Design and Implementation of SCADA System for Micro Industries

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***Abstract*—The main thing of the design is to install a SCADA system for wireless real- time data accession operation. We need to cover all the processes and control the affecting factors since colorful processes are carried out at the same time in large diligence. We can achieve the thing by installing a technology like Wireless SCADA. Microcontroller AT89S52 is connived with temperature detectors. The microcontroller transmits the data continuously wirelessly from the detectors, which is entered at an original USB type trans- receiver with a PC or laptop. The PC software installed saves the information in the database and presents it on the frontal panel of the PC or laptop. The SCADA screen will allow us to change parameters like set point, lower limit, and upper limit. The microprocessor turns on the corresponding relay the moment a detector temperature goes below the specified position. Field bias which are logically connected through relay connections are switched OFF from ON in comparison to their detectors. High and low limits(settings) can be performed so that an alarm is touched off on the PC in case of system failure. SCADA can be used not only at points of exposure but with accurate and safe controlling as well. We can acclimate the parameters and set points on the SCADA screen.**

***Keywords*—SCADA, Microcontroller, Temperature sensor**

I. INTRODUCTION

Supervisory Control and Data Acquisition is a hardware and software system that allows remote or local monitoring and control of industrial or other processes. The SCADA unit allows easier and simpler monitoring and control of all stages of the manufacturing process [1]. The SCADA system is used more today, and its usage grows day by day, but it cannot be utilized by small and medium-sized enterprises to control their plant process because of added expenses. If wired connectivity to a remote site would be expensive or labor-intensive, wireless SCADA would have to be employed. Its Wireless technology, now widely used in the IT community in recent years, can also be suitable for industrial control networks, providing high return on investment solutions for diagnostics, control, and safety. The power-efficiency, timeliness, and scalability also have some potentially interesting characteristics for supporting large-scale ubiquitous computing applications. It is evident from wireless replacement of wires management that standard wireless standards such as Wi-Fi and Bluetooth can be used in manufacturing settings [2,7]. Below shown figure illustrates a block of communication hardware design.

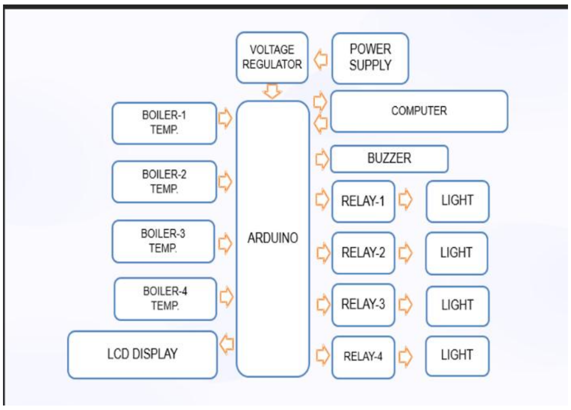

Figure 1: Block Diagram

II. LITERATURE REVIEW

SCADA systems are extensively used in critical infrastructure and mass industries. Earlier studies indicate the use of wired systems for reliability, but recent studies indicate the feasibility of wireless technologies such as Wi-Fi, Zigbee, and Bluetooth in industrial automation. The project intends to fill the gap between cost-effectiveness and industrial requirements by taking a microcontroller-based wireless approach.

Shinde et al. noted the real-world limitations of situations, such as varying ambient conditions. Such variations were overcome by this project, although controlled environments remain best for accuracy. Phuyala et al. showed the way SCADA integrated with PLCs is optimized for industrial monitoring. Similarly, our use of microcontrollers like ATmega328 offered a low-cost option without sacrificing performance. The tests conducted by Dewi et al. on Zigbee-based WSN reflected high correlation of temperature and level sensing, thereby verifying the accuracy and effectiveness of wireless data gathering systems [2019][9].

Nadagoudar et al.'s [2020] IOT-based SCADA system advanced the idea of low-cost real-time access to information, something that is also represented in our prototype [11]. In addition, open-source libraries including Arduino IDE and Dot Net backed by standard communications protocols and constituents facilitated system responsiveness and simplicity when designing user-centric interfaces.

III. METHODOLOG

SCADA is an automation control system in industry that centrally monitors and controls processes in such sectors as oil and gas, power, manufacturing, and water [3]. It collects information from remote sensors and devices and displays it at a centralized control room to be analyzed and automated. The main components include HMIs, PLCs, RTUs, and communication networks. The developing SCADA technology more and more relies on cloud computing, AI, and IoT to enable improved real-time efficiency, reduced downtime, and optimized operation. The concerned system uses a Wireless SCADA system with the capacity to monitor and control actual industrial temperature readings. The technique relies on the incorporation of temperature sensors into a microcontroller (AT89S52 or ATmega328), wireless data transmission, and a PC user interface for SCADA visualization and control.

3.1 System Design and Hardware Components

1. Microcontroller Unit:
AT89S52 or ATmega328 microcontroller serves as the primary processor unit. The microcontroller supplies information to, as well as reads information from, the temperature sensors, and commands to be transmitted wirelessly.

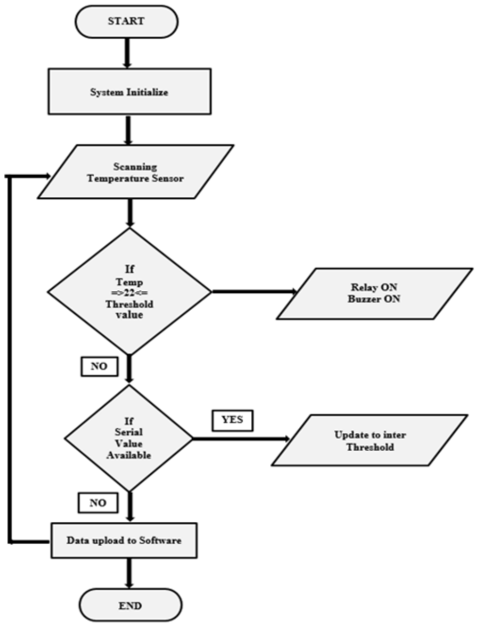

Figure 2: Flow Chart of System Process

2. Wireless Module:
Xbee or Zigbee modules are utilized for creating a wireless data communication channel between the microcontroller and the PC-based SCADA system.
3. Relays:
The microcontroller drives four relays to operate field devices based on sensor values.
4. LCD Display:
A 20x4 LCD is powered by the microcontroller for local display of temperature readings.
5. Buzzer:
A microcontroller-driven buzzer is utilized for providing audio alarms for temperature limits crossed.

3.2 System Design and Architecture

1. Data Acquisition Unit– It is built based on AT89S52 microcontroller to which temperature sensors are mounted.
2. Wireless Communication Module – Facilitates data transfer between the host computer and microcontroller.
3. SCADA Interface – Implemented on a PC/laptop and performs visualization, control, and logging of the system parameters.

3.3 Sensor Integration

Temperature sensors are connected to the AT89S52 microcontroller's analog input pins (via an ADC). Temperature readings in the industrial environment are regularly monitored by these sensors.

3.4 Microcontroller Programming

The AT89S52 microcontroller is designed to:

- Compare with pre-set threshold values (set point, lower limit, and upper limit).
- Send data wirelessly using a USB-type wireless transceiver module.
- Trigger relay control based on threshold conditions to switch field devices ON or OFF.
- Send command/status signals to the SCADA system for visual display or alarms.

3.5 Wireless Data Transmission

The microcontroller data is transferred in real time to the PC/laptop through a suitable wireless transceiver. An equivalent USB receiver is connected to the computer to receive the data being transmitted.

3.6 SCADA Software Development

Custom SCADA software is programmed and loaded onto the host computer.

- A graphical user interface to show temperature data.
- A data logger that stores temperature readings in a local database.
- Control parameter input fields to modify control parameters: set point, lower limit, and upper limit.
- Alert mechanisms to warn users when limits are hit.
- Control logic to send commands back to the microcontroller to drive relays.

3.7 Relay and Field Device Control

- When it senses a temperature reading below or above the given threshold, the microcontroller:
- Initiates the respective relay circuits for activation signals.
- The relays turn on/off external devices such as heating or cooling systems.
- This facilitates automated temperature control and system protection.

3.8 Safety and Alarm System

For added reliability, the system includes alarms triggered by means of the SCADA interface if sensor inputs are beyond critical limits. This permits prompt action by the operator and reduces the chance of system failure or unsafe conditions.

The main role of the SCADA system is industrial and infrastructural process monitoring and optimization via a centralized data acquisition, monitoring, control, and reporting. Measurement and monitoring of WSN are applied very extensively in the industrial sector. To monitor the levels and temperatures of Zigbee Wireless Network Sensors' blending in this research, WSN technology has been employed [5]. SCADA technology is used universally in many micro-industries for improving diverse processes. In a small-scale manufacturing environment, SCADA helps operation such as the metalwork, plastic melding, and assembly lines by controlling and monitoring a machine's health in the production process [6].

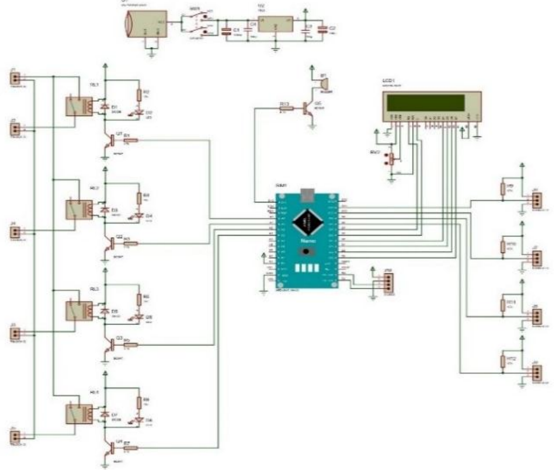

Figure 3: Circuit Diagram

2.1 Working of the Code

This is a SCADA system code written in C++ using Arduino. It is used to control four temperature sensors and four relays, as well as a buzzer, that are interfaced with an Arduino board. The temperature sensors are connected to digital pins 11, 10, 9, and 8, respectively. The relays are connected to analog pins A0, A1, A2, and A3. The buzzer is connected to digital pin 13. The sensor's temperature readings are displayed on a 20x4 character LCD that is connected to the Arduino board with digital pins 7, 6, 5, 4, 3, and 2. Serial communication is set up at a baud rate of 9600 and the LCD display is set up in the code. In the setup function, the code initializes the temperature sensors and defines the mode of the relays and buzzer as output. In the loop function, the code receives serial data sent from a remote device and checks the value of the received code. Based on the code, the code sets the temperature value for all the four temperature sensors [4,5]. The outputs of these temperature sensors can be used to drive the relays and the buzzer

IV. RESULT AND DISCUSSION

The system successfully demonstrated real-time temperature monitoring and control using wireless communication. Relay operation and alarm generation responded appropriately to user-defined set points.

Radio reliability and range worked well in indoors i ndustrial environments. The system offers a cost-effective, scalable alternative to traditional SCADA systems for SMEs.

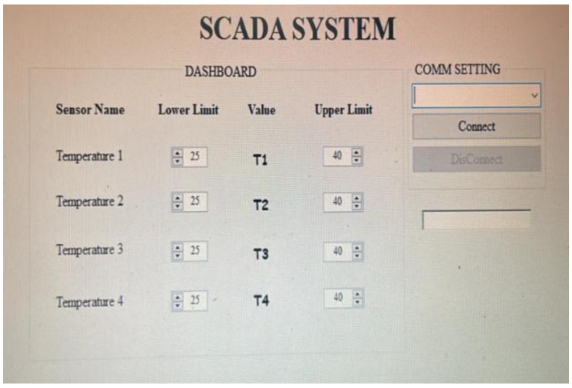

Figure 4: SCADA System

A. Accurate Real-Time Monitoring:

Accurate real-time data acquisition from temperature sensors with correct transmission to the monitoring PC through a wireless USB-type trans-receiver.

B. Dependable Relay Control:

Devices turned ON/OFF based on current temperature values and thresholds set.

C. Alarm Accuracy:

Alarm generation by buzzer operation occurred rightly whenever the temperature sensed deviated outside the user-defined range, verifying fault detection functionality.

D. LCD Output:

LCD output for direct numerical feedback of sensor readings.

E. SCADA

interface implemented with DotNet effectively displ ayed sensor readings and permitted user control of threshold values and set point.

The system responded well to control commands issued from the SCADA interface to the microcontroller, thus proving the entire closed-loop control mechanism.

V. CONCLUSION

The creation of an inexpensive prototype wireless SCADA system to measure load conditions and temperature at a far-off plant. Based on a (programming language) platform, the system will collect real-time data and send it to a PC to be monitored and supervised. Ideal for mini-scale operations, it can be used in small and medium enterprise applications, independent microgrids, and hybrid microgrid systems. The system can be exploited for both educational and commercial use, and possible future developments can include a web-enabled interface and SMS alerts to enhance user convenience and real-time notifications [8].

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