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Wireless SCADA for Industrial Automation

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ABSTRACT: The key objective of the project is to process the real time data acquisition wirelessly using SCADA system. In large industries several processes are carried on concurrently, so there is a necessity to observe all the processes and govern the factors affecting the process. By using a technology like Wireless SCADA (Supervisory Control and Data Acquisition) we can meet the goal successfully. To manifest this real-time situation, a temperature recording system for a remote plant set-up is developed by Visual Studio. Temperature sensors are interfaced to the AT89S52 microcontroller. Information collected from the sensors is continuously sent over 2.4GHz trans-receiver wirelessly to the microcontroller which is then received at the corresponding 2.4 GHz USB type trans-receiver connected to a PC / Laptop. In the computer "DAQ System" (software) is loaded which takes the collected data and presents them on PC / Laptop's front panel, and also logs them into the database. We can customize parameters like set point, lower limit and higher limit on the SCADA screen. As the temperature of a sensor goes below set point the microcontroller issues command to the respective relay. The field devices interfaced through relay contacts (with respect to their sensors) are turned OFF (or ON in vice versa). Higher limit and lower limit features are present for producing an alarm on the PC in the event of breakdown of system. Therefore, processes at dangerous places can be controlled with good accuracy and enhanced safety using SCADA.

KEYWORDS: Data acquisition, SCADA, Microcontroller, Trans-receiver, Temperature.

I.INTRODUCTION

A Supervisory Control and Data Acquisition (SCADA) system is a usually a distributed computerized system used to control and monitor the field devices from a centralized location. Field devices include pumps, heaters, alarms, control valves etc.

The objectives of this SCADA system are as follows:

1. Monitor the system.
2. Obtain control over the system and ensure that required performance is always achieved.
3. Reduce operational staffing levels through automation or by operating a system from a single central location.
4. Store data of system and therefore achieve full compliance.

In today's world most of the large scale industries have become automated. Industries require monitoring and controlling as they do large amount of production. This project concentrates on making automation efficient and economical so that even small scale and medium scale industries get benefited. Our proposed SCADA system is divided into three sub systems Master Terminal Unit (MTU), Remote Terminal Unit (RTU) and Communication Network. The MTU is usually a computer, RTU consists of Microcontroller, Sensors, ADC and other IC and communication is through ZIGBEE technology.

II.RELATED WORK

ZIGBEE is a wireless technology and is interfaced with microcontroller in many applications like home automation, robotics etc. [3]. ZIGBEE with microcontroller is also used for temperature control where we have used the two modules among them one is at the RTU, which includes the controller AT89S52 and that is interfaced with temperature sensor and ZIGBEE module. Second module is at the MTU connected to the PC/Laptop. The module at RTU

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continuously checks the status of the sensors attached with that and sends the current status via ZIGBEE to the module at MTU then the MTU compares the status with data stored and take the action according to the predefined program.

In this application four temperature sensors are used to monitor the system. Two process tanks are taken and these process tanks have different set points. In the first process tank heater and submergible pump are placed. As the temperature goes below the set point the heater gets on and keeps the water at the required set point. The second process tank is a stirring vessel. It has a set point less than the first process tank. As the temperature sensed by sensor goes below set point the hot water is pumped from the first process tank till it maintains the desired set point. The third output is the bulb it is used to monitor the ambient temperature outside the process tanks, if the temperature outside the process tank goes below the set point the bulb gets switched on. The fourth output is the fire alarm, when the output of the sensor is higher than the set point the alarm starts ringing.

III.DETAILED STUDY

REMOTE TERMINAL UNIT is a microcontroller controlled electronic device that interfaces devices present in the environment to a distributed control system or SCADA (supervisory control and data acquisition) system by transmitting data to a master system, and by using messages from the master controlling system to control connected field devices. Another term that may be used for RTU is remote stations.

ZIGBEE is into the class of wireless domain like GSM and RF technology. As it is wireless, the maintenance of the wires and the cost will be effectively reduced compared to the other wired technologies. ZIGBEE also provides a certain bit ON/OFF level to the receiver side so that the same data is transmitted from the transmitter as the wired technologies provide. Thus ZIGBEE replaces the connecting wires and provides a wireless communication.

SCADA is software that is used for controlling the Remote Terminal unit from distance. Using SCADA we can monitor and control the field parameters and also record the data that we monitored. SCADA application is made using Visual Studio and takes data from the Remote Terminal Unit in an unseen way and therefore we can't see the path of data and the data is directly visible on the SCADA software.

IV.ARCHITECTURE

Architecture contains the pair of ZIGBEE modules, Microcontroller (AT89S52), ADC0808, LM35 Temperature sensors, Relay driver (ULN2003), and SCADA software installed in computer. At the computer process control and monitoring takes place. Sensors, ZIGBEE and other inputs are connected at the RTU and the RTU is connected to the MTU wirelessly via ZIGBEE trans-receiver. Outputs such as heater, pump, alarm etc., are connected at the output of side of RTU. At the other side PC connected with ZIGBEE directly through the USB port and this ZIGBEE will communicate with RTU through another ZIGBEE as shown in fig 1 and display the status in SCADA.

Fig. 1 Architecture of the system

As shown in fig 1 ZIGBEE is directly connected to USB port of PC/Laptop and on the other side microcontroller is interfaced with ZIGBEE module at the Remote Terminal unit. When inputs are active, will send the status to RTU and after processing the status RTU will send the data to PC via ZIGBEE and that will be displayed on SCADA software. Now user will respond to that status by passing the command to RTU to process the output.

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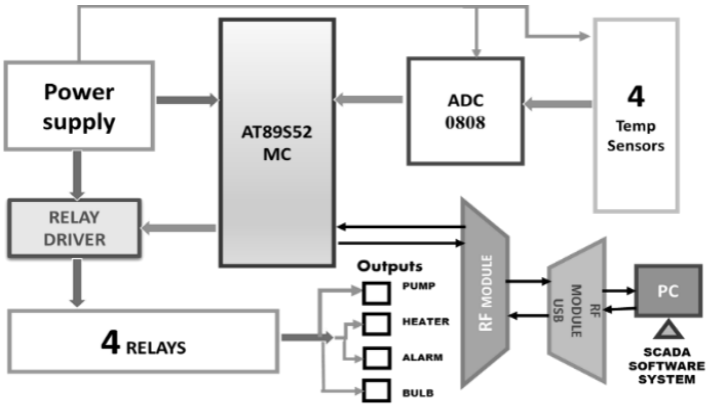

Fig. 2 Block Diagram

Fig 2 shows the block diagram of the system. Here the input signal coming from the sensors goes to the Remote Terminal Unit. The ZIGBEE module in the RTU sends the data to the USB module connected to the PC/Laptop. The Master terminal will issue commands to the Remote Terminal Unit for processing.

MICROCONTROLLER:

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller. The in-system programmable Flash memory is 8K byte. Atmel's high-density non-volatile memory technology is used to manufacture this microcontroller and is compatible with the industry-standard 80C51 instruction set and pin-out. Using conventional non-volatile memory programmer or on-chip Flash the program memory can be reprogrammed. Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution too many embedded control applications as it combines a versatile 8 bit CPU with in-system programmable Flash on a monolithic chip.

The specifications of AT89S52 are a flash memory of 8K bytes, RAM of 256 bytes, 32 input and output lines(I/O lines), watchdog timer, two data pointers, three 16 bit counters, an architecture of six - vector two level interrupt, a duplex serial port, on-chip oscillator and on board circuitry clock. For further insights in AT89S52, it is designed with operation down to zero frequency by static logic and has two different power saving modes. It also has an idle mode, which stops the CPU which enables the RAM, serial port, counters and interrupt system to function. The power down mode conserve the RAM contents by freezing the oscillator and disabling chip functions until the hardware reset or next interrupt.

In this paper microcontroller is interfaced to ADC0808, ZIGBEE module, and relay driver. The analog to digital convertor converts the analog data collected from the temperature sensors into digital format and gives it to the microcontroller. The ZIGBEE module in the RTU sends this data from microcontroller to MTU. The information obtained from the MTU is again given to microcontroller and then to the relay driver to drive the outputs.

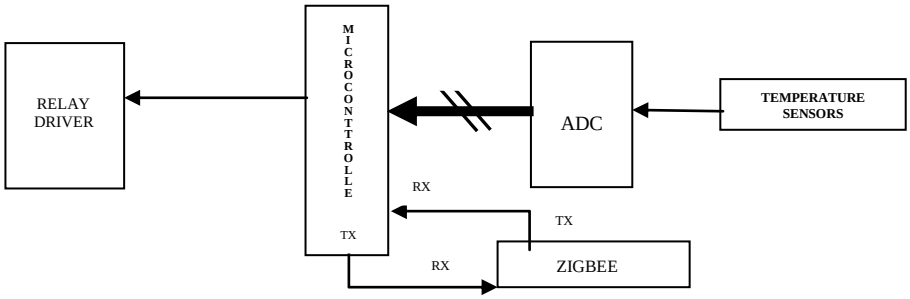

Fig. 3 Interfacing of Microcontroller

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ZIGBEE Module:

ZIGBEE is a device that is based on IEEE 802.15.4 standard as shown in fig 3. ZIGBEE is into the class of wireless domain like GSM and RF technology. As it is wireless, the maintenance of the wires and the cost will be effectively reduced compared to the other wired technologies. ZIGBEE also provides a certain bit ON/OFF level to the receiver side so that the same data is transmitted from the transmitter as the wired technologies provide. Thus ZIGBEE replaces the connecting wires and provides a wireless communication.

Fig. 4 ZIGBEE module

ZIGBEE has four layers based on ISO model. They are physical layer, media access control layer, network layer and application layer as shown in fig 4. It contains three nodes and they are sink node, routing node, terminating node [2]. Sink node is initialized first and during this network and equipment parameters are configured. After configuration it selects the channel for connection to the network. It is fully controllable node. Routing node can be join or re-join the network and also scans channel for new connection. It will act like sink node after the regular operation. Terminal nodes in normal operation just sends or receives data and as a super node it will select the nearest sink or transceiver module.

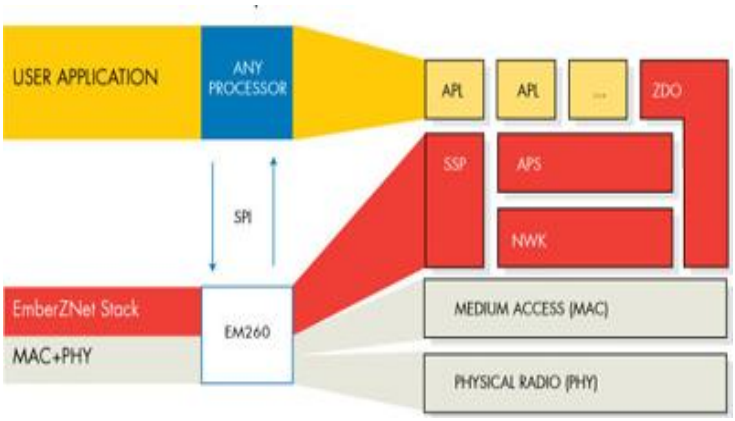

Fig. 5 ZIGBEE communication layers

V. VISUAL BASIC FOR SCADA

VISUAL BASIC is used to develop SCADA software. On start-up, Visual Basic 6.0 will display the following dialog box as shown in figure.9**.** One can choose to start a new project, open an existing project or select a list of recently opened programs. A project is a group of files that makes an application. Various types of applications we can be created, however, we will concentrate on creating Standard EXE programs (EXE means executable program). Click on the Standard EXE icon to enter the VB programming environment.

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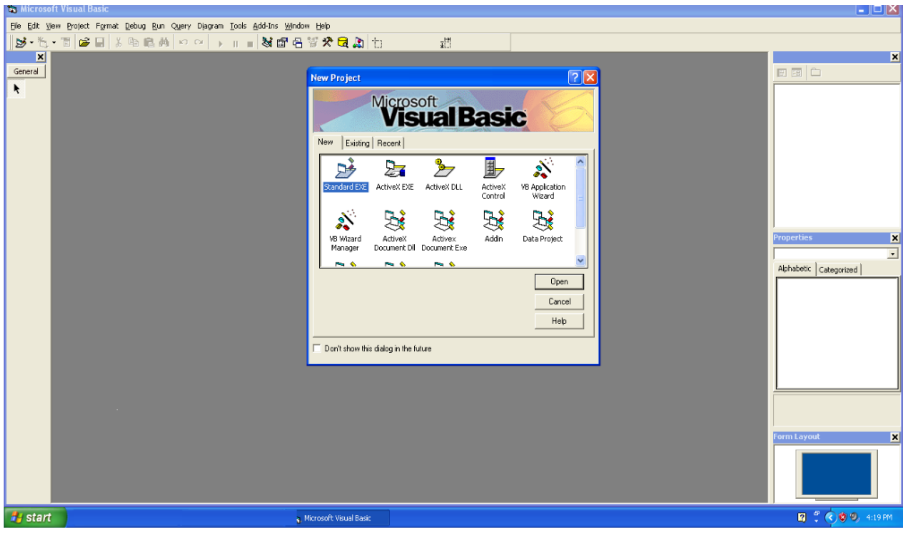

Fig. 6 Visual Basic Start-up Dialog Box

Figure 7 shows the Visual Basic Environment, it mainly consists the following
The Blank Form window is for designing the application user interface.
The Project window carries the files of the application created by the user.
The Properties window exhibits the properties of objects and various controls in the application that are created in the application and also has a Toolbox which has all the essential controls for developing a VB application.
To have an input or display output, there are some tools of controls as boxes, buttons, labels and other objects to be on the form. They also add visual appeal.

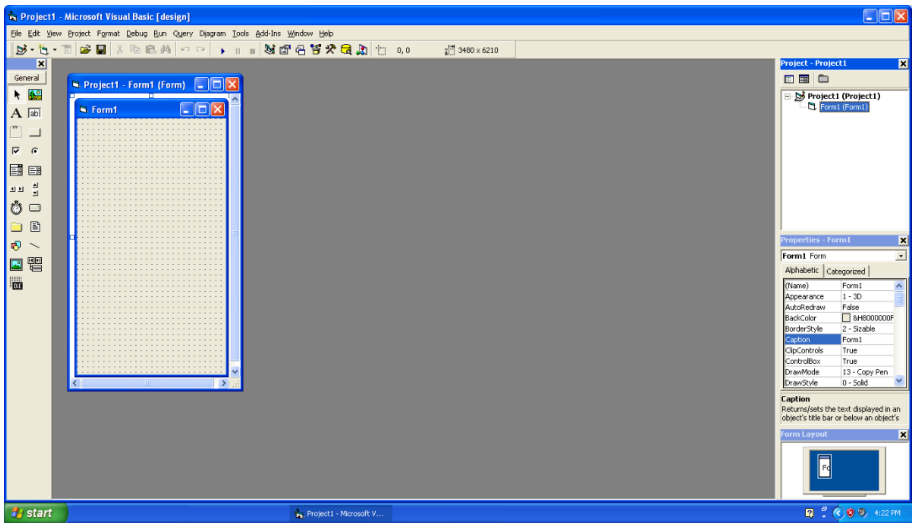

Fig. 7 Visual Basic Environment

VI.RESULT

By using visual studio we have created the SCADA screens with respect to our needs like displaying the sensed temperature, set point, lower limit and the higher limit, setting COM port, Start, Stop and Exit controls and caution and output icons for displaying the outputs.

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Data acquisition and logging system: Using VB 6.0 we have built a SCADA system for industrial temperature control application. The information from all the sensors is given to the SCADA system [7]. The fig shows the temperature parameters, Controls and outputs of the system.

Fig. 8 Data acquisition system

Records: As the Trans-receiver sends the data it is displayed and simultaneously recorded in an excel sheet for all the sensors. Records are shown in Fig.13.This fig gives the details of the temperature values at different times and dates. These Screens are developed by VISUAL BASIC Programming Language.

RECORDS

Sr No	Time And Date	Temp1	Temp2	Temp3	Temp4
1	3/23/2015 10:16:47 PM	32	0	32	32
2	3/23/2015 10:16:50 PM	32	32	32	31
3	3/23/2015 10:16:53 PM	32	32	32	31
4	3/23/2015 10:16:56 PM	32	32	32	31
5	3/23/2015 10:16:58 PM	32	32	32	31
6	3/23/2015 10:17:01 PM	31	32	32	31
7	3/23/2015 10:17:04 PM	32	32	32	31
8	3/23/2015 10:17:06 PM	32	32	32	31
9	3/23/2015 10:17:09 PM	32	32	32	31
10	3/23/2015 10:17:11 PM	32	32	32	31
11	3/23/2015 10:17:14 PM	32	32	32	31
12	3/23/2015 10:17:17 PM	31	32	32	31
13	3/23/2015 10:17:19 PM	32	32	32	31
14	3/23/2015 10:17:22 PM	31	32	32	31
15	3/23/2015 10:17:25 PM	32	32	32	31
16	3/23/2015 10:17:27 PM	32	32	32	31
17	3/23/2015 10:17:30 PM	32	32	32	31
18	3/23/2015 10:17:32 PM	32	32	32	31

Fig. 9 Excel sheet for temperature display

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VII. CONCLUSION

Wireless SCADA for Industrial Automation has been developed and designed, by using this paper, we can control and monitor the temperature, in any industry successfully and economically. This system helps to prevent temperature hazards in the industries like fire accidents. We can also extend this system to control and monitor other parameters like pressure, flow, level etc. This system can be remodelled to be better if we use other technologies like internet and android applications.

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BIOGRAPHY

G.venkateswarlu, Assistant.Professor in Electronics and Instrumentation Engineering at C.V.R College of Engineering, Hyderabad, Ibrahimpatnam. Worked as an engineer in Rosun steels in the department of Instrumentation and control. B.Tech degree is in Electronics and Instrumentation Engineering and M.Tech in VLSI System Design. He has authored several research papers in the field of Labview, PLC designing in various journals and conferences.

E. Prudhvi Teja is an under graduate student. He is going to complete his under graduation in Electronics and Instrumentation Engineering from C.V.R College of Engineering, Ibrahimpatnam. He presented a paper on Wireless Power Transfer and secured first prize in the National level technical symposium by Indian Institute of Information Technology Hyderabad. He has organised a technical event on robotics in national level technical festival held at C.V. R College of Engineering.

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