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REVIEW: DIFFERENT TECHNIQUES OF SPEED CONTROL OF DC MOTOR

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Abstract - *Due to its glorious speed management characteristics DC motor has been wide employed in industry despite the fact that its maintenance prices area unit beyond the induction motor, the speed of DC motor will be adjusted to a good extent thus on give straightforward management and high performance. These days many management theories are developed significantly; we have a tendency to do see the wide fashionable use of proportional-integral (PI) and proportional integral-derivative (PID) controller in speed and torque control, motor drives, control, and instrumentation. The explanation of this satisfactoriness is for its easy structure which might be simply understood and enforced.*
In this paper, different technology for speed control of DC motor is present. Those techniques very much useful for researcher and students those involve in research in the field of speed control of DC motor.

Key Words: DC motor, speed control

1. INTRODUCTION

Due to its fabulous speed management characteristics DC motor has been wide utilized in business although its maintenance prices ar more than the induction motor, the speed of DC motor will be adjusted to a good extent therefore on give simple management and high performance. At present, Proportional-Integral-Derivative "PID" controller, thanks to its simplicity, stability, and strength, may be a variety of controller that's most generally applied.

However, it's troublesome to style once the correct model of plant is sophisticated or the setting of the load on the plant is variable. For Dc motors, factors like unknown load characteristic and parameter variation influence seriously the dominant impact of speed controller. Fuzzy controller doesn't strictly would like any mathematical model of the plant. It's supported plant operator expertise, and it's terribly simple to use. Fuzzy logic has been with success applied to an oversized variety of controlling applications. The foremost ordinarily used controller is that the proportional-plus-integral-plus-derivative controller, which needs a mathematical model of the system. formal logic controller provides an alternate to inflammatory disease controller since it's a decent tool for the control of systems that are troublesome in modeling. The controller action in formal logic controllers will be expressed with straightforward "if-then" rules. Fuzzy management provides sturdy performance for a linear or nonlinear plant with parameter variation. Hardware implementation of the controller will be achieved during a variety of how to form new product. The foremost common technique of implementing Fuzzy controller is employing a general purpose micro chip or microcontroller. the easy and usual thanks to implement these systems is to understand it as a software package program on general purpose computers, these ways that can't be thought of as an appropriate style resolution. Higher density programmable logic device like Field Programmable Gate Arrays (FPGAs) will be wont to integrate giant amounts of logic during a single IC.

In typical approaches, rotational speed of DC motors will be controlled by variable the voltage applied to the motor magnet. However, it can't be dependably controlled at low speeds. What is more, mechanical response of the controlled DC motors isn't dynamically quick enough to output torque responses so as to tackle the cogging torques generated. This makes it troublesome to regulate the speed of DC motors at a high frequency.

2. DC MOTOR SPEED CONTROL TECHNIQUES

D.C. motors area unit rarely utilized in standard applications as a result of all electrical provide corporations furnish AC but, for special applications like in steel mills, mines and electrical trains, it's advantageous to convert AC into electricity so as to use d.c. motors. The explanation is that speed/torque characteristics of d.c. motors area unit way more superior to it of a.c. motors. Therefore, it's not stunning to notice that for industrial drives, d.c. motors area unit as standard as 3-phase induction motors. Like d.c. generators, d.c. motors also are of 3 varieties viz., series-wound, shunt-wound and compound wound. The employment of a specific motor depends upon the mechanical load it's to drive.

The methodology deals with a shift method [1] making certain continuity of the coil current. Associate procedure is projected for the commutation circuit parts. Voltage and current undulation patterns square measure shown for all branches for the entire circuit, and suggests that for up the beginning method square measure delineated. A regulation methodology is projected, making certain rotor current continuity and, as a result, linear and rigid mechanical characteristics. Ways for calculative the parts of the commutation circuit, a method utilizing the switch for beginning, and a general regulation theme square measure conferred.

In silicon-controlled rectifier (SCR) dc motor drive controller, it's fascinating for a chip to perform each the

management law computations and also the logical functions of SCR firing. However, owing to their restricted period of time capabilities, contemporary microprocessors cannot accommodate too protracted management algorithms. This methodology presents a technique [2], appropriate for chip implementation, of dominant the position or speed of Associate in Nursing SCR dc motor drive that uses a half-wave single-phase provide. The state-space equations of the system square measure 1st obtained. The derivation of a straightforward management law is given next, followed by the steadiness and error analysis of the controller. Finally, it's shown from simulation experiments that the theme is effective in dominant a 3-hp dc motor.

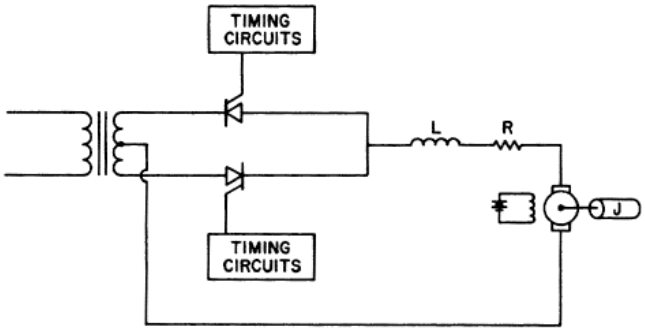

Fig-1: SCR control DC motor drive

A complete microprocessor-controlled variable frequency dc three section thyristor inverter converter system has been investigated. Microprocessor programming facilitates completely different modes of motor load management and conjointly permits a straightforward technique to realize the turn-off sequence, motor reversing, and any necessary start-up sequence. The tendered directed bridge commutated electrical converter facilitates programmable regenerative braking and a commutation cycle freelance of the load and needs no special beginning sequence. The resultant bridge is straightforward, versatile, of low price, and lightweight in weight.

One of technique presents on-line self-tuning artificial neural-network (ANN)-based speed management theme [3] of a magnet (PM) dc motor. For precise speed management, associate degree on-line coaching algorithmic rule with associate degree accommodative learning rate is introduced, instead of exploitation fastened weights and biases of the ANN. The entire system is enforced in real time employing a digital signal processor (DSP) controller board (DS1102) on a laboratory PM dc motor. To validate its efficaciousness, the performances of the projected ANN-based theme square measure compared with a proportional-integral (PI)-controller-based PM dc motor drive system beneath completely different operational conditions. The comparative results show that the ANN-based speed controlling theme is strong, accurate, and insensitive to parameter variations and cargo disturbances.

In this technique, an on-line self-tuning ANN-based speed controlling theme was developed and through an experiment enforced for a PM dc motor. Also, a PI-controller-based drive system is enforced, and also the performances of each the ANN- and PI-controller-based systems were compared. The comparative results indicate that the performances of the ANN-based system are clearly superior, significantly within the case of parameter variations and cargo disturbances, owing to the on-line weights and biases change feature of the ANN. The employment of the reconciling learning rate within the planned system reduces the probabilities of overshooting throughout the transient conditions. The feedback provision within the changed ANN structure not solely reduces the computations in real time, however conjointly enhances the steadiness of the system. The planned ANN-based speed system of the PM dc motor is found to be strong, efficient, and straightforward to implement.

One of the methodology introduces a sensing element less nonlinear management theme for dominant the speed of a permanent magnet synchronous motor (PMSM) driving AN unknown load force [4]. The states of the motor and disturbance force are calculable via an extended nonlinear observer avoiding the employment of mechanical sensors. The management strategy is a certain feedback linearization law, with mechanical phenomenon trailing evaluated on calculable values of the PMSM states and also the disturbance force. The system performance is evaluated by simulations.

A sensorless nonlinear controlling strategy was introduced for dominant the speed of a PMSM motor driving associate unknown torsion. Precise linearization was planned because the management law within the innermost loop; whereas a linear electrical phenomenon chase strategy was planned for the outer loop. The planned management theme was tested by simulations, presenting a awfully satisfactory performance within the whole speed vary, with slowly varied load torsion and uncertainties within the mechanical parameters. The dynamics of the theme will become unstable as a result of electrical parameters variations; however even handed choice of the nominal values reduces the importance of this downside. Our management theme conjointly delivers associate estimate of motor speed that becomes inaccurate within the presence of electrical parameters variations. These inaccuracies and also the overall performance may still be improved exploitation as an example, a better order extended nonlinear observer. The technique presents a unique sturdy speed controller methodology supported the load torsion observer of superior brushless DC (BLDC) motor [5]. Recently, superior BLDC motor drives square measure wide used for variable speed drive systems of the economic applications. Just in case of the management of golem arms and trailing applications with lower stiffness, we tend to cannot style the speed controller gain to be terribly giant from the perspective of the system stability. Thus, the feed-forward compensator with disturbance torsion observer was planned. This methodology will improve the servo stiffness while not increasing the speed controller gain. The improved speed management performance are often achieved and also

the speed response against the disturbance torsion are often improved for superior BLDC motor drive systems during which the information measure of the speed controller cannot be created giant enough. The load disturbance is salaried by detected load torsion through the observer. The compensation current is created through q-axis current. The d-q remodel of section currents was potential by the Fourier series summation methodology. Consequently, the speed management for superior BLDC motor drives becomes improved. The simulation results for BLDC motor drive systems make sure the validity of the planned methodology. One of the studies presents strong management performance of an immediate current (DC) motor with brakes adopting the enormous electrorheological (GER) fluid, whose distinguished feature is a particularly high price of yield stress [6]. As a primary step, Bingham characteristics of the GER fluid is by experimentation investigated exploitation the Couette sort electro viscometer. A cylindrical form of electro rheological (ER) brake is then devised supported the Bingham model, and its braking torsion is by experimentation evaluated. The ER break is then incorporated with a DC motor. Once formulating the governing equation of motion for the DC motor with ER brakes, a friction mode controller formula, that is extremely strong to external disturbances and parameter uncertainties, is synthesized and by experimentation completed so as to realize desired movement speed trajectories. The following responses of the management strategy square measure then evaluated for numerous curving trajectories. Additionally, their following errors square measure evaluated and compared with those obtained from ancient inflammatory disease controller.

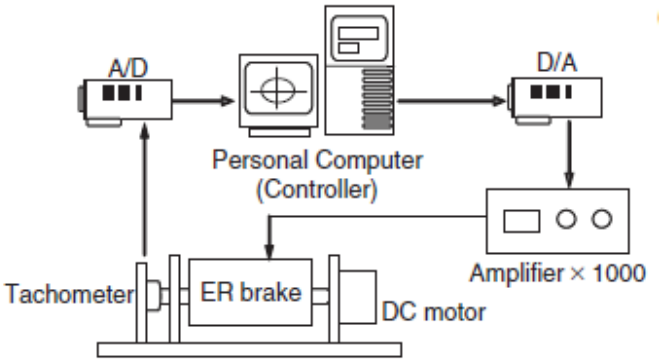

Fig-2: Experimental apparatus for speed tracking control

In order to attain desired speed trajectories, a sliding mode controller (SMC) is developed by considering force variation of the DC motor uncertainty, and by experimentation complete. Afterward, it's been incontestable that the required speed is well achieved by adopting the ER brake and SMC.

One of technique presents the appliance of fuzzy logic for DC motor speed management victimization Particle Swarm improvement (PSO) [7]. Firstly, the controller designed in step with fuzzy logic rules is such the systems are essentially sturdy. Secondly, the symbolic logic controller (FLC) used earlier was optimized with PSO therefore on get optimum adjustment of the membership functions solely. Finally, the FLC is totally optimized by Swarm Intelligence Algorithms. Digital simulation results demonstrate that compared with the FLC the designed

FLC-PSO speed controller obtains higher dynamic behavior and superior performance of the DC motor, yet as excellent speed trailing with no overshoot.

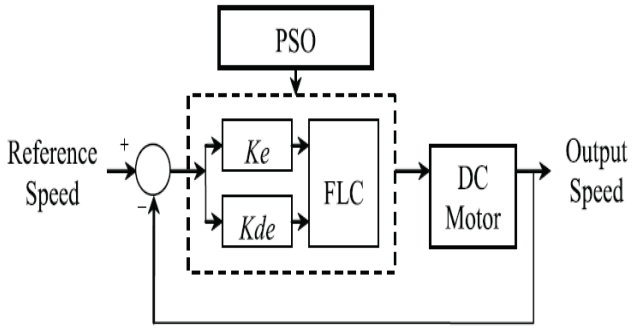

Fig-3: Structure of FLC with PSO algorithms [7]

In this methodology, the speed of a DC Motor drive is controlled by suggests that of three completely different fuzzy controllers. The optimum fuzzy logic is intended mistreatment PSO algorithms. In step with the results of the pc simulation, the FLC1 with PSO algorithms is healthier than the standard FLC while not PSO algorithms. The FLC2 with PSO algorithms is that the best controller that bestowed satisfactory performances and sensible lustiness (no overshoot, stripped-down rise time, steady state error is 0). The foremost disadvantage of the fuzzy controller is inadequate analytical technique style (the choice of the foundations, the membership functions and also the scaling factors). We have a tendency to selected the one with the employment of the PSO algorithmic program for the optimization of this controller so as to manage DC motor speed. Finally, the planned controller provides drive lustiness improvement and provides excellent results and possesses good lustiness.

Technology presents the planning of the composite nonlinear feedback (CNF) controlling law for DC motor speed management [8]. First, a linear feedback controlling law is intended specified the closed loop beneath this linear management law has tiny damping quantitative relation. Then, a nonlinear feedback half is intended supported this linear feedback law. The nonlinear perform of the nonlinear feedback half is tuned by formulating the parameter standardization drawback into a reduction drawback. The reduction drawback is solved by Hooke-Jeeves algorithmic program. The handy CNF controlling method leads to a happy transient performance with tiny overshoot, and quick rising time and subsidence time.

A speed servo system with improved transient performance is intended by victimization composite nonlinear feedback (CNF) management technique. The CNF controlling method may be a composition of 2 linear

management laws. Underneath one among the linear controlling method, the control system incorporates a terribly small damping quantitative relation, whereas underneath another linear management law, the control system incorporates a terribly giant damping quantitative relation. throughout the transient amount, the CNF controlling method switches swimmingly from the linear controlling method with small damping quantitative relation to the linear management law with giant damping ration by a nonlinear perform. By befittingly style the nonlinear perform, the control system underneath the CNF controlling method incorporates a terribly tiny overshoot and fast subsiding time. The simulation results show that the output response of the speed servo system has overshoot less that 0.005%. Speed sensor less DC control victimization Kalman filter was projected [9]. Kalman filter considers the DC motor mathematical model.

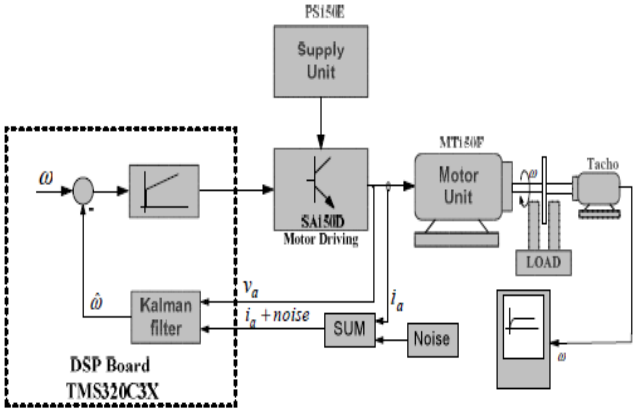

Fig-4: The diagram for the experiment of the sensorless speed control of the DC motor

The speed calculation of the DC motor within the state house has the impact to the noise. If the system has the high level of the noise variance the calculation of the speed should have the noise impact on the calculation. The Kalman filter has the advantage within the condition of the noise rejection as a result of the state house of the DC motor with the Kalman filter equation shown the calculable speed has the noise but the speed calculation while not Kalman filter. The shut loop controller mistreatment PI controller shown the response of the system has quicker than the system while not PI controller.

The design of intelligent controlling systems has become a locality of intense analysis interest. The event of a good methodology for the look of such controlling systems beyond any doubt needs the synthesis of the many ideas from artificial intelligence. The foremost unremarkably used controller within the business field is that the proportional-plus-integral-plus-derivative (PID) controller. Fuzzy logic controller (FLC) provides another to PID controller, particularly once the on the market system models area unit inexact or out of stock. Conjointly speedy advances in digital technologies have given designers the choice of implementing controllers exploitation Field Programmable Gate Array (FPGA) that depends on parallel programming. This methodology has several benefits over classical microprocessors. During this analysis, A model of the fuzzy PID system is enforced in real time with a Xilinx FPGA (Spartan-3A, Xilinx Company, 2007) [10]. It's introduced to keep up a continuing speed to once the load varies. The model of a DC motor is taken into account as a second order system with load variation as associate example for complicated model systems. For comparison purpose, two wide used controllers "PID and Fuzzy" are enforced within the same FPGA card to look at the performance of the planned system. These controllers are tested exploitation Matlab/Simulink program underneath speed and cargo variation conditions. The controllers were enforced to run the motor as real time application underneath speed and cargo variation conditions and showed the prevalence of Fuzzy-PID.

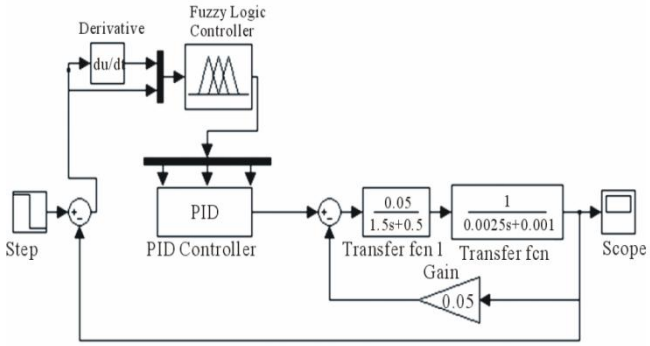

Fig-5: Fuzzy-PID logic speed controller

The one among the tactic to see the best standardization of the PI controller parameter on direct current (DC) motor drive system mistreatment particle swarm optimisation (PSO) rule, Ziegler-Nichols (ZN) standardization and changed Ziegler- Nichols (MZN) standardization technique [11]. The most objective of this technique is to attenuate transient response specifications chosen as rise time, sinking time and overshoot, for higher speed response of DC motor drive. The speed controlling of DC motor is finished mistreatment PI and pelvic inflammatory disease controllers. Implementation of pelvic inflammatory disease controller for DC motor speed control is finished mistreatment metallic element and MZN standardization technique. For PSO rule technique, PI controller is employed to enhance the performance of DC motor speed system. A comparison is created on the premise of objective perform (rise time, sinking time and overshoot) from output Step responses. The projected approach had superior options, together with straightforward implementation, stable convergence characteristic, and sensible machine potency. quick standardisation of optimum PI controller parameters yields high-quality resolution. Compared with ancient metallic element technique and MZN technique, the projected technique is found so a lot of economical and strong in raising the step response of DC motor drive system.

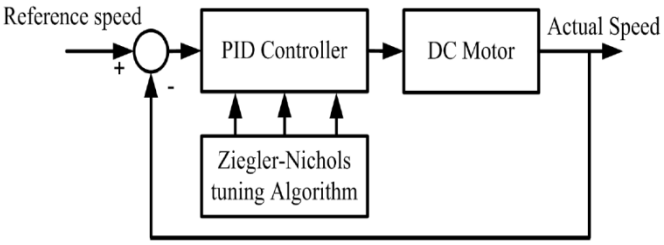

Fig-6: Block diagram of DC motor control system used by PID-ZN and PID-MZN controller

PID controller to supervise and control the speed response of the DC motor and MATLAB program is employed for calculation and simulation inflammatory faulty condition controllers square measure wide utilized in a industrial plants owing to their simplicity and lustiness [12]. Industrial processes square measure subjected to variation in parameters and parameter perturbations.

Accurate performance of a motor is desired feature for any industrial application. Because the age of motor will increase its performance additionally deceases with aging, thus it's desired to gauge the performance of motor from time to time for economical operation the standard technique for shrewd output performance indices square measure quite time intense. The inflammatory disease based mostly approach algorithmic rule worked satisfactory for the take a look at system. The necessary observations created throughout the studies are: the answer time for projected inflammatory disease approach is simply a fraction of your time taken by standard algorithmic rule. A proportional controller Kp can have the result of cut back the increase time and cut back however ne'er eliminate the steady state error. An integral controller Ki can have the result of eliminate the steady state error however it's going to create the transient response worse. A differential controller Kd can have the result of skyrocketing the soundness of the system and reducing the overshoot and improve the transient response. The output performance obtained by normalized worth in inflammatory disease is extremely shut and regarding accuracy. MATLAB used for simulation of entire project is refined and user friendly computer code. It should be mentioned that the potency of the speed algorithmic rule will be improved by exploitation a lot of economical learning techniques and dynamic weight choice algorithmic rule.

One of the methodologies presents the look and implementation of Arduino Uno primarily based DC motor speed system mistreatment Multilayer Neural Network controller and PID controller [12]. A model reference structure is developed mistreatment PID management to get the neural controller .The artificial neural network is trained by Levenberg-Marquardt back propagation formula. Feed forward neural network with two hidden vegetative cells and one output neuron is employed. Speed of the dc motor is controlled by variable the duty cycle of the PWM signal that is fed to the gate of the mosfet irf 640. Simulation and sensible results ar conferred to demonstrate the effectiveness and advantage of the system of DC motor with ANNs compared with the traditional management theme in Matlab/Simulink R2009b. PID formula and ANN controller is enforced in Arduino Uno thanks to its simple compatibility and portability.

3. CONCLUSION

In this paper, the different methodology and techniques were presented for speed control of DC motor drive. DC motor speed control drives very much useful in industrial application.

This paper is used for clarifying the idea about speed control of DC motor and its implementation using software approach or in simulation software. That content will be very much helpful for students and researchers which are working on DC motor speed controlling using different domains or a controller or algorithm.

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