Industrial Parameter Monitoring and Logging System based on SCADA

[1]Nandhini.G, [2]Dr.S.Jayanthy
M.E., Student, Professor
Department of Electronics and Communication Engineering
Sri Ramakrishna Engineering College
Coimbatore

Abstract
The aim of the paper is to develop a microcontroller based embedded SCADA (Supervisory Control and Data Acquisition) system to monitor and control various parameters in industry. In this paper, industrial real time data is collected from different modules such as temperature, humidity, carbon, dust and fire sensors are processing using PIC microcontroller and values are displayed on the Liquid Crystal Display. Simultaneously the SCADA tool monitors all the parameters in the Remote Terminal unit (RTU). When the carbon sensor value is high above the threshold, automatically the exhaust fan will be switched ON and remove contaminate air from the area. Similarly when fire is detected, the pump is turned on and spray the water automatically through relay. All the sensor readings are gather, monitor and processed by the SCADA tool in the Remote Terminal Unit.

Keywords - *Sensor, Relay, LCD, SCADA, Remote Terminal Unit (RTU), Exhaust fan, Pump*

I. INTRODUCTION

SCADA (supervisory control and data acquisition) is a type of control system in software. Most of the control systems in industries are computer controlled systems that monitor and control the real time processes in industries that exists in the physical world. Basically SCADA system is used for automation in industries. In plant SCADA systems generally installed in control room. SCADA system having three types of working stations in control room, first working stations are operating station. In operator station the users can only do real time process parameter monitoring functions. The second type is called Engineering station in such type of work station users can able to do process parameter monitoring function and modification. Then third type of work station is known as server station. In this station users do not monitor. The SCADA system software have stored in server as backup data when in any main station.

A supervisory control and data acquisition (SCADA) system consists of one or more computers with appropriate software (Master Stations) connected by a communication system to a number of remote terminal unit placed at various locations to collect data and for remote control and to perform intelligent autonomous control of a system and report results back to the remote masters. SCADA system includes hardware and software component to control the industry from long distance.

The real time data is collected from different sensors are processing using PIC Microcontroller. In SCADA systems, data acquisition is monitor and control are performed by remote terminal unit (RTU). The main advantage of SCADA is Continuous monitoring of process, Real time control, Automation and protection, reduce the human effort and increase the efficiency.

A. Overview

Supervisory Control and Data Acquisition System (SCADA) is an emerging application for industrial automation. It is being widely used in critical infrastructure for monitoring and controlling the activities. The collaborative environment and interconnectivity of SCADA system needs communications and transmission of sensed real time data like status of machines, breaks and leakages in the system across various devices in the industrial plant. A SCADA system consist of a number of remote terminal units (RTUs) collect field data and sending that data back to a master station via a communications system (N R Sunitha et al, 2015). The proposed system collects the data from different modules such as temperature, humidity, carbon, dust and fire sensor values are monitored with the help of the respective sensors interfaced with PIC microcontroller and readings are displayed on Liquid Crystal display. Simultaneously the SCADA tool monitor and control all the parameters in RTU (Remote Terminal Unit).When the carbon sensor value is high above the threshold, automatically the exhaust fan will get switched on and remove contaminate air. Similarly when fire is detected, the pump is turned on and spray the water automatically. The SCADA system provides facility to monitor and store large amount of data.

II. LITERATURE REVIEW

Daniel F. Merchan et al (2017) proposed, a modern industries demand reliable supervision and control of every process involved in the manufacturing. Computer integrated manufacturing (CIM) systems provide a reference frame for integrating the majority of entities of an automation process by using computers to control production systems. An open source supervisory control and data acquisition (SCADA) system by using the general purpose programming platform, Python. The SCADA system offers communication capabilities through an open source OPC-UA server, which solves data exchange with control devices such as PLC, PAC, etc. The open platform Python is selected to perform the SCADA system. Additionally, an open source OPC-UA server is developed in a Raspberry Pi embedded system, which is placed in the near-end of the control process layer of the CIM reference model to receive all the traffic data from the industrial network, and transparently communicate the information to the HMI/SCADA software. A dc motor speed control system show the versatility and robustness of the open-source SCADA system, which offer similar capabilities of commercial SCADA. The major drawback is that systems are becoming too large and too complex for system managers to maintain them at run-time.

Evgeni M.Portnov et al (2018) proposed a supervisory control and data acquisition systems based on complex trunk-tree structures are widely used in the control and management of distributed power facilities, the oil industry and the railway transport. SCADA systems for the distributed power facilities and industries have been developed in the electric power industry to solve the problem of reliable information transfer and control commands via communication channels from remote control points to a central control center implemented as a central receiving and transmitting station. The efficiency of the dispatching control system is doubled. Obviously, with increase the number of CPs (control point) that can conduct information exchanges at a higher speed. The major drawback is SCADA systems are specifically designed to handle long-distance communication challenges such as data loss and delays posed by the utilized various communication media.

Ahmed et al (2008) proposed a development of Supervisory Control and Data Acquisition (SCADA) based Remote Terminal Unit (RTU) for customer side distribution automation system (DAS). It is to apply automation technique for operating and controlling low voltage (LV) downstream of 415/240V. The SCADA system provides fault isolation operation, monitoring and controlling functions for the operators and data collection for future analysis. An embedded Ethernet controller is used as RTU to act as converter for Human Machine Interface (HMI) and to interact with digital input and output modules. RTU is the master and digital input and output modules are the slaves. RTU will initiate the transaction with the digital input and output modules. Two proprietary software systems are used are to develop algorithm for the controller and to develop HMI for monitoring and controlling functions for the operator. It gathers the real-time data from various remote locations or plants, presents the data on various HMIs, records and logs the data on SCADA database management. The drawback is installation costs are higher and the system supports use of restricted software and hardware equipment.

Jayesh Barve et al (2016) proposed a low cost SCADA platform for level control trainer system was developed using MODBUS RTU communication protocol between NI-LabVIEW and AB MICRO 830 PLC. The developed platform enables the user to visualize real-time process trend. Some other features of SCADA like data logging, remote control, historical trend etc. can be incorporated easily into the system. A GUI designed in LabVIEW makes the real-time monitoring as well as data logging possible the front panel of the developed SCADA in LabVIEW. Using NI-LabVIEW, a SCADA platform is used to monitor the system and log the real-time process data. MODBUS RTU communication protocol is used to exchange the real-time process parameters between PLC and NI-LabVIEW. The disadvantage of PLC based SCADA system is complex in terms of hardware units and dependent modules.

A. Proposed Embedded System Design

The above mentioned papers reveal about the concepts of monitoring the SCADA system like Distributed Automation System (DAS), NI-LabVIEW, HMI/SCADA, and controlling the parameters in Remote Terminal Unit (RTU).Compared to those papers, the proposed system aims to enhance the process by monitoring the sensor values remotely and automatically control the process.

The proposed system to design a microcontroller based embedded system to monitor and control the industrial automation. The PIC microcontroller collects the data from different parameters like temperature, humidity, carbon, dust and fire sensor are processing and transmit the sensor readings to the LCD display. Simultaneously the sensor values are monitored by the SCADA tool in the Remote Terminal Unit.

When the carbon sensor value is high, automatically the exhaust fan will get switched on and remove contaminate air from the area. Similarly when fire is detected, the pump is turned on and spray the water automatically through relay driver.

III.BLOCK DIAGRAM

Fig.1 shows the block diagram of the industrial monitoring system. The PIC16F877A microcontroller collects the data from different modules such as temperature (LM35), humidity (DHT11), carbon (MQ7), Dust (GP2Y1010A) and Fire sensor (LM393). All the sensor values are displayed on the Liquid Crystal Display.

Simultaneously the SCADA tool monitors the data in Remote Terminal Unit. When the carbon sensor value is high, relay1 driver drives the exhaust fan, will be switched ON and automatically remove the containment air from the area and to bring fresh air. Similarly when fire is detected, relay2 drives the pump is turned on and spray the water automatically. All the sensor readings are gather, monitor and process by the SCADA tool in the Remote Terminal Unit.

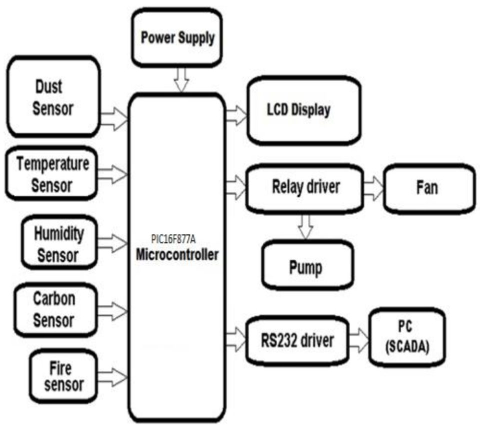


Fig. 1. Block Diagram

IV.SCHEMATIC DIAGRAM

This paper is to design an industrial parameter monitoring system where the different sensor values are continuous monitored by the SCADA to prevent the damage in the industry.

The proposed system is developed with PIC16F877A microcontroller. Temperature, Humidity, Carbon, Dust, Fire sensor, relay, exhaust fan, pump are interfaced with the microcontroller unit. The sensor outputs are fed as input to the Analog channels. Depending upon the sensor values the relay units are switched ON.

LCD will display the sensor values and SCADA monitor the readings in Remote terminal Unit. Advantage of SCADA is Continuous monitoring of process, Real time control, Automation and protection, reduce the human effort and increase the efficiency.

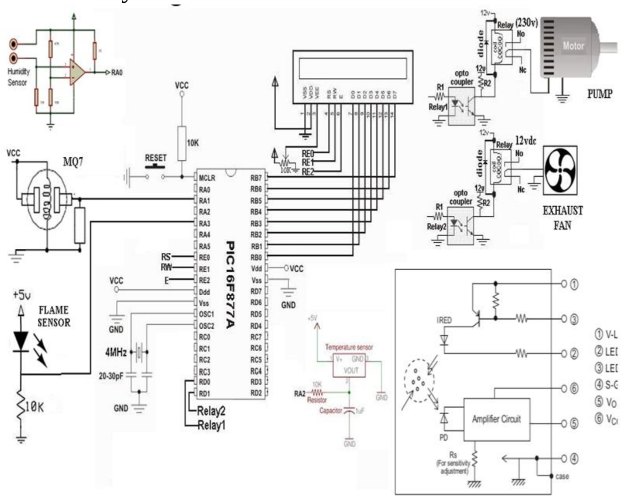


Fig. 2. Schematic Diagram

A.Implementation

The system is developed as mentioned in the schematic diagram shown in Fig.2. The industrial parameter monitoring system has been designed with PIC microcontroller. The coding is done on MPLAB software and is dumped into the PIC16F877A kit.

Sensors output is fed as input to the Analog channels (AN0 to AN4).The temperature sensor whose data pin is connected to the Analog channel (AN0), humidity sensor whose data pin is connected to the Analog channel (AN1), carbon sensor whose data pin is connected to the Analog channel (AN2), dust sensor whose data pin is connected to the Analog channel (AN3), fire sensor whose data pin is connected to the Analog channel (AN4).

LCD is interfaced with PORTB and PORTD of PIC microcontroller. All the data pins (D0-D7) are connected to RB0-RB7 and is configured as output pins. The reset, read/write and enable pins of LCD are connected to RE0, RE1 and RE2 respectively.

The optocoupler act as a switching device which 12V power supply unit supplies power to the relay circuit and 5V power supply is designed to feed power to the controller. Relay driver are connected to PORTD pins as general purpose input and output pins (RD0 and RD1). If carbon sensor (AN2) is enabled, the relay1 RD0 is connected to the exhaust fan will be switched ON and removed the contaminated air from the area and to bring fresh air. When fire sensor (AN4) is enabled, the relay2 RD1 is connected to the pump is turned ON and spray the water automatically. Simultaneously the SCADA tool monitor the sensor values in the Remote Terminal Unit through serial communication.

V. EXPERIMENTAL RESULTS

A. Experimental Setup

In this paper, the embedded system based PIC microcontroller is interfaced with various modules such as temperature, humidity, carbon, dust and fire sensor. These sensor collects the real time data from different modules are processing using PIC microcontroller and values are displayed on the Liquid Crystal Display. Simultaneously the SCADA tool monitor the real time data in the Remote Terminal Unit. When the carbon sensor value is high above the threshold, relay2 driver drives the exhaust fan, and automatically remove the containment air from the area .Similarly the pump is interfaced with Relay driver and connected to the PIC microcontroller. When fire is detected, the pump is turned ON and automatically spray the water through relay1 driver.

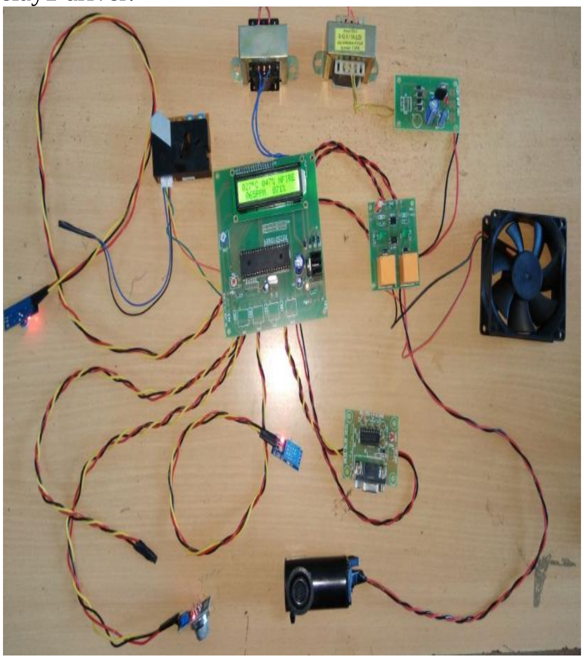
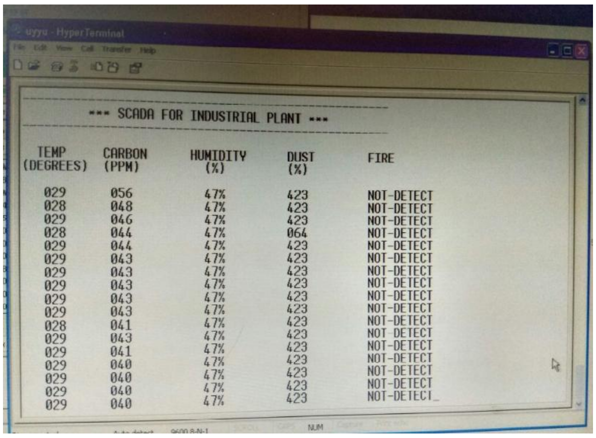


Fig. 3. Industrial parameter monitoring and control system

B. Results Analysis

The results are analyzed from the different modules ... nd fire sensor and co temperature (27°c), humidity (47%), carbon (55ppm), dust (871%) and fire (NFire) values are displayed using the PIC microcontroller. Fig 4(b) shows the sensor values are monitored by the SCADA screen simultaneously.

Fig. 4(a). Sensor values are displayed on the LCD



*** SCADA FOR INDUSTRIAL PLANT ***

TEMP (DEGREES)	CARBON (PPM)	HUMIDITY (%)	DUST (%)	FIRE
029	056	47%	423	NOT-DETECT
028	048	47%	423	NOT-DETECT
029	046	47%	423	NOT-DETECT
028	044	47%	064	NOT-DETECT
029	044	47%	423	NOT-DETECT
029	043	47%	423	NOT-DETECT
029	043	47%	423	NOT-DETECT
029	043	47%	423	NOT-DETECT
029	043	47%	423	NOT-DETECT
029	043	47%	423	NOT-DETECT
028	041	47%	423	NOT-DETECT
029	043	47%	423	NOT-DETECT
029	041	47%	423	NOT-DETECT
029	040	47%	423	NOT-DETECT
029	040	47%	423	NOT-DETECT
029	040	47%	423	NOT-DETECT
029	040	47%	423	NOT-DETECT

Fig. 4(b). SCADA screen monitored the sensor values

Fig 5 shows the carbon sensor value (673ppm) is high above the threshold level and displayed on the LCD.

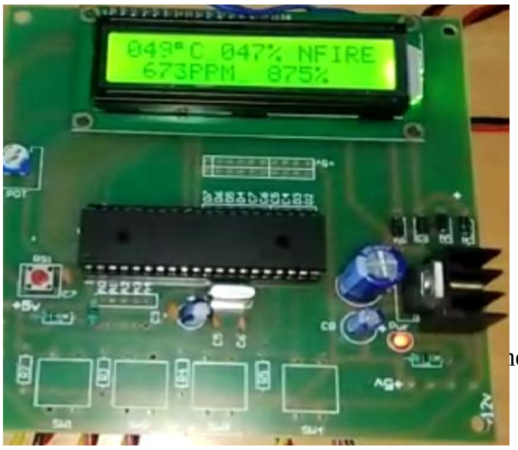


Fig 5 Carbon sensor value is high

Fig 6(a) shows the carbon monoxide is controlled by the exhaust fan through relay driver. The relay2 driver drives the exhaust fan will be switched ON immediately to remove the contaminated air from the area and to bring fresh air. Figure 6(b) shows the SCADA screen to monitor the carbon Value. Depending upon the value periodic maintaince are done by the machines in industry.

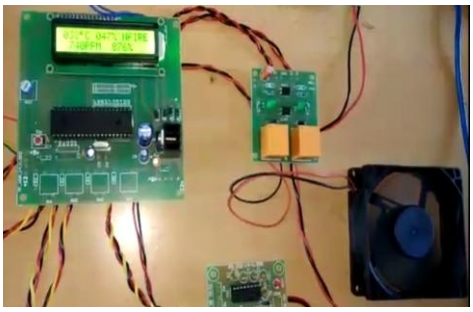
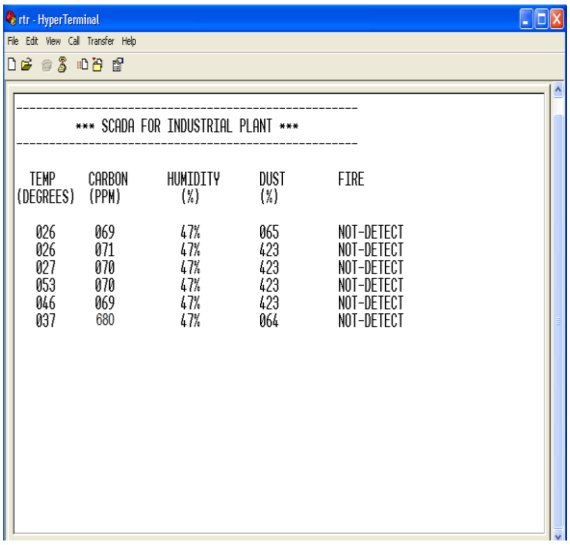


Fig. 6(a). Exhaust fan is switched ON



TEMP (DEGREES)	CARBON (PPM)	HUMIDITY (%)	DUST (%)	FIRE
026	069	47%	065	NOT-DETECT
026	071	47%	423	NOT-DETECT
027	070	47%	423	NOT-DETECT
053	070	47%	423	NOT-DETECT
046	069	47%	423	NOT-DETECT
037	680	47%	064	NOT-DETECT

Fig. 6(b). Periodic maintaince are done by SCADA screen

Fig 7(a) shows the flame sensor sense the fire. Fig 7(b) shows the fire is detected on the LCD display. Fig 7(c) shows the Flame sensor is interfaced with PIC microcontroller which detects fire, automatically the pump is turned ON and spray the water through relay driver. Fig 7(d) shows the SCADA screen monitor the fire in the Remote Terminal Unit to prevent the damage in industry.

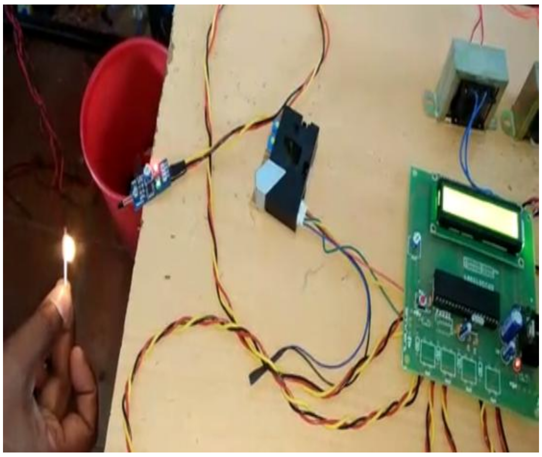


Fig. 7(a). Flame sensor sense the fire

Fig. 7(b). Fire is detected on the LCD display

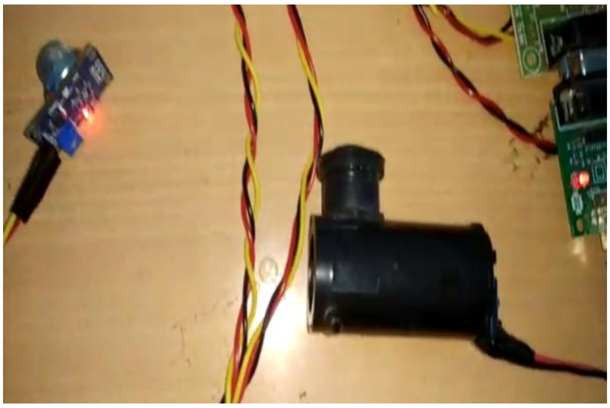
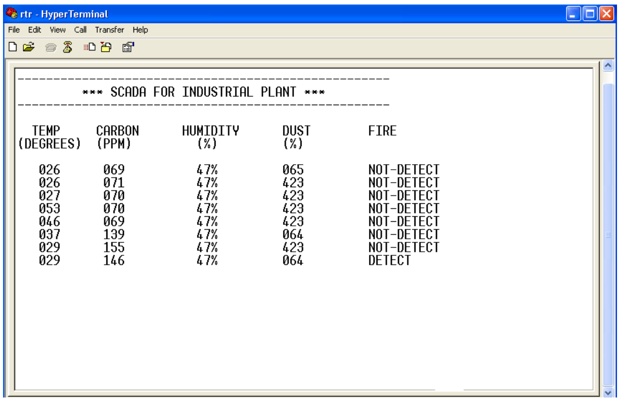


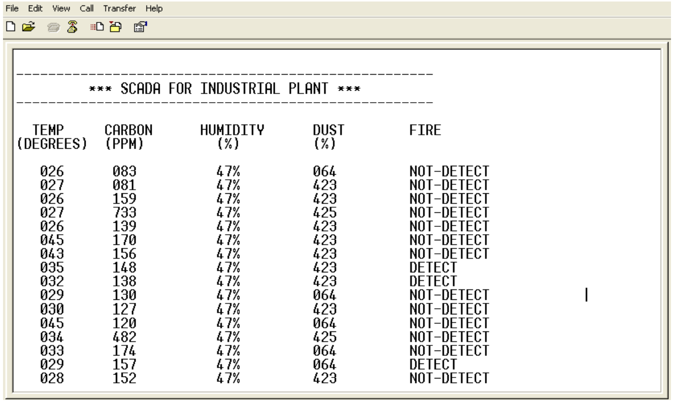
Fig. 7(c). Pump is turned ON



TEMP (DEGREES)	CARBON (PPM)	HUMIDITY (%)	DUST (%)	FIRE
026	069	47%	065	NOT-DETECT
026	071	47%	423	NOT-DETECT
027	070	47%	423	NOT-DETECT
053	070	47%	423	NOT-DETECT
046	069	47%	423	NOT-DETECT
037	139	47%	064	NOT-DETECT
029	155	47%	423	NOT-DETECT
029	146	47%	064	DETECT

Fig. 7(d). Fire value monitored by the SCADA screen in the Remote unit

Fig. 8 shows the different values from the industrial parameter monitoring and logging system based on SCADA. In the Remote Terminal Unit, real time data such as temperature, humidity, carbon, dust and fire sensor are monitor by the SCADA screen.



TEMP (DEGREES)	CARBON (PPM)	HUMIDITY (%)	DUST (%)	FIRE
026	083	47%	064	NOT-DETECT
027	081	47%	423	NOT-DETECT
026	159	47%	423	NOT-DETECT
027	733	47%	425	NOT-DETECT
026	139	47%	423	NOT-DETECT
045	170	47%	423	NOT-DETECT
043	156	47%	423	NOT-DETECT
035	148	47%	423	DETECT
032	138	47%	423	DETECT
029	130	47%	064	NOT-DETECT
030	127	47%	423	NOT-DETECT
045	120	47%	064	NOT-DETECT
034	482	47%	425	NOT-DETECT
033	174	47%	064	NOT-DETECT
029	157	47%	064	DETECT
028	152	47%	423	NOT-DETECT

Fig. 8. Real time sensor data's are monitored by the SCADA screen

VI. CONCLUSION

In this paper, design and implementation of industrial SCADA automation system to be monitored and controlling the system is proposed. The proposed system is capable of monitoring the different modules such as temperature, humidity, carbon, dust and fire sensor are processing using PIC microcontroller. If the fault is detected from the carbon and fire sensor, automatically controlled by the exhaust fan and pump through relay driver. Simultaneously all the parameters are monitored by the SCADA tool in the RTU.

REFERENCES

[1] Simon Kranzer and Dorian Prill(2017) "An Intelligent Maintenance Planning Framework Prototype for Production Systems" IEEE Transactions vol. 46, no.1, pp.271-273

[2] Daniel F. Merchan, Jonnathan A. Peralta and Andres Vazquez-Rodas(2017) "Open source SCADA system for advanced monitoring of industrial processes" Conference on Information Systems and Computer Science., vol.10, no.9, pp. 23-25

[3] Pooja Panchal and Alpesh Patel (2015) "PI Control of Level Control System using PLC and LabVIEW based SCADA" International Conference on Industrial Instrumentation and Control, vol. 11, no.3, pp.1196 - 1201

[4] Syed Akhtar Imam, Amit Choudhary and Vibhav Kumar Sachan (2015), "Design Issues for Wireless Sensor Networks and Smart Humidity Sensors for Precision Agriculture", International Conference on Soft Computing Techniques and Implementations- (ICSCTI)., vol. 9, no. 15, pp. 181-187.

[5] Evgeni M. Portnov , Aung Kyaw Myo , Kyaw Zin Linn3, Vitaly V. Kokin and Kyaw Zaw Y (2018) "The Technique for Increasing the Efficiency of the Control and Management of the Power Facilities in SCADA Systems", IEEE Transactions., vol. 6, no.10, pp. 1773 – 1776

[6] Alexey A. L'vov, Vyacheslav V. Komarov (2018), "Fire Detection and Alarm Sensor for Avionics Based on Current Loop Circuit", IEEE International Conference on Information Processing., vol.9, no.4, pp. 1109 - 1112