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Closed Loop Control of Separately Excited DC Motor

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Abstract: In this project the mathematical model for closed loop control of separately excited dc motor is designed and tested through the MATLAB/Simulink software. In general the high performance motor drive is nothing but a motor drive in which a drive system should have good load regulating response and dynamic speed command tracking. Therefore in acceleration and deceleration the dc motor provides excellent control in speed.
Keywords: Closed loop control, separately excited DC motor and DC motor.

I. INTRODUCTION

The variable speed, reliability and high performance are three main characteristics of an electric drive system due to which it can be easily controlled. The field of motor is connected directly to the power supply for the speed control. At the same time it is necessary for torque and speed control. For low horsepower dc drives are low cost. In addition to this for overhauling loads dc regenerative drives are used.

By field control method and armature control method wide range of speed control both above and below the rated speeds are achieved. Therefore dc motors are used in fine speed applications such as in paper mills and in rolling mills. In general on the basis of dc motor excitation the dc motor are classified into two types. They are separately excited and self excited dc motor. In this project we used separately excited dc motor. Hence its field winding and armature are excited from two different sources. The fundamental of electric drives, power electronic circuits, devices and application are explained in detail [1-3].

II. CONSTRUCTION AND WORKING PRINCIPLE OF DC MOTOR

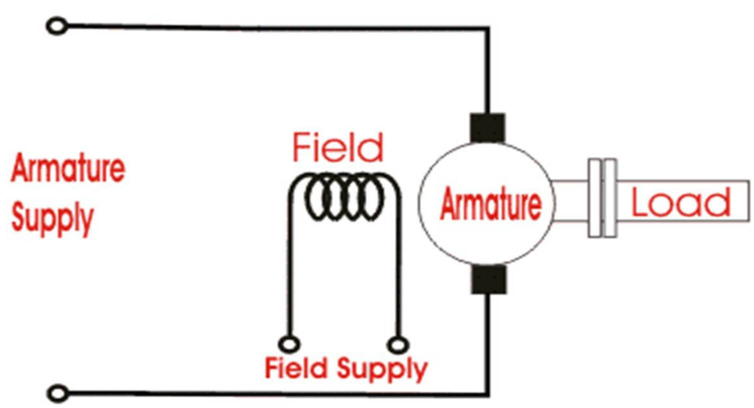

Figure {1} DC motor

In the figure {1} with separate supply the separately excited dc motor has field and armature winding. To excite the field flux the field winding of the dc motor is used. For mechanical work current in armature circuit is supplied to the rotor through brush and commutator.The field flux and armature current interaction produces rotor torque.Okbuka and raju singh has explained about the performance characteristics of controlled separately excited dc motor and stability analysis of separately excited dc motor respectively [4-5]. The working principle of seperately excited dc motor is listed in points below.

Point 1: The field current {if} excites the separately excited dc motor.

Volume 4 Issue V, May 2016
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Point 2: In the circuit armature current {ia} flows.

Point 3: To balance load torque at particular speed. The motor develops a back emf and torque.

Point 4: Any change in armature current has no effect on the field current {if independent of ia}.

Point 5: The field current {if} is much less than the armature current {ia}.

III. MATHEMATICAL EQUATIONS OF SEPERATELY EXCITED DC MOTOR

Armature equation,

$$V_a = E_g + I_a R_a + L_a \left\{ \frac{dI_a}{dt} \right\} \rightarrow Equation.1$$

Armature resistance in ohms {Ra}

Armature inductance in Henry {La}

Armature voltage in volts {Va}

Armature current in amps {Ia}

Motor back emf in volts {Eb}

Torque equation,

$$T_d = J\frac{d\omega}{dt} + B\omega + T_L \rightarrow Equation.2$$

Load torque in Newton-Meter {T_L}

Friction co-efficient of the motor {B}

Moment of inertia in Kg/m^2 {J}

Torque developed in Newton-Meter {T_d}

Angular velocity in rad/sec {w}

IV. SIMULATION MODEL OF DC MOTOR USING HB CURRENT CONTROL TECHNIQUE

Armature resistance {R_a} =0.066 ohms

Armature inductance {L_a} =0.0065H

Moment of inertia {J} =2.85 kg/m^2

Motor constant {Kphi} =4.212 v/rad

Rated terminal voltage {V_a} =230 volt

Viscous friction {Bm} = 0.634 nm/rad/s

Rated armature current {I_a} = 143 Amps

Load torque {T_L} =0

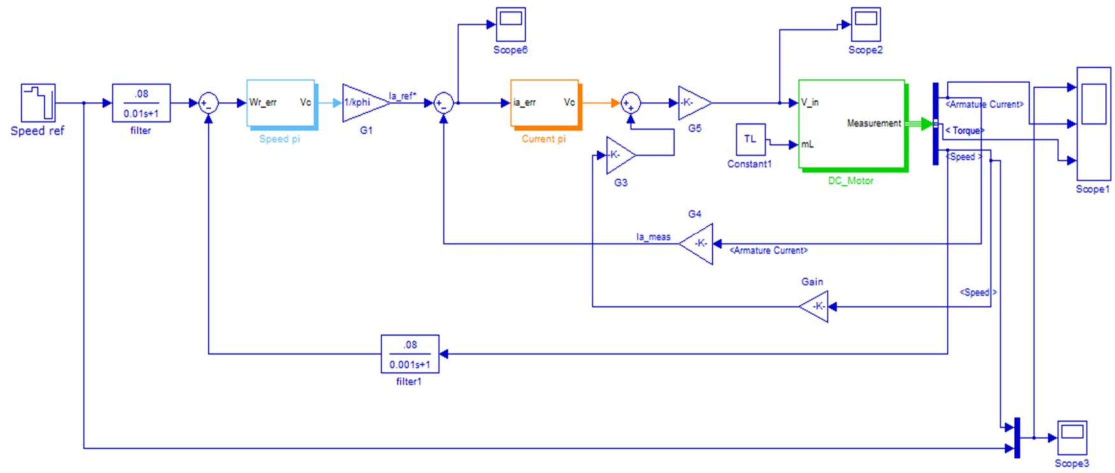

Figure {2} Simulation model of closed loop separately excited dc motor

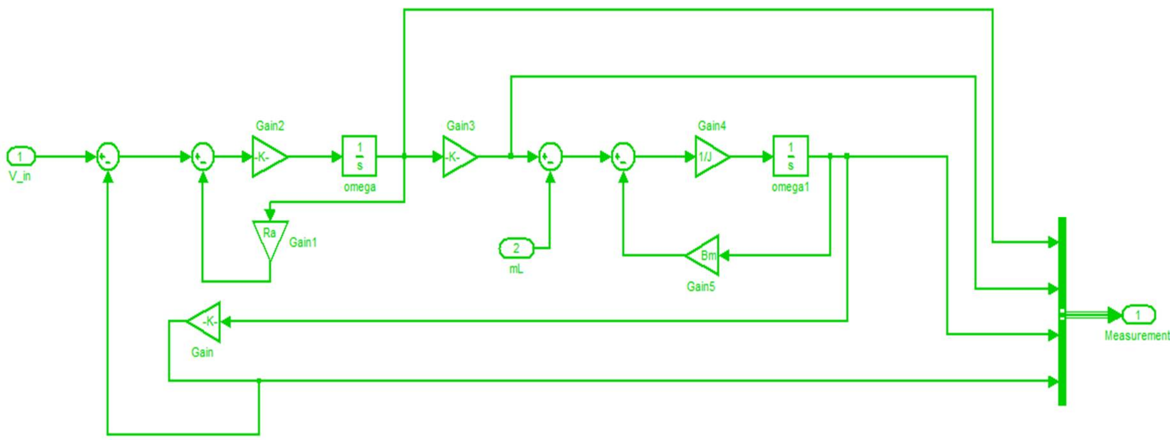

Figure {3} Subsystem simulation model of dc motor

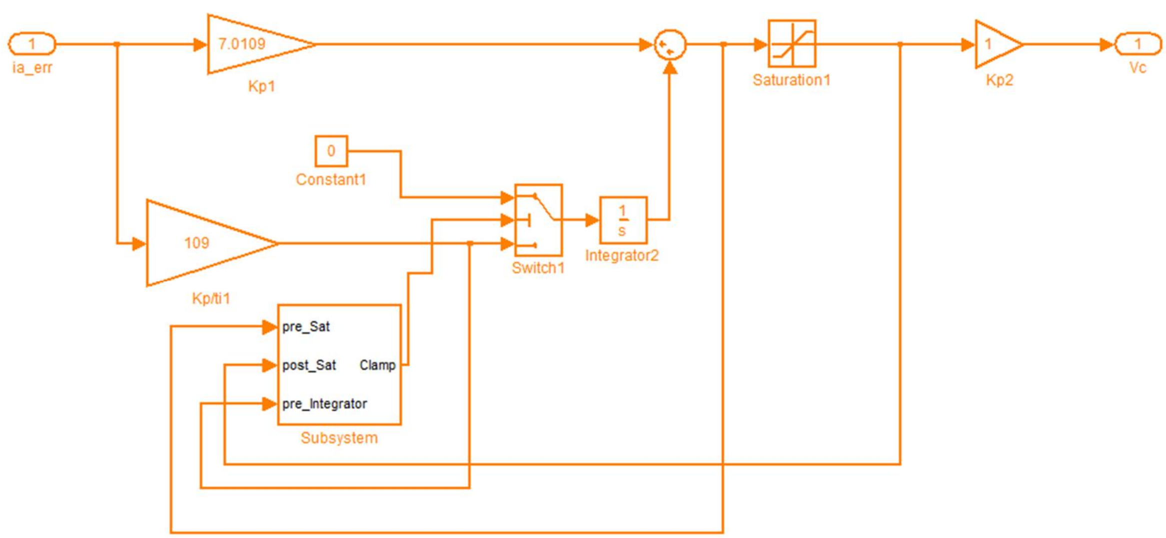

Figure {4} Subsystem simulation model of current block

Volume 4 Issue V, May 2016
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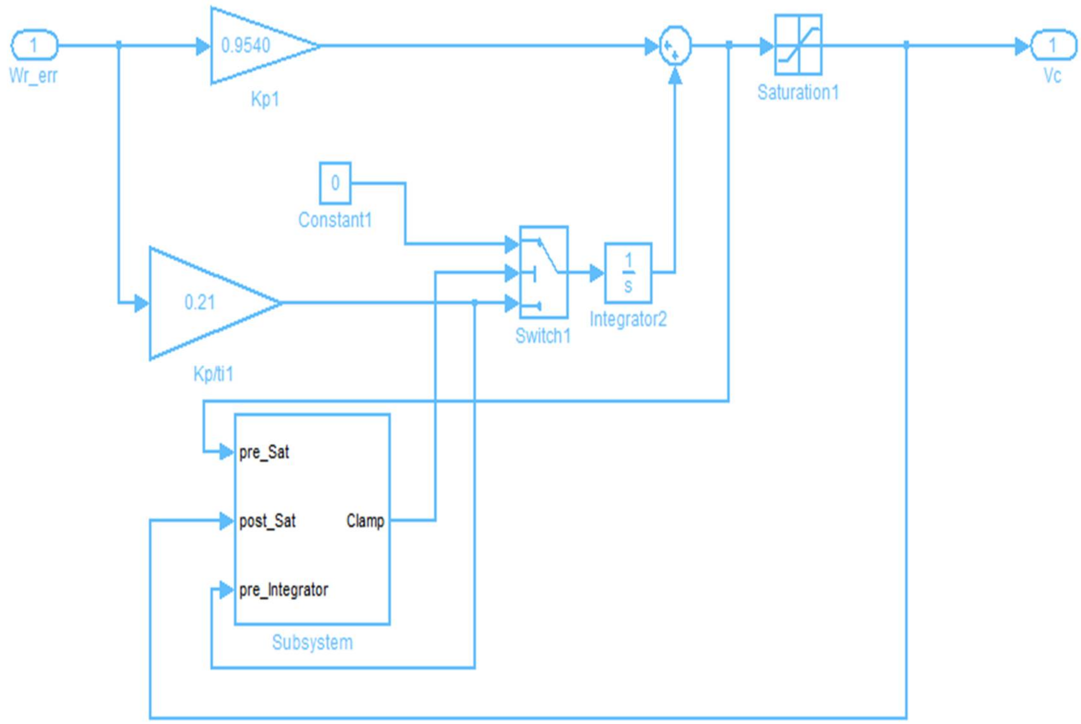

Figure {5} Subsystem simulation model of speed block

V. SIMULATION RESULTS

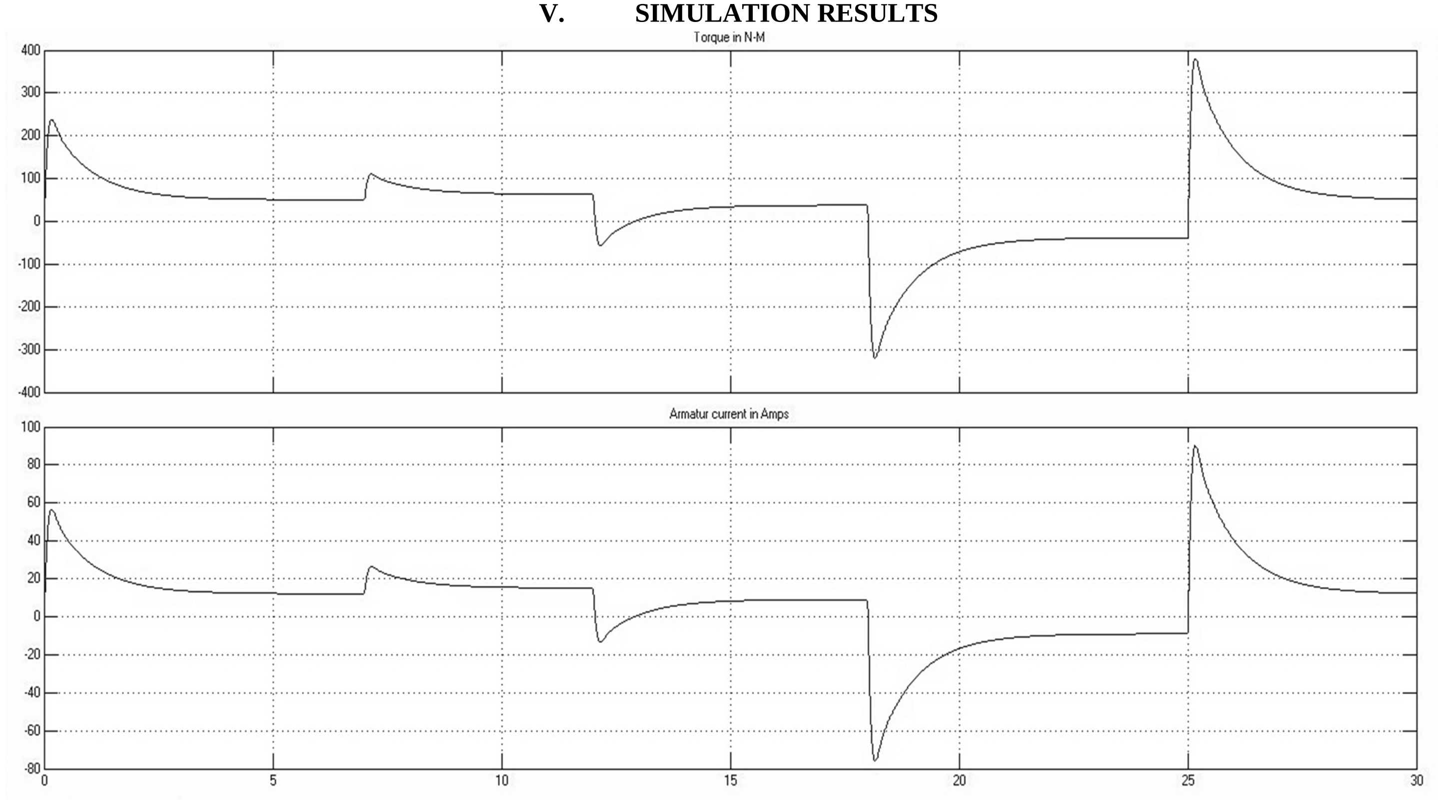

Figure {6} Torque and Armature current

Volume 4 Issue V, May 2016
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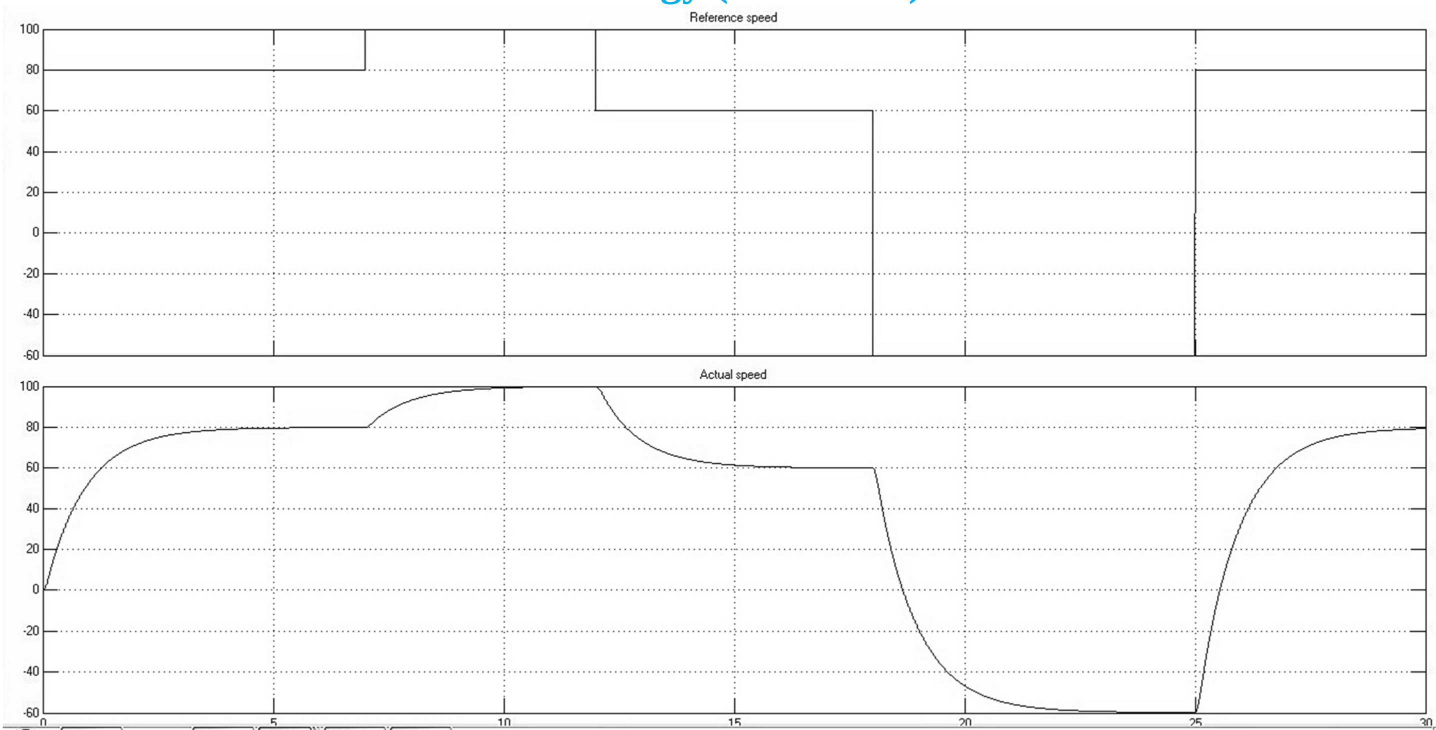

Figure {7} Reference speed and Actual speed

VI. CONCLUSION

The dc motor is the backbone of industrial applications. The industrial application needs high performance motor drives. The dc motor is used as an adjustable speed machine for this wide range of option is evolved. The four main reasons for the usage of dc motors are reliability, simplicity and favorable cost. At the same time the dc motor drive is less complex compare to ac motor drives.

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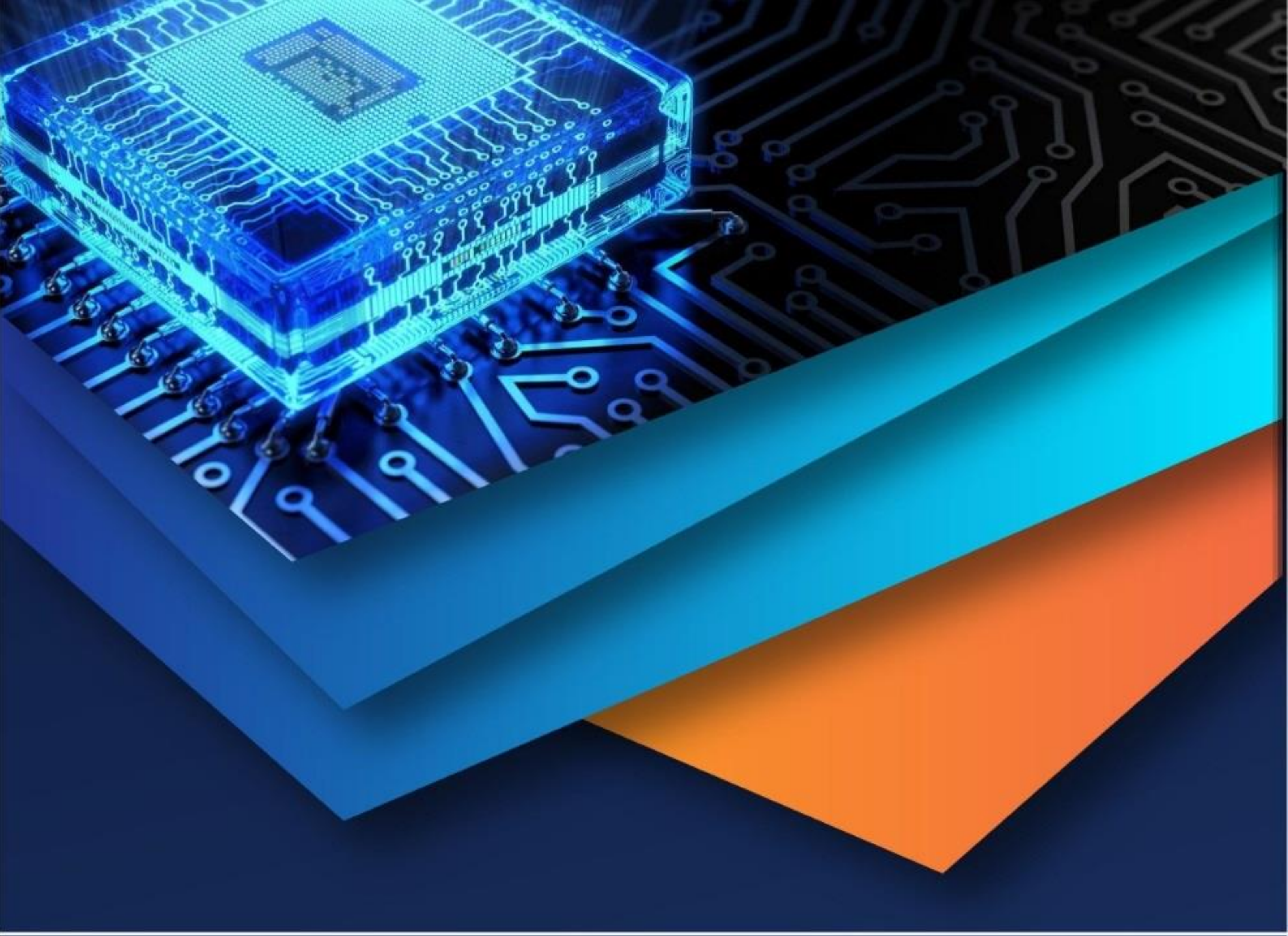
BIOGRAPHY

Mr.J.Vikramarajan received his Master degree in Power Electronics and Drives and Bachelor degree in Electrical and Electronics Engineering from VIT University, India. He has published several international research books and journals. His research interests are electrical machines, power electronic applications, power quality, power electronic converters and power electronic controllers for renewable energy systems.



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