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Predictive Torque Control Scheme for Three-Phase Four-Switch Inverter - Fed Induction Motor Drive

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Abstract-
The four-switch three-stage (B4) inverter, having a lower number of switches, was first introduced for the likelihood of decreasing the inverter cost, and it turned out to be exceptionally appealing as it can be used in blame tolerant control to illuminate the open/cut off of the six-switch three-stage (B6) inverter. Be that as it may, the adjust among the stage streams falls because of the change of the two dc-connect capacitor voltages; along these lines, its application is constrained.

This venture proposes a prescient torque control (PTC) plot for the B4 inverter-sustained enlistment engine (IM) with the dc-connect voltage balance concealment. The voltage vectors of the B4 inverter under the change of the two dc-connect capacitor voltages are determined for exact expectation and control of the torque and stator flux. The three-stage streams are compelled to stay adjust by straightforwardly controlling the stator flux. The voltage counterbalanced of the two dc-interface capacitors is displayed and controlled in the prescient perspective. In this venture fuzzy controller is actualized to decrease the swell substance and contortion in the yield wave shapes. The outcomes checked through MATLAB/SIMULINK condition.

Key words- Fed inductor, Matlab, PTC, IM.

Introduction

Throughout the years, the traditional three-stage voltage source inverter with six switches (B6) has been discovered across the board mechanical applications in different structures, for example, engine drives and dynamic channels. Notwithstanding, in specific applications, a further cost lessening for inverter setup is considered by clients. To accomplish this objective, the three-stage inverter with just four switches was proposed by Van der Broeck and Van Wyk [1] with the end goal of limiting the parts' cost, and it is named four-switch three-stage (B4) inverter in correlation with the B6 one, as appeared in Fig. 1. In spite of the fact that this sort of cost diminishment is to the detriment of yield execution, the B4 inverter can be used in blame tolerant control to tackle the open/impede of the B6 inverter. The possibility of the B4 inverter connected to blame tolerant control is extremely important in some basic events, for example, rail footing, and it has subsequently pulled in light of a legitimate concern for some scientists [2]–[10].

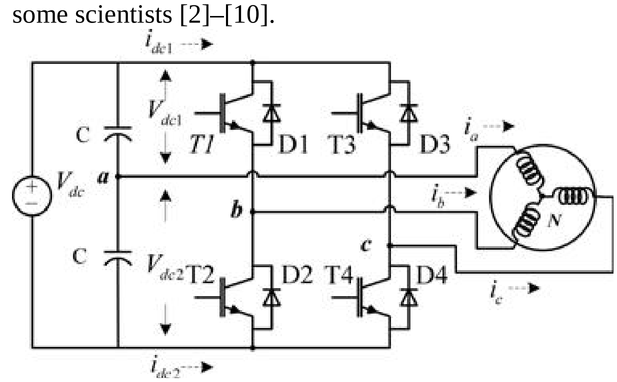


Fig. 1. Circuit diagrams of a B4 inverter-fed induction motor drive.

The four-switch inverters are known to have a few detriments contrasted with ordinary six-switch inverters: the voltage use variable is split contrasted with the six-switch inverter. Then again, the capacitor focus tap voltage is fluctuating, and it obliterates the adjust among the engine stage streams [10]. The capacitor focus tap voltage change increments as the heap torque ends up plainly higher or the recurrence of a B4 inverter progresses toward becoming lower, and the uneven engine current prompts an inverter disappointment and torque throb . With a specific end goal to moderate the impacts of the capacitor focus tap voltage change, a few undertakings were distributed. A versatile space vector tweak (SVM) approach was proposed to repay the dc-connect voltage swell in a B4 inverter . Kim et al. explored engine current unbalance from the point of view of source impedance and the voltage variety caused by the current moving through the capacitor, and proposed a present contortion pay plot. Lee et al. proposed a remuneration technique by altering exchanging times considering the capacitor focus tap voltage change. Wang et al. explored the circumstances and end results of the capacitor focus tap voltage variance in investigative perspective, and the capacitor voltage counterbalance was smothered by utilizing certain exchanging states. In any case, the capacitor voltage counterbalance concealment was accomplished to the detriment of the B4 inverter's yield execution.

The works specified before were committed to acquire the adjusted three-stage streams of the B4 inverter, however the flux and torque control was not considered. As to flux and torque control of a B4 inverter-encouraged IM drive, a few ventures on shut circle control plan were distributed. Uddin et al. examined a shut circle vector control conspire for a B4 inverter-sustained IPM synchronous engine, in which the present circle was controlled by a hysteresis controller what's more, the speed circle was controlled by a fuzzy rationale controller.

Kashif et al. used a three-layer bolster forward back proliferation fake neural system for flux control of a B4 inverter nourished IM drive. El Badsi et al. utilized a DTC plot for torque and flux control of a B4 inverter-encouraged IM drive. Sadly, the two capacitor voltages were accepted steady in these tasks. Truth be told, accordingly of one-stage current moves through the split dc-interface voltage sources, the variance will definitely show up in the two capacitor voltages, which falls apart the yield execution of the B4 inverter (i.e., torque throb and uneven three-stage streams). All the more truly, if the adjusted state of the streams streaming in the two capacitor voltages is undermined, the two capacitor voltages will veer off in two inverse bearings till closing down of the B4 inverter. With the advancement of quick and effective chip, expanding consideration has been committed to the utilization of model prescient control (MPC) in power gadgets . The principal thoughts regarding this system connected to power converters begun in the 1980s . The principle idea depends on computing the framework's future conduct to acquire ideal esteems for the inciting factors. With this instinctive idea, prescient control can be connected to an assortment of frameworks, in which imperatives and nonlinearities can be effortlessly included, multivariable case can be considered, and the subsequent controller is anything but difficult to actualize . These components render the approach extremely appealing and successful for the control of energy hardware framework, including drive control, particularly prescient torque control (PTC; specific for a two-level converter with skyline

N = 1).

In the PTC, the total model and future conduct of the inverter-bolstered drives are considered. A cost work identifying with torque and flux mistakes diminishment is characterized to assess the impacts of every voltage vector and the one limiting the cost capacity is chosen . Notwithstanding the exceptional execution of B6 inverter-bolstered drives in light of the PTC, PTC for B4 inverter-sustained drives did not get numerous considerations to the specialists. Some recreation consequences of PTC for the B4 inverter-nourished drives imitating the B6 case were done in. Be that as it may, the dc-interface voltages change, which is the natural component of the B4 inverter, was not considered. Also, and the counterbalance concealment of the two capacitor voltages was not specified.

In this venture, the extraordinary issues on utilizing the renowned PTC control conspire for B4 inverter-encouraged IM drives are dissected and examined. Every half dc-connect voltage is measured to accomplish exact expectation and control of torque and stator flux. The voltage vectors of the B4 inverter under the vacillation of the two dc-connect capacitor voltages are inferred for exact forecast and control of the torque and stator flux. The shut circle control of torque and stator flux is accomplished by the cost work in the PTC. The adjusted three-stage streams are accomplished by controlling the stator flux well. The capacitor voltage balance is demonstrated and smothered in the prescient perspective. The adequacy of the proposed plan is exhibited by broad recreation comes about. In view of the divided change states relating to B6 one, the constant usage time cost for the PTC scheme in B4 inverter is reduced in a sampling period.

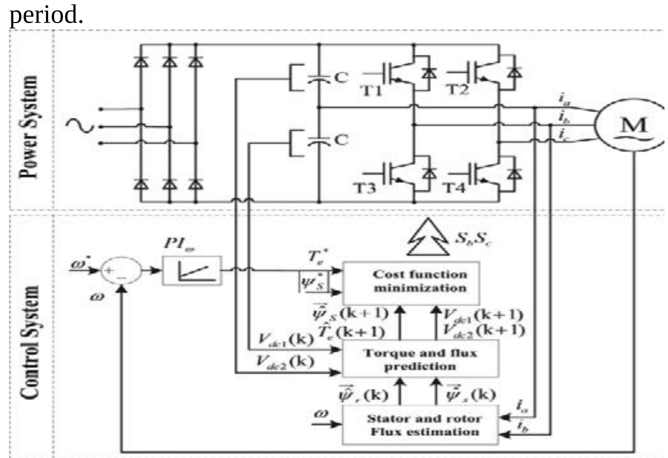


Fig. 2. Structure of the B4 inverter-fed IM drive based on the PTC scheme.

II. PROPOSED SCHEME FOR THE B4 INVERTER-FED IM DRIVE

In the proposed plot, the internal circle is a stator flux and electromagnetic torque controller in view of PTC, while the external speed circle is a customary PI controller. As in any standard PTC conspire, a three-stage calculation is completed: flux estimation, flux and torque forecast, and cost work enhancement. The structure of the B4 inverter-bolstered IM drive-based PTC plan is appeared in Fig. 3.

Flux Estimation

It is advantageous to note that the voltage-demonstrate based flux estimator utilizing the order voltages can roughly evaluate the stator flux in the B6 case . In a B6 inverter, the dc-interface voltage swell presence implies a relative modification of each of the three yield stage voltages and as needs be an abundancy blunder of the normal voltage vector utilized. In a B4 inverter, the voltage swell prompts distinctive change of the voltages on the three stage and to both plentifulness and precise mistakes of the exchanging voltage vectors. Stator Flux and Electromagnetic Torque Prediction, cost estimation and time defer capacities examined in the project[1]

III.FUZZY CONTROLLER

The word Fuzzy means dubiousness. Fluffiness happens when the limit of snippet of data is not obvious. In 1965 Lotfi A. Zahed propounded the fuzzy set hypothesis. Fuzzy set hypothesis shows massive potential for compelling comprehending of the vulnerability in the issue. Fuzzy set hypothesis is a phenomenal scientific device to deal with the vulnerability emerging because of ambiguity. Understanding human discourse and perceiving manually written characters are some normal occasions where fluffiness shows.

Fuzzy set hypothesis is an expansion of traditional set hypothesis where components have differing degrees of participation. Fuzzy rationale utilizes the entire interim in the vicinity of 0 and 1 to portray human thinking. In FLC the info factors are mapped by sets of participation capacities and these are called as "Fuzzy SETS".

Fuzzy set involves from a participation capacity which could be characterizes by parameters. The incentive in the vicinity of 0 and 1 uncovers a level of enrollment to the fuzzy set. The way toward changing over the fresh contribution to a fuzzy esteem is called as "fuzzificaton." The yield of the Fuzzier module is interfaced with the guidelines. The fundamental operation of FLC is developed from fuzzy control rules using the estimations of fuzzy sets by and large for the blunder and the change of mistake and control activity. Essential fuzzy module is appeared in fig.6.

The outcomes are consolidated to give a fresh yield controlling the yield variable and this procedure is called as "DEFUZZIFICATION."

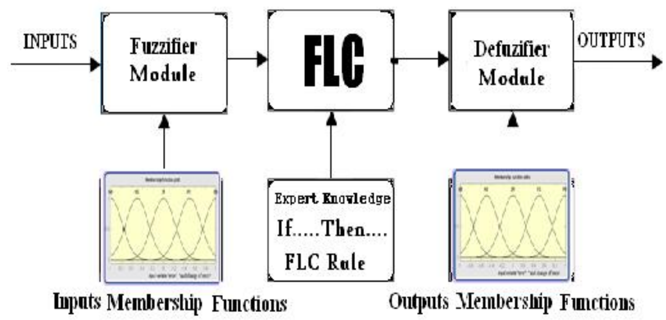
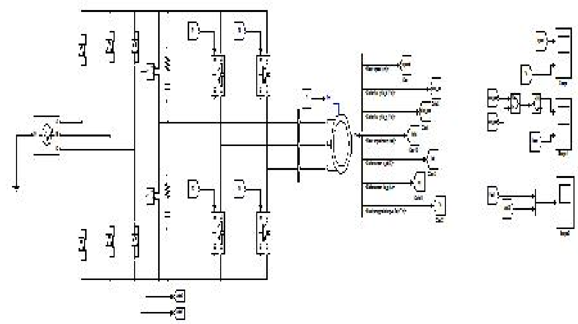


Fig3 : block diagram fuzzy logic

IV.BLOCK DIAGRAM OF PREDICTIVE TORQUE CONTROL USING FUZZY CONTROL



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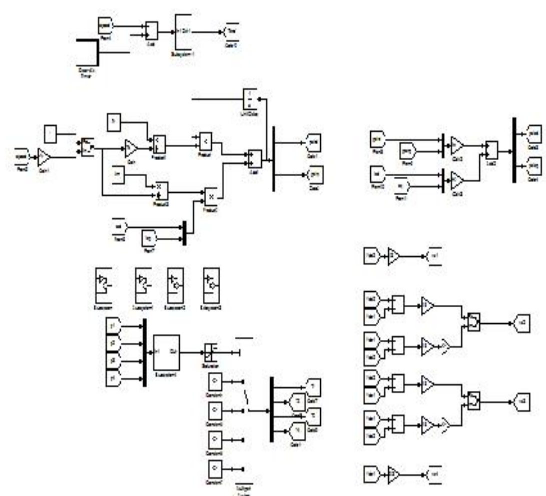

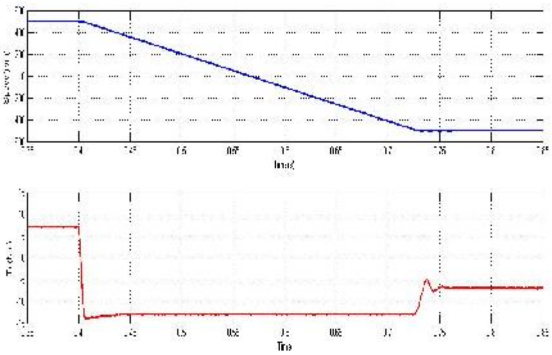

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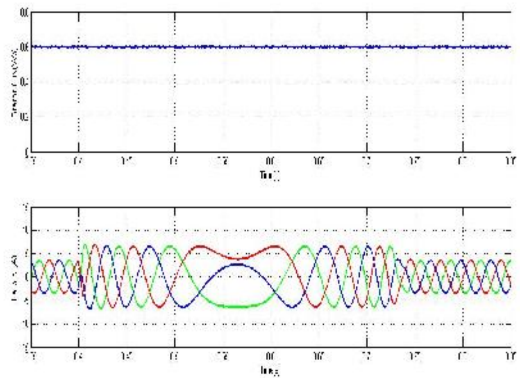

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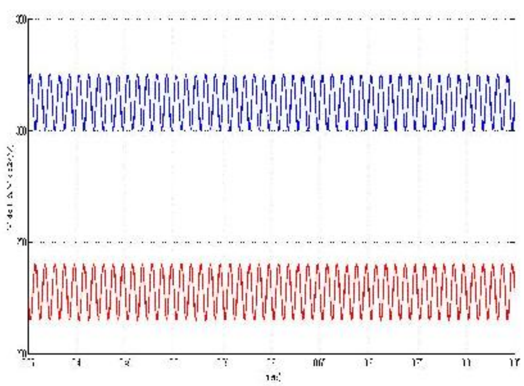
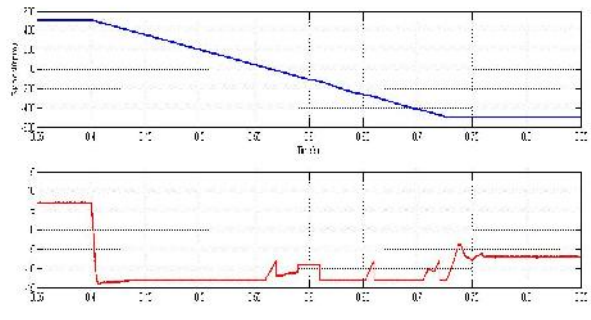


(c)

FIG 4:Fuzzy waveforms in a B4 inverter fed IM. (a) Speed, developed torque,(b) stator flux, stator current and (c) capacitor voltages.



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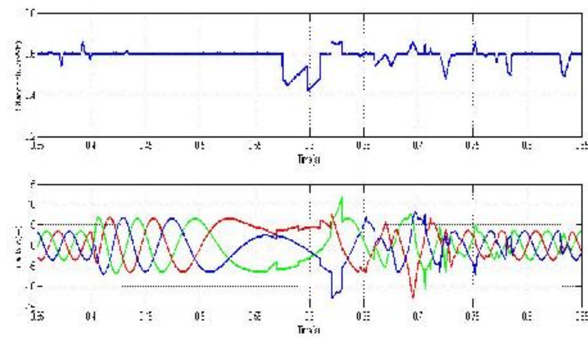

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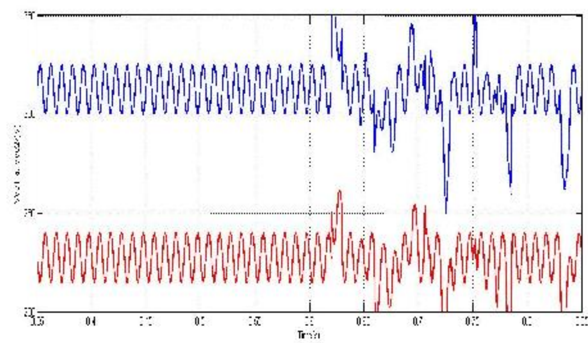
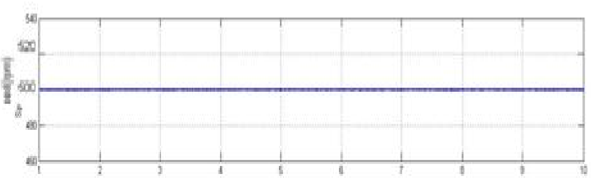


FIG 5:Fuzzy waveforms in a B4 inverterfed IM. (a) Speed, developed torque, (b) stator flux, stator current and (c) capacitor voltages.



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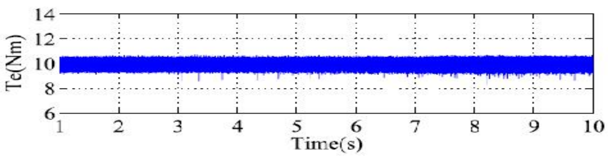

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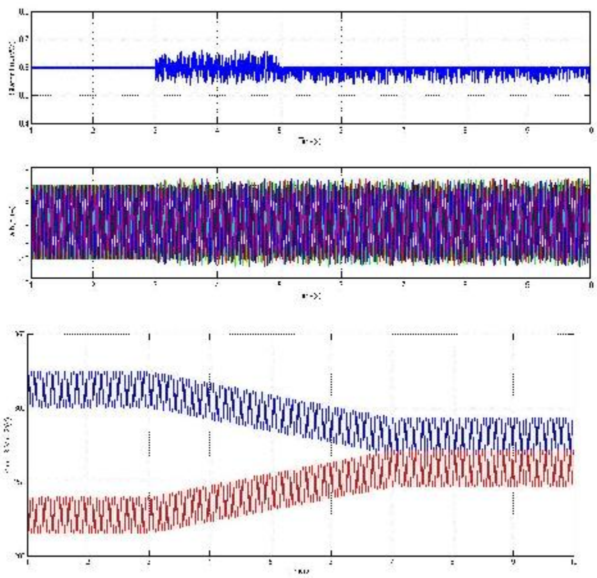
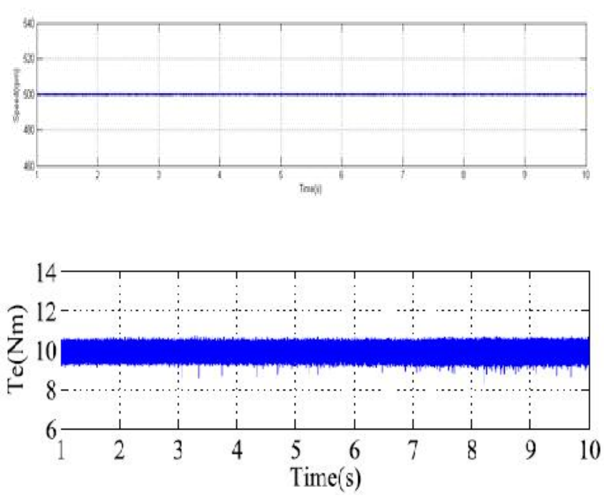


(c)

FIG 6:Fuzzy waveforms of two capacitor voltages (a) speed, developed torque, (b)stator flux, torque and (c) Capacitor voltages.



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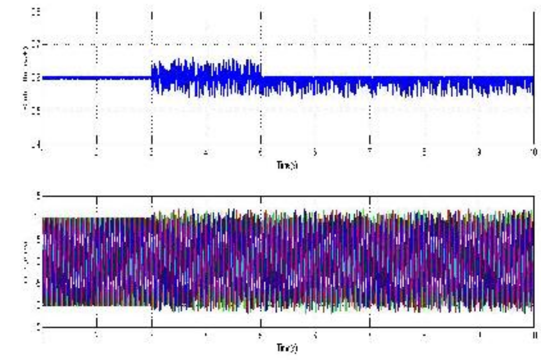

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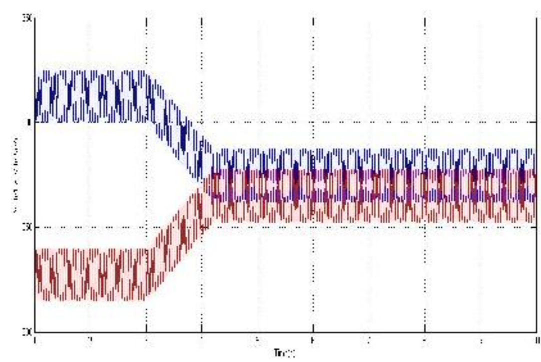

(c)

FIG 7:Fuzzy wavwforms of two capacitor voltages with offset suppression method. (a)) speed, developed torque, (b) stator flux,stator currents and (c) Capacitor voltages.

MOTOR AND B4 INVERTER PARAMETERS

Parameters	Values
DC-link voltage	540 V
DC-link upper capacitor (C_1)	2040 μF
DC-link upper capacitor (C_2)	2040 μF
Dead time	4 μs
Induction motor	
Rated power	2.2 kW
Rated voltage	380 V
Rated speed	1430 r/min
Rated current	4.9 A
Rated frequency	50 Hz
Number of poles	4
Stator resistance (R_s)	2.804 Ω
Stator leakage inductance (L_s)	10.33 mH
Rotor resistance (R_r)	2.178 Ω
Rotor leakage inductance (L_r)	10.33 mH
Magnetizing inductance (L_m)	319.7 mH
Nominal flux-linkage	0.6 Wb
Rated torque	14 N·m

V. CONCLUSION

In this project, the special issues on using the famous PTC control scheme for a B4 inverter-fed IM drives are analyzed and discussed. The voltage vectors of the B4 inverter under the fluctuation of the two dc-link capacitor voltages are derived for precise prediction and control of the torque and stator flux. The balanced three-phase currents are achieved and the capacitor voltage offset is suppressed in the proposed scheme. The theory, design, and performance evaluation of the proposed scheme for the B4 inverter-fed IM drive are investigated. The proposed B4 inverter-fed IMdrive has been found acceptable for high performance industrial variable-speed-drive applications considering its cost reduction and other inherent advantageous features. Certainly, the additional work is still remained to develop more efficient PTC scheme and answers the remaining questions: the robustness toward parameter deviation, parameter sensitivity of In this project fuzzy controller is implemented to reduce the ripple content and distortion in the output wave forms. The results verified through MATLAB/SIMULINK environment.

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