ICTACS - Multidisciplinary Scientific Journal of Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VI, v.1 2026 | Submission: 06/02/2026 | Accepted: 08/02/2026 | Publication: 10/02/2026

PID Control System with Arduino *Uno*

Djonatas Borges Mota

Abstract

The study consists of assessing the mode of operation of the variation of the Programmable Logic Control PID, with the aim of showing that this type of operation can bring various benefits in the production environment, such as energy savings and improved quality in the process due to the control obtained through the application of the process.

Keywords: technology, PID, process improvement.

Summary

This study aims to verify the working method of the PID (Programmed Logic Controller) variation, with the objective of showing that this type of operation can bring several benefits to production, such as energy savings and improved process quality due to the control obtained through its application.

Keywords: technology, PID, process improvement.

1. Introduction

Industrial automation aims to replace manual or non-ergonomic labor done by Man in control of machines and processes through computerized controls, increasing efficiency. Quality, productivity, and reduced costs. Automation has also led to the emergence of new... Professions, materials, and equipment. The technological advances made possible by automation. They involve the development of more reliable and higher quality materials such as plastics and steels. special operations, in addition to machine operations that would be impossible with direct manual labor.

In our semester, specifically in the subject of control, we studied various forms We studied process control mathematics and gained knowledge of PID quantities.

Starting from this principle, we were challenged to implement a type of control in a motor, where Basically, we would apply a force to the motor shaft and then have to correct the error based on that. even to ensure the rotation didn't lose power and maintained the set point.

Now consider a kiln used in ceramics that consumes an average of 1 million per month in gas, if If an on/off system is used, it will waste a lot of energy in order to keep the temperature above the established level. or close to the desired level, but with this type of control there will be no wasted energy or even even to disrupt the process.

2 History

PID control originated with workers making manual adjustments in order to fine-tune the... industry performance, with the implementation of technology in the 20th century, along with the maneuvers Applied today, control engineering techniques are fundamental for improvement and enhancement. of the processes.

FACIMS - Multidisciplinary Scientific Journal of Knowledge.
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The first process was created by the United States Navy in 1911 by the inventor Elmer Sperry as the naval steering objective, mimicking the behavior of a helmsman. that compensates for and predicts the direction of ships on the high seas.

3. Foundations

The knowledge gained during the process control course allows us to... to significantly improve all types of equipment, thereby improving their performance. production capacity, through in-depth studies, mathematical formulas and modeling of In systems, we can assemble various logics so that the system assumes a stable position. One of these One form of control is known as PID (Proportional Derivative Control), which can be used in Different shapes for different applications.

3.1 PID

Controller proportional integral derivative, (PID) is a technique a process control mechanism that combines derivative, integral, and proportional actions, thus causing... the error signal is minimized by the proportional action, zeroed by the integral action, and obtained with a Speed anticipated through derivative action. Put more simply, its objective is... to cancel out excess values by anticipating the movements of each stock, basically it predicts the What needs to be done to ensure that the values do not exceed the desired level?

To give a simple example for better understanding, we can use a resistor. a heat source that must be kept at a constant 70°C for production, so if we use the method Normal on/off switch along with a thermostat; when it exceeds 70°C it will turn off, and when it drops it will turn on. Connecting the resistor would render the system completely uncontrolled. However, if we apply the model using... Using a controller or PLC along with a dimmer, we can implement a control system where the set... a value of 70°C; before reaching 70°C, the system anticipates and reduces the power. Powering the heating element causes the system to slow down the temperature rise ramp and before that as the temperature begins to drop, he applies a power value in order to anticipate the drop. temperature.

3.1.1 Proportional Control (KP)

Compared to the on-off action, this method has the advantage of eliminating the oscillations in the output signal. For this reason, the system remains always on and the output signal is different. from zero. Considering that the output signal is proportional to the error, a non-zero error (known as An offset error is generated. The value of the offset error is inversely proportional to the gain KP and can be... compensated by adding a term to the reference value or by full control. A gain A very high proportional signal generates a high output signal, which can destabilize the system. However, if the

Knowledge - Multidisciplinary Scientific Journal of Knowledge.
ISSN: 2675-9128. São Paulo-SP.

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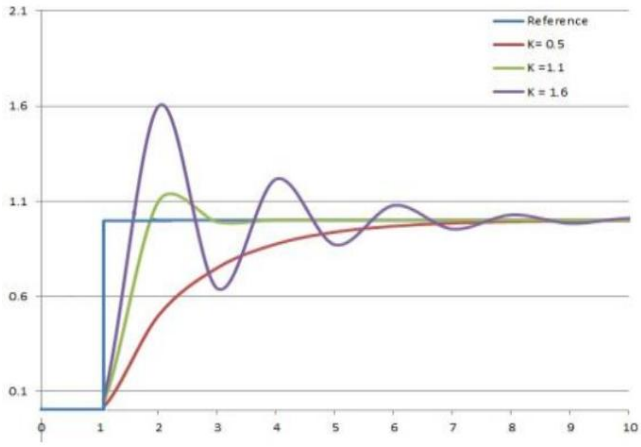
The proportional gain is too low; the system fails to apply the necessary action to correct the problem.
disturbances.

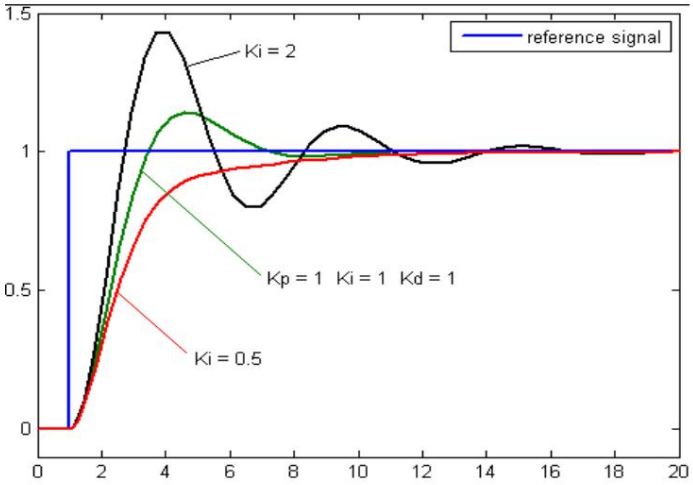
Figure 1



3.1.2 Integral Control (KI)

The integral action corrects the value of the manipulated variable at regular intervals, called
Full-time. This full-time is defined as the inverse of full-time earnings. If full-time earnings
If the gain is low, the system may take a long time to reach the reference value. However, if the gain
If the integral is too high, the system may become unstable.

Figure 2



3.1.3 Derivative Control (KD)

Derivative action provides an early correction of the error, decreasing the response time.
and improving the stability of the system. The derivative action acts at regular intervals, called
Derivative time. This parameter is inversely proportional to the rate of change of the variable.
controlled. This indicates that derivative action should not be used in processes where the system
It must respond quickly to a disturbance, even in processes that produce a lot of noise.
The signal is measured, as it would lead the process to instability.

RCMOS – Multidisciplinary Scientific Journal of Knowledge.
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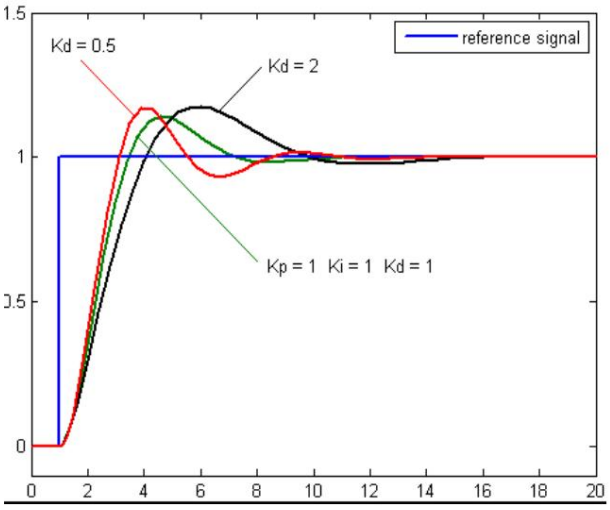
Figure 3



3.1.4 PID Calculation Methods

The PID controller parameters can be adjusted manually or through...
Optimization methods such as the Ziegler-Nichols method. In this method, the gains KI and KD are
first adjusted to zero. Then, we increase the proportional gain until the signal of
Output starts to fluctuate.

Start by testing the value (Kp) until the system has a quick response, but without...
there is a very large fluctuation.

Set (Ki) to remove the residual value, causing the system to reach the setpoint without
there may be a delay.

Enter the value of (Kd) to decrease the response and smooth the oscillations, until the
The system will return to normal quickly.

This Ziegler-Nichols method is the most commonly used for quickly obtaining the values of
PID.

4 The project

The main objective of the project is to control the speed of the motor; it will have
The load variation on the shaft, which will be compensated for, is the voltage on the motor so that...
This does not alter the rotation speed; therefore, we will apply the PID to correct the anomaly, so if the engine is...
with a velocity x_e without any load on its axis when we apply a load to its axis
The same must be corrected and maintain speed x by adding a higher voltage to the motor so that the
even if its production does not undergo permanent alteration.

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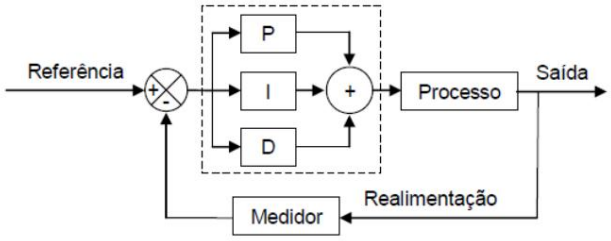
5. Operation

The prototype's operation includes a 24Vdc power supply to power the...
The circuit that will control the motor, a circuit that was assembled using a breadboard and
a 5.5V DC power supply that will power the Arduino Uno.

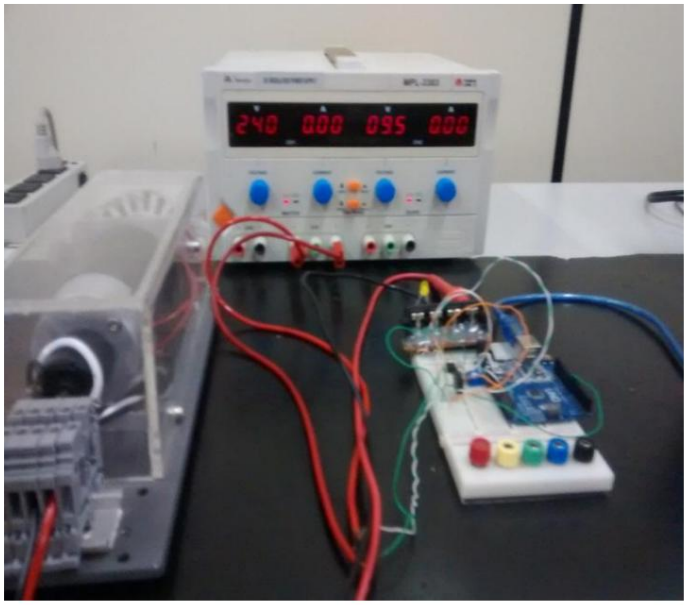
The block system is shown in the figure below, which displays the process map, systems of block.

Figure 4



The system will work as follows: the tachogenerator, which is coupled to the shaft of the...
The motor will read the motor's rotation and convert it to an analog input for the Arduino.
The voltage will vary from 0 to 2.2V, and the program will use this reading to...
to decide how the motor should behave. Therefore, the program will loop and apply it to...
An analog output from the Arduino, “A1”, provides power to the motor. This will allow the program to execute.
to make the reading by the generator a reference for the engine speed.

Figure 5



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6. Working materials

The materials used for the construction of the project were:

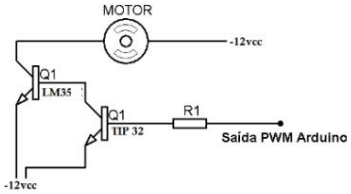
Arduino Uno

ÿ 5.5Vdc power supply

ÿ 24V DC power supply;

ÿ A 12V DC motor; ÿ Tachogenerator;

ÿ TIP 32;
ÿ CI 4LM25;
Resistors;



ÿ Protoboard;

7. PID Calculation

Based on the final course work of the student “LUIZ HENRIQUE "CASSETTARI" was extracted from his research on transfer functions, thus making it possible to obtain The PID values for performing calculations using the first-order Ziegler and Nichols method.

The following figure demonstrates how to apply it.

Nichos - Multidisciplinary Scientific Journal of Knowledge.
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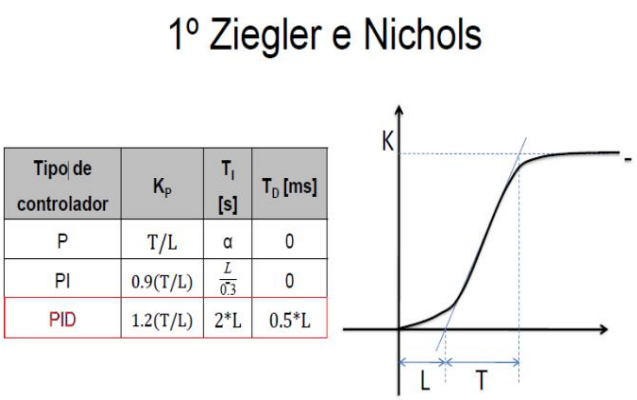
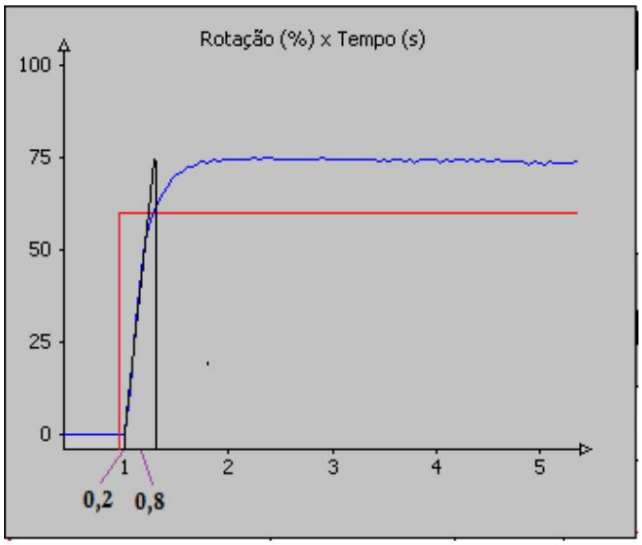
Figure 6



Next, we can see how the motor behaves through the reading in MATILAB, and so on. Extract the data to run the formulas presented above.

Figure 7



Below are the PID values found, which will be applied in the process.

Figure 8

TYPE OF CONTROLLER	**Kp**	**Ti [s]**	**Td [ms]**
P	0.8/0.2 = 0.4		
PI	0.9 * (0.8 / 0.2) = 0.36	0.2 / 0.3 = 0.66	
PID	1.25 * (0.8 / 0.2) = 0.5	2 * 0.2 = 0.4	0.5 * 0.2 = 0.1

8 Conclusion

According to the prototype, we can use automation to improve performance and functioning of any equipment.

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We obtained a satisfactory result and after several tests we managed to get close to... something I wanted, where the PID controller provided a much more efficient system and reliable for potential production in the industrial sector.

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