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Improved Speed Characteristics of a Synchronous Machine using Discrete PID Controller

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ABSTRACT

In this paper speed characteristics of a synchronous machine are improved using a discrete PID controller so that active power output characteristics are also improved. The numbers of overshoots are also reduced for the speed output and the speed characteristics attain a steady state. The active power output characteristics are also improved. The advantage of using PID here is auto tuner is provided for PID values. The required simulation is conducted on mat lab2013/simulink environment.

KEYWORDS: *Synchronous Machine, Discrete PID Controller, Speed, MATLAB Simulink.*

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I. Introduction

The stability studies are more concerned in synchronous machines [1].the power obtained is not stable all the time. Excitation system is provided to regulate the voltage. Use of power system stabilizer provides stable power to some extent. But, the conventional power system stabilizer does not give the stable power to our satisfaction. Using discrete PID controller improves the characteristics of output and improvements compared to without controller.

In this paper the characteristics of power, speed are compared with using PID controller with pss and without using PID and pss.

The model diagram of the synchronous machine is shown in Fig.1.

II.SYNCHRONOUS MACHINE

The diagram shown in fig.1.Consists of hydraulic turbine and governor, excitation system, power system stabilizer, discrete PID controller. The synchronous machine employed here is of salient pole type [2].the excitation system consists of AVR,PSS etc.the main aim of excitation system is to decrease the transients in the rotor angle which leads to instability and to maintain constant voltage. The system used here is modeled as single machine infinite bus system (SMIB) in mat lab/simulink.

The AVR is to regulate the terminal voltage when it drops due to sudden load changes.

By using the discrete PID controller the speed characteristics are improved. The swings are reduced much. The general mechanical torque equation of synchronous machine is given as below [2].

$$Te + Tm = J \times pwr + D \times wr \quad (1)$$

When $D \times wr$ is neglected

$$Te + Tm = J \times pwr \quad (2)$$

The assumptions made during transient analysis of synchronous machine are [2]:

(a) The machine is running initially on no load under steady state.

(b) Speed before and after short circuit remains unchanged at synchronous speed.

The voltage equations of synchronous machine are:

$$vf = (rf + Lfp)if - Md \times pid \quad (3)$$
$$vd = Md \times pif - (ra + Ldp)id + Lq \times wr \times iq \quad (4)$$
$$vq = Md \times wr \times if - Ld \times wr \times id - (ra + Lqp)i \quad (5)$$

Where

$vf: field\ voltage$

vd: direct axis voltage

vq: quadrature axis voltage

rf, Lf, if: field resitance, inductance, current

p: differential operator

Md: mutual inductance

id, iq: direct and quadrature axis currents

Ld, Lq: direct and quadrature axis inductance

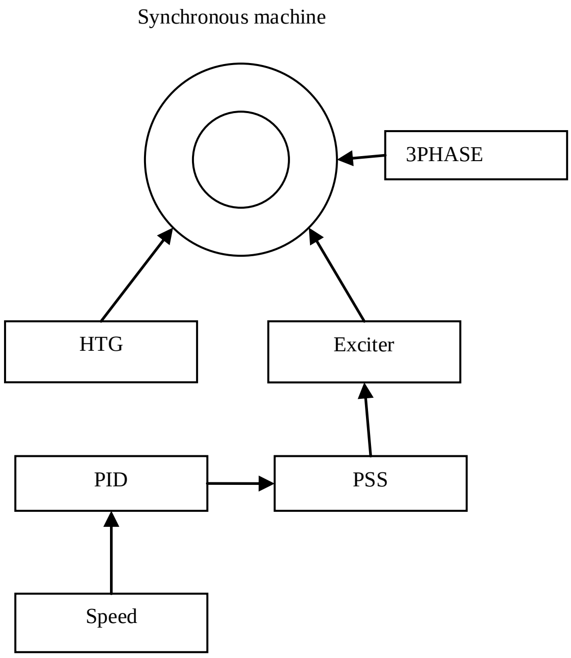

Fig.1.model diagram of synchronous machine

III.DISCRETE PID CONTROLLER

The block diagram for discrete PID controller is shown in Fig.2.The block diagram shown in Fig.2.consists of a discrete PID controller, power system stabilizer (PSS), excitation system, hydraulic turbine governor etc. Speed is given as reference input to the PID controller. The output of PID is given to the power system stabilizer; from there it is given to excitation system which is connected to synchronous machine. The field voltage is fed to synchronous machine which is responsible for the required characteristics.

The compensator equation for PID controller is given as:

$$P(b \times r - y) + \frac{I}{s}(r - y) + D \times \frac{N}{1+\frac{N}{s}}(c.r - y) \qquad (6)$$

IV.RESULTS AND DISCUSSIONS

The output waveform for speed and active output power without discrete PID controller and PSS are shown in Fig. (3) - (4). The waveforms for speed and active power output with discrete PID controller and PSS are shown in Fig. (4)- (5). The speed without PID controller shown in Fig.3.is having more transients and the output active power is also having more transients.inorder to decrease these transients and overshoots we are using a PID controller and the related waveforms shows the improved characteristics of speed and output active power. The speed characteristics are improved a lot. The results are satisfactory compared to without controller.

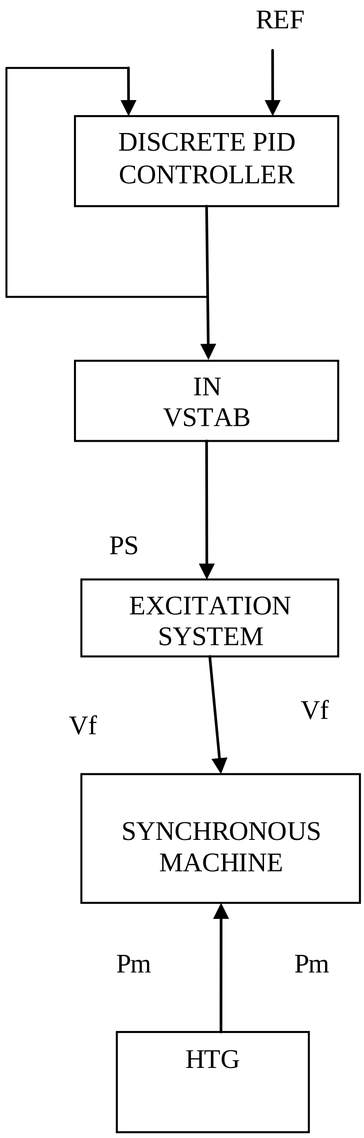

Fig.2.block diagram of discrete PID control

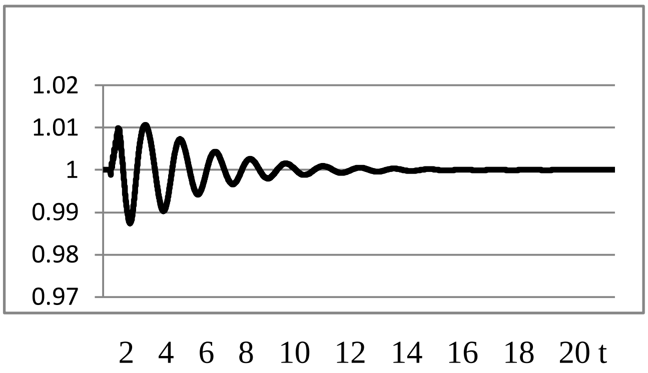

Fig.3.speed without discrete PID controller

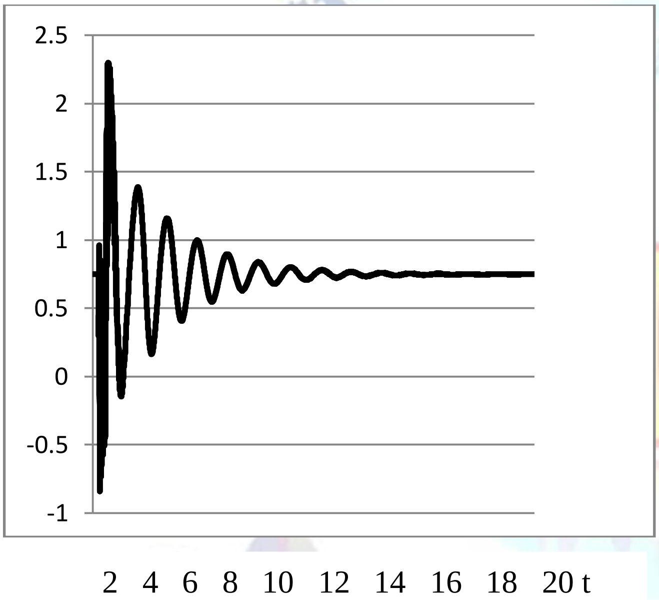

Fig.4.active output power without discrete PID controller

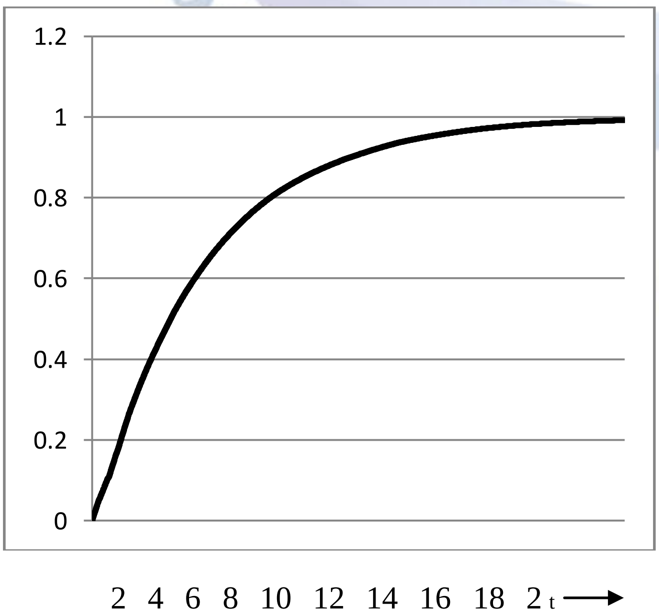

Fig.5.speed with discrete PID controller and PSS

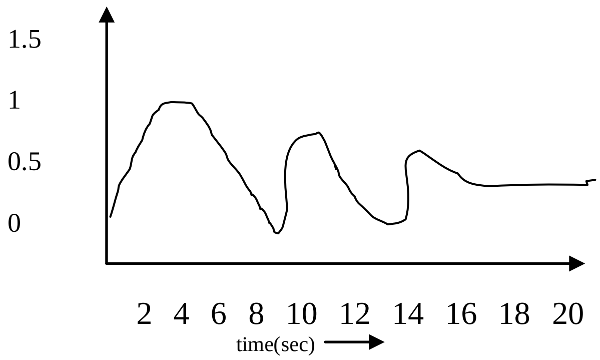

Fig.6.output active power with discrete PID controller and PSS

V.CONCLUSION

The speed characteristics are improved using discrete PID controller which is executed on mat lab/simulink software. The results of speed characteristics are compared with and without discrete PID controller. The results obtained were satisfactory.

VI.APPENDIX

discrete PID controller data:

$P = 0;$
$I = 0.549541\ ;$
$D = 0;$
$N = 100;$
$b = 1;$
$c = 1;$

synchronous machine data:
power rating: $200MVA$
voltage: $13.8KV$

transformer rating:
$210MVA, 13.8KV/230KV$
Source=230KV

VII.NOMINCLATURE

Te: electromagnetic torque
Wr: rotor speed
J: moment of inertia
Tm: mechanical torque
D: damping factor
r: reference input
y: output
N: filter coefficient
b, c: set point weights
Rs: stator resistance
P: number of poles

f: frequency
F: friction factor
peo: activepower output

VIII.REFRENCES

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