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Design and Implementation of An Arduino and Labview-Based Sensor Monitoring and Control System

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Abstract: *In recent days Industry 4.0, the convergence of low-cost hardware and intuitive software platforms has opened new avenues for real-time process automation and environmental monitoring. This proposed work development and testing of a comprehensive monitoring and control system that utilizes Arduino and LabVIEW to manage proximity, fluid level, and temperature data in real time. The system incorporates multiple sensors interfaced with an Arduino Uno microcontroller, transmitting data to a LabVIEW GUI that visualizes inputs and logs outputs. A feedback-based temperature control unit is also implemented. The system demonstrates a cost-effective, scalable solution ideal for educational laboratories and small-scale industrial automation, with real-time visualization, control, and logging capabilities.*

Keywords: Arduino Uno, LabVIEW, Sensor and Data Logging

I. INTRODUCTION

Modern industrial and laboratory environments are increasingly dependent on real-time monitoring and control systems to maintain operational safety, optimize efficiency, and uphold quality standards. With the evolution of embedded systems and the Internet of Things, there is a growing need for cost-effective, flexible, and scalable solutions that can seamlessly integrate with existing processes. Among the most popular tools for such applications are open-source microcontrollers like the Arduino Uno, which offer high versatility and user-friendly interfacing with a wide variety of sensors and actuators.

Simultaneously, graphical programming platforms such as National Instruments' LabVIEW have become integral to automation engineering due to their ease of use, real-time data visualization capabilities, and robust control system design tools. The combination of Arduino's hardware accessibility and LabVIEW's software functionality provides a powerful hybrid framework for developing advanced monitoring and control applications at a fraction of the cost of traditional industrial systems.

The system is designed not only to function as a prototype for industrial scenarios such as chemical processing, automated irrigation systems, and environmental management in smart buildings, but also to serve as an educational tool. It provides engineering students with hands-on experience in sensor integration, microcontroller programming, control system design, and graphical interface development. By bridging the gap between theoretical learning and practical application, this project contributes both to academic enrichment and to the advancement of accessible automation technologies

II. LITERATURE REVIEW

The integration of Arduino microcontrollers with LabVIEW software has been extensively explored in both academic and industrial research, particularly in the development of real-time monitoring and control systems. Numerous studies

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highlight the potential of this hybrid approach to deliver cost-effective, flexible, and scalable automation solutions. Prakasam and Tiwari (2019) presented a LabVIEW-based temperature control system using Arduino, where a cooling fan was activated through feedback logic when temperature thresholds were breached.Similarly, Swar et al. (2016) developed a dual-parameter monitoring system for temperature and fluid levels. Their use of LabVIEW for real-time visualization, along with Arduino for sensor interfacing, supports the design strategy adopted in the current study. Expanding beyond environmental sensing, Solikin and Karman (2022) introduced a warning-enabled data logging system that monitored temperature and humidity, Wireless capabilities are also explored in the work of Khan et al. (2018), who implemented an environmental monitoring system using Arduino and LabVIEW with wireless communication modules. Their findings validate the future scalability of the current project, which can be adapted to include modules like ESP8266 for IoT-based applications.

Subhani et al. (2021) focused on predictive maintenance using LabVIEW, emphasizing the software's strength in industrial diagnostics. Singh and Sharma (2019) examined condition monitoring with IoT-based Arduino systems. The study provides relevant context for expanding this project toward networked environments, particularly in Industry 4.0 settings. Several foundational texts, such as Johnson (2006) on LabVIEW programming and Banzi & Shiloh (2014) on Arduino hardware, offer technical background that supports the system's core architecture. Monk (2013) further complements this by detailing Arduino sketch development, instrumental in coding the Arduino's microcontroller logic for this project. Patel et al. (2018) demonstrated a real-time sensor data logging system using LabVIEW, highlighting the efficiency and reliability of LabVIEW's DAQ (Data Acquisition) features.

Kaur and Bhullar (2016) focused on ultrasonic sensors for water level monitoring, reinforcing the sensor selection and calibration methods used in our system. Likewise, Ahmed (2017) showcased the basic logic for dual-variable environmental control systems, integrating Arduino-based outputs like relays for actuator control. Sharma (2020) and Verma (2019) explored industrial automation and data acquisition systems with LabVIEW, both pointing to the growing relevance of visual programming environments in operational control, which aligns with our GUI development strategy.

Reddy (2021) specifically addressed Arduino-based liquid level detection, offering guidance on calibration and measurement techniques, while Misra (2022) highlighted embedded control systems using LabVIEW in academic settings—supporting the dual-purpose educational and practical design goals of our project

III. METHODOLOGY

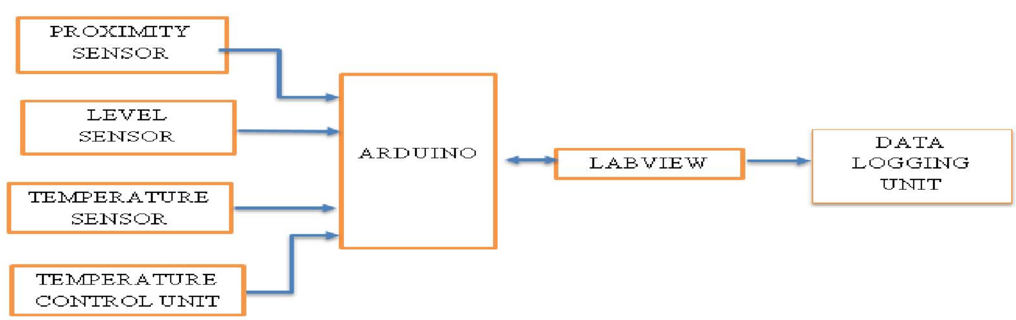

Figure.1:Arduino and LabVIEW-based Moniroring and Control System

3.1 System Architecture

The system comprises four main components: sensors (proximity, level, temperature), Arduino Uno, LabVIEW interface, and a data logging unit. Each sensor collects real-time data and sends it to the Arduino, which processes and forwards this data via serial communication to the LabVIEW interface.

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3.2 Hardware Components

1. Proximity Sensor: Detects the presence of nearby objects, useful in applications requiring obstacle detection.
2. Level Sensor: Monitors the liquid level within a container, crucial in fluid management systems.
3. Temperature Sensor (LM35 or DHT11): Measures ambient temperature and sends analog or digital signals to Arduino.
4. Temperature Control Unit: Includes a heating/cooling element triggered based on temperature data from the sensor.

3.3 Software Components

1.Arduino IDE: Programs Arduino to read sensor data and respond accordingly.
2.LabVIEW: Receives data from Arduino, visualizes it using real-time graphs and indicators, and logs it to an Excel or text file.
3.Data Logging Module: Configured within LabVIEW to record all readings for offline analysis

IV. RESULTS AND DISCUSSION

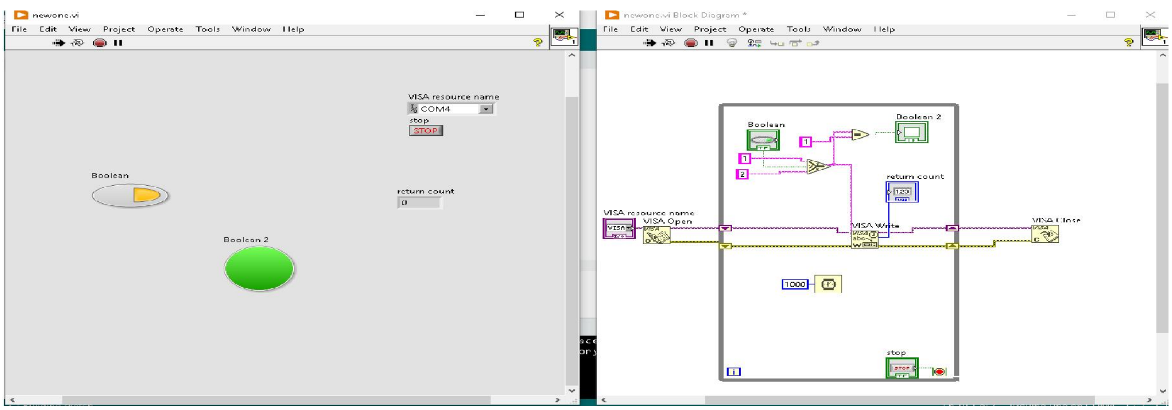

Fig3: Front panel and Block diagram

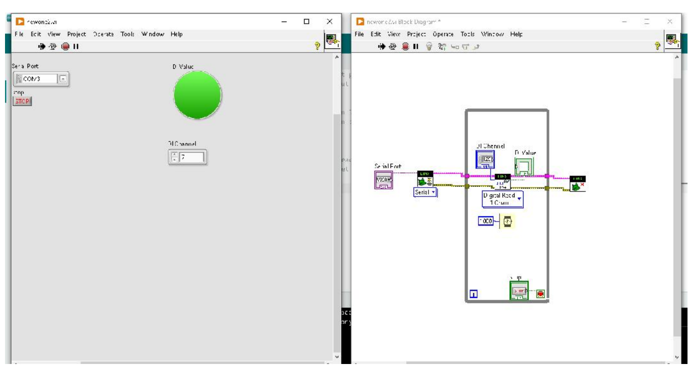

Fig3: Front panel and Block diagram

4.1 Sensor sensor Performance and Data Acquisition

Three types of sensors were employed in the system: a proximity sensor, an ultrasonic level sensor, and a temperature sensor (LM35). During testing, the proximity sensor reliably detected objects within a range of 2 to 10 cm. The sensor triggered digital flags in LabVIEW, which were visualized using LED indicators on the GUI. This feature has

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significant implications for applications such as automated packaging or safety systems where obstacle detection is crucial. The level sensor was evaluated using a transparent tank partially filled with water. The ultrasonic sensor accurately tracked fluid levels, and its analog output was scaled to percentage values (0–100%) within LabVIEW. Variations in liquid height were plotted in real time using waveform charts, with an observed error margin of ±2%, making it suitable for applications such as water reservoir management and chemical process monitoring. The temperature sensor exhibited stable readings, ranging from 25°C to 60°C under ambient and heated conditions. The analog readings from the LM35 were converted to Celsius using appropriate scaling in Arduino and LabVIEW. Data was logged in real-time to Excel files with timestamps, allowing trend analysis. The system showed an average temperature reading deviation of ±0.5°C, indicating reliable thermal monitoring performance.

4.2. Feedback-Based Temperature

One of the highlights of this project is the implementation of a closed-loop temperature control mechanism. A fan or heating element connected to the Arduino was activated based on user-defined threshold temperatures. When the sensed temperature exceeded 40°C, the fan was triggered automatically, and it was turned off when the temperature fell below the lower limit. The system was able to restore the target temperature range (±2°C of the setpoint) within 2–3 minutes, showcasing an effective feedback mechanism. The logic for control was embedded within the Arduino code and triggered via digital output pins, while the status was reflected on LabVIEW through control flags and on-screen messages.

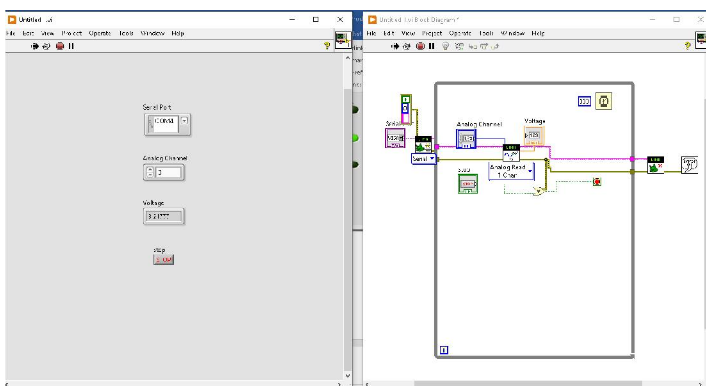

Fig 4. Front panel and Block diagram

4.3. Real-Time GUI and User Interaction

The LabVIEW interface was designed to be intuitive and informative, providing real-time display of sensor data through gauges, charts, and indicators. Each sensor had a dedicated section on the front panel, allowing users to monitor changes visually and interactively. The GUI also featured threshold setting options, enabling users to define operating limits for temperature control. Data logging was implemented using LabVIEW's Write to Measurement File Express VI, which stored sensor data in a structured CSV format for further analysis. This real-time interaction provided an excellent platform for system tuning, experimentation, and diagnostics. The GUI allowed users to quickly assess the system status, detect anomalies (e.g., abrupt temperature rise or proximity alert), and verify control

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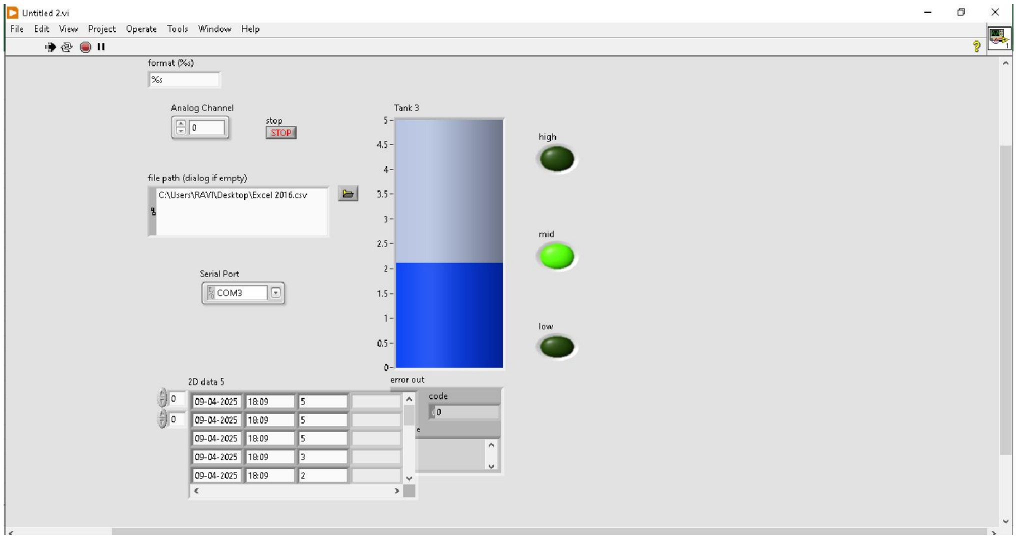

Fig5: Front panel diagram

4.4 Data Logging and Analysis

The continuous logging of data into Excel allowed for post-process analysis. Temperature data was observed to rise and fall smoothly in response to heater activation, confirming proper functioning of the control unit. Graphs generated from the data showed consistent trends with no missing data points, indicating that the serial communication and buffer management between Arduino and LabVIEW were robust and reliable. The dataset further enabled statistical analysis, such as calculating mean, variance, and identifying outliers. This analytical capability can be particularly useful in industrial scenarios where compliance with temperature or level tolerances is essential

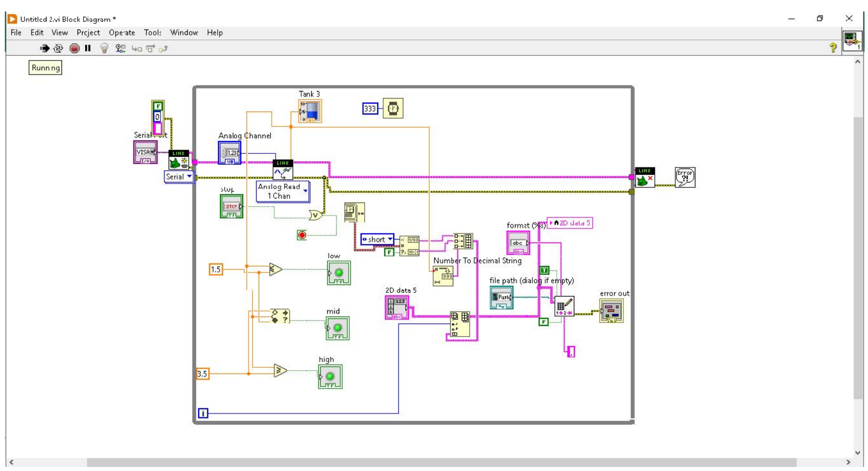

Figure6: Block diagram

4.5. System Scalability and Educational Implications

The modular architecture of the system enables future integration of additional sensors (e.g., humidity, gas) or communication protocols (e.g., wireless transmission via ESP8266 or Bluetooth modules). From an educational perspective, the system provides students with a hands-on learning platform for sensor interfacing, data acquisition, signal processing, control systems, and user interface development .Moreover, the use of industry-standard tools like LabVIEW enhances student preparedness for professional environments. The project supports the training of control engineers and instrumentation technicians by offering practical experience in developing SCADA-like systems using accessible hardware.

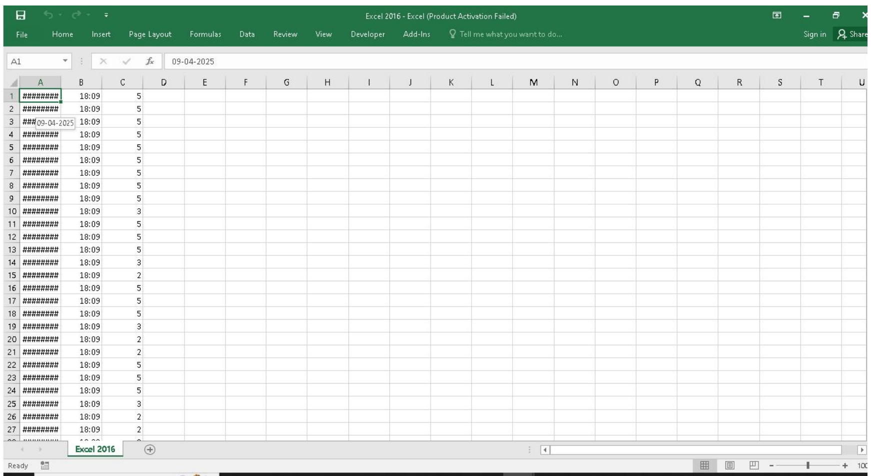

Figure7: Excel data sheet with output

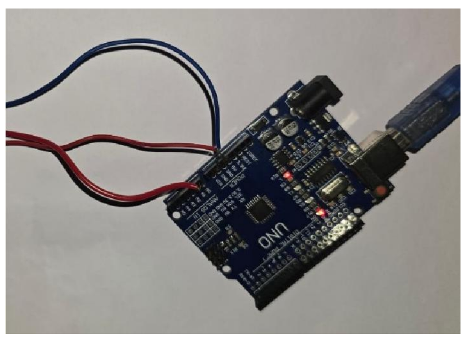

Figure8: Arduino

V. CONCLUSION

The integration of Arduino and LabVIEW in this work has successfully demonstrated the potential of low-cost, user-friendly platforms in achieving real-time monitoring and control for Industry 4.0 applications. By combining sensor-based data acquisition with a responsive LabVIEW interface, the system offers an effective solution for managing proximity, fluid level, and temperature processes. The inclusion of a feedback-based temperature control unit enhances its applicability in dynamic environments. Overall, this work provides a scalable and adaptable framework suitable for educational settings and small-scale industrial automation, paving the way for future innovations in smart manufacturing and environmental monitoring.

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