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Design of Smooth Starter for a DC-DC Buck Converter Driven DC Motor

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Abstract: The common problem in DC motor system is trajectory tracking with an angular velocity. To rectify this a buck power converter is used in which two level of controlling systems are used. The first controller is to control the Motor which is DC and secondly controlling the converter, these two together helps a DC motor to drive smoothly. The flatness while controlling the DC motor with a voltage v and the angular velocity w is monitored continuously and trying to achieve the required angular velocity w^*. The resulting control utilizes a course control framework applied to the Buck converter to deliver the voltage profile v_p required by the dc engine. This control achieves that the converter yield the level of voltage tracked to the base reference voltage v such that the $v \rightarrow v_p$. Utilizing a various leveled controller, it was conceivable to do the coordination of the two controllers. Total circuit is designed and simulated in matlab simulink.
Keywords: DC/DC Buck Converter, DC Motor, Cascade control

I. INTRODUCTION

DC motors are broadly utilized in frameworks with high control necessities. Therefore, moving factories, twofold hulled big haulers, and high-accuracy advanced instruments can be referenced as instances of such frameworks. By and large, to control the stepless speed and perfection, modification of the armature voltage of the engine is utilized [1]; while, surely, applying beat width tweak (PWM) signals regarding the engine input voltage is one of the strategies generally utilized to drive a DC engine. Be that as it may, the basic hard exchanging procedure causes an unacceptable powerful conduct, delivering sudden varieties in the voltage and current of the engine [2]. These issues can be tended to by utilizing dc/dc power converters, which permit the smooth beginning of a dc engine by applying the necessary voltage as per the one requested for the performed task, being typically the following of either an ideal precise speed direction or an ideal rakish position direction. Specifically, the dc/dc Buck power converter has two vitality putting away components (an inductor and a capacitor) that produce smooth dc yield voltages and flows with a little current wave, diminishing the boisterous shape brought about by the hard exchanging of the PWM [3]. In this manner, so as to accomplish the rakish speed direction following undertaking of the dc/dc Buck power converter–dc engine framework, this paper centers around the plan of a progressive controller.

Dc Buck converter–dc engine framework, it was discovered that the issue of controlling the framework under investigation has been tended to by two techniques: I) by utilizing a fourth-request numerical model that, for the most part, prompts long controllers, whose usage is typically intricate; ii) by utilizing a second-request model, acquired by disregarding a few boundaries or conditions of the framework, which is badly designed for low-and medium-power applications [10]. Then again, to the creators' information, as to the presentation of the controllers structured, as of recently, for the rakish speed guideline and direction following errands, test approval has not been accounted for in a paper where various parametric vulnerabilities have been thought of, for either the converter or the engine, nor when the boundaries' ostensible qualities are exposed to significant varieties.

II. LITERATURE SURVEY

A. Control strategy of buck converter driven DC motor: A comparative assessment

DC Motors are given propensity for mechanical applications, for example, electric trains, cranes, stock lifts. Regardless, they have high beginning current. This high beginning up current must be diminished since it might hurt the windings of the engine and produces power use. It could be constrained by a sensible driver structure and controller. A unique controller , which is merged by a control related with the dc engine subject to dierential levelness at the raised level, and a control related with the dc/dc Buck converter dependent on a course control plan at the low level. The control at the raised level permits the dc engine smart speed to follow an ideal heading what's more gives the ideal voltage profile that must be trailed by the yield voltage of the dc/dc Buck power converter. To guarantee the course control, the inward current circle utilizes sliding mode control (SMC) and the outside voltage circle utilizes the Fuzzy Logic Control melded Proportional-Integral-Derivative(FLC-PID) control.

B. "Sliding mode-delta Regulation GPI Control of a DC engine through a buck Converter"

In this manner, one Generalized Proportional Integral (GPI) criticism control plot is proposed for a smooth " starter" for a DC engine dependent on a change controlled DC-to-DC power converter of the "buck" type. The dynamic criticism controller depends on an appropriate blend of GPI based control, evenness and a modulator usage of the normal structured controller. The plan proposes an immediate guideline of the engine shaft speed. As an outcome, the proposed criticism controller, which are not founded on asymptotic eyewitnesses nor computations dependent on samplings, utilize just an optical speed sensor. The viability of the proposed controller was checked by PC reenactments utilizing the P-Spice circuit reproduction program.

C. DC motor velocity control through a DC-to- DC power converter

This paper considers the progress of a smooth "starter" for a DC motor dependent on a change controlled DC-to-DC power converter of the "buck" type. The dynamic information controller depends upon a fitting mix of nonattendance of commitment based control, fairness and a/spl Sigma/ -/spl Delta/modulator execution of the standard sorted out controller. The course of action proposes a wandering standard of the engine shaft speed by systems for input current principle on the "buck" converter circuit. Subsequently, the proposed examination controller doesn't require the utilization of an electromechanical speed sensor for assessing the specific speed. The adequacy of the proposed controller was checked by PC augmentations utilizing the P-Spice circuit amusement program.

D. Control the velocity of the Motors DC Buck Converter potential DC/DC

This article presents the structure and execution of a speed controller for a DC engine through a buck converter, which tracks a smooth reference direction planned by a Bezier polynomial addition. The framework lessens voltage and current abrupt tops in the armature circuit of the engine during the beginning. The computation of the speed control is acquired from a yield F called flat yield (determined through the Kalman controllability framework). This control depends on input from all states as far as the flat yield and its progressive subordinates for following the direction. With the guide of the shaft position strategy it is conceivable to appropriately tune the controller in shut circle. The effectiveness of the framework is verified tentatively by methods for a stage that comprises of the DC engine buck converter and a PWM modulator.

E. DC-DC power converter components in DC motor speed flexible control

This paper manages the issue of speed control of a DC engine considering the parts of the DC-DC power converter, expected here of Buck type. We will convey for the general structure, set up by joined DC-engine and Buck-converter, a model of fourth sales. Taking into account this model a controller is sorted out utilizing the backstepping strategy. The control clarification behind existing is, on one hand, asymptotic quality of the shut circle framework and, then again, immaculate after of the reference signal (the machine speed). Both non versatile and adaptable varieties are masterminded and appeared to yield incredibly captivating shows. A theoretical appraisal shows that the two controllers meet their destinations. These outcomes are declared by reenactments which, similarly, show that the adaptable change supervises load power changes.

III. CONTROL OF DC-DC BUCK CONVERTER

The DC motor system with Buck converter is shown in Fig 1. The system design have some consideration with the parameters in the circuit shown.

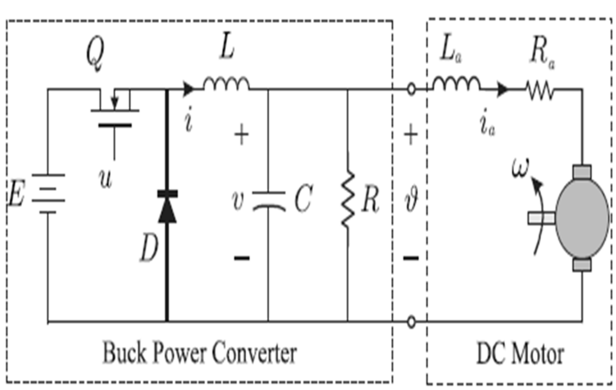

Fig 1. DC-DC Buck Converter

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The designed parameters are input current is i, armature current is i_a which is a DC motor current, the output voltage is given as v, motor having angular velocity ω.

From fig 1,

$$L\frac{di}{dt} = -v + Eu \quad (1)$$

$$c\frac{dv}{dt} = i - i_a \quad (2)$$

$$L_m\frac{di_a}{dt} = v - R_m i_a - K_e\omega \quad (3)$$

$$J\frac{dw}{dt} = K_m i_a - B\omega - T_L \quad (4)$$

Here T_L is considered as torque load, B is the frictional constant and electromagnetic force constant is K_e.

Two switches are considered that are normally a transistor and a diode which fundamentally function of the buck converter which has a current in an inductor. Shut switch is termed as on state and if the switch is open termed to be a off state. In all the converters these type of segments are greatly viewed. In particular, the switch and the diode have zero voltage drop when on and zero current stream when off and the inductor has zero arrangement opposition. The span of the cycle will not change based on the profile voltage and the yield voltage.

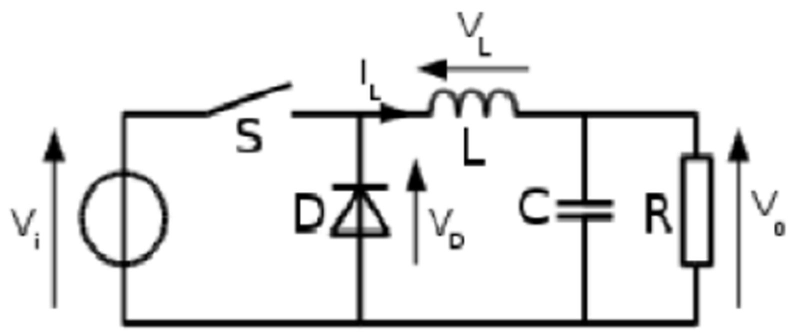

Fig 3. Circuit diagram of Buck Converter

For the Buck converter, the course control conspire appeared in Fig. 3 is utilized, where i* is the criticism reference current, υ* is the reference voltage, E, υ, I, and u are as characterized beforehand, and the voltage mistake, e, is characterized by e = υ* − υ. The course control for the Buck converter considers a control for the current I and another for the voltage υ.

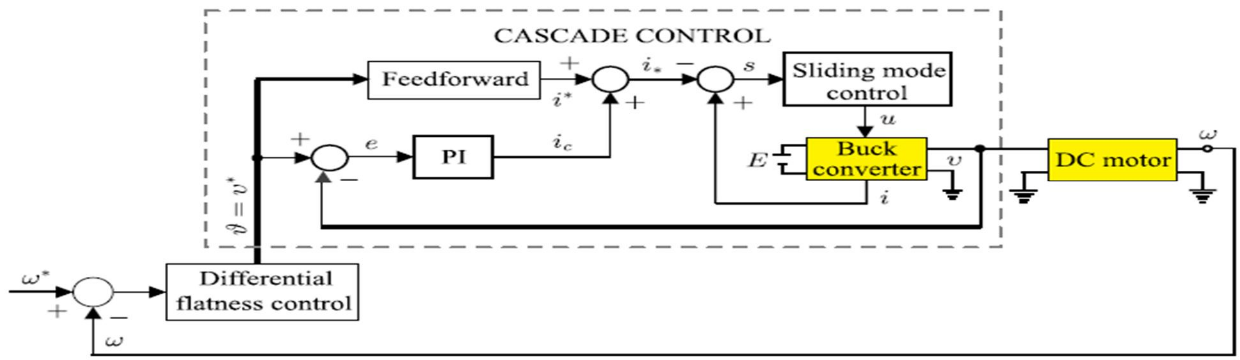

Fig 4. Block diagram of Proposed Control System

Various levelled controller is planned to complete the rakish speed direction following errand for the dc/dc Buck power converter–dc engine framework, which is appeared in Fig 4. Such a control has the following parts.

1) In the high chain of importance level, a control dependent on differential evenness, v_p, which executes the trajectory speed direction following task, has been created for the dc engine. The comparison is done between the ideal voltage profile that the yield voltage of the Buck converter needs to follow.
2) So as to guarantee that the converter yield voltage, υ, tracks v_p, a course control is created in the low progression level. In this control, the inward current circle utilizes SMC, while the external voltage circle utilizes a PI control.

IV. RESULTS & DISCUSSIONS

Spurred by the previously mentioned and by the various leveled control approaches utilized in portable mechanical autonomy [17], where the scientific condition that oversees the high progressive system control forces to a low chain of command control, by methods for an inward control circle, the ideal direction to be followed. The principle commitment of this paper is to propose a various leveled controller that does the rakish speed direction following undertaking for the dc/dc Buck converter–dc engine framework. To accomplish this, as a variety of I) two autonomous controllers are structured; one for the dc engine (by means of differential evenness) and another by means of the course plot (through the SMC and PI control) for the Buck converter, which are then interconnected so as to fill in general. Also, exploratory approval of the proposed progressive controller's presentation is incorporated, demonstrating how the direction following assignment is effectively cultivated, in any event, when unexpected varieties of the framework boundaries show up, so displaying the heartiness of the controller introduced. The significance of such exploratory approval is that it could prompt a useful utilization of the controller in this introduced.-

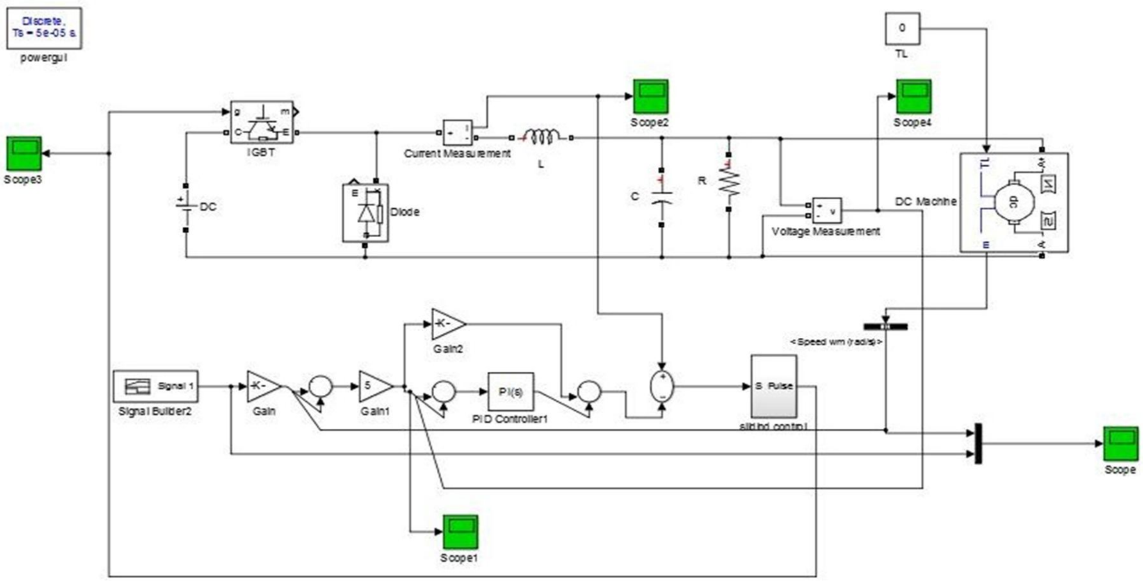

Fig 5. Proposed simulation circuit configuration

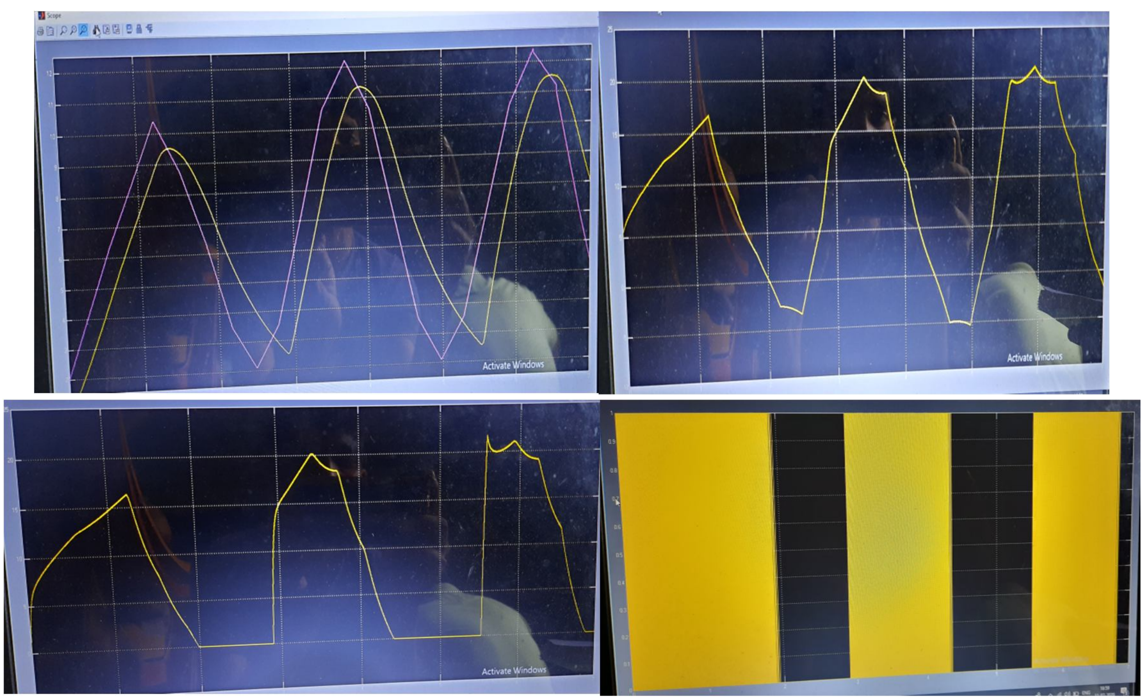

Fig 6. Simulation Results for Buck Load with v_m

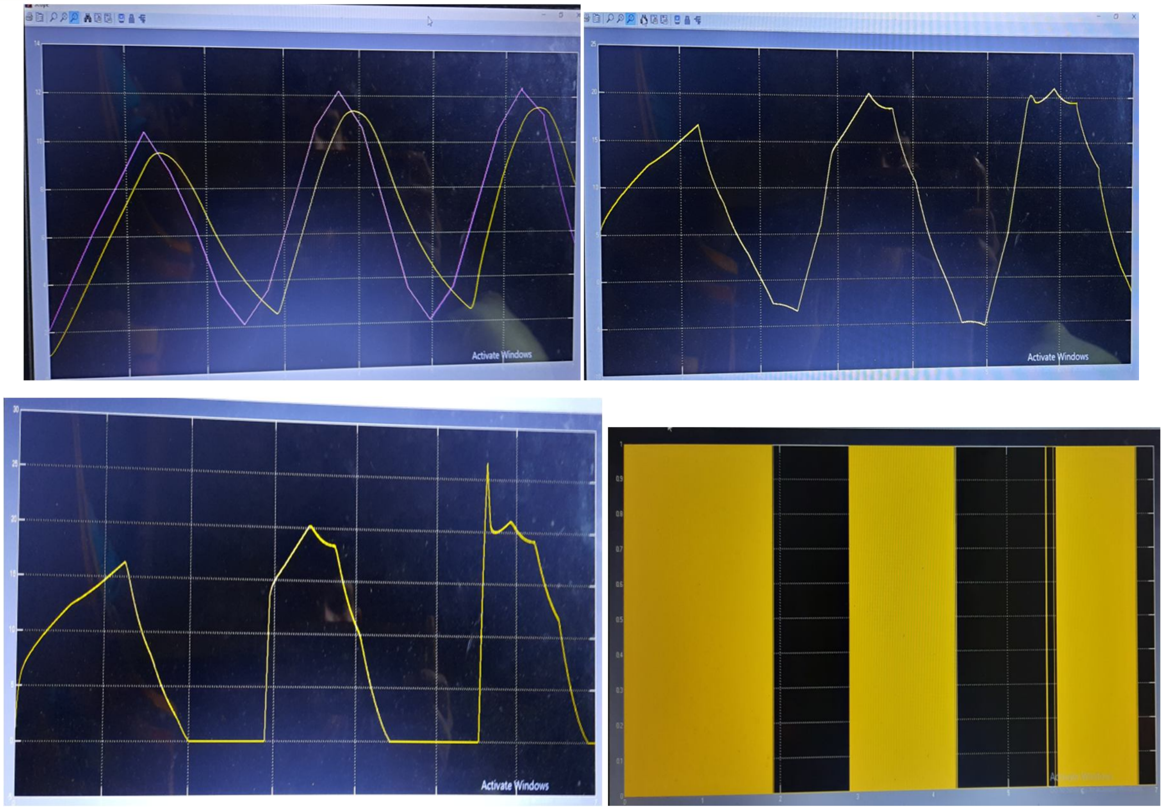

Fig 7.Simulation Results with system containing Lm and Cm

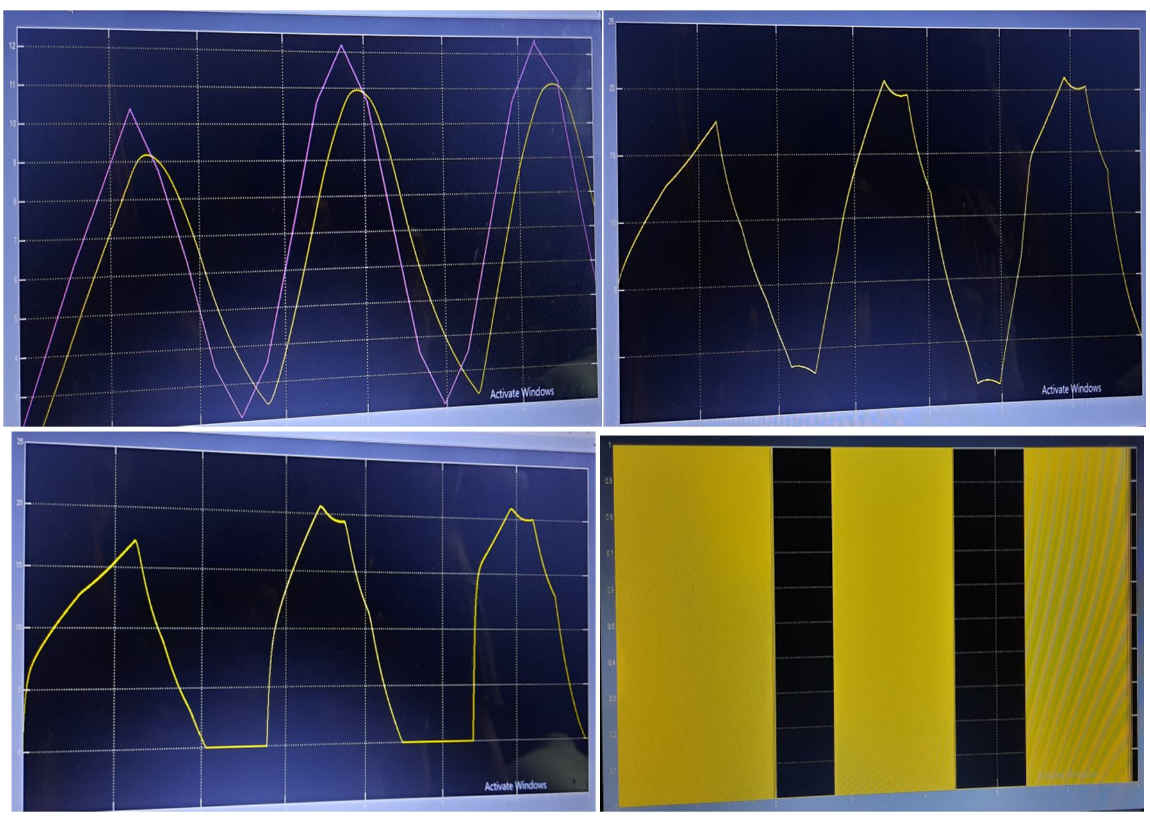

Fig 8.Simulation Results with system containing R_m

The simulation result shown in Fig 6, Fig 7 and Fig 8 gives the adequacy of the proposed methodology in design of a DC motor.

V. CONCLUSIONS

Persuaded by the various leveled control approach applied in the portable mechanical technology zone, in this paper, an answer for the trajectory speed direction following issue for the dc/dc Buck power converter–dc engine framework was introduced. As said the use of two controllers is imposed and implemented, the first control is on determining the voltage profile $\boldsymbol{v_p}$ and its effectiveness so that angular trajectory speed can be controlled and also improve $\boldsymbol{\omega}$ ***to*** $\boldsymbol{\omega}^*$. The other controller is to obtain the converter yield voltage to voltage profile $\boldsymbol{v_p}$. By using the combination of these controllers as shown in fig 3 the outcome of the proposed methodology is designed. In this the motor speed is tracked and designed with respect to the required voltage, load , inductance and capacitance. Underline that these kinds of unexpected varieties don't occur practically speaking simultaneously, nor with such huge varieties in regards to their ostensible qualities. In any case, the analyses were embraced to show that the proposed controller presents a decent exhibition under sudden varieties related with the framework boundaries, which would make conceivable the presentation of this controller in useful applications.

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REFERENCES

[1] M. A. Ahmad, R.M. T. Raja Ismail, andM. S. Ramli, "Control strategy of buck converter driven DC motor: A comparative assessment," Australian J. Basic Appl. Sci., vol. 4, no. 10, pp. 4893–4903, 2010.

[2] F. Antritter, P. Maurer, and J. Reger, "Flatness based control of a buckconverter driven DC motor," in Proc. 4th IFAC Symp. Mechatron. Syst., Heidelberg, Germany, Sep. 12–14, 2006, pp. 36–41.

[3] S. E. Lyshevski, Electromechanical Systems, Electric Machines, and Applied Mechatronics. Boca Raton, FL, USA: CRC Press, 1999.

[4] J. Linares-Flores and H. Sira-Ram´ırez, "A smooth starter for a DC machine: A flatness based approach," in Proc. 1st Int. Conf. Electr. Electron. Eng., Acapulco, Mexico, Sep. 8–10, 2004, pp. 589–594.

[5] J. Linares-Flores and H. Sira-Ram´ırez, "Sliding mode-delta modulation GPI control of a DC motor through a buck converter," in Proc. 2nd IFAC Symp. Syst., Struct. Control, Oaxaca, Mexico, Dec. 8–10, 2004, pp. 405–409.

[6] J. Linares-Flores and H. Sira- Ram´ırez,"DCmotor velocity control through aDC-to-DC power converter," in Proc. IEEE 43rd Conf.Decision Control, Atlantis, The Bahamas, Dec. 14–17, 2004, vol. 5, pp. 5297–5302.

[7] R.Ortega, A. Loria, P. J. Nicklasson, andH. Sira-Ram´ırez,Passivity-Based Control of Euler- Lagrange Systems. London, U.K.: Springer- Verlag, 1998.

[8] J. Linares-Flores, "Control suave de velocidad de motores de CD mediante convertidores de potencia CD/CD," Ph.D. dissertation, Secci´on de Mecatr´onica del Departamento de Ingenier´ıa El´ectrica del CINVESTAVIPN, Mexico City, Mexico, 2006.

[9] J. Linares-Flores, A. Orantes-MolinayA. Antonio-Garc´ıa, "Arranque suave para un motor de CD a trav´es de un convertidor reductor CD- CD," Ing. Investigaci´on Tecnol., vol. 12, no. 2, pp. 137–148, Oct. 2011.

[10] H. El Fadil and F. Giri, "Accounting of DC- DC power converter dynamics in DC motor velocity adaptive control," in Proc. IEEE Int. Conf. Control Appl., Munich, Germany, Oct. 4– 6, 2006, pp. 3157–3162.

[11] R. Sureshkumar and S. Ganeshkumar, "Comparative study of proportional integral and backstepping controller for buck converter," in Proc. Int. Conf. Emerging Trends Electr. Comput. Technol., Tamil Nadu, India, Mar. 23– 24, 2011, pp. 375–379.

[12] O. Bing¨ol and S. Pac¸aci, "A virtual laboratory for neural network controlled DC motors based on a DC-DC buck converter," Int. J. Eng. Educ., vol. 28, no. 3, pp. 713–723, 2012.

[13] M. Z. M. Tumari, M. S. Saealal, M. R. Ghazali, and Y. A. Wahab, "Hinfinity with pole placement constraint in LMI region for a buck- converter driven DC motor," in Proc. IEEE Int. Conf. Power Energy, Kota Kinabalu Sabah, Malaysia, Dec. 2–5, 2012, pp. 530–535.

[14] H. Sira-Ram´ırez andM.A.Oliver-Salazar, "On the robust control of Buckconverter DC- motor combinations," IEEE Trans. Power Electron., vol. 28, no. 8, pp. 3912–3922, Aug. 2013.

[15] R. Silva-Ortigoza, J. R. Garc´ıa-S´anchez, J. M. Alba-Mart´ınez, V. M. Hern´andez-Guzm´an, M. Marcelino-Aranda, H. Taud, and R. Bautista- Quintero, "Two-stage control design of a Buck converter/DC motor system without velocity measurements via a $\Sigma - \Delta$-modulator," Math. Probl. Eng., vol. 2013, pp. 1–11, 2013. [Online]. Available: http://dx.doi.org/10.1155/2013/929316

[16] V. M. Hern´andez-Guzm´an, R. Silva- Ortigoza, and R. V. Carrillo- Serrano, Automatic Control: Design Theory, Prototype Construction, Modeling, Identification and Experimental Tests (in Spanish), Mexico City, Mexico: Colecci´on CIDETEC–IPN, 2013. [Online]. Available: http://www.controlautomatico.com.mx.

[17] J. Linares-Flores, J. Reger, and H. Sira- Ram´ırez, "Load torque estimation and passivity- based control of a Boost-converter/DC-motor combination," IEEE Trans. Control Syst. Technol., vol. 18, no. 6, pp. 1398–1405, Nov. 2010.

[18] J. Linares-Flores, H. Sira-Ram´ırez, J. Reger, and R. Silva-Ortigoza, "An exact tracking error dynamics passive output feedback controller for a Buck-Boost-converter driven DC motor," in Proc. 10th IEEE Int. Power Electron. Congr., Cholula, Puebla, Mexico, Oct. 2006, pp. 1–5.

[19] Y. S¨onmez, M. Dursun, U. G¨uvenc¸, and C. Yilmaz, "Start up current control of Buck-Boost convertor-fed serial DC motor," Pamukkale Univ. J. Eng. Sci., vol. 15, no. 2, pp. 278–283, May 2009.

[20] J. Linares-Flores, J. L. Barahona-Avalos, H. Sira-Ram´ırez, and M. A. Contreras-Ordaz, "Robust passivity-based control of a Buck– Boostconverter/ DC-motor system: An active disturbance rejection approach," IEEE Trans. Ind. Appl., vol. 48, no. 6, pp. 2362–2371, Nov./Dec. 2012.