MEASURING SYSTEM FOR PELTON TURBINE

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Summary

This article presents the methodology of implementation of the system of measurement and communication of the angular velocity and pressure in a Pelton turbine of type training; using LabVIEW ® and a Microchip ® microcontroller and its display in a graphical user interface. A device that receives a signal or stimulus and responds with an electrical signal was used for the acquisition of the variables. The tools presented in this implementation, you can acquire and submit accurate data at a speed of 12 Mb/s. The communication is done using the Call Function Library for LabVIEW ® tool, which makes use of mpusbapi provided by Microchip ®. The bridge that establishes the communication via USB libraries of the CCS C Compiler ® and the driver mchpusb for Microsoft ® software.

Key words : Turbine Pelton, LabVIEW, angular velocity, pressure.

1 INTRODUCTION

The laboratory of hydraulics of the Distrital Francisco José De Caldas faculty technological University has a Pelton turbine, however this did not have a precision measurement system for variable pressure and RPM generating large errors.
The measurement system developed for the Pelton turbine, has a system of acquisition from an inductive sensor (*SC1204)* to measure the angular velocity and a differential pressure *(MPX5700)* pressure sensor, signal conditioning and processing was performed using a Microchip microcontroller. The display of measurements are displayed on an LCD and a user interface developed in LabVIEW.

2 FEATURES OF THE PELTON TURBINE

The principle of Pelton turbine is to convert the kinetic energy of the water jet in the speed of rotation of the wheel or rotor. To ensure that this is done with maximum efficiency the water must leave spoons with a small amount of kinetic energy remaining.
In large hydroelectric plants, this type of turbines only is considered to heights greater than 150 meters. For applications in micro hydropower can be used for much smaller jumps. For example a Pelton turbine that rotates at a high speed of rotation can be used to generate 1 Kw with less than 20 meters height. For larger powers the rotation speed decreases and the rotor becomes very large.
Turbine Pelton (see Figure 1), has a needle valve shrink that adjusts the flow. The Pelton wheel blades are clearly visible through the transparent cover of the turbine. Table 1 shows the specifications of the Pelton turbine.

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Figure 1. Pelton Turbine

Table 1. Technical specifications of the Pelton turbine

Variables	Rango	Unidad
Speed range.	0-200	RPM
Pair	10	W
Gauge range	0-2,5	bar
Number of pallets	16	
Radio drum	30	mm
Range of diameters	10-20	N
Dimensions:	750 x 400 x 750	mm
Weight		

2.1 MEASUREMENT OF VARIABLES

2.1.1. Measurement of the Angular speed

After doing a search for information on the measurement of angular velocity, will implement a proximity sensor of inductive type that allows you to accurately measure this variable (RPM), using an encoder in the rotor of the turbine that allows the sensor to detect the number of segments featuring the disk holes in this case. And so to measure a frequency in the rotor of the turbine where it was located.

The inductive sensor electronic detector SC1204 of proximity of metal pieces, which is based on the variation of electromagnetic fields, act in silence, without impact or rebound of touch, insensitive to vibrations and does not contact due to slow approaches insecurity, has a system of protection degree IP 67 (against dust and water).

For the selection of the Encoder allowing sensing the frequency in the turbine Pelton took into account the functional characteristics of the inductive sensor. As surface enables the zone through which high frequency sensor field enters the space of air (Figure 2). The standard measuring plate, to calculate the distance for action on the sensor.

The correction factor in the distance of performance materials, in our case the aluminum with a correction factor of 0.3 to 0.45. The switching frequency which corresponds to the maximum number of switching sequences for second 2ms Max.

For processing the signal delivered the sensor, it is necessary to make a match of it, so the current signal that varies from 4mA to 20 mA should become voltage signal that varies from 0V to 5V. For the current signal voltage is connected a resistance to the output of the sensor and the other end to ground.

Due to the movement of a current in resistance is causes a voltage drop this connects to a common emitter with a load configuration on the base where takes the response signal frequency which is sent to a frequency to voltage converter. This output voltage must be applied to a follower of voltage due to the impedance of the circuit. The frequency was obtained from equation (1).

$$f = \frac{n \times p}{60} \quad (1)$$

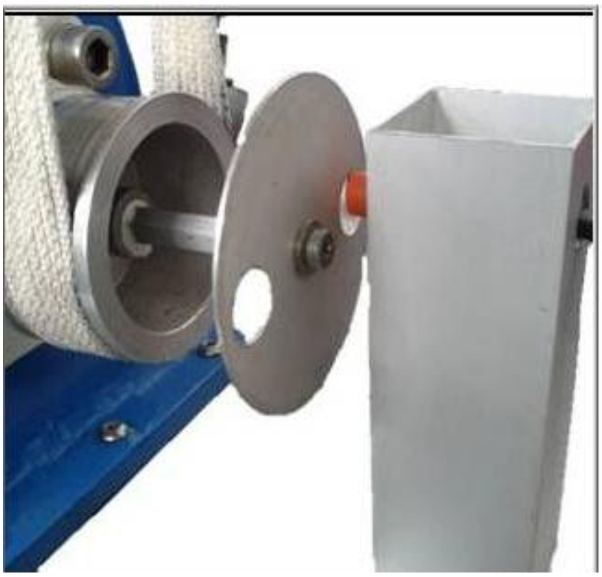

Figure 2. Implementation of the encoder

2.1.2 Pressure measurement

For the measurement of this variable was taken into account thePressure sensors with semiconductor based on a variation of pressure on a membrane that causes Act a semiconductor single piezo-resistive element. Motorola manufactures a series of pressure sensors with semiconductors, low-cost and whose presentations are part of good technology.

Motorola MPX series pressure sensors functioning is based on the patented design of the force gauge. The output is an analog voltage that is proportional to the inlet pressure and the radiometric power supply voltage. The high sensitivity and an excellent repeatability in the long term make them the units most appropriate for most applications. The precision is very good your resistances of calibration and compensation adjustments with laser controlled by computer, giving very precise pressure over a wide temperature range. The effect of temperature is typically ± 0.5% of full scale over a temperature range of 0 to 85 ° C, while the effect on the tension of offset on a similar temperature range, is ± 1 mV maximum. [4]

MPX5700 Piezoresistive transducer series is a pressure sensor monolithic Silicon art designed for a wide range of applications, but especially for insert a microcontroller with a/D this patented transducer inputs, single element combines advanced micromachining techniques, metallization for thin film and processing bipolar to provide an analog output signal level required, high it is proportional to the applied pressure.

By applying pressure to the diaphragm, a resistance change occurs in the strain gauge, which in turn causes a change in the output voltage in direct proportion to the applied pressure. The strain gauge is an integral part of the Silicon diaphragm, and therefore does not introduce typical errors due to differences in thermal expansion. [4]. In Figure 3. Inlet pressure sensor with respect to the signal output is displayed.

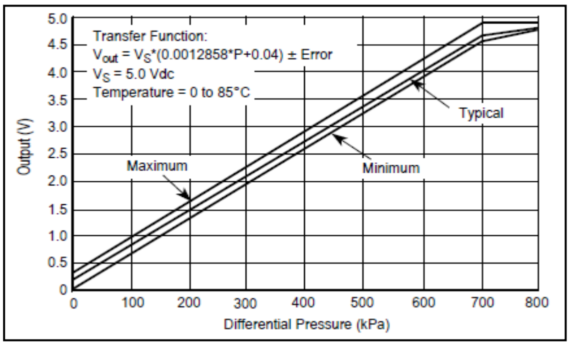

Figure 3. Pressure output voltage.

Connected a hose to 3 cm long and 3 mm internal diameter to the sensor connection P1. The other end of this hose was connected to one of outlets of a "T" connector on the tube of 7 cm where passes the water generated by the movement of the turbine, another of the sockets of the connector joined the analog gauge.

For the coupling of the sensor is a decoupling in the power outlet and a filtration stage. A combination of a RC filter and a limited number of samples gives the best results, as shown in Figure 4.

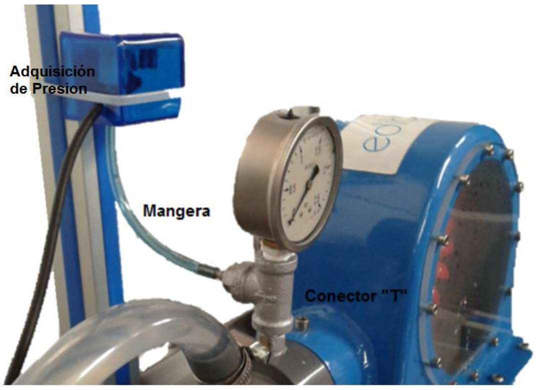

Figure 4. Pressure measurement

3. Communication system

In this work the option choose Bulk Transfers, two-way mass transfer of information, since it allows the transmission of data from high (Full Speed) speed of 12 Mb/s. Bulk transfers are designed to withstand those devices that need to send or receive large amounts of data. The diagram of the Figura5 illustrates the flow of data USB from the LabVIEW software that manipulates the USB device through the mpusbapi library. The library makes the transmission of data to the address of the device to the host USB set up to use the driver. The driver provides the bridge between the PC and the microcontroller. Within the microcontroller runs the firmware which communicates with elements of our acquisition S.A. Board, performed some useful functions for the user, or what you want to control.

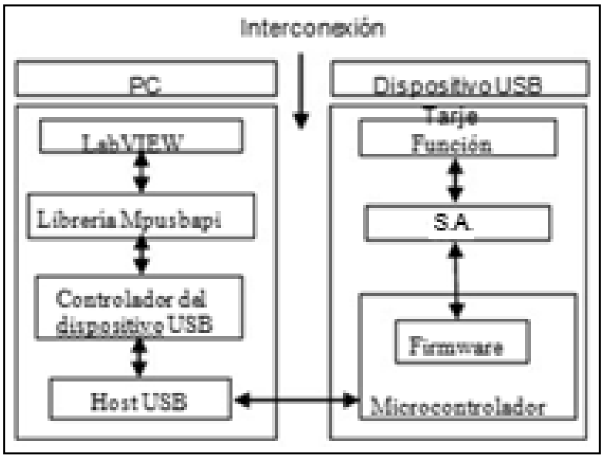

Figure 5. Stages of communication between the PC and the USB device.

The USB cable used is the model US09. The speed supported by these cables is 12 Mbps, up to 480Mbps USB 2.0 cables for. The cable consists of only four wires, Vbus, D +, D - and GND. Information and data are moved by wires D + and D-. Through these wires generates a kind of differential signal

The transfer of information is done in a bi-directional manner, but not at the same time. The same differential signal between D + and D - it sends and receives the data frames. A Sync, PID, and optional signal is observed within this signal, these three form the package of plot where is included the information that you want to convey. To set the USB communication interface is selected the PIC18F4550 microcontroller. This device supports communication via USB, i.e. include an internal USB controller and boasts PIN to connect to the PC without the need for external circuitry or pull-ps. Interface type USB 2.0 defines lines of communication between applications running on the host (customers) and the different endpoint (servers) USB devices, and referred to as Pipes (virtual link or Association) between the host and the Endpoints. When a USB device is connected to a system, and the system recognizes it and configures it, the device is organized as a certain set of endpoints. The system provides all lines of communication (pipes) required between the system and each of the endpoint available in this configuration. The system chooses a certain configuration depending on the particular functionality that is needed for the device. [5]

4. LabVIEW user interface

LabVIEW is a graphical programming that allows you to perform simulations, testing, control and process and system design. The language used is called language G (graph).The programs developed with LabVIEW virtual instruments (Vis) are called.
Programming in LabVIEW took place through a subVI (PicUSB-Labview) that allows you to manipulate the device more easily. [6] Created subVI is shown in Figure 6 below

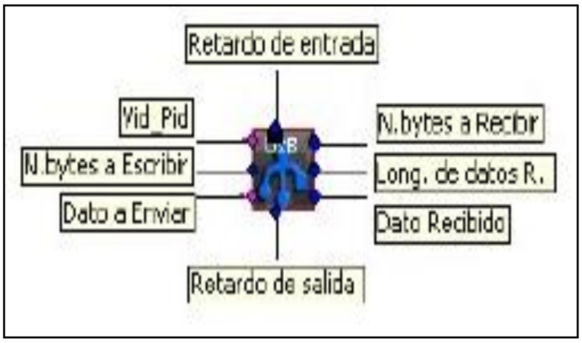

Figure 6. PicUSB, LabVIEW

In the initial part of the program is carried out the initialization of variables, ports, the LCD display and the analog-digital converter. The order is as follows, first the ports, then the screen and at the end the converter, this in order to allow the time needed before proceeding with the conversion of analog signals.

The direction of data flow must be defined in the initialization of the ports, i.e. they define if they are input or output ports. It is worth mentioning the input ports are analog ports and output ports are digital ports, the latter will connect to the screen to display the measured values and deliver visual alarms.

In the next phase of the program is the signal acquisition and processing of data. First the signal is acquired and subsequently moves to the analog-digital converter where the 10-bit conversion is performed, the result of this conversion is sent to another module where an adjustment is made to show the correct value in the display, after this setting is passed to the block "BCD conversion" where they generate characters as decimal for them to deploy on the display. Subsequently the digital analogue conversion result compares with previously established limits correspond to the specifications.

Used for this communication programming display and inner workings of the sensors is shown in the following flowchart (Figure 7).

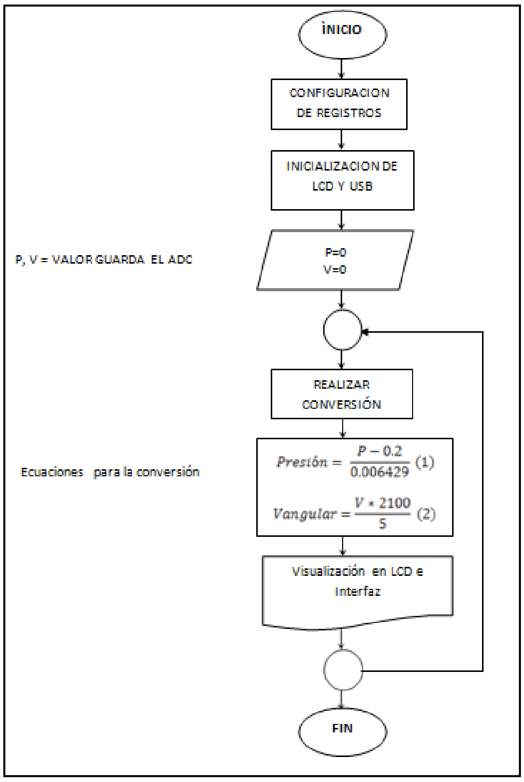

Figure 7. Flowchart of the microcontroller

For variable pressure you can view in the user interface in real time in a graphical manner, submitted values are in the system of units metric and English.

5 CONCLUSIONS

The project described in this document has fulfilled the objectives that were initially raised. Since the system was capable of measuring and displaying with appropriate accuracy, pressure and speed, parallel and continuously.

This article presented a methodology that enables communication between a PIC18F4550 microcontroller and LabVIEW for data acquisition tasks. The results show that the implemented methodology works perfectly, is achieved high-speed data transfer.

Since the sensing distance is constant for the standard lens. However, for non-ferrous targets such as bronze, aluminum and copper, occurs a phenomenon known as "epithelial effect". That gives as result that the sensing distance decrease the thickness of the lens increases.

It is worth mentioning that this set of devices to make a complete Control system should add you more functions, since on this occasion only considered the controlled variables, i.e. the quantities measured and manipulated variables which are quantities that are modified by the driver in order to affect the controlled variables were not taken into account.

For this system the user of the autoclave acts as driver, it will compare the parameters displayed in the display with the desired parameters and to undertake actions required to correct for these differences. It is for this reason that it is difficult to consider equations to describe the behavior of human control, in this case, one of the many factors that complicate it is the learning ability of the human being, as this is gaining experience as an element of control improvement and this should take into account when analyzing system

Thanks

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