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Wireless Secured Real Time Supervision and Controlling for Industrial Utility

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Abstract: The fundamental principal behind this work is to obtain a system that is low cost and a budget wireless data acquisition and monitoring solution for small enterprises. The representation of the system is done using two individual modules, one representing the site called Remote Node and another is to monitor and control all the parameter associated with the remote node called as Access Monitor. The system is designed such that it is easy to implement for small industries as well as can be improved to be used for larger industries with increased input and output parameters. This paper is to represent an embedded communication system developed to be used in any kind of industry who cannot spend more on their monitoring & data logging assets. The system having a master and several slave modules is the idea behind this work with introduction to online data logging mechanism simultaneous to the wireless communication for monitoring. The master is having a LCD display to indicate all real time parameters received through the communicating nodes, and also having alarm system whenever the process value crosses the set point. In the slave node the transducers are connected to the wireless network via microcontroller, the microcontroller is interfaced with micro-SD card for onsite data logging and report generation purpose. Industrial parameters like Temperature, Pressure Level etc., are converted to electrical parameters like voltage and current. This electrical signal is processed at the node itself and an actual value is generated. This is then processed in the microcontroller and the same is stored in the node memory space with the real time stamp, simultaneously the data processed is communicated to the wireless network and displayed on the LCD display board that is the Access Monitor.

Keywords: Real time systems, wireless monitoring, time stamping, data acquisition, micro-SD card, ADC, LCD.

I. INTRODUCTION

In small industries some limited parameters are needed to be processed for data logging systems and monitoring applications. At present the available systems in the market made for larger industries are used in small industries, because of which the cost become high and the industry management rule out the need for data logging and monitoring applications causing production report and other documents to be made manually. Here the need for a low cost and budget solution for marking excellence in production and safety at the same time arises and this work completes this requirement in an effective manner within real time.

II. WORKING PRINCIPLE

The supervisory and control system is an integrated system that is intended to allow the operators to monitor any industrial utility from the access monitor in real time also allowing real time stamped data logging. It is very much essential in case of some industrial as well as experimental setup to monitor as well as controlling process parameter variables continuously in real time. Monitoring and controlling physical parameters by embedded systems using microcontrollers are very much effective in industrial and research oriented requirements. The purpose of this work is to explore the possibility to continuously monitor parameter variations. This Project consists of industrial parameters monitoring and simultaneous data logging in a micro-SD card. This unit or system can be installed in a room or in any industry where we need to monitor and control these variables. This work consists of two basic modules. First is the master situated at the control room and in access to the staff and the operator called as Access Monitor, the second is the another wireless module with on-chip micro-SD card installed called as Remote Node present at the site having sensors and transducers interfaced at the microcontroller. The micro-SD card is a storage device which stores real time data with time stamping from the external clock.

III. SYSTEM OVERVIEW

The system consists of two individual modules to contribute as Remote Node and Access Monitor, one at remote site and another at the site control respectively. Each individual system is communicating to each other via RF wireless communication technology using secured access transceivers. These two systems are elaborated in details at the following sections.

A. Remote Node

The remotely situated industrial process interfaced with process transducers is connected to the signal processing module known as Remote Node, The process transducers convert physical parameter such as pressure, temperature, level etc. to electrical signal such as analogue voltage, current or pulse signals. Various transducers are used to acquire the atmospheric data or the values of process parameters like pressure, temperature, level etc., which are connected to analogue input terminal of the microcontroller chip.

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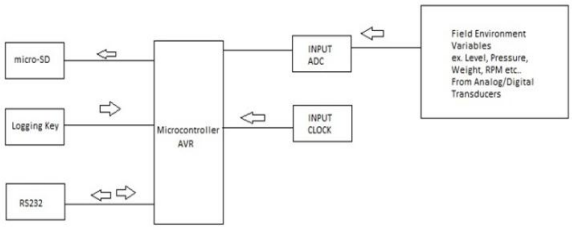

Fig. 1. Remote Node - Site Part including process transducers & micro-SD card interface

Process parameters at the remote site are converted to electrical signals using transducers and sensors. The transducers used are pressure transducer, Ultrasonic level sensor, load cell and Resistance Temperature Detector (RTD). The supervisory and controlling mechanism implemented in this work is totally a low cost solution. The data inside remote node is stored locally in the micro-SD card for report generation and production chart purpose. The System is also equipped with necessary hardware to initiate control action for process parameters as soon as they reach higher than some particular set values. The result obtain from the project shows that the process parameters are logged with real time stamp and monitored as well as controlled effectively and more accurately.

B. Access Monitor

The another wireless module available at the operator end is the Access monitor, this system consist of a wireless secured transceiver module which collects data from the Remote Node and takes the received data to the processing microcontroller chip via the Rx and Tx pins. The Access monitor is intended to be used as a real time process parameter monitor device having a 20x4 LCD module interfaced to the microcontroller chip. All the process parameters transmitted via Remote Node is received at this end of the system and displayed in the order in which they are received.

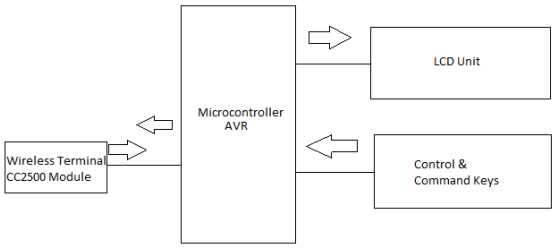

Fig. 2. Access Monitor - Control & Monitor Room Part with LCD & Control Keys

The Access Monitor is designed such that it shows all the data in real time and respective tags are displayed to avoid confusion. It is also implemented with an alarming system, which operates alarms with respect to each process value going above the desired level. There is also a provision made in the Access Monitor by which the operator can command the Remote Node to start or stop data logging, also to operate the switches at the remote node, it means that the operator can take the complete process in manual control by just sending a command to the remote node.

IV. DESIGN REQUIREMENTS

There are following design requirements proposed to be met by the system. The system should be compatible to be used with any kind of industry process application and the place should have a RF communication access. It should be able to monitor remote site process in real time and the data should be logged into local memory as well as displayed on the LCD monitor present with the operator at the Access Monitor. Wireless data communication with each node avoiding the use of additional cables. It should be able to monitor as well as control all the parameters associated with the process. Provide a support of a simple configuration mechanism to set time and date on hyper-terminal on a computer for easy user access. The date and time i.e. the clock works at the power down mode by inbuilt battery provided at the Remote Node. The system is a low cost solution available to any small or large industry. Configuring new process parameters should be simple and easy to add and remove any new old parameter as per the process. There are two main mechanisms in this system, one is the Data Logging Mechanism and another one is Wireless Communication Mechanism, these are elaborated in detail as follows.

A. Data logging Mechanism

The data logging mechanism is based on the RTC input to the microcontroller chip, The micro-SD card can store a large quantity of data in CSV format files with FAT32 format. Here, ATmega32 is used for data collection and micro-SD card interface. The data is received from in-build 8-channel analogue inputs of ATmega32. Each channel can be used for reading a particular process parameter from respective transducers. It can be used to interface 8 different sensors with analogue output connecting to the ADC of ATmega32. The data is stored in CSV (comma separated values) format, which can be read using a PC/Laptop with Microsoft Excel or other compatible software. The file after opening in MS Excel gives us entire logged data of all 8 Channels with real time stamping. The module used for micro-SD card interface is shown in figure. This module is used here as it provides a stable interface and makes the card compatible with 5v supply and 5v signals of microcontroller chip. The data logging system is developed using I2C bus IC DS1307 with standby battery interfaced to store and manage the date and time provided at the time of configuration process. Other than the micro-SD socket, this low-cost module also contains on-board 3.3v regulator for the micro-SD card, a 5v-3.3v level converter and other safety features required for the card.

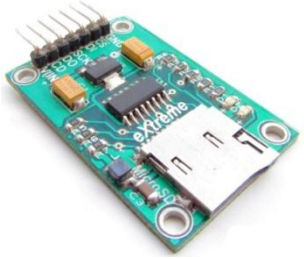

Fig. 3. Micro-SD card interface adapter

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The system contains RTC interface for date and time storage, RS232 for connection with PC and a micro-SD module.

B. Wireless Communication Mechanism

In this system of communication, we have introduced a secured and feature rich wireless transceiver module known as CC2500 module. CC2500 RF Modem is a transceiver module which provides easy to use RF communication at 2.4 GHz. It can be used to transmit and receive data at multiple baud rates from any standard CMOS/TTL source. This module is a direct replacement for serial communication it requires no extra hardware and no extra coding to turn the wired communication into wireless one. It works in Half Duplex mode i.e. it provides communication in both directions, but only one direction at same time (not simultaneously). This switching from receiver to transmitter mode is done automatically. In this work, we have used CC2500 as a RF communication transceiver, CC2500 is wireless transmitter receiver developed by Texas instruments which is used in 2400-2483.5 MHz ISM/SRD band systems. The input present at PORTA i.e. the ADC port of Remote Node Atmega32 is transmitted wirelessly to the Access Monitor Atmega32. The CC2500 RF module is a low-cost 2.4 GHz transceiver used in very low power wireless applications. The RF transceiver is integrated with a highly configurable baseband modem. It supports OOK, 2-FSK, GFSK, and MSK modulations. It works in voltage range of 1.8 - 3.6V. Two AA batteries are enough to power it. It has 30 meter range with onboard antenna. It is always used with microcontroller having SPI communication support.

V. TRANSDUCERS INTERFACED

There are many transducers which can be interfaced with the system chip, here we have interfaced 3-4 different process transducers. The output of each transducers we have used here differs from each other in the context to the usability of this system with different kind of transducers. The system comprises of various sensors are used to acquire the atmospheric data or the values of process parameters like pressure, temperature etc., which are connected to ADC of the ATMEGA32 microcontroller. Process parameters at the site are converted to electrical signals using transducers and sensors. The transducers used are pressure transducer, level sensor, load cell, Ultrasonic distance sensor and RTD. The system is also having the ability to interface with any kind of process parameter sensors. Interfaced transducer details are given in the following table.

TABLE I: INTERFACED TRANSDUCERS

Transducer	**Process Parameter**	**Output**
RTD	Temperature	Resistance
Ultrasonic Sensor	Level	Pulse
Manometer	Pressure	Voltage

VI. RESULTS AND DISCUSSIONS

The output of the system is displayed on the PC for configuration, stored in micro-SD card for logging, and displayed on LCD for monitoring.

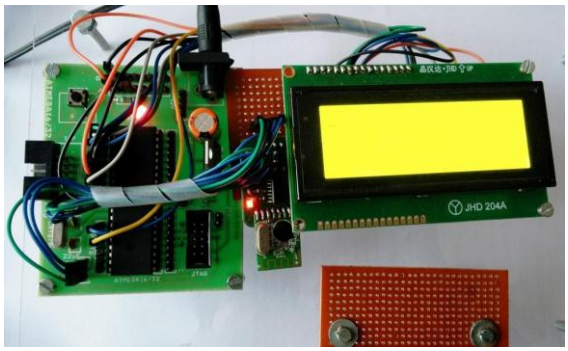

Fig. 4. Access Monitor in Idle Condition

The Access monitor in idle condition shows that the RF transceiver is configured properly with ID and Channel number.

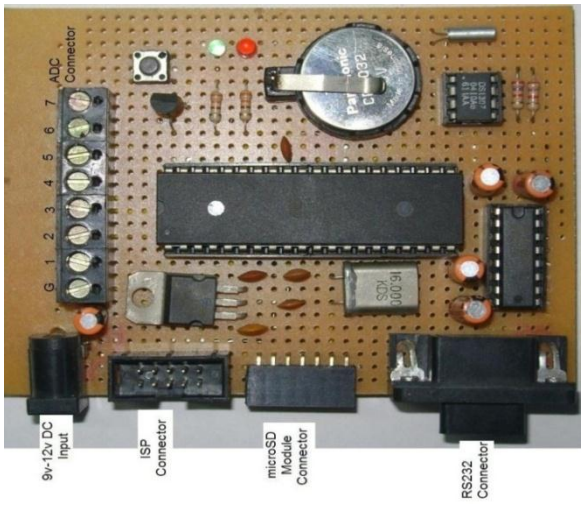

Fig. 5. Remote Node on Zero PCB

The Remote node as shown above is a Basic version for testing, with micro-SD card interface and ADC connectors on board. The ISP programming pins are used to program the micro-controller using Atmel Studio 6.0, RS232 connector is used to configure date and time through PC.

```
0 : Exit the Menu
1 : Display current Date/Time
2 : Update Date
3 : Update Time
4 : Get file list
5 : Read File
6 : Delete File

Enter the option:
```

Fig. 6. Configuration Menu in Hyper-terminal - Configuring Data/Time using RS232 Port on PC

The hyper-terminal connection is required only for setting RTC date and time. Once the date and time are set, the RS232 connection is not required anymore for normal data-logging operation.

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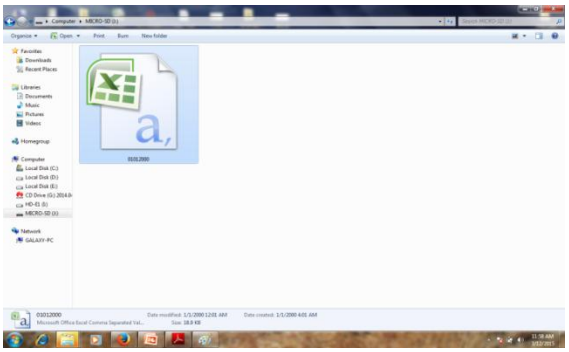

Fig. 7. Output CSV file with Name as Date in Explorer

The data is stored in CSV (comma separated values) format, which can be read using a PC/Laptop with Microsoft Excel or other compatible software.

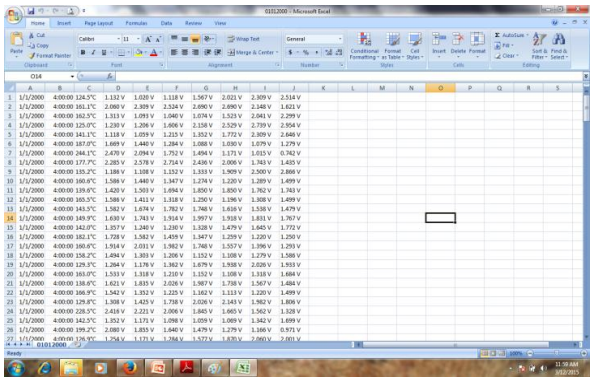

Fig. 8. Output CSV file with tabulated data in MS Excel 2007

The file after opening in MS Excel gives us entire logged data of all 8 Channels with real time stamping.

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BIOGRAPHIES

Mr. Mohammed Junaid has obtained his B.E. in Electronics & Telecommunication Engineering from Anjuman College of Engineering and Technology, Nagpur, in 2011 and presently perusing his masters in Embedded systems and Computing from Nagpur Institute of Technology, Nagpur, 2013-15 batch. His areas of interest are electronic circuits, signal processing and embedded systems.

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