Simulator of Water Tank Level Control System Using PID-Controller

MAZIYAH MAT NOH, MUHAMMAD SHARFI NAJIB, NURHANIM SAADAH ABDULLAH
Faculty of Electrical & Electronics Engineering,
Universiti Malaysia Pahang,
Karung Berkunci 12, 25000 Kuantan, Pahang,
MALAYSIA

Abstract: **-** *The difficulty of a Water Tank Level Control System (WTLCS) is often operates under unstable condition such as above setpoint level or below setpoint level. The unstable condition normally contributes to damage of devices and equipments of a process plant. However, this problem can be solved by introducing feedback controller by visualizing it using interactive simulator. One of the feedback controller is a Proportional (P) controller. Nonetheless, the P controller has drawbacks to control the non-linearity of a water level. The aim of this paper is to present the implementation of a PID controller to control virtual WTLCS. The P controller and PID controller is implemented in a WTLCS virtual model which has been developed using Microsoft Visual Basic 6.0 (VB). The both P and PID controller have been compared. The simulation result shows that the PID controller gives better control system response as compared to P controller.*

Key-Words: - PID, Level Control, Visual Basics, Simulator, Water Tank

1 Introduction

Proportional Integral Derivative (PID) controllers are widely used in industrial practice over 60 years ago. The invention of PID control is in 1910 (largely owing to Elmer Sperry's ship autopilot) and the straightforward Ziegler-Nichols (Z-N) tuning rule in 1942 [1]. Today, PID is used in more than 90% of practical control systems, ranging from consumer electronics such as cameras to industrial processes such as chemical processes. The PID controller helps get our output (velocity, temperature, position) where we want it, in a short time, with minimal overshoot, and with little error [2]. It also the most adopted controllers in the industry due to the good cost and given benefits to the industry [3]. Many nonlinear processes can be controlled using the well-known and industrially proven PID controller [4]. A considerable direct performance increase (financial gain) is demanded when replacing a conventional control system with an advanced one [4]. The maintenance costs of an inadequate conventional control solution may be less obvious. The tricky part of controller design is to figure out just how much of a corrective effort the controller should apply to the process in each case. Some situation requires tighter control of the process variable than On-Off control can provide. Proportional control provides better control because its output operate linearly anywhere between fully on and fully off [5]. As its name implies, its output changes proportionally to the input error signal. Proportional controller simply multiplies the error by a constant to compute its next output. In 1930s the control engineers discovered that the error could be eliminated altogether by automatically resetting the set point to an artificially high value [3][6]. The PID controllers function is to maintain the output at a level that there is no difference (error) between the process variable and the setpoint in as fast response as possible

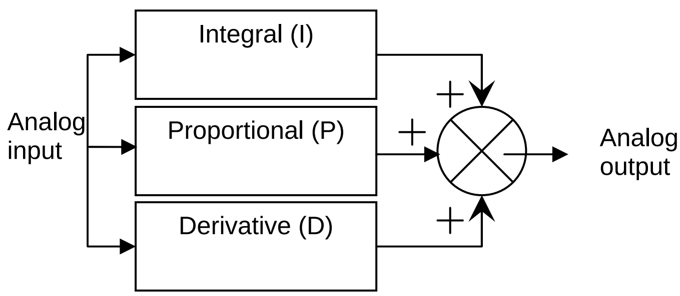

Figure 1: A practical PID controller

2 Approach and Methods

The objective of the system is to examine a simplified PID control loop in water tank with level control. The water tank is constructed of a tank with a manual input valve that can either be controlled manually, or be controlled by the computer using PID control algorithm. When the system starts, the system is already placed into automatic mode with stable setting for the PID algorithm. The user can alter the valve position and see how the computer adjusts the output valve to maintain the level setpoint. Below is the simplified explanation of this system:

Automatic mode :

- This system is by default at ‘automatic mode’
- With a stable setting for the PID algorithm
- User can alter the inlet valve and see the computer adjust the output valve to maintain the level to set point.

Manual mode:

- User can control the manual inlet valve and outlet valve to get closer to the set point
- How well user can control the valves to get to the set point

Make changes to the level SP or PID variables:

- PID loop will calculate the new output value until it reaches set point
- User can see from the graphs

Proportional (GAIN):

- 0 – 100% is to amplify the output based on the error (SP - PV)

Integral (RESET):

- Measurd in seconds and is also called (repeats per minute)
- How many times the system resets the error and re-evaluates the values. This removes the offset that occurs between the PV and SP.

Derivative (RATE):

- Measured in seconds also. This is the amount of time that it advances the output
- This can be used to adjust processes that are very sensitive to output changes.

The next section presents the Visual Basics (VB) GUI windows and the various GUI controls were used extensively throughout the GUI development process. A discussion here focuses on the design of GUI features. It is during this stage that the functionality of the GUI is assessed, and the complete layout determined. These assessments form an iterative process in the sense that the overall functionality of any design tool is greatly dependent on the ability of the user to understand the design layout. The purpose of the virtual WLTCS is already explained in the introduction. The various figure windows of the GUI will be thoroughly discussed and explained.

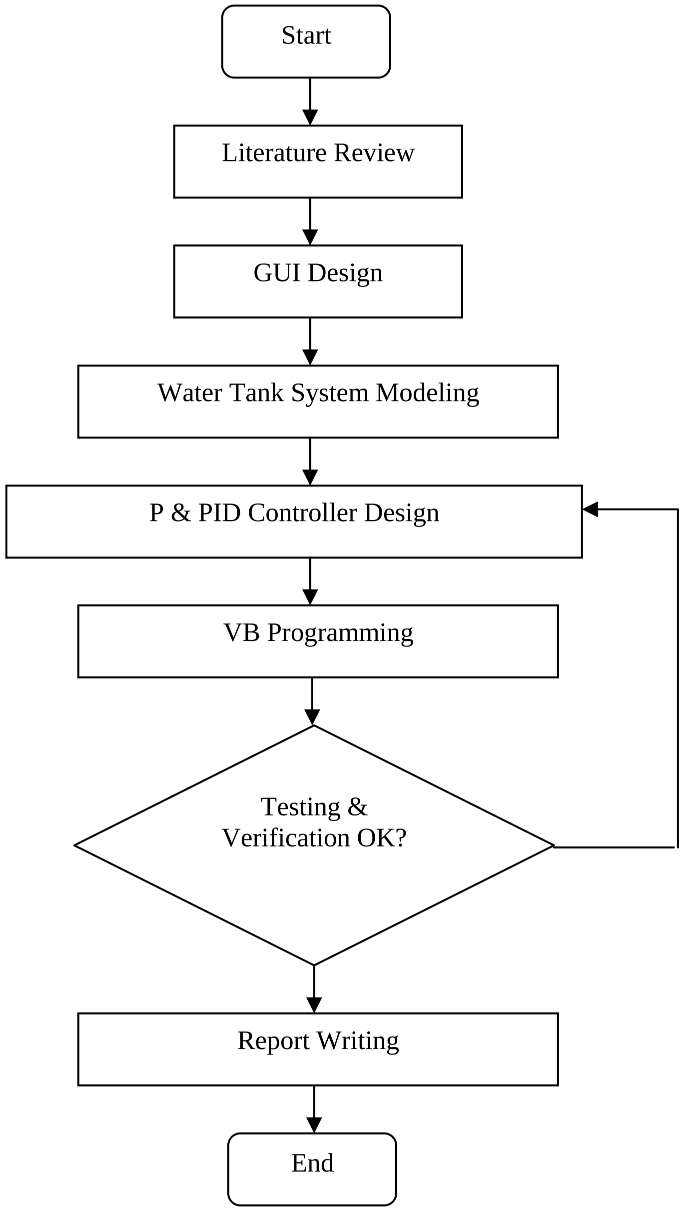

Figure 2: Research Methodology

3 Result

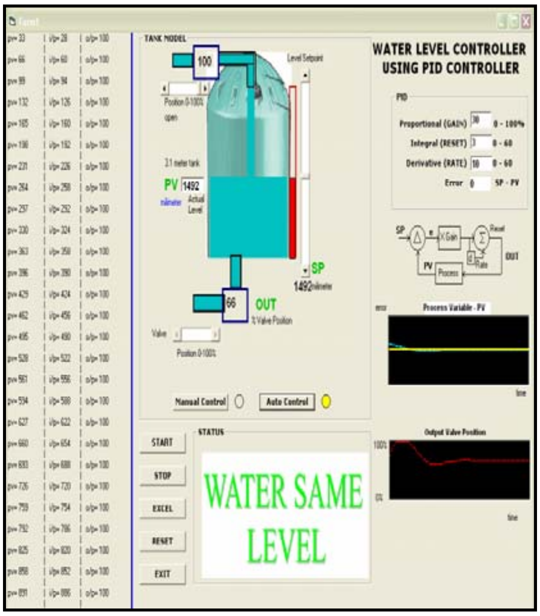

Figure 3: GUI of Virtual WTLCS

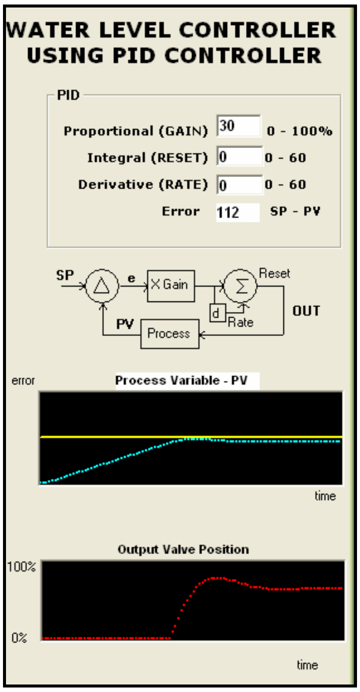

Figure 4: The gain and output graphs of P controller

This graph was obtained when only P gain is used without integral and derivative gain. For over some range of errors about the setpoint, each value of error has a unique value of controller output in one-to-one correspondence. A high gain means large response to an error. The response was fast but cannot eliminate error

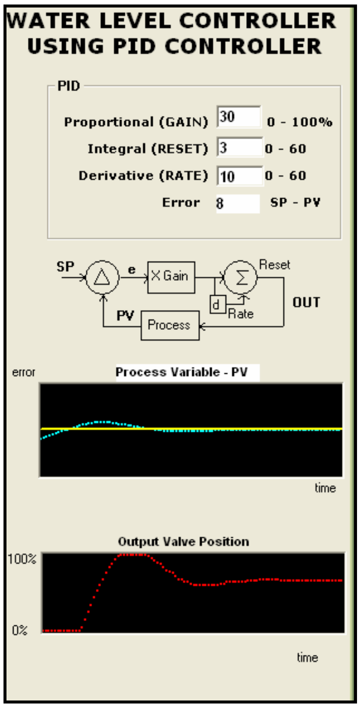

Figure 5: The gain and output graphs of PID controller

4 Discussion

The graphs above show the effect of using PID controller. This controller eliminates the offset of the proportional mode and still provides fast response. This can be used for virtually any process condition including this water level controller. The PID controller is one of the most powerful but complex controller mode operations combines the proportional, integral, and derivative modes.

PID controller is one powerful but complex controller that combines the proportional, integral and derivative modes. This system can be used for any process condition including controlling water level in a tank. This computer based control project is very useful in process industries that involving automatic level controller. It displays level warning on computer screen for easy monitoring. The water level can be controlled continuously without manual adjusting of the valve. The PID algorithms will automatically response to the system so that the system is stabilized near the setpoint. Every time the gain or the setpoint is changed by the user, the PID algorithm will do the adjusting of the errors automatically. For the future works for this project, we can upgrade the system to two tanks or more. By using PID controller, the level can be controlled faster with less overshoot. We also can add up temperature control in the tank as well. By using interface card, this system can be integrated to the real tank in process industries.

Table 1: Comparison of Controller

Controller	Error (%)	Settling Time (S)	Overshoot (%)
P-Controller	4.35	6.23	10.13
PID-Controller	3.12	4.56	3.76

5 Conclusion

In conclusion, it shows the PID controller is the most effective controller that eliminates the offset of the proportional mode and still provides fast response. This is the reason of choosing PID controller as the controller for this water level controller can be added to the controller unit to have more options for the controller unit.

References:

[1] J. Swder,G.Wszoek,W.Carvalho, Programmable controller design Electro-pneumatic Systems, Journal of Material Processing Technology 164-1655(2005) 14659-1465

[2] Terry Bartelt, Industrial Control Electronics: Devices, Systems and Applications, Second Edition, Delmar, 2002

[3] Aurelio Piazzi and Antonio Visioli, A Noncausal Approach for PID control, Journalof Process Control, 4 March 2006.

[4] S. Gerks¡ic¡ et al. / Control Engineering Practice 14 (2006) 935–948, Advanced Control Algorithms Embedded in a Programmable Logic Controller, 22 July 2005.

[5] Paul H. Lewis and Chang Yang (1997). Basic Control Systems Engineering: Prentice Hall

[6] Carl Knopse, Guest Editor, PID Control, IEEE Control System Magazine, February 2006