INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 5, Issue 2)
Available online at: www.ijariit.com

Study of software development for a PID controller system

Yashika Thakur
yashika09thakur@gmail.com
Atharva College of Engineering, Mumbai, Maharashtra

Yash Siddham
yashsiddham@gmail.com
Atharva College of Engineering, Mumbai, Maharashtra

Karan Patel
karanpatel344@gmail.com
Atharva College of Engineering, Mumbai, Maharashtra

Deepali Maste
deepali.maste@gmail.com
Atharva College of Engineering, Mumbai, Maharashtra

ABSTRACT

There are a variety of machines performing different specific tasks being used in industry. One of those, is a standalone PID controller having multiple input/output industry is having inbuilt processor. System control module and multiple communication channels, a floating-point arithmetic unit, multiple Ethernet controllers and also, an Analog Input acquisition module, Digital Input acquisition module, Contact Output Module is to generate contact out being used for annunciation purpose. We have used C programming to write applications, drivers' code in a Linux environment. Cross compiler is used for compiling the code. A general purpose PID controller can be used to control a number of different parameters, which can be represented as an Analog Signal. It monitors critical parameters and issues alerts in case of deviant behaviors. Countermeasures can be deployed to take appropriate actions. The uses of such a general purpose PID controller can be extended to various applications in different fields.

Keywords— *PID controller, Linux environment, C Programming*

1. INTRODUCTION

An embedded system is a special-purpose computer system configured to perform a few dedicated functions, often with real-time computing constraints. It is usually entrenched as part of a complete device including hardware and mechanical parts.

Proportional-Integral-Derivative (PID) control is a widely used method in industrial control applications. PID is a software routine run by the MCU's processor. Its purpose is to correct or diminish the error between a measured process variable and a target value. The PID algorithm involves 3 separate parameters: Proportional (the gain), Integral (the reset), Derivative (the rate of change during a given interval). PID loops implement control of any customizable measurable variable including temperature, flow rate, speed or pressure [1]

The major use of the PID will be to enable remote control, as well as regulate the control loops. This way any kind of human resources needed in running the controller can be minimized from direct contact.
The overall function of control can be expressed mathematically as:

$$C_{PID}(s) = K_P\left(k + \frac{k_i}{s} + k_d s\right)[2]$$

Where, K_p, K_i, K_d, all non-negative, denote the coefficients for the proportional, integral, and derivative terms respectively (sometimes denoted P, I, and D) [2].

2. REVIEW OF LITERATURE

2.1. Title: PID control system analysis, design, and technology - IEEE Journals & Magazine 2005.
Authors: Kiam Heong Ang, G. Chong, Yun Li [1]
This paper presents a modern overview of functionalities and tuning methods in patents, software packages and commercial hardware modules. It is seen that many PID variants have been developed in order to improve transient performance, but standardizing and modularizing PID control is desired, although challenging. The inclusion of system identification and & techniques in software based PID systems helps automate the entire design and tuning process to a useful degree. This should also

assist future development of & PID controllers that are widely applicable and can be set up easily and operate optimally for enhanced productivity, improved quality and reduced maintenance requirements.

2.2. Title: Custom-Made Design of a Digital PID Control System - IEEE Conference Publication 2006.
Authors: F. Fons, M. Fons, E. Canto [2]
In the field of real-time signal processing, like most of automatic control systems nowadays present at the industry and focused on PID (proportional-integral-derivative) controllers, it is common to find software-oriented solutions based on powerful 32-bit DSP, RISC or CISC processors. This work deals with the hardware/software co-design of a PID coprocessor, all embedded on a system-on-chip device. The performances reached by a platform composed of an 8-bit MCU and a dynamically reconfigurable FPGA allow scheduling the PID algorithm as a set of tasks executed by both devices concurrently.

Moreover, thanks to the flexible hardware characteristics, some modules synthesized into the FPGA are reconfigured at run-time while the rest keeps on active. This cost-effective approach, encouraged by its parallelism, is an alternative to commercial -both general-purpose and specific-purpose-processors in whatever made-to-measure engineering application.

2.3. Title: Design of On-line auto-tuning PID controller.
Authors: Myung-Hyun Yoon and Chang-Hoon Shin
PID Controller is a microprocessor based standalone industrial control system to monitor and control critical parameters depending on the field and user inputs (Set Point). PID uses the same CPU and the same tool chain, which is used for application software development of our in-house systems.

This document contains the test plan for PID controller which includes the following:

1. Design Verification Test
2. Functional Test
3. Debugging and Failures
4. Appendix and References

3. PROPOSED SYSTEM

The idea for the proposed system for this project was for us to design software for a PID controller as shown in the Figure below, which enables the PID to monitor and control critical parameters in real time. And to enable the operator on-site to adjust the values of a few parameters through the device module itself, as well as to wirelessly send data to a remote terminal for analysis and rectification/data keeping. Lastly, we would aim to develop a firewall that keeps out any kind of unethical access attempts.

This would allow us to enable a system that allows remote access only to accessible individuals for changes & develop a system that doesn't get affected by latency, meaning whether human input occurs or not, there should a system that works parallel to it and doesn't let the performance be affected by the delay. Also, to develop a system that allows analog as well as digital inputs in real-time would be a small addition to enable simple Input/Output model. Lastly, the HMI (Human Machine Interface) should cause minimal issues whilst accessing, either visually or technically, as mentioned above.

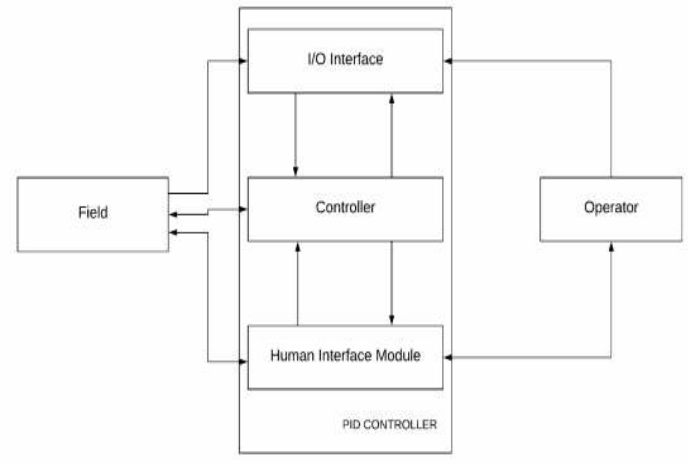

Fig. 1: Block Diagram

4. PROBLEMS IN EXISTING SYSTEM

This is the paper on which the project will be made, this is the base paper for the project and therefore, the most referred. The paper outlines the creation of the controller, scope and purposes of an in house PID controller system. It also includes test procedures and debugging steps for the same. Along with it, proper documentation for each and every part of the controller is presented, and references to the appropriate systems used.

In this paper the authors, present a modern overview of functionalities and tuning methods in patents, software packages and commercial hardware modules. This also assists future development of "plug-and-play" PID controllers with improved quality and reduced maintenance requirements. The major flaw in this paper is that it doesn't take in account the security complexities that come with the mass market application of "plug & play" & which is why an in house PID is needed

This paper is a custom-made design for a PID by the authors. It outlines the control techniques, hardware-software co-design, & some experimental work testing the custom-made controller as well. Thanks to this a cost-effective approach to an industrial spec of hardware can be taken, thus saving costs as well as material labor

5. ACKNOWLEDGEMENT

We are grateful for having Prof. Deepali Maste as our guide and project coordinator along with Prof. Mamta Meena, and Prof. Mahendra Patil, Head of Computer Engineering Department, during our research on Software Development for a Standalone PID Controller, which would have seemed insurmountable without their motivation, constant support and valuable suggestions.

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