CONTROL STRETAGIES FOR POWER QUALITY IMPROVEMENT OF BLDC MOTOR

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Abstract:-The brushless DC motor drives behave very well during the test trajectories. The DC bus voltages are maintained at relatively constant levels during the deceleration of the motors. The developed torques are proportional to the motor currents' amplitudes. This demonstrates the good operation of the field-oriented control algorithms. Brushless DC motors find wide applications inindustries due to their high power density and ease of control. These motors are generally controlled using a three phase power semiconductor bridge. For starting and the providing proper commutation sequence to turn on the power devices in the inverter bridge the rotorposition sensors required. Based on the rotor position, the power devices are commutate dsequentially every 60 degrees. To achieve desired level of performance the motor requires suitable speed controllers.

1. BACKGROUND

Brushless dc (BLDC) motors are preferred as small horse power control motors due to their high efficiency, silent operation, compact form, reliability, and low maintenance.However, the problems are encountered in these motor for variable speed operation over last decades continuing technology development in power semiconductors, microprocessors, adjustable speed drivers control schemes and permanent-magnet brushless electric motor production have been combined to enable reliable, cost-effective solution for a broad range of adjustable speed applications.Household appliances are expected to be one of fastest-growing end-product marketfor electronic motor drivers over the next five years [4]. The major appliances include clotheswasher's room air conditioners, refrigerators, vacuum cleaners, freezers, etc. Household appliance have traditionally relied on historical classic electric motor technologies such as single phase AC induction, including split phase, capacitor-start, capacitor–run types, and universal motor. These classic motors typically are operated at constant-speed directly frommain AC power without regarding the efficiency. Consumers now demand for lower energy costs, better performance, reduced acoustic noise, and more convenience features. Those traditional technologies cannot provide the solutions.

1.1. TYPICAL BLDC MOTOR APPLICATIONS

BLDC motors find applications in every segment of the market. Such as, appliances,industrial control, automation, aviation and so on. We can categorize the BLDC motor control into three major types such as

1. Constant load
2. Varying loads
3. Positioning applications

1.2. PROBLEM STATEMENT

Generally, different types of robot controller give different output performance of robot movement. The performance of a robot arm can be analyzed by evaluating the movement from an initial position to a final position. Nonlinearities, parameter uncertainties and external disturbances exist in linear robot controllers. Therefore, it is difficult to eliminate these undesired effects in order to achieve good stability and precise tracking control performance. Output response of linear controller would sometimes deviate from the desired input trajectory. Thus, a robot controller must be designed to handle both linear and nonlinear systems. The controller is used to minimize the error between the intended and the actual positions. The controller must meet certain specifications. These specifications such as reducing overshoot, minimizing rising time and eliminating the steady state error. In addition the robot arm should be able to operate as usual when the external disturbance is applied to any joint of the robot arm.

2. BRUSHLESS DC MOTOR BACKGROUND

BLDC motor drives, systems in which a permanent magnet excited synchronous motor is fedwith a variable frequency inverter controlled by a shaft position sensor. There appears a lackof commercial simulation packages for the design of controller for such BLDC motor drives.One main reason has been that the high software development cost incurred is not justified for their typical low cost fractional/integral kW application areas such as NC machine toolsand robot drives, even it could imply the possibility of demagnetizing the rotor magnets during commissioning or tuning stages. Never the less, recursive prototyping of both the motor and inverter may be involved in novel drive configurations for advance and specialized applications, resulting in high developmental cost of the drive system. Improved magnet material with high (B.H), product also helps push the BLDC motors market to tens of kW application areas where commissioning errors become prohibitively costly. Modeling is therefore essential and may offer potential cost savings. A brushless dc motor is a dc motor turned inside out, so that the field is on the rotor and the armature is on the stator. The brushless dc motor is actually a permanent magnet ac motor whose torque-current characteristics mimic the dc motor. Instead of commutating the armature current using brushes, electronic commutation is used. This eliminates the problems associated with the brush and the commutator arrangement, for example, sparking and wearing out of the commutator-brush arrangement, thereby, making a BLDC more rugged ascompared to a dc motor. Having the armature on the stator makes it easy to conduct heat away from the windings, and if desired, having cooling arrangement for the armature windings is much easier as compared to a dc motor.

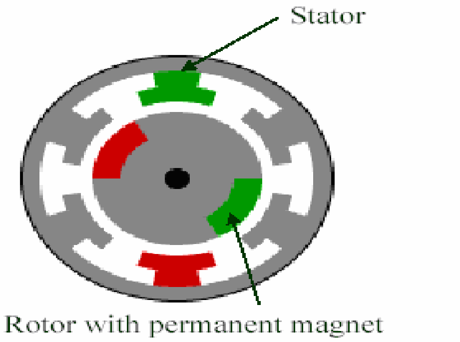

Fig 1 Cross-section view of a brushless dc motor

In effect, a BLDC is a modified PMSM motor with the modification being that the back-emf is trapezoidal instead of being sinusoidal as in the case of PMSM. The“commutation region” of the back-emf of a BLDC motor should be as small as possible,while at the same time it should not be so narrow as to make it difficult to commutate a phase of that motor when driven by a Current Source Inverter. The flat constant portion of the back emf should be 120° for a smooth torque production.The position of the rotor can be sensed by using an optical position sensors and its associated logic. Optical position sensors consist of phototransistors (sensitive to light),revolving shutters, and a light source. The output of an optical position sensor is usually a Logical signal.

2.1 PRINCIPLE OPERATION OF BRUSHLESS DC (BLDC) MOTOR

A brush less dc motor is defined as a permanent synchronous machine with rotor position feed back. The brushless motors are generally controlled using a three phase power semiconductor bridge. The motor requires a rotor position sensor for starting and for providing proper commutation sequence to turn on the power devices in the inverter bridge.Based on the rotor position, the power devices are commutated sequentially every 60 degrees. Instead of commutating the armature current using brushes, electronic commutation is used for this reason it is an electronic motor. This eliminates the problems associated with the brush and the commutator arrangement, for example, sparking and wearing out of the commutator brush arrangement, thereby, making a BLDC more rugged as compared to a dc motor.

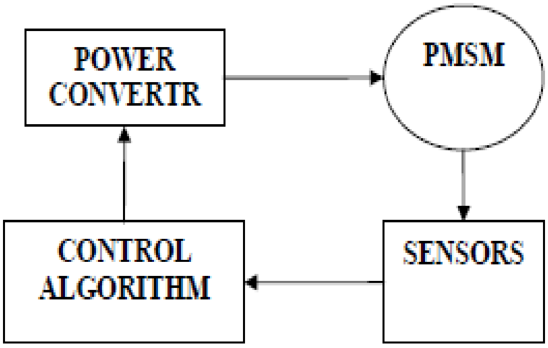

Fig. 2.Basic block diagram of BLDC motor

3. RESULT AND DISCUSSIONS

3.1. EXPERIMENTAL SYSTEM

Instead of using an analog PI controller for the proposed drive, a digital controller was implemented on a TMS320LF2407 DSP processor from Texas Instruments. Although the analog PI controller may have a greater bandwidth than a digital PI controller, it is subject to deviation due to the drifts in nominal values of its components. Another fact is that it is much more difficult to adapt an analog PI controller to changes in the system parameters, for example, replacement of the motor by other BLDC motor and other factors. For a digital PIcontroller, all that needs to be done in order to adapt it to a new system is to change the parameters of the controller by reprogramming the DSP.

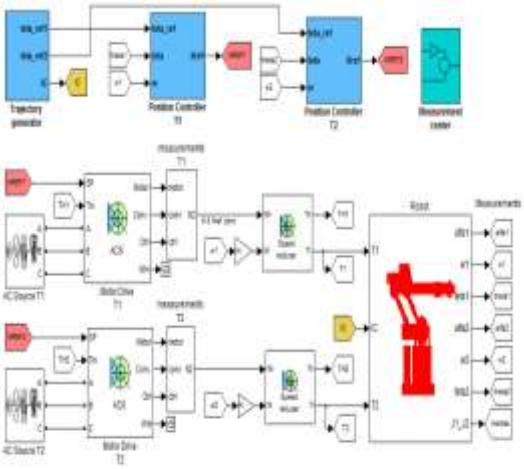

Fig 3. Simulated brushless motor controller

The experimental setup block diagram of BLDC motor diagram as show in Fig.5.12 and it consists of following systems.

1. Intelligent power module
2. Voltage and current sensor
3. Signal conditioner
4. Protection circuit
5. Opt coupler
6. 3φ diode bridge rectifier
7. Speed sensor
8. Frequency to voltage converter

3.1.1. INTELLIGENT POWER MODULE

Intelligent power module as work as DC-DC converter (chopper) or DC-ACconverter. It works using an IGBT based IPM and works on basis of software from DSP processor .The power module can be used for studying the operation of chopper, three phase inverter. Intelligent power modules are advanced hybrid power devices that combine high speed, low loss IGBT with optimized gate drive and protection circuitry. Highly effective over current and short-circuit protection is realized through the use of advanced current sense IGBT chips that allows continuous monitoring of power device current. System reliability is further enhanced by the IPM integrated over temperature and under voltage lock outprotection.

3.1.2. VOLTAGE AND CURRENT SENSOR

Intelligent power module output voltage and current is not directly feed to controlcircuits. intelligent power module output voltage is very high but control circuit operate inminimum voltage .So necessary for IPM output high voltage is convert in to very low voltage and current transducer sense from high voltage and output of transducer low voltage (max5v). The sensors used for sensing current and voltage are work on the principle of hall effect thence the sensors is called hall effect transducer hall effect transducer output voltage and currents depends upon transducer primary and secondary winding ratio. A hall effect current transducer sense the current I dc, I W and one hall effect voltage transducersense the dc link voltage DC V

3.1.3. FREQUENCY TO VOLTAGE CONVERTER

The square wave of speed sensor output is feed frequency to voltage converter circuit.The XR4151 can be used as a frequency to voltage converter. The voltage applied comparator input should not be allowed to go below ground by more then 0.3V. The input frequency range 0 to 20kHz and corresponding voltage output level is -10mv to -10v.

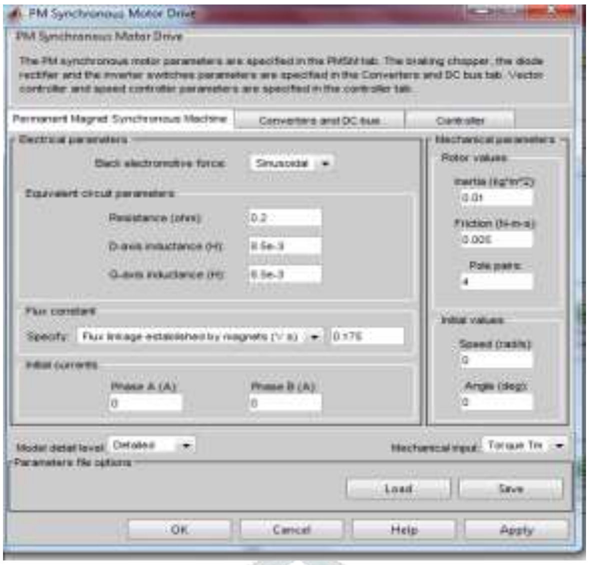

Fig 4. Parameters of synchronous motor drive

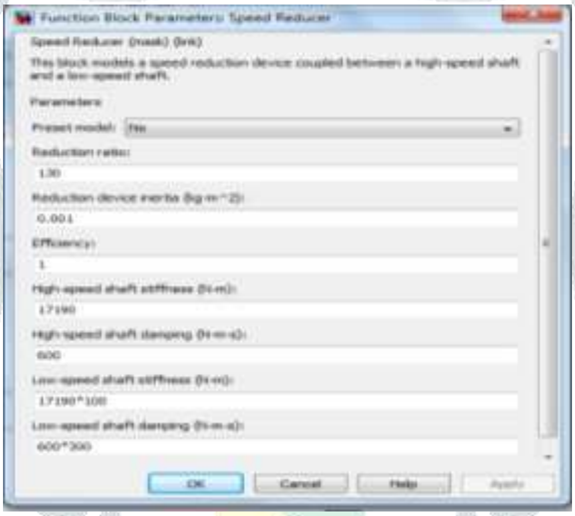

Fig 5 Parameters for speed reducer

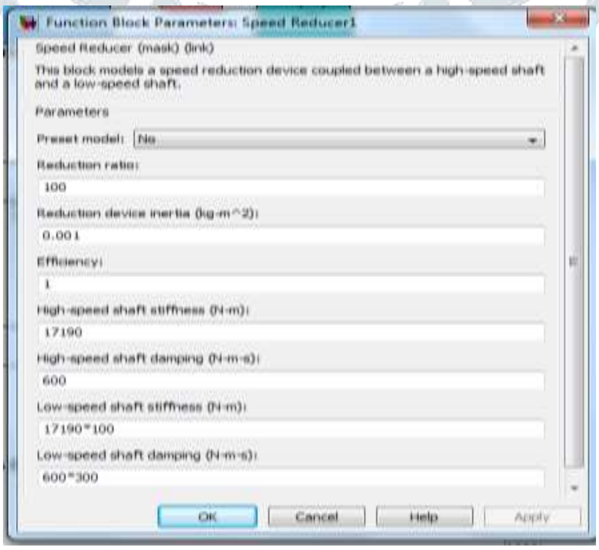

Fig 6 Parameters for speed reducer1

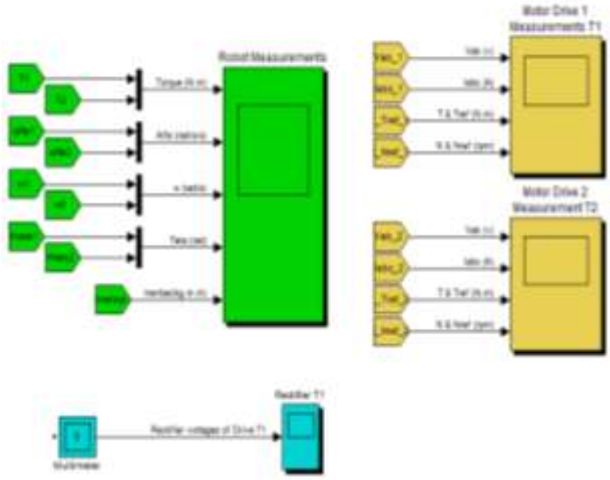

Fig 7 Scope of simulated Matlab proposed work

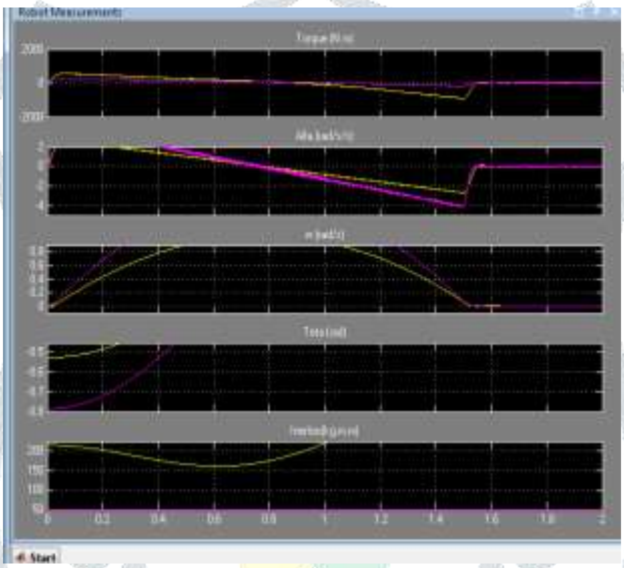

Fig 8. Brushless DC motor control torque, measurement

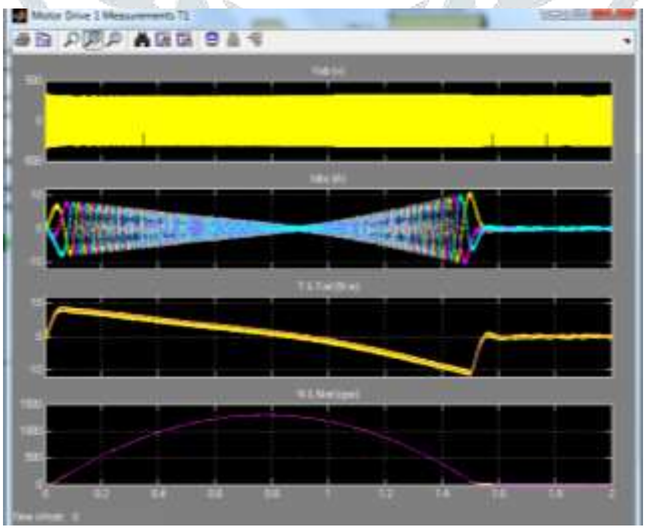

Fig 9. Brushless DC motor control Voltage current and speed Measurement for Drive1

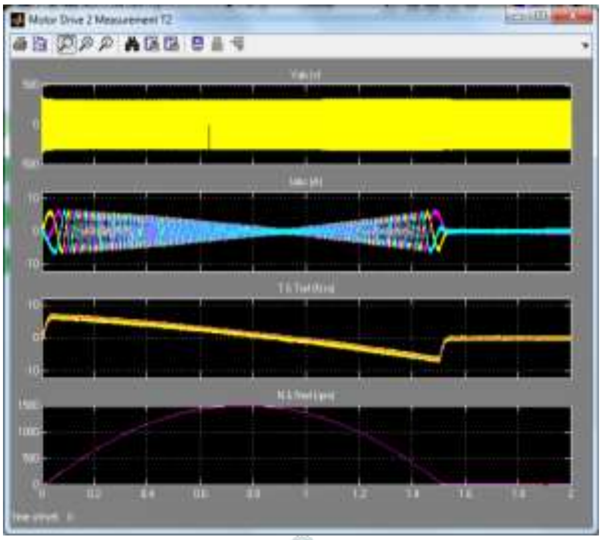

Fig 10 Brushless DC motor control Voltage current and speed Measurement for Drive 2

We can observe the motor stator current, the back EMF, the rotor speed and the electromagnetic torque on the first scope. The speed set point and the torque set point are also shown. On the second scope, the DC bus voltage and the bus current are displayed. Note that all signals are multiplexed to compare the two models.
At time t = 0 s, the speed set point is 2400 rpm and the full load torque is applied to the motor. Observe that the speed follows precisely the acceleration ramp.
At t = 0.6 s, the inverter is saturated due to insufficient inverter voltage. You can observe loss of current tracking which decreases the motor torque. This saturation point occurs when the speed is about 1200 rpm. That's the same point as predicted by the operation region during acceleration (when load torque is 11 Nm) given by the Speed-Torque curve tool (double-clcik on the 'Speed-Torque curve' tool to check the operating regions).

4. DISCUSSIONS

The speed response of the BLDC drive system using and PI controller and fuzzy logic controller is shown in Fig.6.1 and Fig.6.8. With the motor at rest, the reference speed is set at 75rad/s (700rpm) with a settling time 0.05 seconds the motor speed reaches the reference speed with a percentage overshoot of 6.667 with PI speed controller. The phase currents at the time starting getting transient due to initial phase back emfs machine are zero. After the speed reaching reference speed, phase currents are reaches the reference current. Phase currents are conduction with 120 angle duration shown in Fig 6.4.

5. CONCLUSIONS

The brushless DC motor drives behave very well during the test trajectories. The DC bus voltages are maintained at relatively constant levels during the deceleration of the motors. The developed torques are proportional to the motor currents' amplitudes. This demonstrates the good operation of the field-oriented control algorithms. For this research we reviewed number of research article for proposed research.
The modeling's and simulation of the complete drive system is described in this thesis. Effectiveness of the model is established by performance prediction over a wide range of operating conditions. controller to be adjusted such that manual tuning time of the classical controller is significantly reduced. The performance of the BLDCM drive with reference to controller, and experimental verified with conventional using DSP processor. speed controller improved the performance of BLDC Drive .

5.1. FURTHER WORK

The hybrid integrator back stepping controller is proposed for robotic manipulators actuated with brushless dc motors in the presence of arbitrary uncertain inertia parameters of the manipulator and the electrical parameters of the actuators.However, the study of the control of robots actuated by the BLDCM was relatively recent .In a robust feedback linearizing control was proposed. By using integrator back stepping techniques, robust and adaptive controllers are proposed, respectively. It should be noted however that all those results are suitable only for a single-link manipulator (an inertial load).
The objective of this study is to develop a control scheme for a rigid n-link manipulator where the joint actuators are driven by BLDCM's. Based on the integrator back stopping techniques, a hybrid integrator back stopping controller (i.e., adaptive and robust adaptive) is proposed.
The proposed controller has the following features:

- It does not require joint acceleration feedback;
- Knowledge of the robot or any of the BLCDM uncertain parameters is not required
- A semi global asymptotic stability result is obtained in the Lyapunov sense.

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