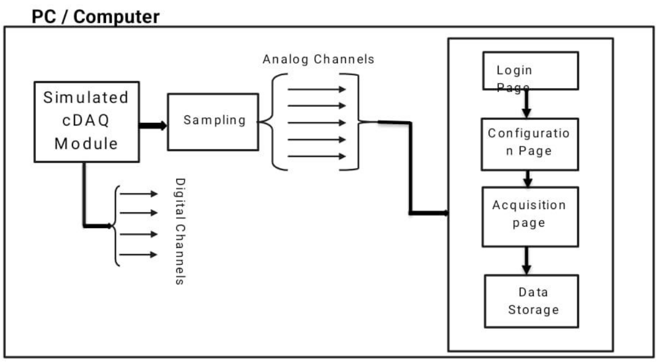

Figure 1. Block Diagram

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1.Simulated cDAQ Module

The Simulated Compact DAQ (cDAQ) Module is a virtual hardware component provided by NI-DAQmx, which allows users to simulate the behaviour of real National Instruments (NI) hardware devices within a software environment. It serves as the core of the data acquisition and control system, enabling development and testing of applications without the need for physical DAQ hardware.

In this project, the simulated cDAQ module is used to perform two key functions:

- Analog Signal Simulation and Acquisition.
- Digital Signal Output for Device Control.

The simulated cDAQ is created and configured using NI Measurement & Automation Explorer (NI-MAX), where a user can choose the device type, channel configuration, and assign virtual names for use in LabVIEW. This feature allows complete system development, validation, and demonstration even in the absence of physical DAQ hardware.

2.Sampling

Sampling converts analog signals into digital data for processing. In this project, the Sampling Module captures signals from the Simulated cDAQ at 1000 samples per second, ensuring high-resolution data. LabVIEW's DAQmx Timing and Read functions enable accurate, continuous acquisition. Sampled data is then processed and stored under user-defined test names for analysis.

3.Analog channels

This project simulates analog channels in a data acquisition system using NI-DAQmx's virtual cDAQ module in LabVIEW, mimicking the behaviour of physical sensors.

Table 1: Analog channels list

No.	Parameter	No. of Channels
1.	Pressure	8
2.	Force	8
3.	Temperature	8

4.Digital Channels

Using NI-DAQmx in LabVIEW, digital channels in the Data Acquisition & Control System mimic external device control in binary mode, simulating actual actuator behaviour in industrial systems.

5.Login Page

The Login Page provides secure access control to the Data Acquisition & Control System, ensuring only authorized users can access and modify their accounts.

6.Configuration Page

The Configuration Page lets users customize system settings. Users can select channels for signal acquisition, set maximum and minimum values, choose channels for controlling virtual external devices, and save their configurations each time they make changes.

7.Acquisition Page

The Acquisition Page is essential for real-time data acquisition and control. It processes signals, visualizes data, and generates control outputs. Users can input a test name, acquire pressure, force, and temperature data, and store it in a file named after the test.

8.Data Storage Page

The Data Storage Page is responsible for logging and managing the acquired data. It ensures that test results are saved properly and can be accessed later for analysing or reporting.

IV. FLOW CHART

The flowchart illustrates how the user interacts with the Data Acquisition & Control System, ensuring smooth navigation, data integrity, and user accountability.

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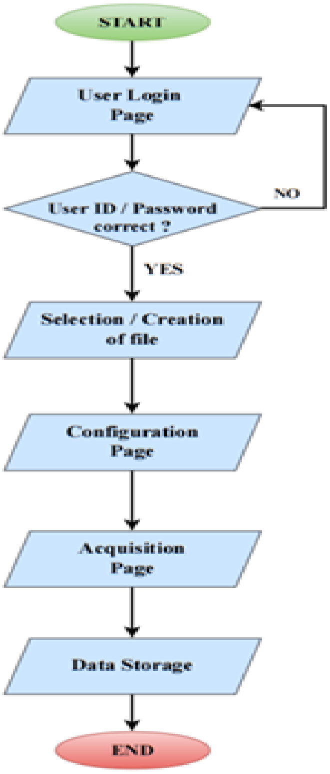

Figure 2. Flowchart

V. RESULTS AND DISCUSSION

1. User Login Window

The Login Module ensures secure user authentication for system access, offering registration and password update options. It effectively restricts unauthorized entry, provides functional features like new registration and password change, and handles access errors efficiently.

Figure 3. User Login Window

2. Configuration Window

The Configuration window enables users to configure input channels, operational parameters, and threshold values for customized acquisition sessions, generating a configuration data file for review or validation.

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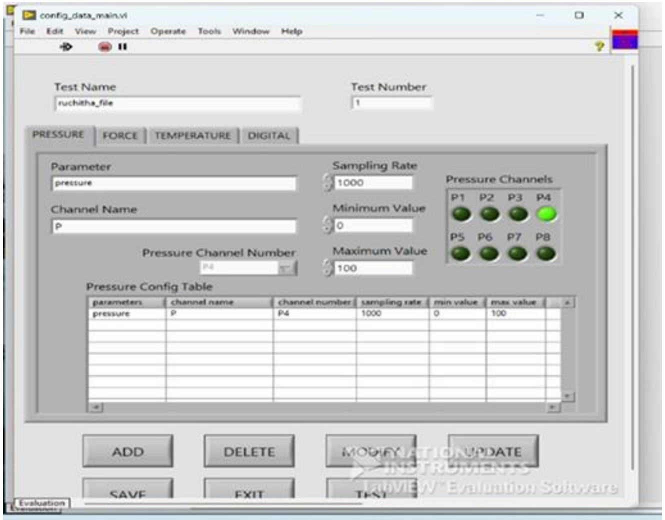

Figure 4. Configuration Window

3. Acquisition Window

The Acquisition window efficiently manages real-time data acquisition, processing, and visualization, ensuring accurate data display and seamless control of virtual external devices via digital outputs.

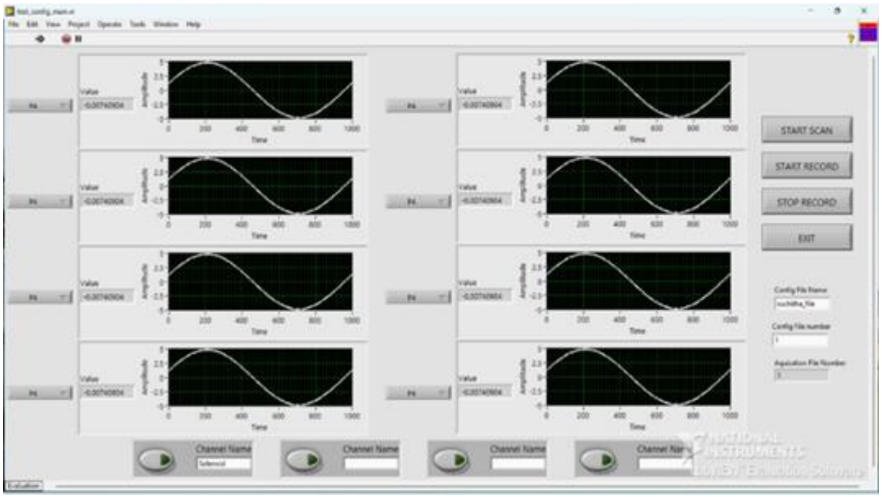

Figure 5. Acquisition Window

4. Data Storage Module window

The Data Storage Module in LabVIEW efficiently logs and retrieves data under user-defined test names, providing insights on signal flow, sampling accuracy, device control, and data handling, with timestamped values and digital outputs.

VI. APPLICATIONS

1. Industrial Automation: Monitor and control machinery and equipment in manufacturing plants using real-time sensor data (e.g., pressure, force, temperature).
2. Environmental Monitoring: Acquire data from remote sensors for parameters like temperature, humidity, and air quality to monitor and manage environmental conditions.
3. Research & Development: Test and validate prototypes or new product designs by collecting and analysing sensor data under various operating conditions.
4. Healthcare Applications: Interface with biomedical sensors to monitor patient vitals (e.g., body temperature, respiration rate) and visualize data for diagnosis or remote monitoring.

VII. ADVANTAGES

1. Hardware-Independent Development: The system was developed and validated using NI-DAQmx simulated cDAQ modules, allowing complete testing and demonstration without requiring physical hardware. This makes it cost effective and ideal for prototyping and academic environments.
2. User-Friendly Interface: The graphical front panel built in LabVIEW provides an intuitive interface for configuration, acquisition, and monitoring. Users can easily navigate through different modules without prior programming experience.
3. Secure Access Control: The system includes a login module that enables secure user authentication, ensuring that only authorized users can access or modify test data and settings.
4. Customizable Configuration: Users can flexibly select input/output channels and set threshold values based on application needs. The configuration settings are saved and associated with specific test names for traceability.

VIII. LIMITATIONS

1. Lack of Physical Hardware Integration: The system is entirely simulation-based using NI-DAQmx simulated cDAQ modules. It does not interface with real sensors or actuators, which means physical behaviours such as signal noise, latency, hardware faults, or device response time are not tested.
2. Fixed Signal Type: The analog input is limited to a simulated sine wave. The system does not currently support variable waveform types or external signal conditioning, which would be necessary for more diverse or realistic testing.
3. No Remote Access or IoT Support: The current implementation is desktop-based and does not support remote monitoring, cloud integration, or wireless sensor networks, which are increasingly important in modern DAQ systems.

IX. FUTURE SCOPES

The system, designed for scalability and real-world deployment, operates in a simulated environment and can be enhanced for improved functionality, usability, and practical applicability.

1. Integration with Physical Hardware: The system can be extended to work with actual NI cDAQ hardware and real sensors, enabling real-time monitoring and control in physical environments such as laboratories, manufacturing plants, or remote monitoring setups.
2. Support for Multiple Signal Types: Future versions can include support for various types of analog and digital signals, including triangular, square, or custom waveforms, as well as sensor-specific calibration and filtering.
3. Wireless and IoT Connectivity: Adding remote monitoring features using cloud platforms (e.g., ThingSpeak, MQTT, or LabVIEW Web Services) will allow users to view data and control devices from anywhere.

X. CONCLUSION

The Data Storage Module in LabVIEW efficiently logs and retrieves acquired data under user-defined test names. It saves data with timestamped values and digital outputs, allowing users to review and display in binary formats. The system mimics real-world scenarios, providing insights on signal flow, sampling accuracy, device control, and data handling. Can you provide examples of how users can benefit from the systematic logging and retrieval features of the Data Storage Module in LabVIEW.

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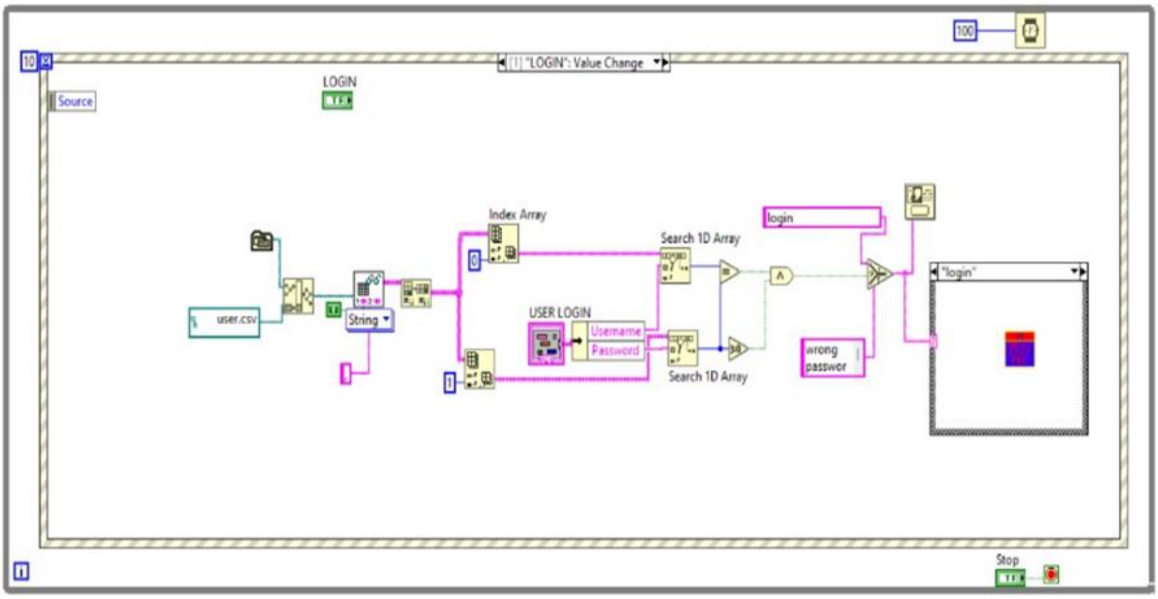
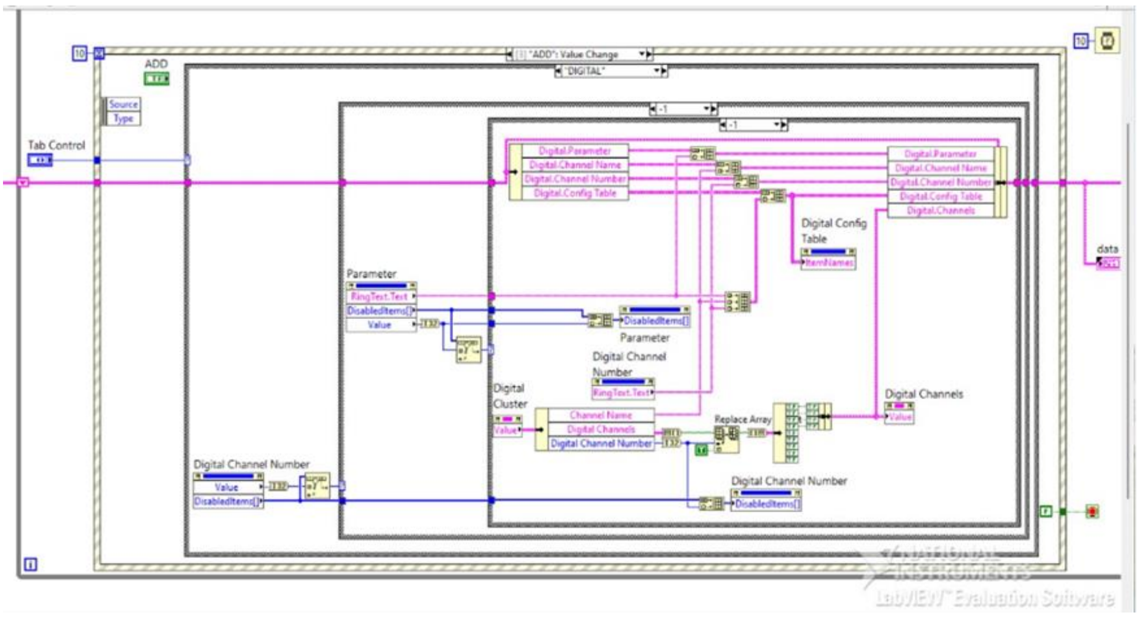
APPENDIX

USER LOGIN WINDOW CODE



CONFIGURATION WINDOW



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ACQUISITION WINDOW