Remote Monitoring System With Wireless Access To Industrial Processes

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Abstract— **Trough history, the mankind has had the need to communicate between them along great distances, with the objective of to share variety of information. The industry has required this communication too, and, for this reason, since many years ago have been developed different protocol to be used in control and monitoring industrial processes. However, in almost all industrial companies the use of wired o of this communication, what can be a limiting.**

For this reason in this document we will show an innovative system that uses a wireless communication between the industrial processes with the different sensors and the central of monitoring. Also, this system involves a serial server device, which allows monitoring the process for anywhere, via internet through a graphical interface.

Keywords- ***Industrial; Processes; Monitoring; Sensor; Serve; Wireless.***

I. INTRODUCTION

The new technologies in telecommunications and the different tools and applications provide more effective and efficient opportunities for processing, and transport of information in all environments that require access to it constantly.

In the case of industry, access to information is essential for monitoring and control of different processes and for the optimization of resources, quality and efficiency. For these reasons it is important to have a communications system, that, integrating hardware and software tools, enable instant and continuous access to plant information and remote monitoring from anywhere in the world.

The integration of different communication protocols with instrumentation and control systems may be an innovative solution that asks to specific requirements, so as to optimize resources in accordance with current technology trends.

II. DESING AND IMPLEMENTATION

The Remote monitoring system with wireless access industrial processes takes place in six stages, as shown in the block diagram in Fig. 1.

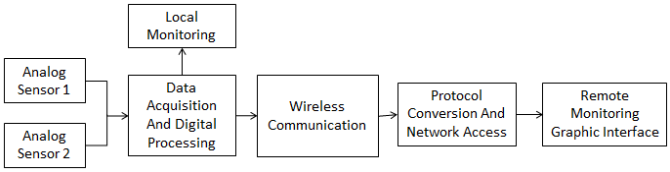

Figure 1. Block Diagram.
Source: The Authors.

A. *Analog Variables Sensing*

A sensor is a device capable of measuring physical or chemical quantities, known as instrumentation variables and transforms them into electrical variables. Instrumentation variables can be for example: temperature, light intensity, distance, acceleration, inclination, displacement, pressure, force, torque, flow, humidity, pH, etc.

Is possible the simultaneous acquisition of several analog signals from sensors that are in the process, enabling scalability and adaptability to any type of need in various environments such as industrial, agricultural, or environmental, among others. In this case only have two sensors whose signals must first be conditioned in order to facilitate the acquisition and processing.

B. *Data Acquisition and Digital Processing*

The number of analog signals to sensing is limited by the number of channels of the converter used, in this case is employed a microcontroller reference MC68HC908GP32, that through the digital analog conversion module that has internally, and programmed in assembly language[1], allows the adaptation of eight channels for the acquisition of data and perform a conversion of digital data to facilitate processing within the microcontroller.

[1] Assembly is a type of low-level language used for writing software, this code is used by microcontrollers to perform its configuration

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Once the conversion is done and the data are stored in special purpose internal registers of the microcontroller, is configured the order of the data which will be used for local monitoring and shaping the frame that subsequently will be sent.

C. *Local Monitoring*

When monitoring is done locally, is necessary to implement a display system, which allows to have knowledge of the state of the sensed variables in the place where the process is running.

For this stage of the project is implemented by a liquid crystal display (LCD), as shown in Fig. 2, which visualize all alphanumeric characters, allowing to represent information in an easy and economical way. This LCD screen is programmed by the microcontroller, showing real-time status, allowing users to verify any of the conditions sensed variables and be aware of what is happening now in the process.

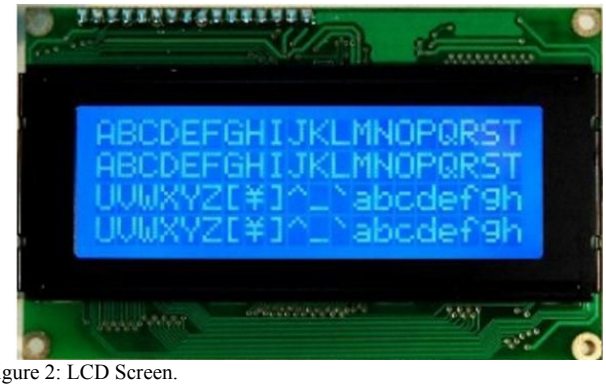

Figure 2: LCD Screen.
Source: Hitachi LCD Datasheet

In this case we will monitor the status of two instrumentation variables, then was necessary to use a 4x40 screen (four lines of forty characters), but in case of having a large number of sensors is possible to expand the local display using a screen more extending or creating controls aided by pull-down menus associated with each of the variables measured.

D. *Wireless Communication*

In wireless communication stage it is necessary to organize the data within the microcontroller in order to obtain a frame of five fields, each with a length of 1 byte, as shown in fig. 3, where: Data 1 and Data 2 refer to the signals obtained in sensing step.

HEADER	DATA 1	DATA 2	ERROR DETECTION	TRAILER

Figure 3. Communication Frame.
Source: The Authors.

To obtain the data for the error detection field of the frame, is used the checksum method, which consists of adding all data of the frame and get the complement to one.[2]

This data frame is sent serially through SCI module (serial communications interface) of the microcontroller, which is set to the desired transmission rate, in this case is defined a rate of 57.600 baud.

Serial communication involves sending bits of information in a sequential manner, one bit at a time and a set speed between the transmitter and receiver. A serial communication system, the transmitter sends one by one for each data bit, so that the receiver rearranges the data from the bit stream that is coming.

Taking into account that some processes may be difficult to access variables wired systems, wireless communication is added to the serial protocol previously established, using radio frequency modules OEM 9Xcite MaxStream, Inc. Which are a useful tool for low-power wireless communications that on the 900MHz frequency band. In Fig. 4, is shown the physical appearance of these modules.

Figure 4: 9Xcite OEM RF module.
Source: 9XCite OEM MaxStream Datasheet.

These modules provide a software which permit configure the specific parameters to work, such as the size of the data received, the transmission rate, parity bits among others. It also has a connector adaptable to different types and sizes of antennas allowing to connect the terminal that best suits the needs of the process required, depending on the tax environment where there will be implemented.

The wireless communication is made of two stages, transmission and reception, together with the means of transmission, in this case is the free space, form the building blocks of any communication system for exchange of data between two or more points.

a. *Transmission*

At the stage of transmission is the serial output of the microcontroller connected to the RF module's input, the connection is shown in fig. 5, which shows the

[2] TOMASI, Wayne. Sistemas de Comunicaciones Electrónicas. Cuarta Edición. 2003. p. 535.

correspondence of the pins of each device, data input, output, and the respective polarizations.

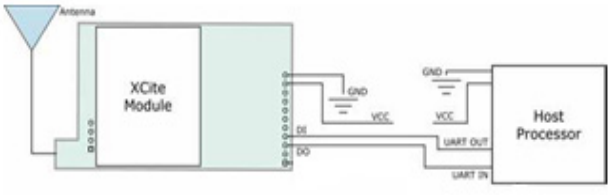

Figure 5. Transmission Diagram
Source: The Authors.

b. Reception.

At the stage if reception is the wireless module is connected to the serial interface card MaxStream, which converts TTL levels to the levels of rs232 serial protocol with a DB9 connector, allowing connection to another device that handles the same standard as for example a computer. In Fig. 6 shows a diagram of reception connected to a PC with RS232 serial protocol.

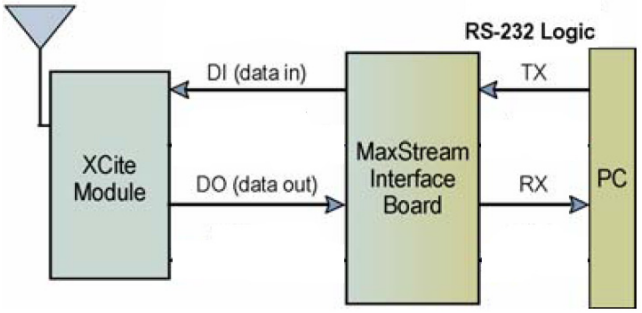

Figure 6. Reception Diagram.
Source: The Authors.

With the help of the serial interface card, various tests were done to analyze the behavior of modules, subject to various conditions, which determined a range of mind about 100 meters line of sight, also were tested different speeds of transmission, and how it affected the power of the modules with various types of antennas. The entire wireless communication system shown in fig. 7.

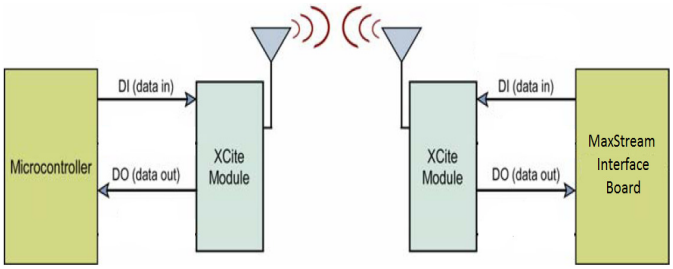

Figure 7. Connections wireless communication
Source: The Authors.

Taking into account that the system has application in industrial environments, it is important to mention the impact they can have noise and electromagnetic interference own industrial plants in wireless communication. This interference can be caused by the operation of machinery, engines, switching converters and industrial welding. However, these interferences can be minimized by using frequency of communication over frequency noise signals.

E. Protocol Conversion and Network Access

A few years ago most computers and devices had serial interfaces (RS232, RS485 or RS422). Dedicated cables were used to connect to the PC of control. Although the configuration using serial cable is simple, involves high installation and maintenance costs, limitations of distance between the device and the computer, and only the assigned pc can be used to control the device.

The rise of networks and the Internet became viable to leave the serial cable and all kinds of devices connect directly to the LAN. This reduces considerably installation costs by using existing network wiring, control devices from any PC on the network, eliminating the distance limitations imposed by the dedicated serial cables.

Protocol conversion to serial rs232 ethernet module is done by the Tibbo DS100 shown in Fig. 8, which is a serial device that connects any computer with serial port RS-232 or RS-485 to Ethernet 10BaseT networks.

Figure 8. Tibbo DS100 Module.
Source: Tibbo DS100 Module Datasheet

It is configured with server software toolkit Tibbo. mode allows full duplex and half duplex modes and the same network server, client and server/client, and of course the configuration of different transmission rates.

The device applications include:

- Data Capture & safety equipment
- Meters and remote sensing
- Auto-ID scanners
- Electronic message boards
- PCs trapping systems
- Vending machines
- Laboratory instruments
- Telephone exchanges (PBX)

F. Remote Monitoring Graphic Interface

To implement the graphical interface using the National Instruments software LabView, which manages a graphical programming environment for developing sophisticated systems of measuring, testing and control using graphical icons and intuitive and cables that look like a flowchart. Labview offers unparalleled integration with thousands of hardware devices and offers a variety of integrated libraries for advanced analysis and data visualization.

Making use of the data reading module is possible to set different parameters for acquiring the frame sent to the computer, once acquired this plot processing is performed on these data, in order to separate the frame in the five bytes mentioned above, performing the process of comparing byte by byte, followed by a parameterization of the data fields. In Fig. 9, one can observe a block diagram of the programming made.

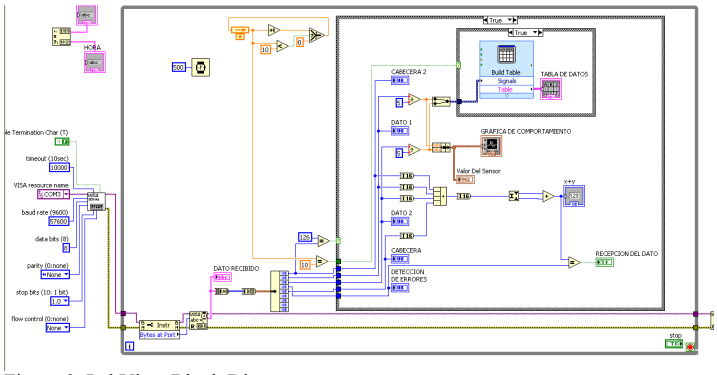

Figure 9. LabView Block Diagram.
Source: The Authors.

Each of the parameters to be displayed, is added an indicator or display that is located in a graphic field where the end user may see the behavior of industrial and data variables of interest, such as in Fig. 10, we can observe the data received by the computer (frame), in hexadecimal and byte by byte separation with matching fields assigned.

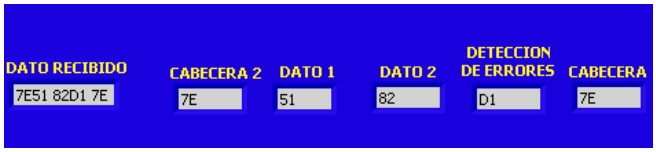

Figure 10. Frame and data separation in LabView
Source: The Authors.

Because the end-user needs known variables according to type of sensor with an appropriate range of action, Is made a parameterization process using mathematical tools provided by LabView, so that reading the data can be understandable for people who are not directly linked to the process that is being monitored.

In Fig. 11, at the top are the data of the two sensors parameterized and measured in real time, these figures vary according to the sensed values and indicate the current time value, in the bottom we can observe two behavior graphs, which show the behavior and changes that have sensed variables over time, shown in hours, minutes and seconds, and thus see the state of the variable.

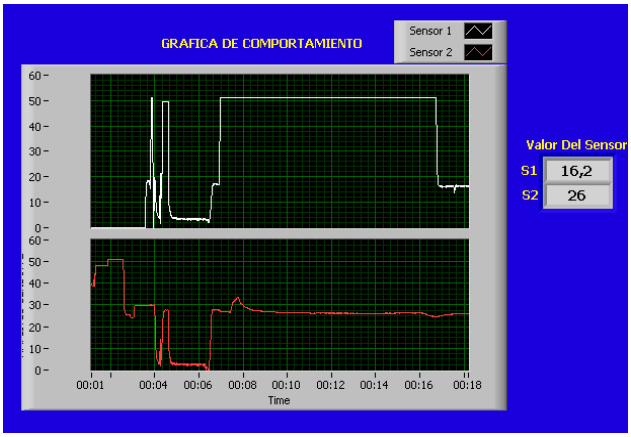

Figure 11. Parameterized data and graphs of behavior over time.
Source: The Authors.

In Fig. 12, you can observe the monitoring GUI, where you can see both the values of the plot and the data, as the value of the sensed variables parameterized and its behavior over time and table where registered, with the respective date and time, the values obtained for each of the sensors.

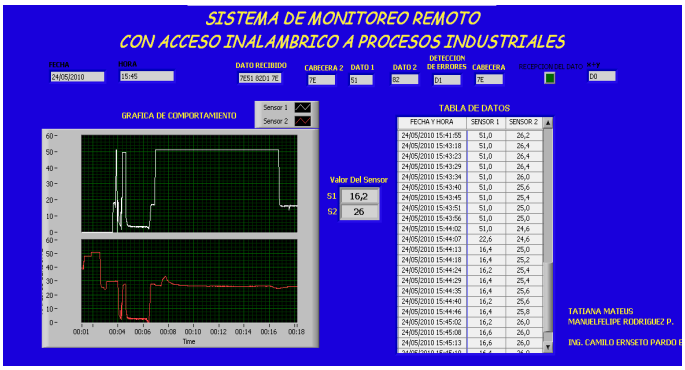

Figure 12. Remote Monitoring Graphic Interface.
Source: The Authors.

III. CONCLUSIONS

1. The system allows acquisition of signals from different types of sensors, however, is essential to take into account the scale corresponding to the physical or chemical magnitude is feeling in them, in each case.

2. The baud rate set for serial communications module microcontroller (SCI) makes imperceptible the time between each conversion digital analog, given that they are not simultaneously but sequentially, according to the code structure.

3. Local monitoring is helpful in the industry to make a continuous review of information on the site is running

the process, allowing to have a backup system in case of not having internet connection to use remote monitoring, also, use LCD screens allow that the local system has high scalability, it is an economical solution that programmatically allows you to display a variety of information in an effective and relevant for users.

4. The creation of a data frame and an error detection system makes the delivery of information is reliable and low susceptibility to interference, ensuring that through 9Xcite OEM modules MaxStream, inc. configured properly, there is a correct data transmission for the reception and display these remotely.

5. Serial protocol converter devices to TCP / IP as the DS100 allows that exists compatibility between traditional equipment with serial interfaces, and new network technologies, reducing considerably the limitations and costs of conventional wiring also provides remote access to information since it allows direct connection to a LAN or even internet.

6. LabView is a revolutionary graphical development environment with integrated functions for data acquisition, and for the fair presentation of these, allowing a user interface presentation nice and easy to understand.

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