Case Study: DEAD TIME

Paras Oberoi[1], Himanshu Garg[2], Dr. Arvind Rehalia[3]
[1&2]Student, [3]Associate Professor
Bharati Vidyapeeth, College of Engineering, New Delhi, India

Abstract: Dead time is the delay after each event during which the system is not able to record another event. The presence of dead time is never a good thing in control loop. Basically, it is the amount of time it takes for the process variable to start changing after the measurement of an event.

Keywords: Dead Time, Event, Control Loop

I. CAUSES OF DEAD TIME

Dead time can arise in a control loop for a number of reasons [1, 2]:

- Due to wear and tear of components.
- Time taken by Sensors and analysers.
- Time taken by measuring device to analyse the output.
- Due to electrical failure.
- Transport time.
- Mechanical process.
- A human controller may need some significant time to think and take proper control action.
- Final controlling element.

Dead time is one of the main sources of closed-loop instability.

Due to increase in dead time of an open-loop transfer function, the following two undesirable effects take place:

1. The crossover frequency decreases
2. The ultimate gain decreases

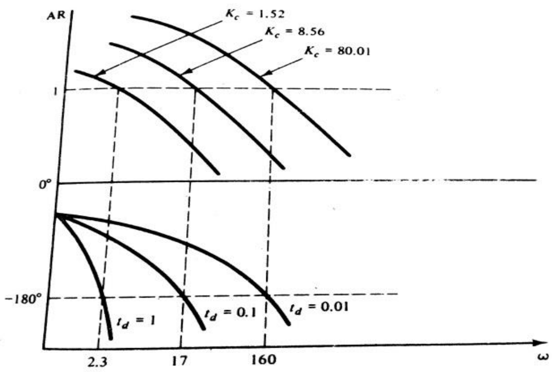

Figure: 1. Effect of dead-time on cross-over frequency

II. DEAD-TIME COMPENSATION

So, to reduce the instability of the control loop we require dead time compensation.

We have assumed that all the dead time is caused by the process:

$$G_p(s) = G(s)e^{-tdS}$$

For simplicity assume $G_m(s) = G_f(s) = 1$. The open loop response to a change in asset point is equal to

$$Y(s) = G_c(s)\,[G(s)e^{-tdS}]\, y_{sp}(s)$$

It is delayed by t_d minutes.

III. METHODOLOGY

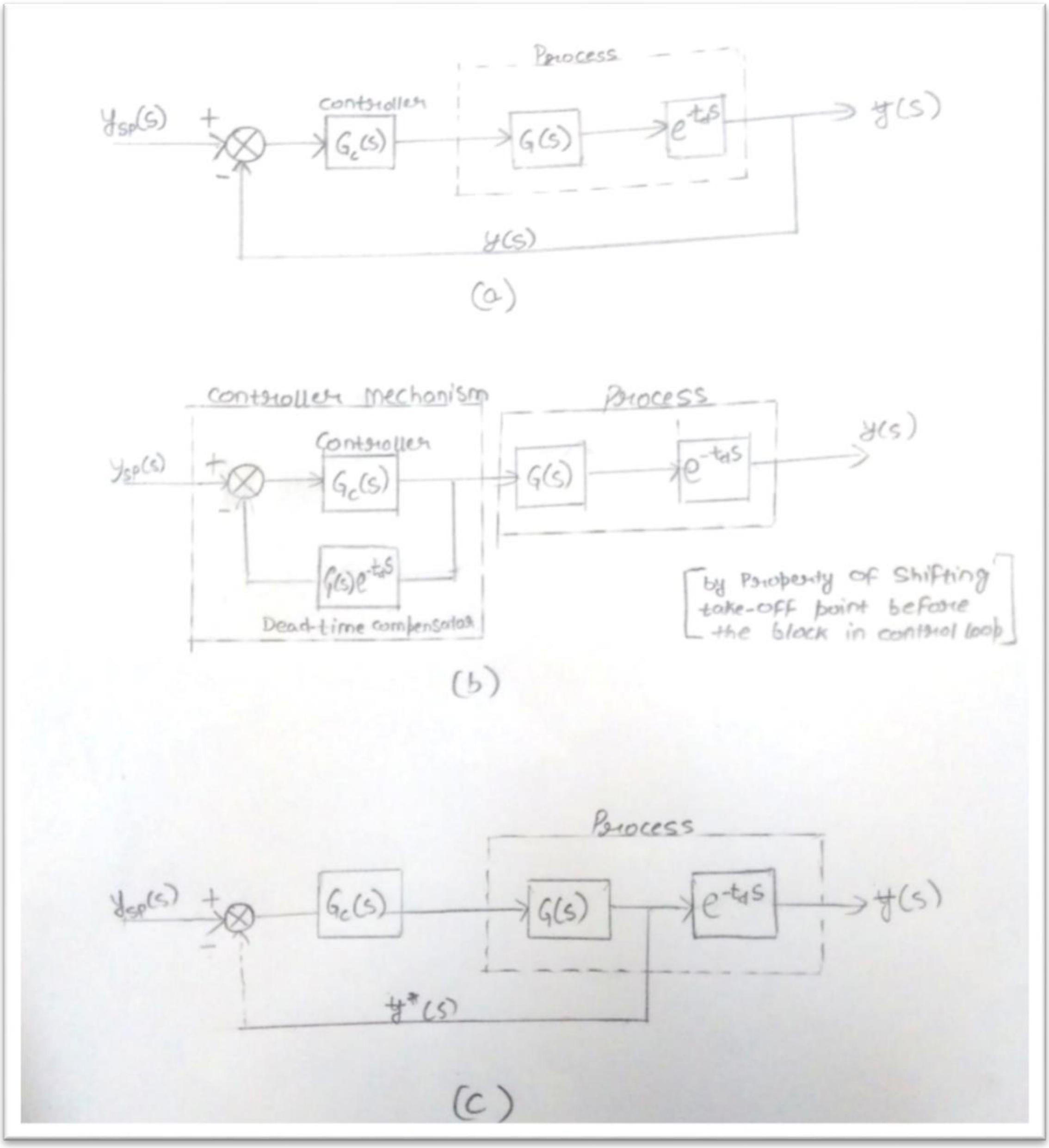

Figure:2. (a) Feedback system with process dead-time; (b) feedback with complete dead-time compensation; (c) net result of dead-time compensation

To eliminate the undesired effects, we would like to have an open-loop feedback signal that carries current and not delayed information, such as

$$\bar{y}^{*}(s) = G_c(s)G(s)\bar{y}_{sp}(s)$$

This is possible if in the open-loop response $\bar{y}(s)$ we add the quantity

$$\bar{y}'(s) = e^{-t_d s}G_{c(}(s)G(s)\bar{y}_{sp}(s)$$

It is easy to verify that

$$\bar{y}'(s) + \bar{y}(s) = \bar{y}^{*}(s)$$

IV. RESULTS

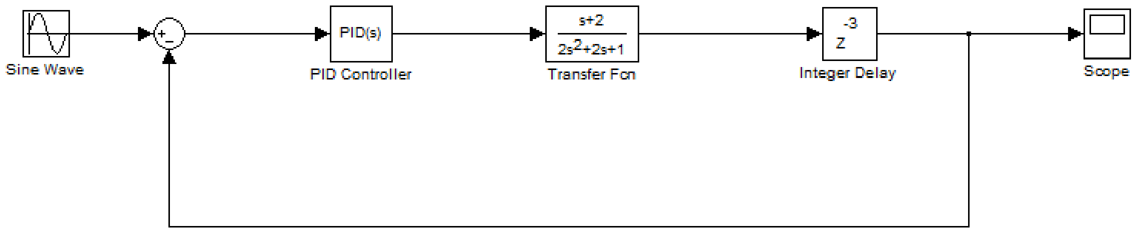

Figure: 3. Design of the system

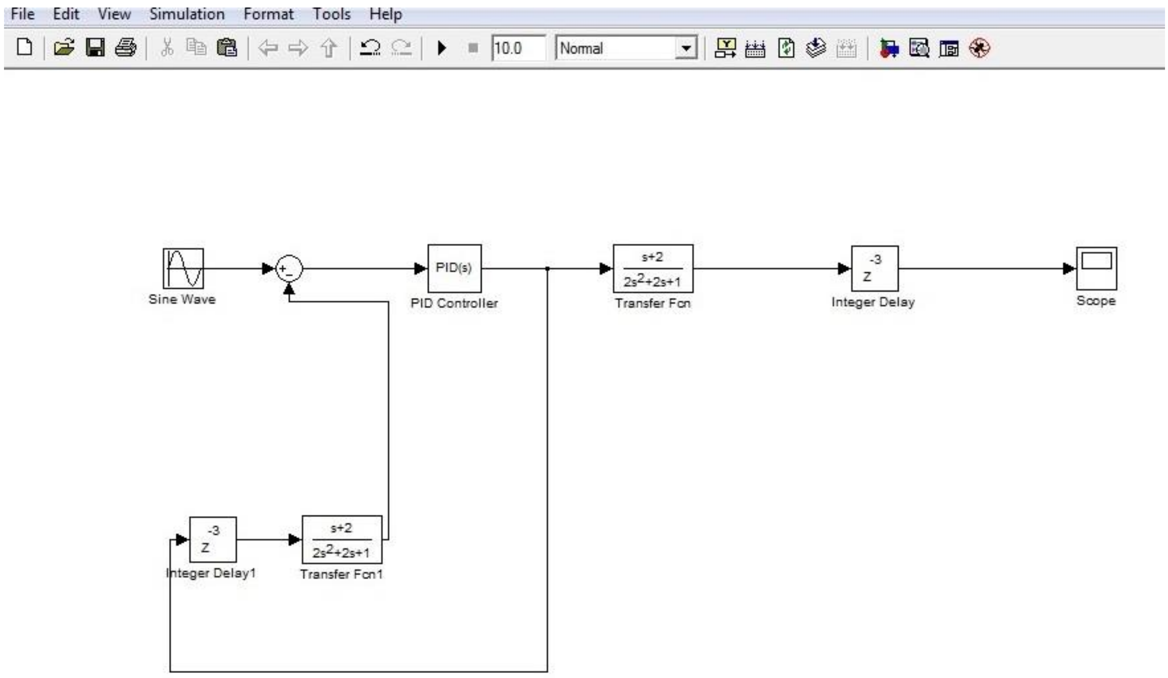

Figure: 4. A control loop designed using the new methodology

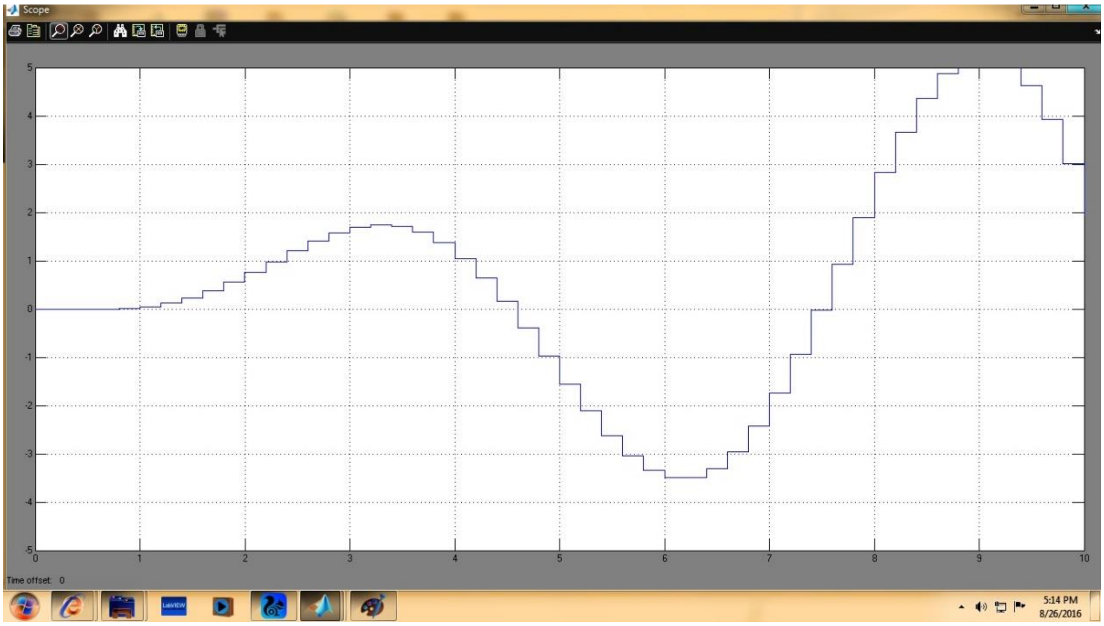

Figure: 5. Output of the control loop using old methodology

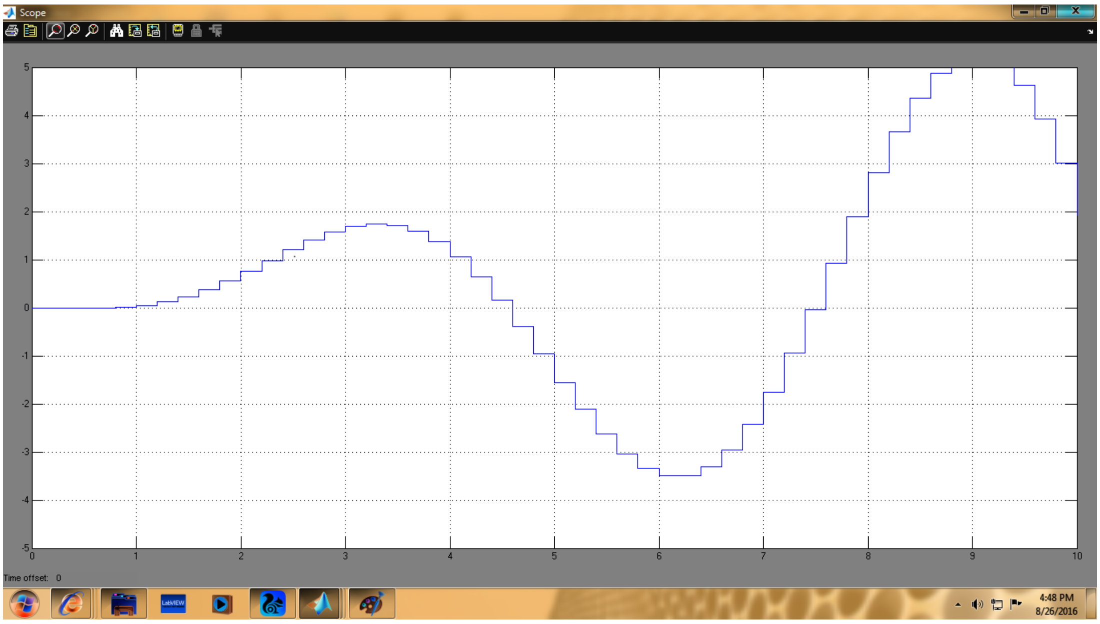

Figure:6. Output of the control loop using the method

V. CONCLUSION

As we can see the output of both the methods are same. So, it signifies that the new method satisfies for the control loop of the system. It reduces complexity of solving the control loop. It has lesser number of feedback loops as compared to the old method in the control loop of the given system.

Conflict of Interest: We declare that we have no conflict of interest.

Ethical Statement: We have followed all ethical responsibilities.

REFERENCES

[1] Stephanopoulos, George. "Chemical process control: an introduction to theory and practice." (1984).

[2] Available at: *https://en.wikipedia.org/wiki/Dead_time*

