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FASTER RESPONSE AND ELIMINATED OVERSHOOT OF AN AN IP CONTROLLER OPERATED D.C MOTOR

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Abstract:
In this paper to control speed of a DC engine for an abrupt burden change a DC engine is reproduced by another mechanical IP regulator, it is hard to reach at reference or wanted set speed assuming we don't utilize any Controllers. This is a result of higher overshoot happens in speed when burden increments. At the point when DC engine is executed with Controllers overshoot gets diminished and engine gives better reaction as far as time boundaries. IP Controller is generally reasonable on the off chance that we consider overshoot decrease. It can lessen overshoots to zero percent (0%). PID Controller is best plan on the off chance that quickest reaction to stack change is required yet it contains overshoots making framework less steady.

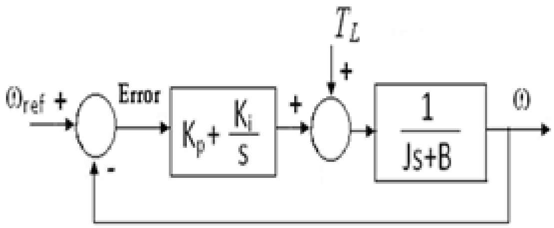
1. INTRODUCTION

Alternating current motors are ending up noticeably more famous for applications in mechanical situations because of its ease, roughness, dependability and the accessibility of engines in the scopes of fragmentary pull to multi-megawatt limit. In speed control frameworks, air conditioning enlistment engines, especially the confine sort, are all the more broadly utilized because of the qualities of higher proficiency, less latency, littler volume, and lower cost. The capacities to work at higher velocities, higher torques, and bigger power evaluations make the enlistment engines more alluring than dc engines for medium and high-control engine drives [1]. In addition, rather than dc engines, enlistment engines can be utilized for quite a while without support in light of their brushless structures. Open-loop control can be used in induction motor speed drives for simple applications. The major problem in open loop speed control is that the machine is susceptible to speed and flux drifts. Moreover, speed errors will occur due to disturbances. To overcome these weaknesses, closed loop controls employing tachometer or encoder feedback are generally used in induction motor speed drives [2]. There are mainly two control techniques used for Induction motor drives namely, scalar control and vector control. DC engine is an electric engine which changes electrical vitality into mechanical vitality. They are to a great degree utilized where broad speed control range is required [1]. DC engine are exceptionally utilized as a part of industry because of good speed control attributes despite the fact that its support cost are more prominent than A.C engine. All the more ever techniques utilized for DC engine to control its speed are basic and modest when contrasted with those utilized for AC engines [2]. The target of a controller intended for speed control of an engine is to get a flag that speak to the coveted speed and to drive it at that speed [3]. There are two diverse sort of a controller which are utilized to gauge the speed of a DC engine: shut circle and open circle controllers. Shut circle controller can gauge the real speed of an engine however open circle can't quantify the genuine speed. Shut circle controller is superior to anything open circle however it is more convoluted and costly because of input parts. Shut circle control framework is generally utilized for precise speed control of an engine [4]. The corresponding indispensable (P-I) controller is a nearby circle controller which are exceedingly utilized for DC engine to control its speed. P-I controller has its capacity to make zero relentless state mistake with a stage change in reference speed [5]. In the meantime there are a few drawbacks in P-I controller like high overshoot and affectability to pick up parameters corresponding increase and Integral pick up .These disservices of P-I controller can be evacuated by supplanting P-I with I-P controller. Integral-relative (I-P) controller is a changed type of the Proportional Integral (P-I) controller. The vast majority of the property of P-I and I-P controller are like each other [6]. The reaction of these controllers can be enhanced by legitimate tuning of their pick up parameters. In This paper we think about the transient reaction of P-I and I-P controller in [7, 8] with Ziegler-Nicholas based P-I and I-P controllers for separately energized DC engine to control its speed. Reproduction comes about demonstrate that the overshoot in Ziegler-Nicholas based P-I and I-P controller are slighter than the customary P-I and I-P controllers.

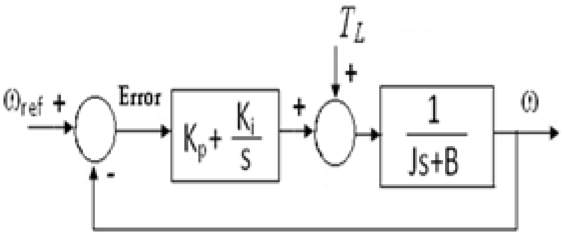
IP vs. PI control theory:

The Proportional-Integral (P-I) controller is the conventional controller and it has been widely used for the speed control of Induction motor drives [8]-[12]. The major feature of the P-I controller is its ability to maintain a zero steady-state error to a step change in reference signal [13]-[14]. At the same time, P-I controller has some disadvantages namely; the undesirable speed overshoot, the sluggish response due to sudden change in load torque and the sensitivity to controller gains Ki and Kp.

When the I-P controller is used for the vector control of Induction motor, the zero introduced by the P-I controller is absent in the case of I-P controller, and thus the overshoot can be reduced to a great extent with an I-P controller.



PI CONTROLLER



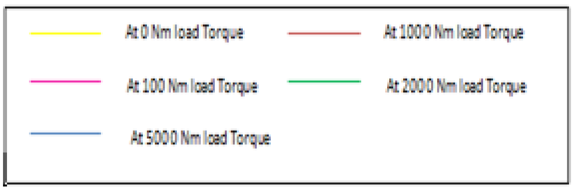
IP CONTROLLER

IP CONTROLLER

Simulation waveforms & result discussion Here DC motor is implemented with different Controllers one by one and its speed response is analysed in MATLAB (Simulink). Transient analysis with different Controllers is compared at different loads. Effect of increasing speed is also discussed.

We also analysed percentage change in rise time, settling time and maximum percentage overshoots at different speed and by increasing loads to two times and five times. All the simulation model with results has been discussed below.

DC motor at different loads:



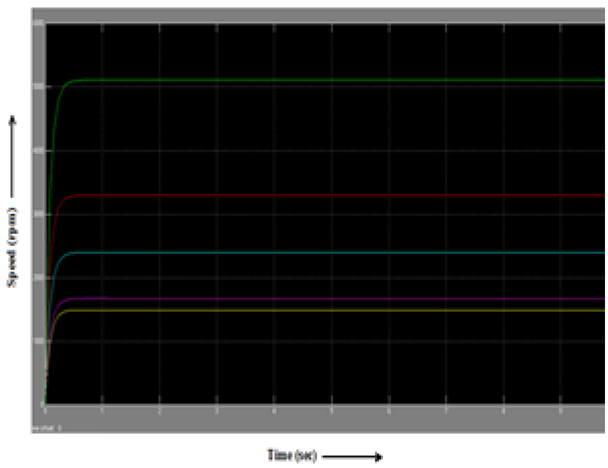
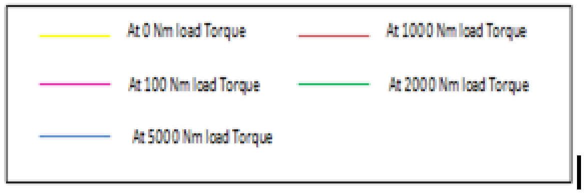


Fig 6.c: Effect on speed at various loads for DC motor without any Controller

Here DC motor is implemented without any controlling schemes at 1500 rpm (reference speed) and 500 Nm load torque. When there are not any controlling schemes, it results very high overshoots (59.9%). It is desired to settle down speed at the reference speed of 1500 rpm but we observe here that settling time is infinity here. Speed of the motor can never achieve the desired speed (1500 rpm). Here time parameters are high and system becomes unstable.

If we increase the loads from 0 Nm to 2000 Nm, overshoots in speed also gets also increased from - 6.66% to 240%. If we consider rise time with increase in load torque it decreases. Also, settling time is infinite in all the cases. This makes the system response unstable. And this is totally undesirable. We can observe it with the simulation graph given above.

DC motor at different loads with PI Controller



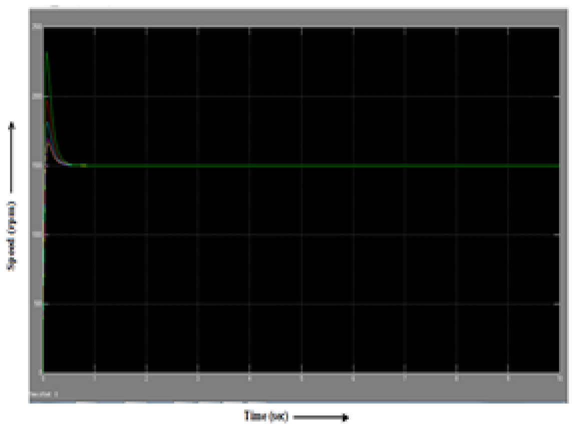
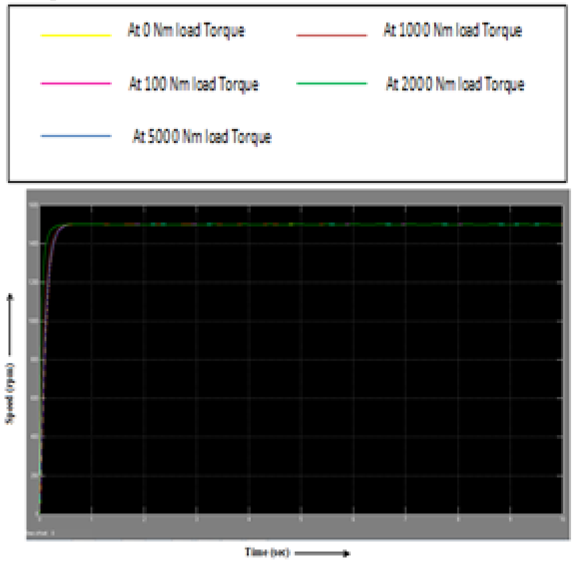


Fig 6.f: Load variation on DC motor with PI Controller

Here using proportional integral Controller speed is controlled to desired value (1500 rpm) but there are overshoots (20.9%) at 500 Nm load torque which are desired to be reduced so that fast response without any disturbance is achieved. Here rise time and settling time is 0.0233 sec and 0.330 sec respectively which are less than when we take DC motor without any Controller. Load variation of DC motor with PI Controller is shown below:

Here it can be easily observed that with increase in load from 0 to 2000 Nm overshoots get increase and speed of 1500 rpm (ref. speed) is reached in all cases. If we consider rise time and settling time, rise time decreases and settling time increases with increase in load

DC motor at different loads with IP Controller
Here proportional gain is in feedback loop and integral is in forward loop. Removal of proportional gain parameter from forward path results the reduction of unwanted overshoots.



It is observed with increase in load from 0 to 2000 Nm there is not any effect on overshoots. In all the cases overshoots is 0%. Hence there is no effect on speed when load is varied. System remains stable even after any sudden undesirable disturbances. Therefore it can be concluded that IP controlling scheme is best scheme compared to PI and PID controlling schemes.

CONCLUSION

To control speed of a DC engine for a sudden load transform it is hard to reach at reference or fancied set speed in the event that we don't utilize any Controllers. This is a direct result of higher overshoot happens in speed when load increments. At the point when DC engine is executed with Controllers overshoot gets diminished and engine gives better reaction regarding time parameters. IP Controller is most reasonable in the event that we consider overshoot lessening. It can diminish overshoots to zero percent (0%). PID Controller is best plan if quickest reaction to load change is required however it contains overshoots making framework less steady.

Transient parameters for speed reaction of DC engine get influenced as:

- Rise time: When load expanded ascent time gets diminished. When we execute DC engine with PID rise time is minimum. With increment in speed of DC engine then ascent time get lessened in all cases.

- Settling time: Settling time is boundless when no controlling plan is utilized. In the event of PI Controller it is increments if stack increments and with PID and IP it gets diminished. Settling time is slightest for PID Controller. At the point when speed expands settling time increments yet there is very little variety in it. % lessening is increasingly when speed increments if load is expanded.

- Percentage overshoots: There is no impact of load minor departure from overshoots with IP Controller. Overshoots are max if no Controller is utilized and increment with increment in load if there should arise an occurrence of PI and PID. PID has bring down overshoot than PI Controller. Overshoots diminishes if speed is expanded. There is no impact of speed minor departure from overshoots in the event of IP Controller.

Future work:

Future scope of this research is to analyse performance of these controlling schemes for many other systems like for AC motors and with other types of DC motors. We can also compared these schemes for speed control of DC motor with other evolutionary computing techniques like fuzzy logic control, Genetic Algorithm (G.A), Particle Swarm Optimization (PSO), Differential Evolution (D.E) etc. these techniques base on I-P Controller can also be analysed with induction motor or with some other AC motor.

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