IJRISE International Journal of Research In Science & Engineering
Volume: 3 Issue: 5 Sep.-Oct. 2017
e-ISSN: 2394-8299
p-ISSN: 2394-8280

# A REVIEW STUDY OF FOPID CONTROLLER AND ITSAPPLICATION

**Imran Beg[1], Dr.Md Sanawer Alam[2], Mohd Asif Ali[3]**

[1]*M.Tech scholar, Department of Electronics, AIET,* ***imranbeg007@gmail.com***
[2]*Assistant Professor, Department of Electronics, AIET,* ***sanawer@gmail.com***
[3]*Assistant Professor, Department of Electronics, AIET,* ***asifaliec@gmail.com***

**ABSTRACT**

***The main purpose of this paper is to throw a ray of light on the new generation PID controller, it is also written as $PI^{\lambda}D^{\mu}$ controller. This paper also mention the brief description of FOPID in different fields. As we know that FOPID has five parameter to tune for the optimized result which is two more than the simple PID controller which can be applied to the more complex problem of the control system. However the efficiency of the control system much often get better than the conventional one, when these controller will apply to the system. The main advantage of the fractional order controller is that, it is very less sensitive to the change of parameter of a controlled system and controller. Automatic voltage regulation, load frequency control , cardiac pacemaker etc. uses the FOPID controller. If we talk about the stability,FOPID is more stable than PID controllers.***

***Keywords:FOPID, Stability of FOPID, Cardiac Pacemaker, Magnetic bearing system***

---

## 1 INTRODUCTION:-

Process control industries have been using the the Propotional Integral Derivative since many decades of years. The simplicity of design and better performance makes the PID controller wide range popular. Low Percentage Overshoot and small settling time for slow process plant[5] also plays an important role in popularity of PID controller. Inspite of being very popular in industries it also has some limitation of this type of controller, continuous attempt had been taken to improve the performance and robustness of PID controllers. Due to advancement in the field of fractional calculus, there were a great trend expand in the area of generation of PID controller which is commonly known as fractional order PID or $PI^{\lambda}D^{\mu}$ controller.This new PID controller i.e. FOPID controller is an elaborated version of the classical PID controller. The fractional order controller controller has the advantage to show the resistivity in the change of parameters of control system and controller.[5]

FOPID controller provides the flexibility in the adjustment of the dynamical properties of the feedback system under observation which could be more complicated setup.

### 1.1 FOPID controller :-

As I discussed previously a fractional order PID controller is an updated version of the conventional PID controller. Fig.1 shows the block diagram of FOPID used with feedback system . The fractional order controllers are less sensitive to update the parameter of the control system and the controller. Also the damping can also be easily achieved by the fractional order controller [1]. The generalize equation of the Transfer function of FOPID controller is given by

$$C(s)= \frac{V(x)}{E(x)} = \frac{K_i}{S^{\lambda}} + K_D S^{\mu}$$

Where, C(s)=controller output
V(s)=control signal
E(s)=error signal
$K_P$=propotional constant gain
λ=order of integration
μ=order of differentiation [5]

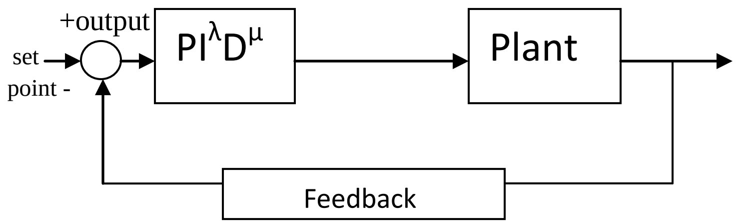


**Fig-1. Block diagram of fractional PID controller**

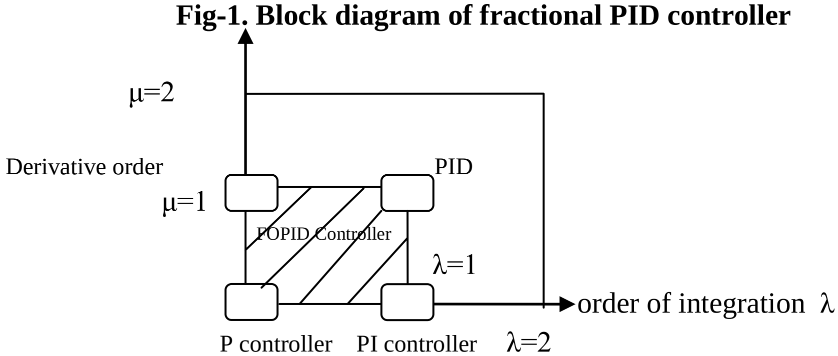


**Fig-2. Fractional PID**

In general, the range of fractional order considered is between 0 to 2. In this plane,
If, λ=1 and μ=1, then it is classical PID controller.
λ=0 and μ=1,then it is classical PD controller.
λ=1 and μ=0, then it is classical PI controller.
λ=0 and μ=0, then it is classical P controller.[5]

In the fractional-order proportional integral derivative, (FOPID), controller, I and D operations are usually of fractional order. There-fore, besides setting the proportional, derivative and integral constants $K_{P,}$, $K_I$ , $K_D$, we also have to set two more parameters namely the order of fractional integration λ as well as fractional derivative μ. Finding an optimal set of values for $K_P$, $K_I$ , $K_D$, λ and μ inorder to meet the user specifications for a given process, it needs parameter optimization in five-dimensional hyperspace.

## 2.1 Application of FOPID

Many of the field like automatic voltage regulation industry, load frequency control DC motor, intelligent heart pacemaker control industries etc. are using FOPID.

### 2.1 Active Magnetic bearing system:

This paper has proposed a improved version of adaptive genetic algorithm for the optimized design of a fractional order PID controller and applies its result to the bearing system .The proposed algorithm has a better efficiency of convergence speed and better stability in the global optimum result . Another advantage of this method is the way of defining the fitness function based on the concept of multi objective optimisition.[2]

### 2.2 Comparision of PID and FOPID controller response for voltage regulation:

It can be concluded from the result obtained in paper that when we use FOPID controller tuned by Zieglar Nichols method that the overshoot found is less as compared to the PID controller tuned by conventional method. FOPID also has the advantage of lesser settling time.[3]

### 2.3 FOPID heart rate controller for Pacemaker:

For regularity the heart rate in the dynamic environment, efficiency and robust control action of pacemaker is manadatory for life saving of any heart patient. PID controller and Fuzzy logic control had also come into existence but they both have their limitation to face the dynamic environment of regulating heart rate. In this paper a revised study of regulating heart rate. In this paper revised study of a fractional order PID controller is designed tuning based on Zieglar Nichols method. The stable FOPID controller overcome the PID controller with different tuning method in terms of the rise time, percentage overshoot, settling time. The fractional order PID controller minimizes the complexities and limitations as compare to other designs which is feasible for rate adaptive pacing.[6]

## 3. STABILITY CONDITION OF FOPID:

As we all know that an integer order LTI system is stable if and only if all the roots of the polynomial are negative or have negative real part, if they are in complex conjugate system. This employs that the roots are located on the left portion of the imaginary axis of the complex plane (s). Fig. shows the FOPID stability region when we deals with the fractional order system the polynomial equation is a multivalued function of 's' the domain of which is a Riemann surface. The stability region of FOPID is defined as the area bounded by a cone whose vertex is at the origin and expand to the right half of the s plane covering the angle of $\alpha\pi/2$ as shown in figure:- [1]

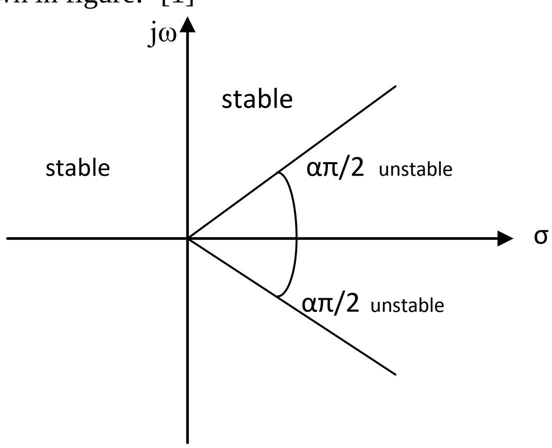


**Fig-3. stability region of fractional order system**

**CONCLUSION :**

This paper gives a short description of FOPID and its different application in different fields of engineering. Now there is a need to explore the variations in tuning domain of PID controller mentioned in the paper. erformance of FOPID can be enhanced by several tuning technique like ZN method and PSO etc.

**ACKNOWLEDGEMENT**: I am very thanksful to my HOD Dr. Md Sanawer Alam, head of department Electronics Instrumentation and control Engineering. Special thanks to all faculty member of the department for their cooperation without them this would not be possible.

**REFERENCES :**

[1] Jun-Yi Cao, Bing-Gang Cao "Design of Fractional order controller based on particle swarm optimization," International Journal of Control, Automation, and Systems, vol. 4, no. 6, pp. 775-781, December 2006.

[2] Long-Yi Chang, Hung-Cheng Chen, TUnig of Fractional PID controllers Using Adaptive Genetic Algorithm for Active Magnetic Bearing System,WSEAS transactions on systems,Issue 1, vol. 8, January 2009.

[3] Tushar Verma, Akhilesh Kr. Mishra , "Comparitive study of PID and FOPID controllerResponse for Automatic Voltage Regulation" , IOSR Journal of Engineering, Vol. 4, Issue 9, pp 41-48, September 2014

[4] Navid Bayati, Akbar Dadkhah,Behrooz Vahidi, Seyed Hossein Hesamedin Sadeghi, "FOPID Design for Load-Frequency Control Using Genetic Algorithm ," SINTE, pp 3089-3094,2015

[5] Pritesh Shah, Sudhir Agashe, "Review of fractional PID controller," Mechatronics, Elsevier, 2016.

[6] Shivaram P. Arunachalam,Suraj Kapa, Siva K.MulPuru, Paul A. Friedman, and Elena G.Tolkacheva, "Intelligent Fractional Order PID Heart Rate Controller for Cardiac Pacemaker",

[7] Shweta Bajpai, Md Sanawer Alam, "A Review on FOPID controller and its various application'' ,IJRISE, Vol.3, Issue 3, May-June 2017