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Implementation of Bluetooth Protocol For Scada Systems with Open Source Tools

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Abstract

The main objective of this document is the implementation of a bidirectional Bluetooth system class 2, linked to a physical system with RS232v2 communications protocol for the control and monitoring of a tank with high temperature fluids using a SCADA system using the development tool of open source MyOpenLab. This solution allows to make changes in the monitoring process as well as in the control strategy of the system in a fast way, only making modifications in the software layer and adding more sensors or wireless devices, without requiring significant modifications in the mechanical or electrical system. By implementing the application on an Open Source platform, the application development costs are significantly reduced, which allows the application to be competitive for the local market, city, region.

Keywords: Bluetooth, SCADA systems, Open Source.

I. INTRODUCTION

Modern industries require a high demand for control and supervision of processes for the management of systems with multiple variables in real time [1], these systems require the use of sensors and transducers for their control and monitoring, all these needs make the SCADA systems are ideal for remote multiple control [2]. In some industries these systems have quite high costs affecting the growth of small and medium industries [3], which want an efficient production, for this it is imperative the creation of open source systems that help these industries to increase their productivity [4].

The current monitoring and control systems have communication schemes susceptible to security threats, which could cause damage to the equipment due to the low use of computer security tools, some of these implement security solutions based on free software [5], said set-ups use Linux as a base to avoid the current vulnerability of these systems [6].

Nowadays, growing industries need minute-to-minute follow-up with high precision and high-speed response systems, both process correction and early warning alarms, the costs of implementing a highly complex SCADA system, could generate high costs, unfeasible for small and medium industry, for this reason, the developments are set to systems with multiple technologies [7], preferably at low cost and using free tools [8] reusing somewhat old but reliable technologies [9].

The SCADA-RFID mixed embedded systems implemented under the LINUX open operating system, seek greater coverage of processes at low costs thanks to the nature of their system, helping growing industries to have a competitive advantage [10], some wireless communication protocols such as Bluetooth, Xbee or the same RFID allow communications with bidirectional transmission systems, without physical network infrastructure to perform data acquisition and / or visualization tasks in a simple way [11] [12].

Bluetooth and Wi-Fi technologies are the most used for this type of solutions [13], they are efficient and high-speed communication protocols, practical in complex systems with a large number of signals and information channels, applicable in control and monitoring systems. industrial plants [14] [15].

In the development of this document, a SCADA system is proposed that performs the monitoring and control of a tank with fluids at high temperature, this system has level and temperature sensors that provide information minute by minute of what happens in the system, together with Early alarms and security systems for emergency opening and ventilation, all this is done through a Bluetooth communication system. The graphic elements and the implementation per block were developed in the graphic programming language MyOpenLab facilitating visualization tasks and communications.

II. METHODOLOGY

In this implementation has been used a SCADA system that monitors and controls a tank, the system has multiple level sensors Stainless Steel 45/220 mm and a central temperature sensor DS18B20 with joint compensation, the sensors have communication with a PLC, which receives and sends data under the RS232v2 protocol as a bridge to the Bluetooth module with wireless connection where a computer performs the monitoring, visualization and control of the data.

The implementation begins with the design of the graphic interface under the programming language MyOpenLab, where modules and intuitive elements are available for connection and later configuration, the programming language has a pre-designed module for the connection with the RS232v2 protocol that goes directly to a wireless connection that completes the connection via Bluetooth with the PLC for reading the sensors.

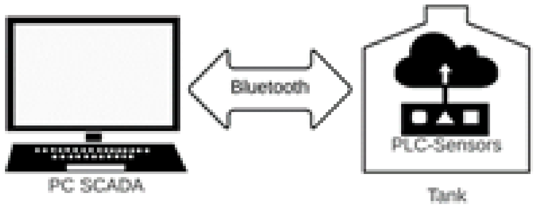

Fig 1. Generalized system diagram

A. Bluetooth

It is one of the most widely used wireless personal area network (WPAN) standards, this communication technology allows the transmission and reception of audio or data between devices with frequency links in a specific 2.4 GHz ISM band. With the creation of this link between nearby devices, it is intended to create a communication channel with a standard protocol, to transfer data in different formats and file sizes, on the basis of its operation allows to create networks for transmission and reception of information for any type of equipment.

Depending on the characteristics of allowed power, range and bandwidth, 4 classes of Bluetooth devices are defined, as can be seen below.

TABLE 1. CLASSES AND RANGES BLUETOOTH

Class	Maximum power allowed (mW)	Maximum power allowed (dBm)	Reach (approaching)
Class 1	100	20	~ 100 meters
Class 2	2.5	4	~ 5-10 meters
Class 3	1	0	~ 1 metro
Class 4	0.5	0	~ 0.5 metro

(a)

Version	bandwidth (BW)
Version 1.2	1 Mbit/s
Version 2.0 + EDR	3 Mbit/s
Version 3.0 + HS	24 Mbit/s
Version 4.0	32 Mbit/s
Version 5	50 Mbit/s

(b)

The "base" communication protocol uses simple single-line channels that combine the sending circuits with the data packets, to have reliable communication and ensure that the blocks of data arrive complete and in the correct order, the blocks of information are sent in a synchronous system, but now the systems can be asynchronous too, but the channels organize and reserve spaces to guarantee the order of the blocks of information. Asynchronous systems have a transfer rate of 721 kbit / s in one direction and 56 kbit / s in the opposite direction, now with synchronous systems transfer rates reach 432.6 kbit / s in both directions.

B. SCADA (Supervisory Control and Data Acquisition)

It is a concept based on the implementation of software for devices, which allows to control and supervise industrial processes in different control rooms. As it is a supervision system, it allows the visualization and second-to-second feedback of events occurring in the systems (sensors and actuators), with this it is possible to assign values and behaviors that are desired in the system. The main characteristics for the implementation of SCADA systems are: Acquisition and storage of data, visualization of obtained data, supervision and easy transmission of data for analysis and subsequent processing.

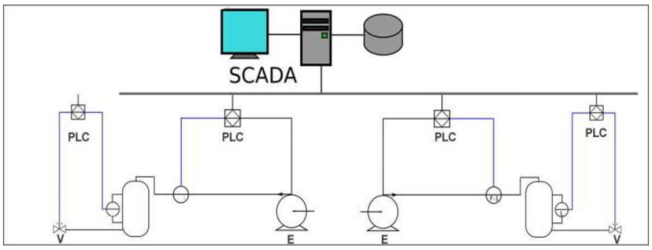

Fig 2. Basic SCADA system [16]

In the diagram of figure 2. the basic elements for the operation of a SCADA system are observed: the visualization of the physical variables, storage and processing of the information sent by sensors and activation signals of the error correction systems that trigger the PLC's and / or valves, together with the necessary mechanisms to keep the process in proper operation.

III. IMPLEMENTATION AND RESULTS

The design of a tank filling system was carried out, which will have the capacity to control the temperature of the liquid, to carry out communication tasks, the RS232 V2 communication standard was used, which serves as a bridge for the Bluetooth protocol, for the realization of the graphic interface was used the free tool MyOpenLab, said programming platform facilitates the implementation of monitoring and control tasks necessary for SCADA systems.

Based on programming of graphic elements is an open tool in the development of control systems or in function of graphic monitoring. The elements in the integrated libraries facilitate the union between them making it an intuitive program, easy to manipulate.

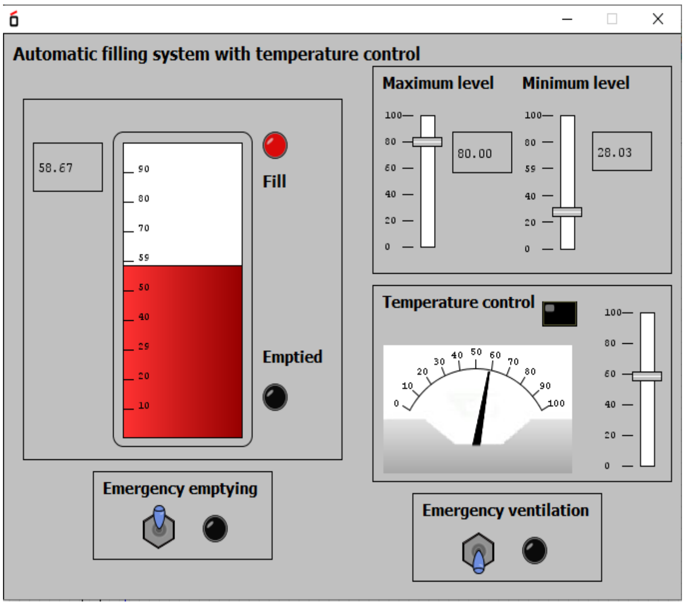

Fig 3. Front elements in MyOpenLab

The front elements seen in figure 3. emulate a high temperature tank with level sensors, fill / empty alerts, drain switch and emergency ventilation. The water clocks and the tank level receive the data in floating point for greater precision, the light indicators give a warning of what happens with the pumps and the opening and closing valves of the tank, both the high temperatures and the envelope tank filling are notified by the light alerts.

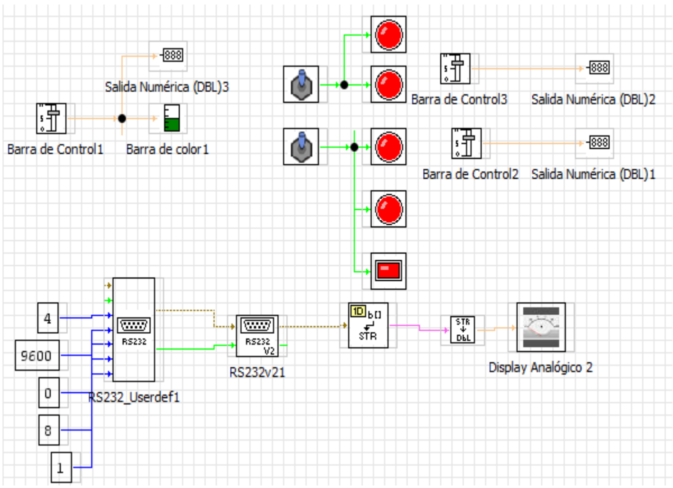

Fig 4. Back elements in MyOpenLab

In the back elements are observed the connections of the light alerts, switch, communication systems and output display to observe the reception values and the relevant data that are sent to a SCADA control point. The configuration of the RS232 v2 protocol is done manually, with the values of the input port on a digital analog converter and with the digital connection with the naked eye, two input-output channels communicate the SCADA system. They receive the data in the form of a bit string to a floating format for later display on the cover display and the observation of limits on the part of front elements.

Table 2. Proposed communications arrangement

Frame Fields		Offset	Examp	Description
Start Delimiter	INITX	0	@	Frame Beginning
Frame Specific Data	ID	1 2	528	ID number
	Info	MBS 3 LSB 8	34 62 89 46 32 90	Password
	Function	9	R	Read /Write
End Delimiter	FINT X	10	#	

Around the processes for communication of the SCADA control unit with the sensor system to the PLC, a communication frame was designed that provides the system with all the necessary information for the quickest response associated with the remote configuration of the system. action, the defined structures favor the identification of protocol bytes and the segments of bytes associated with the useful data; this is carried out in order to reduce the time in which a control action or command is executed under the internal algorithm of the control system. The proposed arrangement can be seen in table 1.

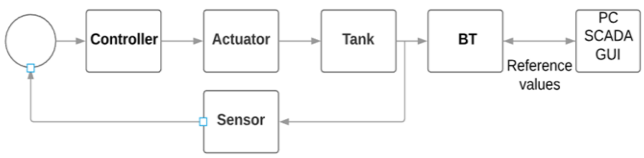

Fig 5. SCADA system control loop

The typical feedback loop shows the standard behavior of a system under control where the level and temperature sensors give a minute by minute of the behavior data entered into the reference system, which receives the desired reference data, the actuators open and close the valves and turn off the filling and heating systems; finally, the tank controlled by the aforementioned systems behaves as desired. The communication systems, these assets permanently to maintain the operation of the plant in the established ranges.

V. CONCLUSIONS

Taking advantage of the benefits of the MyOpenLab graphic language, a monitoring and control implementation was achieved to meet all the standards of a conventional SCADA system, quickly and modularly, which allows future changes to be made with minimal effort. For this work, we used a personal computer with a Core I7 of 2.8 Gigahertz, with 16 Gigabytes of RAM and a Gforce 8 Gigabyte graphics card, which makes the reading of the sensors, the calculations and the control actions take to out in a fluid way, giving the possibility of adding more sensors or control loops without compromising the correct functioning of the system.

The design of communications provides a reliable and updated set of elements, since it was developed under open source tools is easily adaptable to various control systems, the processes of sending and receiving data was established for a time of 10,4 milliseconds approximately, while the associated transfer rate a bit time of 104 microseconds was obtained, thus establishing a total transmission time of 20.8 miliseconds

Thanks to the communications system used, the displacement of the control system is easily relocated or re-installable in another computer, the wireless connection gives a much broader versatility than the systems implemented directly in the plant. The Bluetooth communication used offers a displacement range of at least 50 meters for both the pressurized tank and the monitoring point, in addition to having a speed of 432 Kbits / s bandwidth that allows the handling of up to a hundred sensors of wireless features at the aforementioned distance.

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