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DESIGN AND IMPLEMENTATION OF A PID FUZZY CONTROL FOR THE SPEED OF A DC MOTOR

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ABSTRACT
This paper presents the design of a speed control for a DC motor using fuzzy logic by software LabView, is also a literature review the design and implementation environment is presented by fuzzy logic describing the materials and methods used. Various processes on the subject highlighting the idea, creation, development and implementation of intelligent control and finally the results considering the application and development for this purpose are presented exposed.

Keywords: intelligent control, fuzzy logic, labview, matlab, rules, industrial applications.

INTRODUCTION
Recently the use of artificial intelligence has risen exponentially in fields such as power electronics, control systems and positioning systems [1], [2], [3].

To carry out this development methods are needed with a large database or knowledge to be able to describe the system analysis to facilitate decision-making. One of these methods is the fuzzy logic [4], [5], [6], which arises as a need for improvement against classical logic and simply a statement can be understood as a logical value 1 or 0.

In the control field, specifically in the DC motor control can be applied intelligent control techniques as fuzzy logic is further to apply in parallel with conventional techniques control. In fuzzy logic are two well-known algorithms: logarithm logarithm Mamdani and Takagi Sugeno, these two are useful in applications such as microelectronics and power electronics.

Figure-1. 12v DC motor.

MATERIALS AND METHODS

Process description
In the block diagram of Figure-2, shows the control process. In the first stage, the input is the set point or reference rate to be applied to the motor. Followed is the analog-digital converter which is distinguished as a data acquisition card. In the second stage is the fuzzy logic control developed in LabVIEW. Again we find the data acquisition card as this should act as either analog-digital converter at the input and digital-analog converter on the output. After this analog signal passes through the actuator block which is an H bridge PWM modified using [7], [8], [9], the motor speed. The next block is the plant here is the DC motor. The tachometer, which is built into the DC motor, feedback system to check whether the engine speed has no such mistake and eliminate unwanted phenomenon.

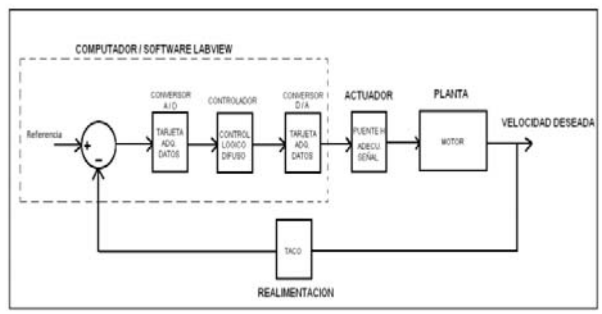

Figure-2. Process control (closed loop).

LABVIEW [10], [11], [12] is the software used to develop the controller through its fuzzy logic blocks. To facilitate programming toolbox uses or Toolkits are made. This software is mainly used for data acquisition, mathematical analysis, and instrument control and controller design. In 2008 it was used to control the LHC [13], [14], [15] a particle accelerator designed by about 2000 scientists from 34 countries around the world. This appliance is the largest of its kind and is located near Geneva.

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Figure-3. LabVIEW software programming.

To interact with Labview user requires a data acquisition card, we use National Instruments NI myDAQ. Function data acquisition card is to collect physical signals during the process and transform them into electrical voltages that are subsequently scanned on a PC and can be processed. To make the transformation to digital signal is in need of a stage adaptation.

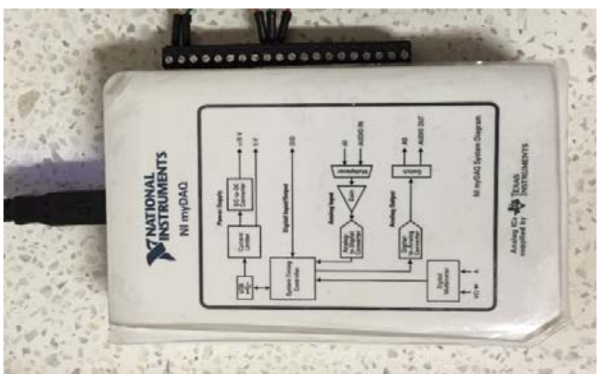

Figure-4. Data acquisition card.

Within the data acquisition process is the transducer, which is an element that converts the physical quantity to be measured in an output signal, usually a voltage or current that is then processed on a PC or system.

The signal conditioning is the stage that is responsible for filtering and adapting the outgoing signal transducer and subsequently sends them to the analog-digital converter, which as we know, is the stage responsible for converting an analog signal to a digital, finally output stage to connect the data acquisition system with a PC.

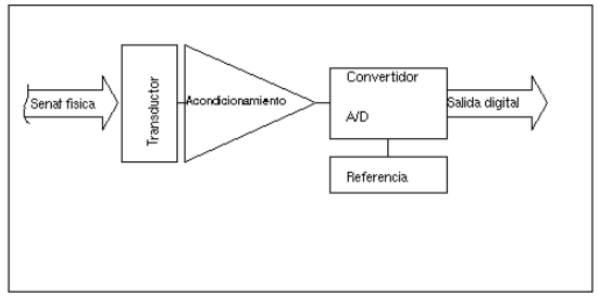

Figure-5. Process control (open loop).

In the initial window for the design of a new fuzzy controller data such as name, designer name, date and time data are observed project. In the window antecedence, Fuzzy Set Editor and the consequences are introduced.

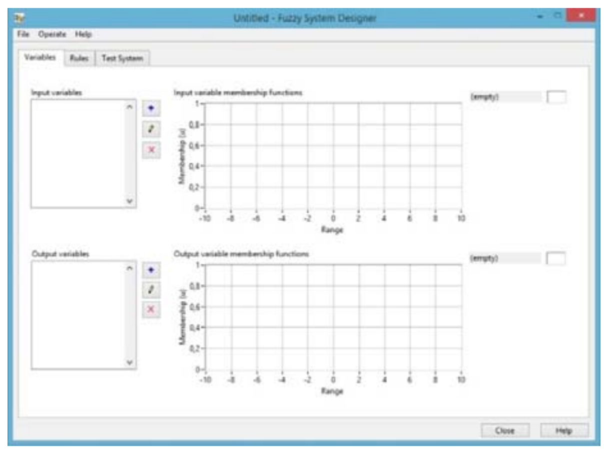

Figure-6. Main window to start a new fuzzy controller in LABVIEW.

The input variables, output linguistic variables, and their ranges are entered functionality. It takes into account that Fuzzy set editor starts with a default configuration. The advantage over a conventional PID controller is that a Fuzzy-PD Controller can implement nonlinear control strategies and that it uses linguistic rules. The rules evaluate the difference between the measured value and the set value, the error signal, and the tendency of the error signal to determine whether to increment or decrement the control variable.

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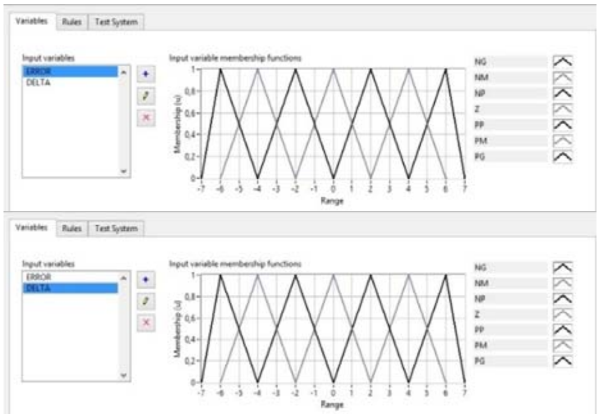

Figure-7. Fuzzy default settings set editor.

By deploying the box, he is with the input linguistic variables, each of which contains the following linguistic terms:

NEx (term negative), ZOx (zero), POx (term positive), default data range is -1 to 1, variable names default:
INX with x = 1, ..., 4.

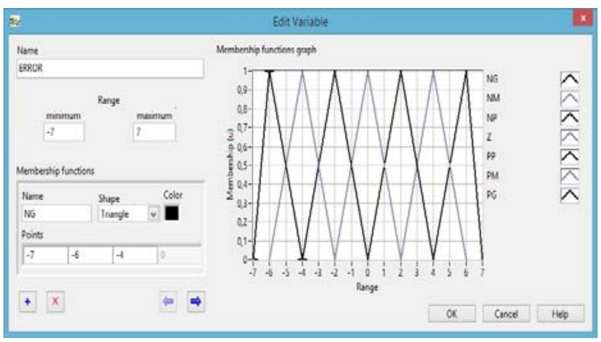

Figure-8. Input linguistic variables.

In the aftermath is output linguistic variables, which contains the following linguistic terms:

NEo (term negative), ZOo (zero) and POo (term positive), default data range is from -1 to 1, the variable name default: Output.

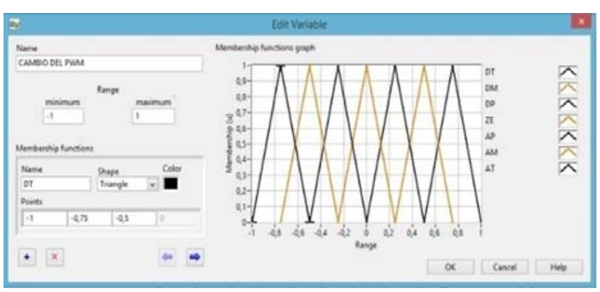

Figure-9. Output linguistic variables.

The interference method, the method of defuzzification and output default configuration is determined on the basis of the rule editor.

Figure-10. Rule editor.

The block features input and output simulates the controller and graphically displays the output behavior regarding rules in the rule editor.

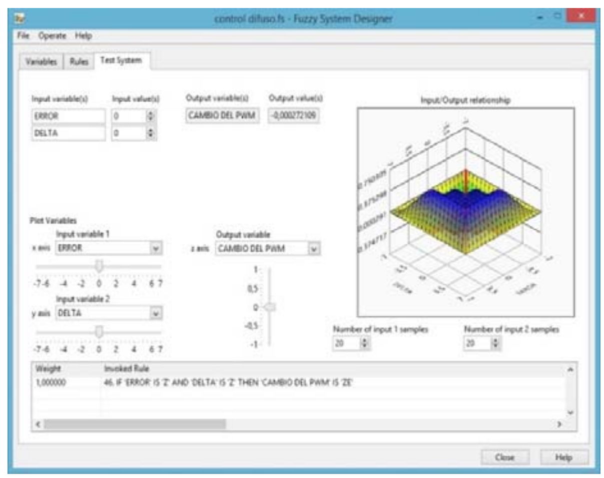

Figure-11. Input and output characteristics.

At the end of this process, the fuzzy controller with all the information on the rules, which is observed in the graphical environment of LabVIEW as a block, is obtained.

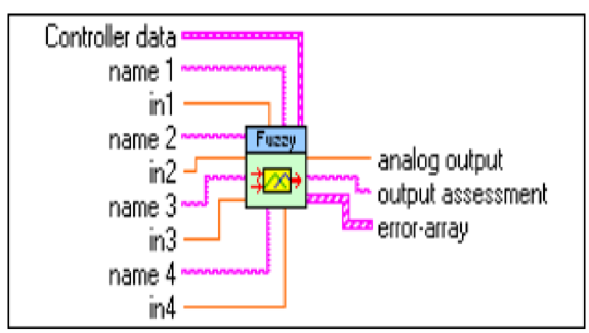

Figure-12. Fuzzy controller in LABVIEW graphical interface.

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PWM (Pulse Width Modulation) is a process in which the duty cycle of a periodic signal, whether to transmit information is modified through a communications channel or to control the amount of power sent to a load.

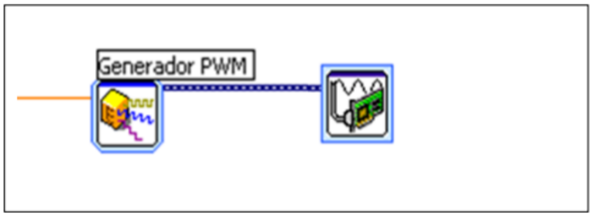

Figure-13. PWM output in LabView.

The H Bridge implemented for controlling the DC motor is LMD18200 reference [16], which is constructed with bipolar circuitry control CMOS and DMOS and accommodates peak output up to 6A.

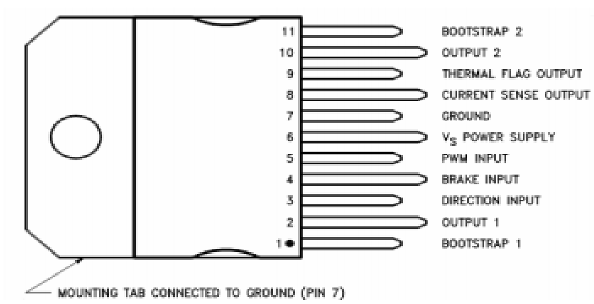

Figure-14. Datasheet LM18200T H bridge.

Feedback should be between the values of 0 to 5v as it is the voltage that supports the card data acquisition. Tachometer generates voltages from 0 to 12V which does not serve as input to the program, so it designs and implements a adecuador to condition the signal, taking into account the behavior guarantees range between 0 and 5 volts range optimal voltage for scanning the signal.

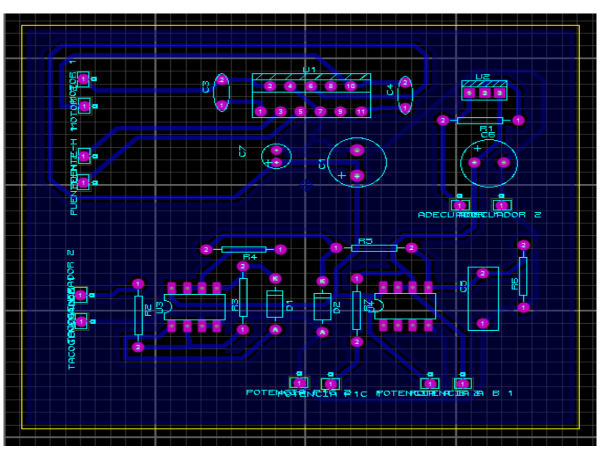

Figure-15. Design of the transducer in PROTEUS software.

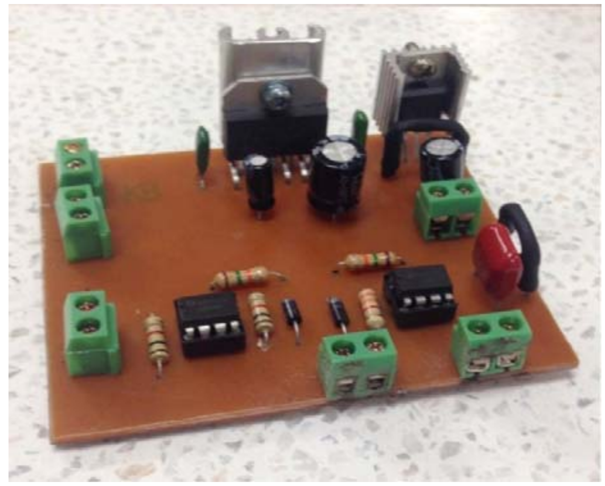

Figure-16. Card and bridge transducer circuit H.

In Figure-17 are the blocks of indicators and controls, such as the While Loop for all the blocks work in a continuous cycle. DAQ Assistant Express VI block communicating with the card data acquisition. Merge Signals Function is the graphic indicator that shows the sign of the set point (red) control signal (green) and engine response (blue). Shift Registers and the Feedback Node in Loops used to calculate the change of error, Time Domain Math Express VI is used to perform mathematical operations in time, in this case the change will be integrated PWM and get the output from the desired range. Strip path Function maintains the file path generated by the designer .fc extension simulate Signal Express VI simulates wave square for PWM, Fuzzy Logic Controller, Controller and Load Fuzzy Set point [17], [18].

A While Loop encloses the set of all blocks, which is responsible for implementing everything inside continuously.

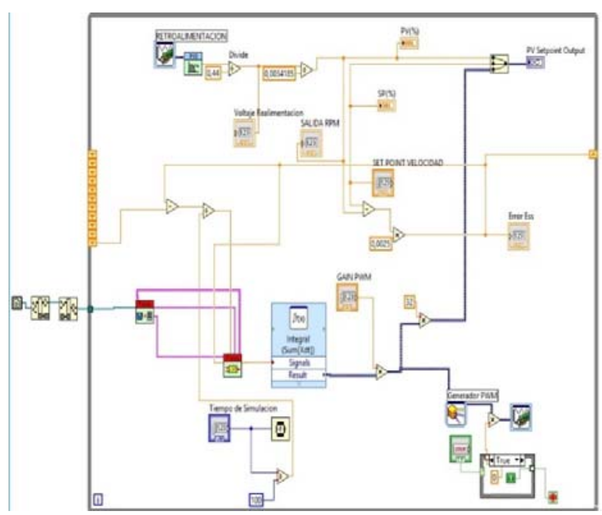

Figure-17. Block diagram for DC motor controller in LABVIEW.

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In Figure-18 is the view of the front panel, which is where the user runs the program and the results are seen through a graphical as well as the values obtained after the control action.

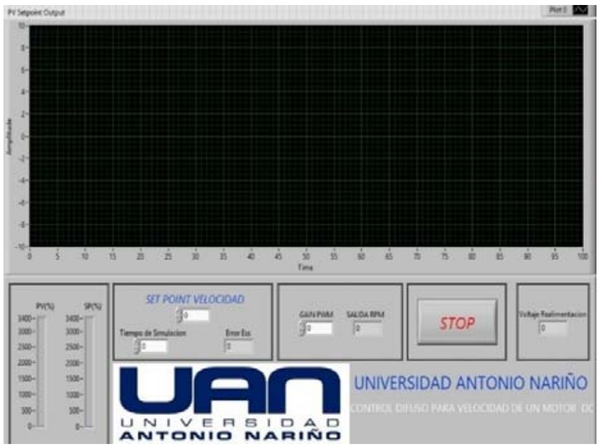

Figure-18. Front panel for DC motor controller in LABVIEW.

RESULTS AND DISCUSSIONS

At the time of connecting the entire set of devices such as the engine, transducer, font, procuring card data and PC takes into account the configuration of the H bridge pins and motor feedback. After verifying, that the assembly was correct speed control is executed in LabView and the system is energized.

Within the controller, a value is entered within a range of 1600 RPM to start control of engine speed and on the graphic belonging to the GUI LABVIEW variation PWM observed in terms of engine speed in RPM. You can compare these results with a classic PID control showing that our fuzzy logic controller meets the design requirements. Achieving values of error of 3%, which is acceptable in a practical manner.

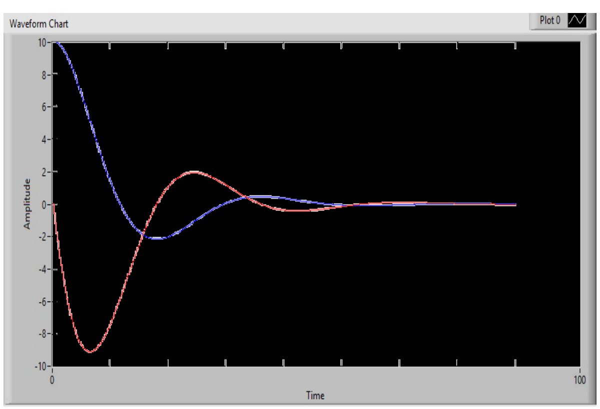

Figure-19. Front panel showing the resulting graph of fuzzy control.

CONCLUSIONS

This is accomplished by designing the control system in order to understand alternative control applications that can run in a field, such as industrial.

It is noted that fuzzy logic is a method of fast, solid and robust control for a system that affects constant disturbances, which in this case could be disturbances affecting a DC motor by applying opposing forces or weights within its axis rotational.

The great advantages and possibilities offered by the LABVIEW software for these applications is also stressed.

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