ANALYSIS OF PID CONTROLLER WITH DIFFERENT RESPONSE FUNCTION

Jitendra Kumar Dahariya[1], Kamesh Sahu[2], Khomesh Verma[3], Mr.Ganesh Ram Ratnakar[4], Mr.Vikas Chandra[5], Mrs. Mohini Moitra Bhaduri[6]

[1, 2, 3]–B.TECH Scholar, Chouksey Engineering College, Bilaspur
[4, 5, 6] – Assistant Professor, Chouksey Engineering College, Bilaspur
Department of Electrical & Electronics Engineering

Abstract - *This work examines PID controllers with various response functions. In industrial control systems, control engineers utilize a PID (Proportional – Integral – Derivative) control to adjust temperature, flow, pressure, speed, and other process-related parameters. The most precise and reliable controllers are PIDs, which regulate process variables via a feedback loop.*

An established method for guiding a system toward a target location or control parameters is PID control. It is used in many scientific and chemical processes, as well as automation, and is essentially universal as a temperature control method. PID control maintains a process's real output as near to the set point or target output as feasible.

Key Words: **PID controller, step, ramp, parabolic, sinusoidal function.**

1.INTRODUCTION

In industrial automation and process control systems, a PID (Proportional-Integral-Derivative) control is a commonly used control algorithm. By continuously modifying the control input in response to the difference between the setpoint (the desired condition) and a process variable (also known as the present state), it can maintain the desired result level. This is what makes it effective. PID controllers are a key element of contemporary control engineering since they are necessary in many different applications, such as motor speed control and furnace temperature management.

1.1 Historical Context

Feedback control was first conceptualized in the early 1800s. As industrial processes grew more complicated and necessitated more advanced control tactics, the word "PID controller" gained popularity in the middle of the 20th century. PID control was made feasible by the advancement of electronic components, which paved the way for its broad use in a variety of industries, including robotics, aerospace, and manufacturing.

A PID controller operates on the premise that each of the three terms—proportional ("P"), integral ("I"), and derivative ("D")—needs to be "tuned" or changed separately. The correction factor is computed and utilized for the input based on the variation between these values. For instance, the temperature will be raised if the oven is colder than needed.

The three steps are as follows:

Correcting a goal according to the difference is known as proportional tuning. Because the applied correction decreases as the difference gets closer to zero, the desired value is never reached.

1.2 Uses

1. Control of Temperature

PID controllers are widely utilized in HVAC systems, furnaces, and ovens that regulate temperature.

2. Control of Speed

PID controllers regulate the motor's voltage or current to control speed in electric motors.

3. Control of Position

PID controllers, which are utilized in robotic and CNC (Computer Numerical Control) equipment, guarantee accurate mechanical component placement.

4. Flow Control PID controllers manage the movement of gases and liquids in reactors, tanks, and pipelines.

5. Control of Pressure

PID controllers regulate pressure levels in systems such as reactors, boilers, and gas pipelines.

2. DIFFERENT RESPONSE FUNCTION

2.1 Unit Step Function

A key idea in control theory, processing of signals, and systems analysis is the unit step function, which is frequently represented as u(t) and H(t) (Heaviside step function). It functions as a mathematical representation of a signal that changes from 0 to 1 at a given moment.

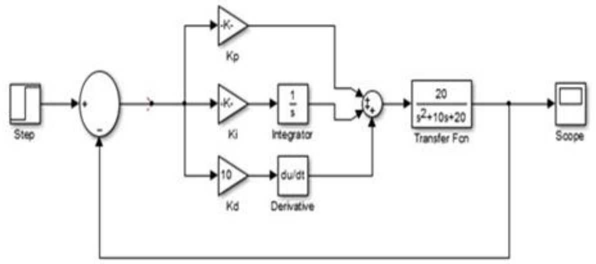

Fig -1: Block Diagram of Unit Step Function Using PID Controller

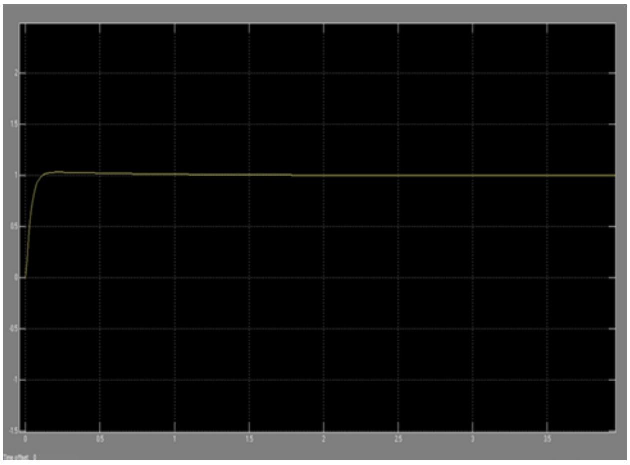

Fig -2: Graph of Unit Step Function

2.2 Unit Ramp Function

Another crucial component in the study of signal processing, control systems, and systems analysis is the unit ramp function. The unit ramp function grows linearly over time, in contrast to the unit step function, which stays constant at a certain point.

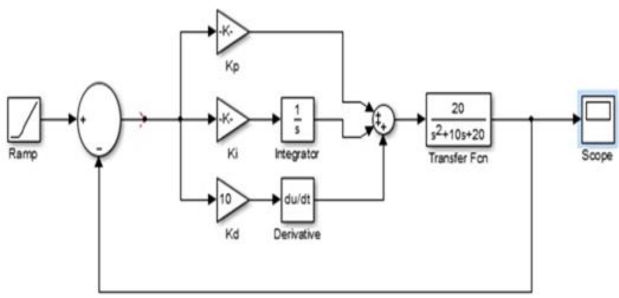

Fig -3: Block Diagram of Unit Ramp Function Using PID Controller

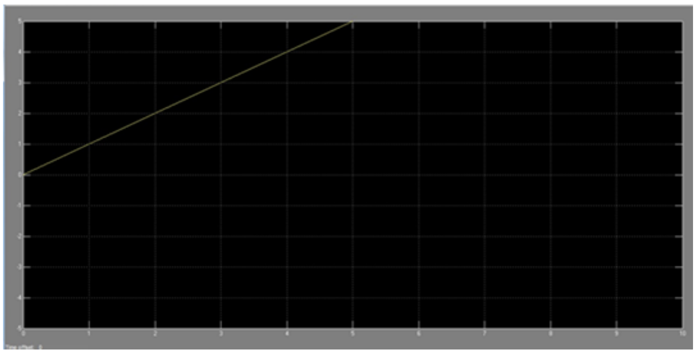

Fig -4: Graph of Unit Ramp Function

2.3 Unit Parabolic Function

A mathematical function utilized in signal processing and control systems is the unit parabolic function.

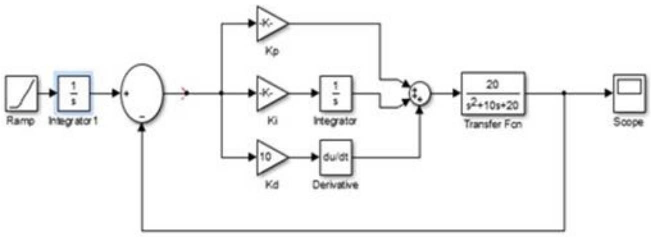

Fig -5: Block Diagram of Unit Parabolic Function Using PID Controller

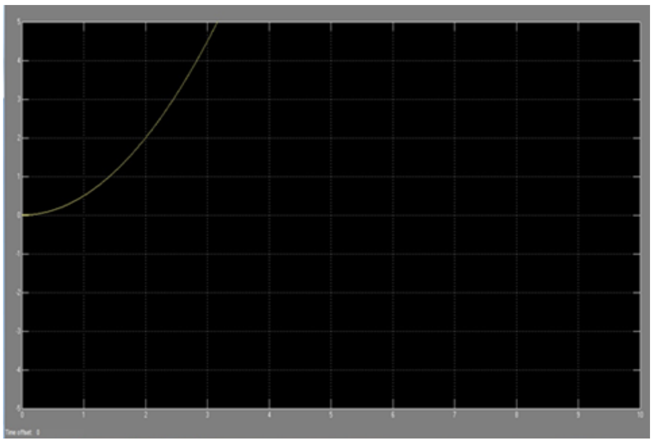

Fig -6: Graph of Unit Step Function

2.4 Sinusoidal Function

A basic mathematical function that characterizes periodic oscillations is the sinusoidal function. It is extensively used to depict waveforms and oscillating motion in a variety of domains, including signal processing, engineering, and physics.

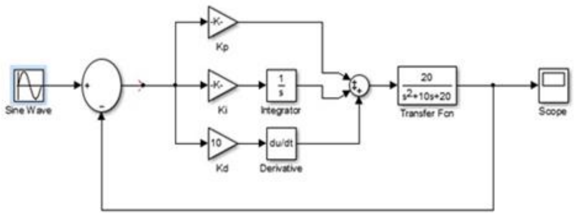

Fig -7: Block Diagram of Sinusoidal Function Using PID Controller

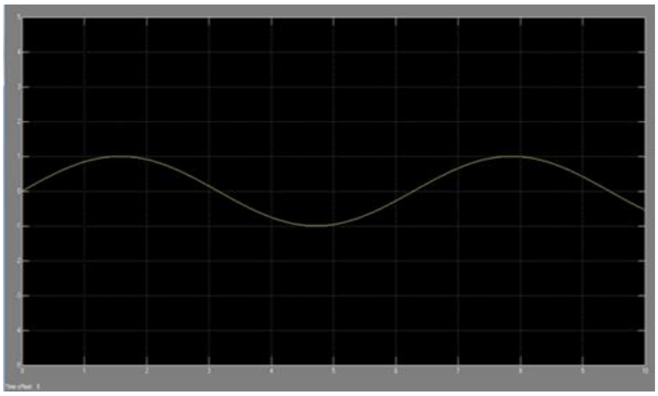

Fig -8: Graph of Sinusoidal Function

3. CONCLUSIONS

The design and optimization on the control systems in this study depend heavily on the analysis on PID controllers that have different response functions. Engineers may create responsive, stable, and effective systems by comprehending how PID controllers work with step, ramp, and sinusoidal inputs. PID controllers are still a mainstay in robotics, industrial automation, and many other domains due to their adaptability. PID controllers' capabilities may be further improved by continuing research into sophisticated control algorithms as technology advances, guaranteeing their use in the future.

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