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Speed Control of BLDC Motor using Buck-Boost Converter (Result)

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ABSTRACT: This paper presents performance evaluation i.e. simulationsof DC–DC Converter feeding BLDCM drive with adjustable speed controlfor low power application. The purpose of DC–DC converter is to provide controlled DC voltage to the BLDCM drive for an uncontrolled DC output of a single-phase AC mains. In proposed system, single-phase supply is feeding to rectifier which is uncontrolled type and DC–DC Converter is used to control the voltage of DC link capacitor. The DC link capacitor is used to control the speed of BLDCM. The output of DC link capacitor fed to inverter and speed of BLDCM can be controlled by changing switching position of inverter switches. A voltage follower and current follower technique is used for operation of BLDCM under wide range of speed adjustment. Buck-boost converter connected in between theinput DC source and three phase bridge inverter, used forminimizing the commutation torque ripples in PermanentMagnet Brushless DC Motor is presented in this paper. Torqueduring the commutation period depends on phase current whichis not undergoing commutation, so by controlling it, torque ripplecan be minimized.

KEYWORDS: Brushless Direct Current Motor (BLDCM), Discontinuous Inductor Current Mode (DICM), Power Factor Correction (PFC), Voltage Source Inverter (VSI), Current Source Inverter (CSI), Electromotive Force (EMF)

I. INTRODUCTION

BLDCM, are becoming more popular and find a wide variety of applications in the field of science and technology where space and weight are the key factors. Due to brushless structure, high reliability, wide speed adjustment, precise speed control and high output power density are the attractive features of BLDCM. Recently, they have been widely used in home appliances and industry for energy saving aspects but it suffers from the problems of commutation torque ripples which leads to mechanical vibration and noise. A detailed analysis on commutation torque ripple is described. It is identified that torque ripples are about 49.50 % or more than that of rated torque. BLDCM are preferred motors for a compressor of an air-conditioning system due to its features like high efficiency, wide speed range and low maintenance requirements. The operation of the compressor with the speed control results in an improved efficiency of the system while maintaining the temperature in the air-conditioned zone at the set reference consistently. Whereas, the existing air conditioners mostly have a single-phase induction motor to drive the compressor in on/off control mode. This results in increased losses due to frequent on/off operation with increased mechanical and electrical stresses on the motor, thereby poor efficiency and reduced life of the motor. Moreover, the temperature of the air conditioned zone is regulated in a hysteresis band. Therefore, improved efficiency of the Air conditioning system will certainly reduce the cost of living and energy demand to cope-up with ever-increasing power crisis. A BLDCM which is a kind of three-phase synchronous motor with permanent magnets (PMs) on the rotor and trapezoidal back EMF waveform operates on electronic commutation accomplished by solid state switches. It is powered through a three-phase voltage source inverter (VSI) which is fed from single-phase AC supply using a diode bridge rectifier (DBR) followed by smoothening DC link capacitor.

II. PROBLEM FORMULATION

The proposed buck-boost converter based BLDCM drive operated with voltage follower control. The proposed controller is operated to maintain a constant DC link voltage with PFC action at AC mains. The DC link voltage is sensed and compared with a reference voltage which results in a voltage error. This voltage error is passed through a voltage controller to give a modulating signal which is amplified and compared with saw-tooth carrier wave of fixed frequency to generate a pulse widthmodulated signal for the switching device of the DC-DC converter. For the speed control, the speed signal derived from rotor position of the BLDCM, sensed using Hall effect sensor is compared with a reference speed.The resultant speed error is passed through a speed controller to get the torque equivalent which is converted to an equivalent current signal using motor torque constant This current signal is multiplied with a

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rectangular unit template waveform which is in phase with top flat portionof motor's back EMF so that referencethree-phase current of the motor are generated. Buck-boost converter based scheme is an alternative toCuk converter based scheme and offers torque ripple close tothat by Cuk converter scheme. Instead of using two inductorsin Cuk converter based scheme, Buck-boost converter basedscheme requires only one inductor. The system achievessmooth running and noise free operation especially at thehigher speed range.

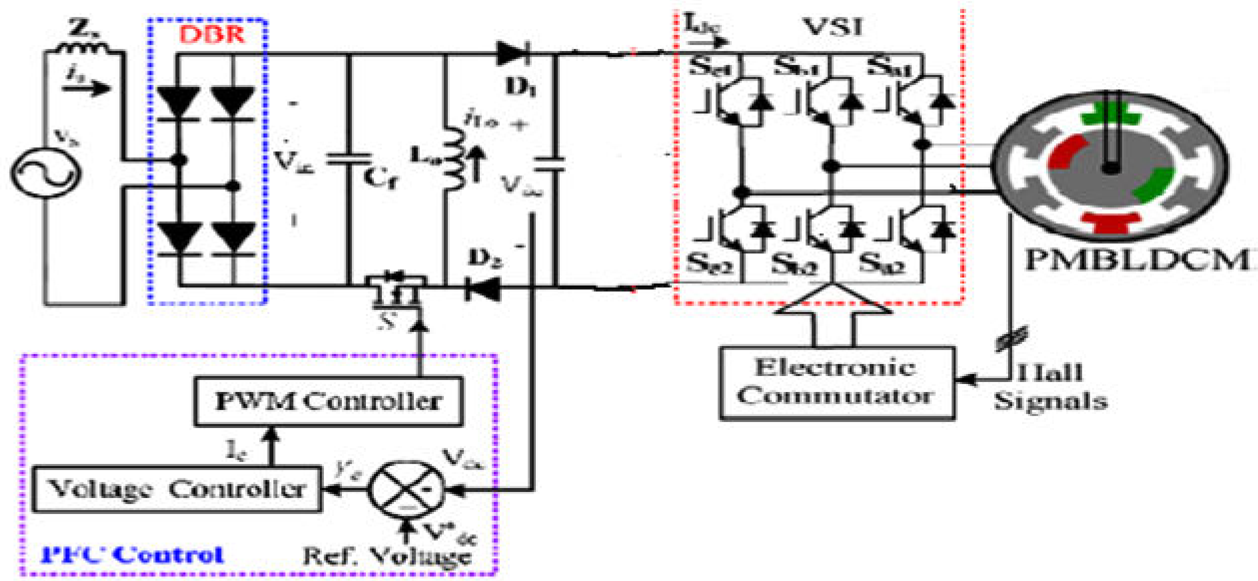

Fig. 1. DC-DC converter fed BLDCM drive with voltage follower control

The proposed speed control scheme controls referencevoltage at DC link as an equivalent reference speed, therebyreplaces the conventional control of the motor speed and astator current involving various sensors for voltage andcurrent signals. Moreover, the rotor position signals are used to generate the switching sequence for the VSI as anelectronic commutator of the PMBLDC motor. Therefore,rotor-position information is required only at the commutation points, e.g. every 60°electrical in the threephase.The configuration comprises of a Buck-boost converterand a mode selection circuit. During commutation period ahigher DC voltage is required compared to the normalconduction period. A Buck-boost converter is insertedbetween DC source and inverter to control the DC linkvoltage. Mode switching circuit effectively handles theoperating approach of the converter in the commutationinterval to boost the input of the inverter. Fig.2. shows theschematic diagram of closed-loop control with this topology.This simple scheme can be used for medium preciseapplications where a moderate torque ripple is allowed at lowspeed range like fans, pumps etc. and best suited for highprecise control applications at high speed range. a Buck-boost converter is connected to meetthe voltage demanded by the PMBLDCM during commutationtime interval. PWM chopping of the inverter are used toregulate the DC link voltage effectively. This configurationwith control technique can effectively reduce the torqueripples in PMBLDCM especially at higher speed range.a greater DC link voltage is neededduring the commutation time period in comparison to the normalconduction period. The Buck-boost converter operates in boostmode in commutation period for stepping up the DC voltage tothe inverter. A simple mode switching circuit is employed toamend the output modes of the Buck-boost converter in normaland commutation time intervals. Simulation studies of thistopology are carried out in MATLAB/Simulink environment.

III. SIMULATION OF PROPOSED SYSTEM

Buck-boost converter based scheme for minimizing commutation torque ripples in PMBLDCM is presented. Mathematical analysis of the commutation torque rippleis performed and it is seen that torque during commutationperiod depends on non-commutating phase current. Hence, bycontrolling it, torque ripples can be efficiently reduced. Buck-boostconverter operate in the boost mode to meet the voltagerequired to make the non-commutating phase current constantand offers a significant reduction in commutation torqueripples.

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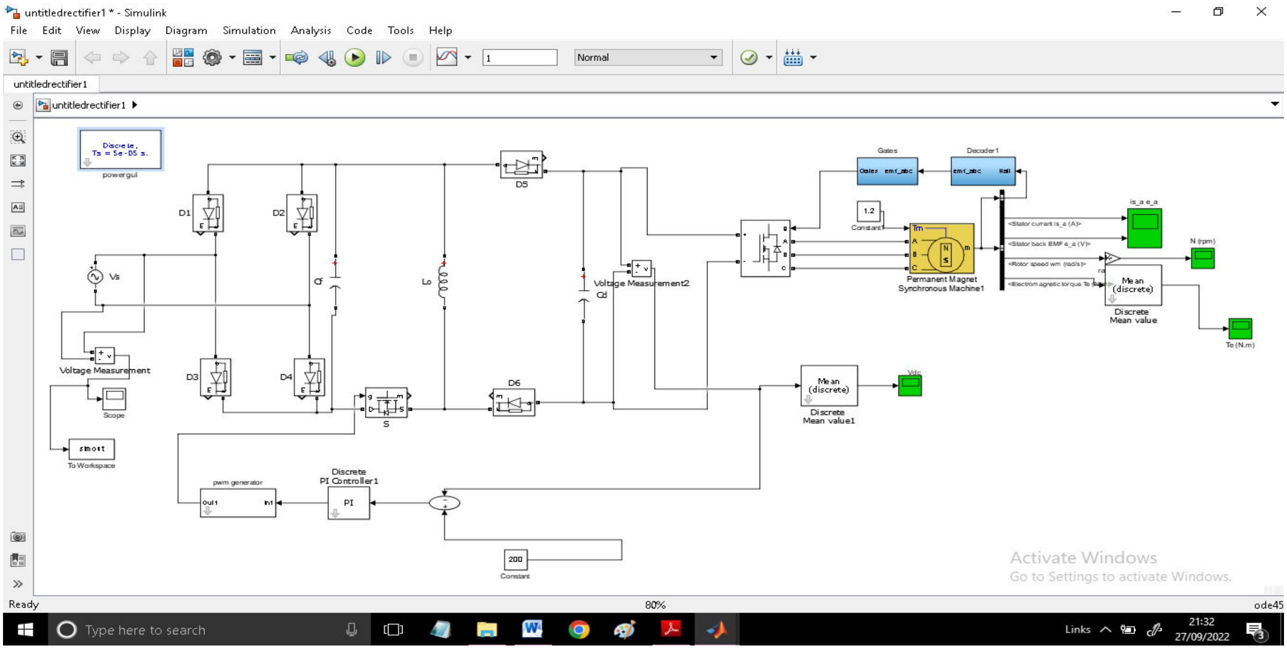

Fig.2. Modelling of proposed test system

The above figure shows the modelling of brushless D.C motor using MATLAB.

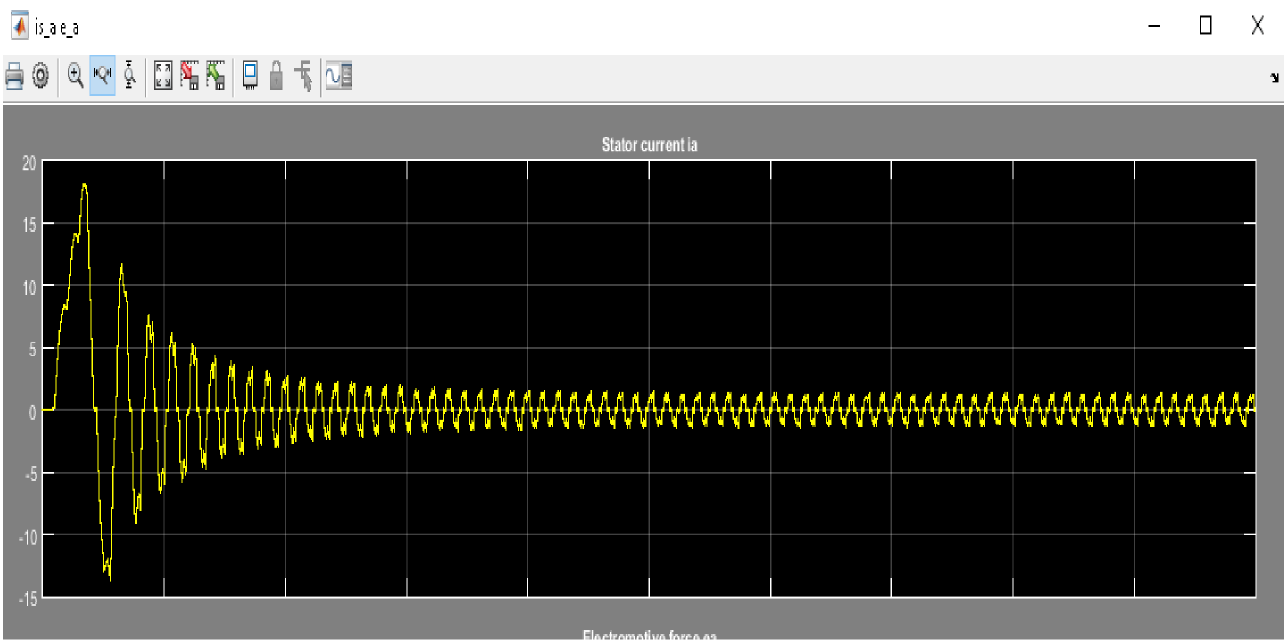

Fig. 3. Stator Current

The above graph shows that at the time of starting the motor takes the high current and after few milliseconds it goes on decreasing.

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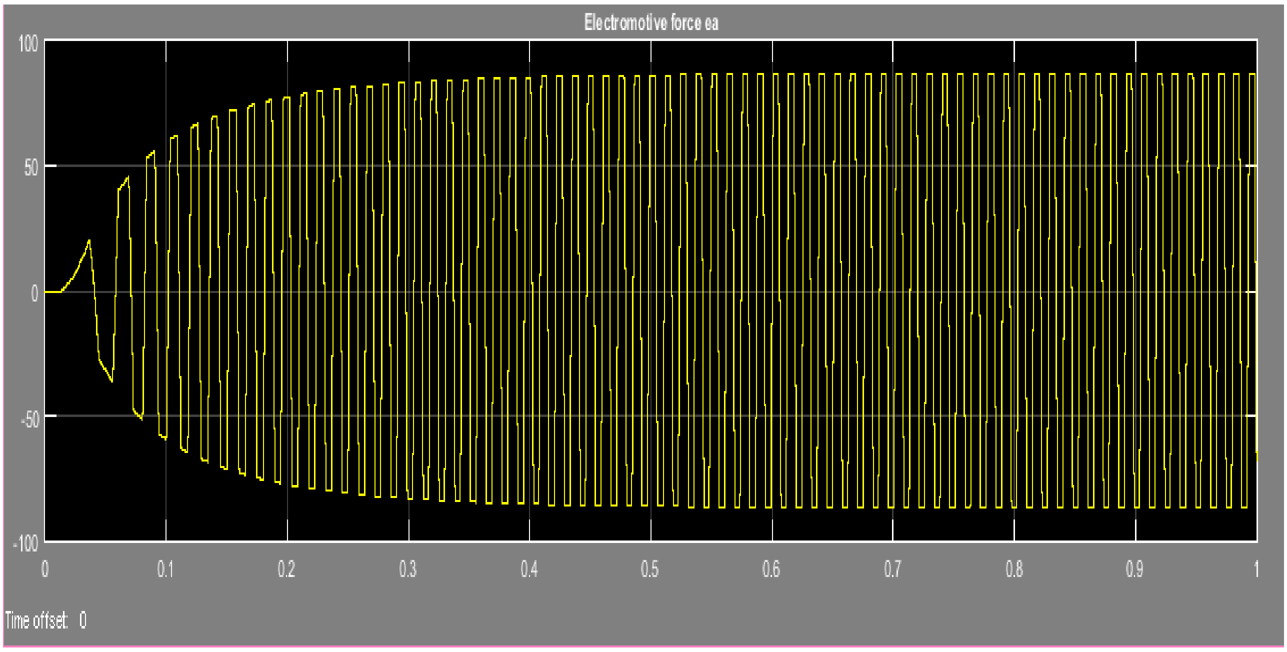


Fig. 4. Electromotive Force

The above graph shows that the EMF of motor increases gradually and after few milliseconds the core saturates and EMF remains constant.

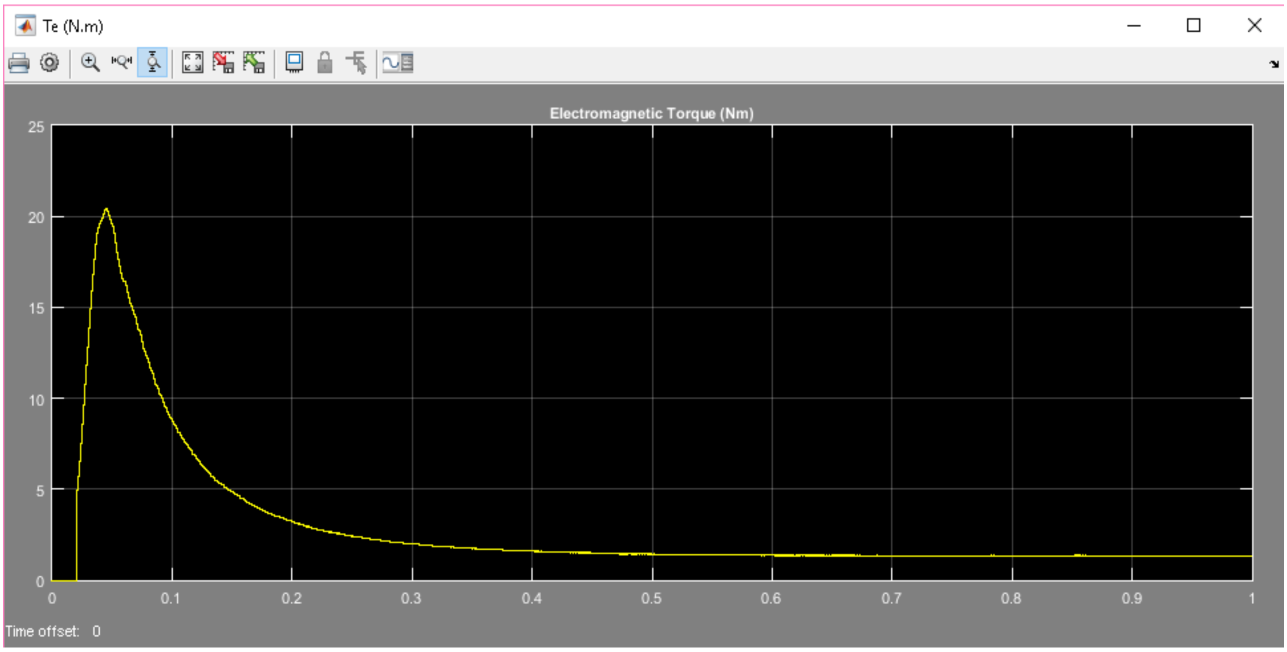


Fig. 5. Shaft Torque

The above graph shows the higher starting shaft torque at time 0.04 second and after 0.04 second it is to be noted that the shaft torqure goes on decreasing gradually. It means BLDCM has good starting torque.

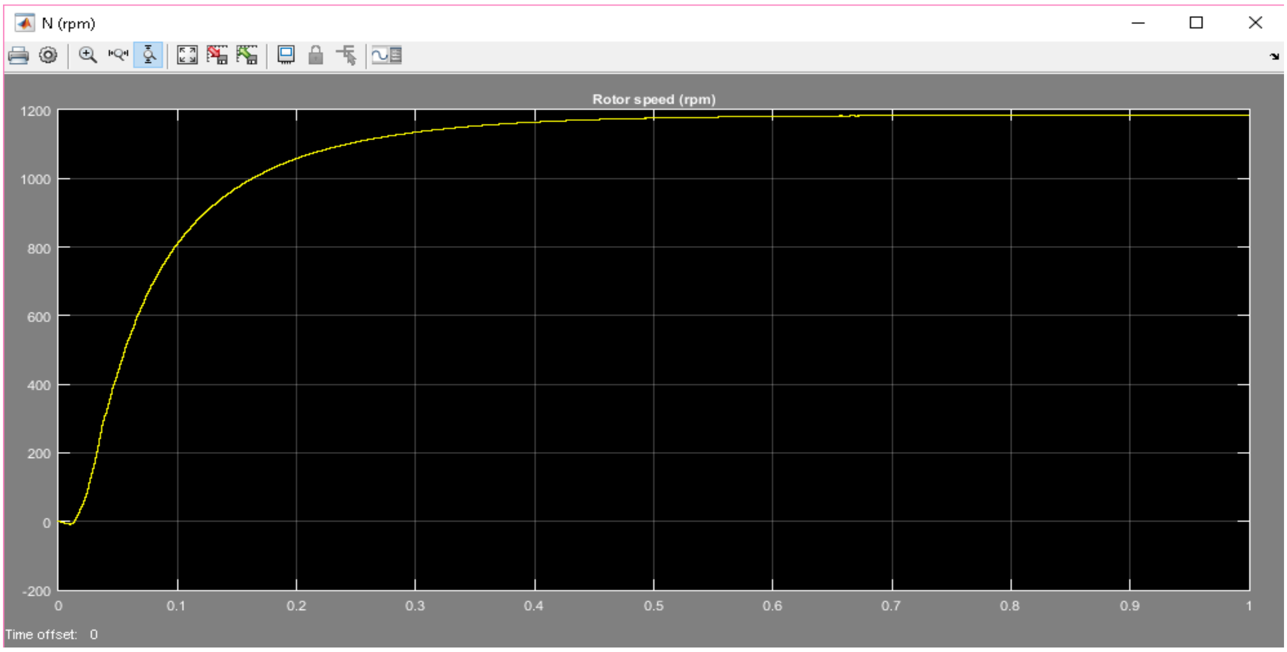


Fig. 6.Rotor Speed

The above graph shows the variablespeed of BLDC motor. We can control and adjust the speed of BLDCM. The speed control is directly proportional to thevoltage control at DC link.

IV. CONCLUSION

It it seen that speed control of Brushless D.C motor is controlled by using buck-boost converter methodology without any interruption. The speed control is directly proportional to thevoltage control at DC link. The rate limiter introduced in thereference voltage at DC link effectively limits the motorcurrent within the desired value during the transientcondition (starting and speed control).

REFERENCES

[1]B.CHANDRA KRISHNA, and M.NAGESWARA RAO “Speed Control of BLDC Motor using ModifiedBuckBoost Converter”, IEEE, 2014.

[2] Sanjeev Singh and Bhim Singh, "Power Quality Improved BLDCM Drive for Adjustable Speed Application WithReduced Sensor”, IEEE pp180-185, 2011.

[3] VashistBist and Bhim Singh “An Adjustable-Speed PFC Bridgeless Buck–Boost Converter-Fed BLDC Motor Drive” vol. 61, NO.6, IEEE, 2014.

[4] Z. Pan, F. Zhang, and F. Z. Peng, “Power losses and efficiency analysis of multilevel DC DC converters,” in Proc. IEEE Appl. Power Electron.Conf., pp. 1393–1398, Mar. 2005.

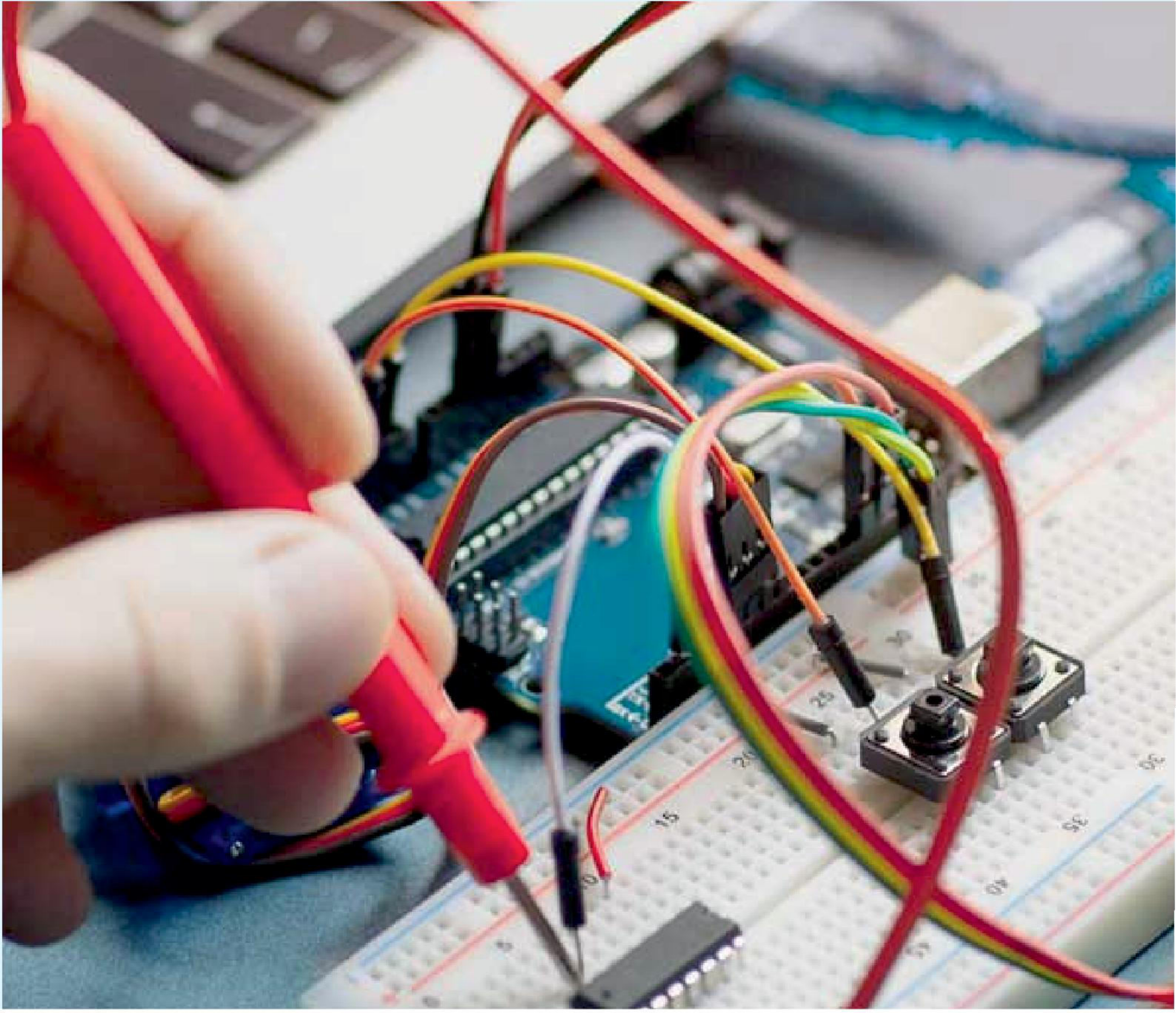
[5] R.Krishnan,“Electric Motor Drives Modeling, Analysis and Control”,PHI Learning Private Limited, 2001,pp.577 620.

[6] R. Carlson, M. Lajoie-Mazenc, and J. C. D. S. Fagundes, “Analysis of torque ripple due to phase commutation in brushless DC machines,” IEEE Trans. Ind. Appl., vol. 28, no. 3, pp. 632–638, May/Jun. 1992.

[7] J. Shi and T. C. Li, “New method to eliminate commutation torque ripple of brushless DC motor with minimum commutation time,” IEEE Trans.Ind. Electron., vol. 60, no. 6, pp. 2139–2146, Jun. 2013.

[8] W. Chen, Y. Liu, X. Li, T. Shi and C. Xia, “A Novel Method of Reducing Commutation Torque Ripple for Brushless DC Motor Based on Cuk Converter,” IEEE Trans. Power Electronics, vol. 32, no. 7, pp. 5497–5508, July 2017.

[9]Chiacchiarini, H.; Mandolesi, P.; Oliva, A. (1999). "Nonlinear analog controller for a buck converter: Theory and experimental results". ISIE '99. Proceedings of the IEEE International Symposium on Industrial Electronics (Cat. No.99TH8465). Vol. 2. pp. 601–606. doi:10.1109/ISIE.1999.798680. ISBN 0-7803-5662-4.S2CID 111350228.



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