DATA PROCESSING WITH MICROPROCESSOR DEVICE USING RADIOFREQUENCY

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Bernardo Tadeu[1]
Raphael Yuri Quintel Diniz[1]
Ms. Wagner de Aguiar[2]

Data transmission using radio frequency is an effective method, and used since its invention. Radio stations, communication by walk and talk and Bluetooth are examples of how this technology is used in everyday life. Industrial monitoring systems also use this, in order to achieve communication between the machinery and their supervisors. This work has as a proposal to develop a microprocessor-based remote monitoring system for a device using radio transmission for data transfer, for which will be proposed a control protocol. Through this communication it will be possible to monitor the behavior of devices facilitating system management. The proposal is to control the system, allowing it to be held in the event of a change in the information received and analyzed, taking advantage of existing Processes Plant at Instituto Federal, and using a Microcontroller to the data processing, data transmission by means of monitoring and control with wireless.

Keywords: RF 433 MHz, PIC 16F877A, Sensoring, Data Processing, PWM.

A transmissão de dados por radiofrequência é um método eficaz e utilizado desde a sua invenção. Estações de rádio, comunicação por walk and talk e Bluetooth são exemplos de como esta tecnologia é usada na vida cotidiana. Os sistemas de monitoramento industrial também fazem uso dessa tecnologia, a fim de conseguir a comunicação entre uma máquina e seus supervisores. Este trabalho tem como proposta desenvolver um sistema de monitoramento remoto baseado em microprocessador para um dispositivo que utiliza transmissão de rádio para transferência de dados, para o qual será proposto um protocolo de controle. Através desta comunicação será possível monitorar o comportamento dos dispositivos facilitando a gestão do sistema. A proposta é o controle do sistema, permitindo que ele seja realizado em caso de alteração das informações recebidas e analisadas, aproveitando a Planta de Processos existente no Instituto Federal e utilizando um Microcontrolador para o processamento de dados, transmissão de dados por meio de Monitoramento e controle com wireless.

Palavras-chave: RF 433 MHz, PIC 16F877A, Sensorização, Processamento de Dados, PWM.

[1]Engenharia de Controle e Automação
[2]Professor Orientador, Engenharia de Controle e Automação, Instituto Federal de São Paulo – campus São Paulo

1 INTRODUCTION

Radiofrequency: According to the *Agência Nacional de Telecomunicações (ANATEL)*, the radio waves are known as radiofrequency waves or, simply, radiofrequency. Those waves are electromagnetic field utilized in wireless communication. Since these waves carry energy from one point to another, it allows the data transmission without the requirement of wires, such as televisions, radio and cellphones transmission.

Radiofrequency are signals that are spread by a wired conductor, usually copper, and are irradiated in air through an antenna. An antenna transforms the signal from a wired system to a wireless signal and vice-versa. The signals irradiated in open air, as electromagnetic waves, spread straight in all directions.

Sensor for level measurement: There are many types of sensors for level measurement currently in market, such as ruler, flowmeter and switches. However, in this Project, it is used a magnetic float level sensor, due to its easy installation and application. This sensor has a range from 0 to 60cm height, and sends an analogical sign from 4 to 20 mA which is sent to the A/D converter inside the microcontroller. (NARAYANA, Komanapalli Venkata Lakshmi et al. Design and development of improved linearized network based liquid level transmitter. In: Control, Automation, Robotics and Embedded Systems (CARE), 2013 International Conference on. IEEE, 2013. p. 1-6.).

A/D Converter: These converters are, basically, the connection between the real world and the electronic world and they are present in almost all electronic instruments and devices (Silva, Renato A., 2006). Once they are physical measurement instruments, or instruments that may need control in their operation.

- Dynamic Range: is the operation amplitude range of the analog signal, within the work area and normally, the A / D converters have a dynamic range of 0.1 to 10V.
- Resolution: This is the lowest amount that can be converted within the dynamic range of the input signal and is specified by the number of bits of the converter. In practice, there are converters with resolutions from 8 to 20 bits.
- Conversion Time: The time required to obtain the converted output value from the moment the input signal was applied. Considering that the higher rate of resolution implies in more time for data conversion.
- Linearity error: Demonstrates the conversion result of the diversion to an ideal ramp and is expressed as a percentage of the total value or number of bits

2 DEVELOPMENT

The project aims to transmit the data generated by the float level sensor via RF, which will be given greater focus in the plant that contains the tank where the magnetic float level sensor is installed, as shown in Figure 1 attached.

It is also worth notice that the tests and transmissions are made in 433MHz frequency, using a transmitter and receiver according to the specifications given in this article.
This project uses a PIC 16F877A to control the transmission and data processing. The drivers in the plant and other types of microcontrollers will not be discussed or studied in this article.
For the purposes of curiosity and better knowledge of the plant, the general characteristics of this Didactic Process Plant are shown below.

Figure 1 – Magnetic Float Level

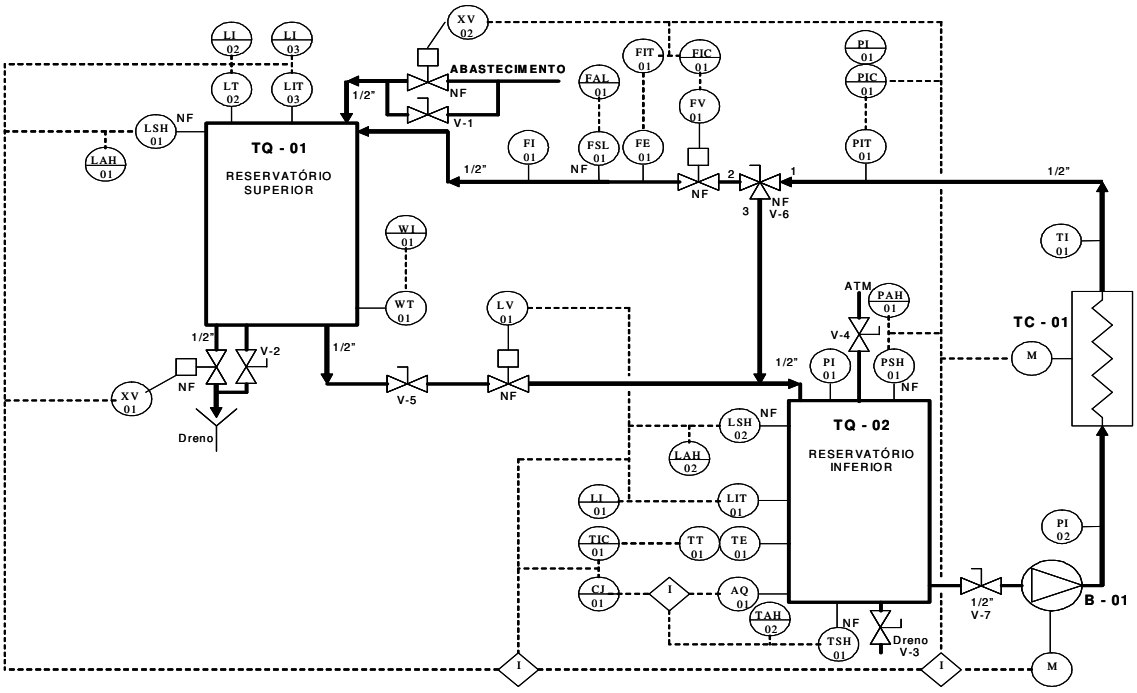

Figure 2 – Didactic Process Plant's Flowchart

The Didactic Process Plant was designed to allow easy transportation, and it has the following important features:

- Does not require any of its elements is removed or dismantled to transport to short or long distances, because it has wheels for displacement;
- Weight enough to be maneuvered with ease for two medium-sized people in a floor plan.
- A main Acrylic tank with 100 liters capacity and a second made of stainless steel with capacity of 120 liters.

The electric panel consists externally in a digital PID controller, digital indicators, Human-Machine Interface (HMI), push buttons, emergency button and toggle switch. Internally it has a frequency inverter, power controller, programmable logic controller (PLC), circuit breakers, fuses, and so on.

So far, the tests consist of the transmission of data acquired by the magnetic float sensor. This sensor operates with a current of 4 to 20mA, and, therefore, to use the A/D converter in the microcontroller for interpreting the data it was necessary to develop a circuit for converting this current linearly in 1V to 5V. This circuit uses two Trimpots of 1kΩ and 1W adjusted to have the same voltage across them, to ensure that linearity occurs even when considering variation in resistance due to heating.

Thus, when the tank is empty the A/D converter receives a voltage of 1V, which is equivalent to code $33_{(H)}$. Therefore, any code below that, indicates error in the power conversion system and the value $00_{(H)}$ indicates that the circuit is open somewhere. Following the data measured by the magnetic float sensor and interpreted by PIC 16F877A:

Table 1: Tank Level Values

Level Ruler (cm)	Magnetic Float (cm)	PIC 16F877A (cm)
7,0	7,0	7,03
8,5	8,4	8,39
10,2	10,3	10,35
14,7	14,7	14,65
21,1	21,0	21,09
27,0	26,9	26,95
33,5	33,5	33,59
44,8	44,9	44,92

This difference above its caused by the range of the sensor is 50 cm, and 256-bit resolution, therefore, each bit represents 0.1953125 cm. To approach, it was used only the centesimal part of centimeter.

The analog to digital converter in the microcontroller has two resolutions pattern: 8 bits (00 to FF - in hexadecimal) or 10 bits (0000 to 03FF - in hexadecimal). Due to the nature of the experiment, the resolution with 8 bits becomes suitable for the application in question. This is mainly due to the sensor used to work with the specification 4-20 mA and making more precise the receiver implies in making it more sensitive to noise, affecting the accuracy of the data collected. The measurement took place with values from code $33_{(H)}$, since the empty indication begins by this.

As an initial test, were sent a few bytes from the microcontroller to the computer, as AA11 (H), AA22 (H), AA33 (H), and the computer received the information correctly after the two synchronization characters (AA (H)). Therefore, it is possible to associate a data byte code and then transmit the microcontroller tank level monitor to the computer.

3 CONCLUSION

Currently, the project is developing the communication protocol with the computer that will be responsible for monitoring the status of the tank. This protocol is based on asynchronous communication with a transmission rate of 9600 bauds, no parity, 2 synchronization characters. After sending the sync byte will be sent the data representing the level of tank through a code, not defined yet.

It is noteworthy that the transmitters will use the communication through On-Off Keying modulation (OOK), where logic "0" (zero) represent the absence of carrier, and logic "1" (one) for the presence carrier.

Tests conducted so far show us that the system is able to recognize from the sensor information, and to test the feasibility of the project is necessary to conclude the protocol under development.

After ensuring the monitoring of the tank, control tests will be carried out in the tank. It will be used a pulse-width modulation (PWM) to control the flow of the tank through a control valve, which at first will be directly in the microcontroller which will study duty cycle required for each level of openness the valve and system flow. Then, a computer communication protocol to the microcontroller which will be responsible for determining the initial parameter in the tank level will be proposed.

Once the previous step is carried out, a control protocol is created to maintain a stable level of tank according to pre-programmed parameters. We will study options for a PI or PID control, performing the comparisons necessary to stipulate which presents the most satisfactory results, thus completing the proposed for this project.

REFERENCES

ZARUBA, G.V. Erik Jonsson Sch. of Eng. & Comput. Sci., Texas Univ., Dallas, TX, USA Communications, 2001. ICC 2001. IEEE International Conference on MIPS Technologies, Inc (2009). **Android on MIPS, "MIPS Technologies**".

Silva, Renato A. **Programando Microcontroladores PIC : Linguagem “C” /** Renato A. Silva. – São Paulo : Ensino Profissional, 2006. 172p.

Costa, Renato Silveira da; **Aquisição de dados e interface de comunicação nos instrumentos de medição em massa**, Disponível em: <http://repositorios.inmetro.gov.br/bitstream/10926/815/1/2005_RenatoSilveiradaCosta2.pdf>. Acesso em: 05, Abril 2015.

AGENCIA NACIONAL DE TELECOMUNICAÇÕES. **Radiofrequencia** <http://www.anatel.gov.br/Portal/exibirPortalNivelDois.do?acao=&codItemCanal=671&codigoVisao=$visao.codigo&nomeVisao=$visao.descricao&nomeCanal=Radiofreq%FC%EAncia&nomeItemCanal=Apresenta%E7%E3o&codCanal=296> Acesso em 05, Abril de 2015

ZANCO, Wagner da Silva. **Microcontroladores PIC – Técnicas de Software e Hardware para Projetos de Circuitos Eletrônicos**. Editora Érica, Primeira Edição, 2006.

NARAYANA, Komanapalli Venkata Lakshmi et al. **Design and development of improved linearized network based liquid level transmitter.** In: Control, Automation, Robotics and Embedded Systems (CARE), 2013 International Conference on. IEEE, 2013. p. 1-6

NISE, Norman S. **Engenharia de Sistemas de Controle** - Editora LTC, Sexta Edição, 2012. 760p.