International Journal of Scientific Research & Engineering Trends
Volume 7, Issue 6, Nov-Dec-2021, ISSN (Online): 2395-566X

Design and Implementation of Solar Powered BLDC Motor Driven Electric Vehicle

Jaysingh Prajapati, Devendra Dohare
Department of Electrical Engineering
Maharana Pratap College of Technology
Gwalior (M.P.)
jaysingh25196@gmail.com, devendra.mits@gmail.com

Abstract- The solar energy is used to feed the Brushless DC motor which is operated using four switch models instead of conventional six switches using PID fuzzy logic controller to have better speed accuracy Any equipment without power is an idle bunch of components. It is very prominent with those dependable upon the non-renewable sources. It's a pro-active approach to shift our source of energy to renewable source. This paper details the study of designing a Solar Powered BLDC Motor Driven Electric Vehicle which is one of the solutions for the oncoming crisis.The approach of selecting the appropriate components for this application is studied and each of them are simulated and subjected to various tests in real time environment. The integrated system consisting of the solar module, charge controllers, batteries, boost converter and BLDC motor, henceforth developed into the Solar Powered Electric Vehicle. The charge controllers direct this power acquired from the solar panel to the batteries. According to the state of the battery, the charging is done, so as to avoid overcharging and deep discharge. Primarily trying to increase the range of the electric vehicle.

Keywords- Solar, BLDC motor, battery HEV, EV, sensor.

I. INTRODUCTION

The vehicular systems have been in use since past many decades and have made the life of humans easy. To assure the ever growing vehicular load demands, the automotive industries are trying to incorporate more electrical systems.

So, it is expected that the electric vehicles will bring a drastic change in the automotive industry in next 10-20 years. Electrification in automobile industry will lead to ample demand for high-performance and efficient energy storage system (ESS) technologies for electric vehicles (EVs) and hybrid electric vehicles (HEVs). The current situation is such that the demands for electric power and higher fuel economy are driving the vehicular power system voltages to higher levels. The power demand is expected to increase by 3-4 times of the current value due to the increasing demand of the electric vehicles.

The points to be discussed in this section are
1. BLDC motors:
Regenerative braking, Electric vehicle (EV) is one of the alternatives to internal combustion engine powered vehicle due to pollution concern, cost and availability of the oil.

These vehicles are propelled by electric motors of either AC or DC. DC motors are mainly used for propulsion since batteries are used as the main power source. In recent days, due to advancement in power electronics converters, motors such as brushless DC (BLDC) motors, permanent magnet synchronous motors (PMSM) and switched reluctance motors are used.

2. Regenerative Braking:
Methods while stopping / breaking the electric vehicle. In regenerative braking motor acts as generator and gives the energy back to the battery. During regenerative braking, the vehicle inertia together with power electronic converters makes the motor to act as the generator to send the energy back to the battery. Studies are ensuring that the driving range can be improved by 8–25% using an alternative method is proposed using the single stage converter which drives the BLDC motor. The single stage converter is able to perform regenerative braking by applying regenerative braking. Switching pulses in a proper sequence without any additional power converter.

In this single stage converter, different types of braking methods based on different switching topology namely single switch, two switch and three switch are used for braking. In order to ensure effective braking at all speeds, this paper proposes a new electrical braking system for a BLDC driven EV based on various electric braking methods such as single, two, three switching topologies and plugging.

II. RESEARCH BACKGROUND

Automobiles play an important role in the life of modern society. An automobile with internal combustion engine (ICE) is a significant achievement of the modern technology which has earned laurels in the industry. However the gigantic development of the automobile industry across the globe is a serious threat to the environment and fossil fuel resources [1].

Therefore, the present research in the automotive industry is focused to design the electric transportation system for providing clean, secure and smart alternative in the form of EVs and HEVs. EVs have their own advantages as well as challenges. Considering the electricity being generated from fossil fuels, EVs prove to be more efficient in comparison to ICE vehicles in terms of both equivalent miles and the cost of driving per mile. The electricity is also generated from renewable resources which provide the minimal threatening to pollution and resources. [2]

However the high cost, limited driving range and long charging time have handicapped battery driven vehicles, thereby paving the way for HEVs in which the drive train depends both on the conventional ICE and electrical machines

1. Solar Cell:
Working source Solar cells are prime parts of photovoltaic boards. Most are produced using silicon still however different assets are excessively utilized. Sunlight based cells take estimation of the photoelectric consequence the capacity of pintsized semiconductors to modify electromagnetic aftermath straight into electrical flow. The charged units produced by episode radiation are isolated reasonably make an electrical flow by a proper plan of the structure of the sun powered cell, as will clarify in short lower. For further subtleties, the peruser can counsel references [4] or [10].

A sunlight based cell is essentially a p-n intersection which is produced using two different layers of silicon doped with a little amount of soil particles: in case of the n-layer, molecules without one more valence electron, called supporters and the instance of the p-layer, utilizing one less valence electron, known according to acceptors. At the point when the two layers are converged, close to the interface the capable electrons of the n-layer is diffuse in the p-side, separating behind a region emphatically charged the givers.

The free gaps in the p-layer are diffuse in the n-side, abandoning segment hurtfully charged by acceptors. This makes an electrical field inside the two sides that is a conceivable blockade to additionally stream. The harmony is come to in association when the electrons orholes can't better that potential obstacle and along these lines can't move. This electric field pulls the electrons or gaps in clashing ways so the flow can keep running in one manner no one but: electrons can go from the p-side to the n-side or openings the other way. A figure of the p-n intersection seeing the impact of the notice electric field is delineated in Figure 3.3

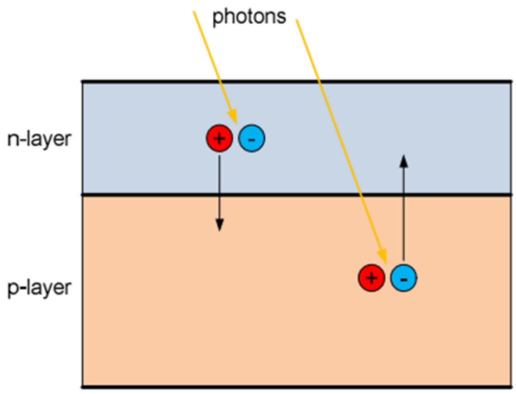

Fig 1. Solar cells. [4]

The basic components of most solar cells are semiconductor materials, whose properties vary with their composition. Semiconductors doped with elements that can donate electrons to silicon, such as those from the VI group of the periodic table, have an increased number of electrons in the conduction band. These semiconductors are known as n-type materials. Semiconductors doped with elements that can accept electrons from Silicon, such as those from the III group of the periodic table, are known as p-type materials. The electronic asymmetry within a p-n junction encourages the flow of electrons from the n-type region to the p-type region and the flow of holes in the opposite direction, generating current.

Solar energy in the form of photons is absorbed in a semiconductor, which allows the generation of electron-hole pairs. To generate electricity, they must travel all the way towards from their respective regions to the electric grid and live long enough by avoiding recombination within the solar cell. When electrons get to the p-n junction, they are separated by an electric field and collected by metal contacts thus providing electricity to the PV System.

III. PROPOSED SCHEMES AND MODELLING

This proposed modelling designed by solar input .in this proposed two types of BLDC motor designed with sensor and without sensor. The description of the SPV based boost converter fed BLDC motor drive for air cooling system is depicted in Fig.2. The solar panel output is given to the DC-DC boost converter through the SMM based MPPT controller and output of the boost converter is given to two VSI's which are fed to two BLDC motors to drive the centrifugal water pump and a fan blower.

The detailed designs of various stages such as SPV array DC-DC boost converter, SPWM technique based inverter, BLDC motor driven centrifugal water pump and fan Blower are described as follows. The proposed system comprises of a SPV array, a BB converter, VSI and a

International Journal of Scientific Research & Engineering Trends
Volume 7, Issue 6, Nov-Dec-2021, ISSN (Online): 2395-566X

BLDC motor coupled to sensor. A BLDC motor of 4.4 kW control rating is chosen to drive a and different segments of the proposed system are composed in like manner as explained in the accompanying areas.

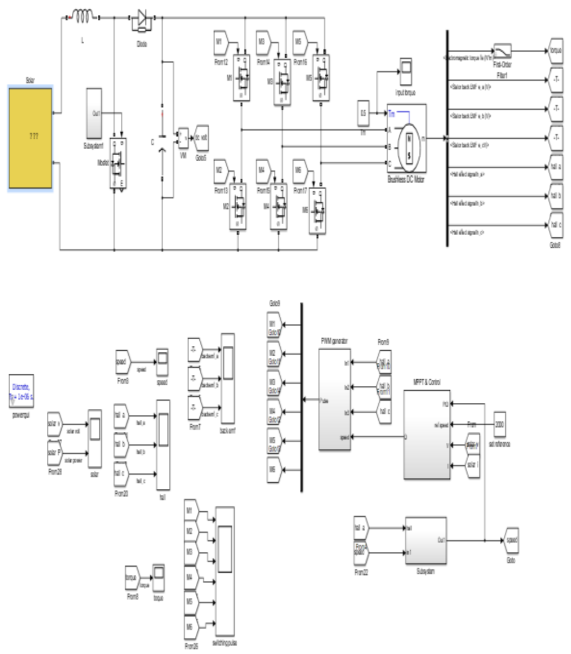

Fig 2. Simulink Model of Proposed System with sensor.

1. Battery:
Battery is acts the continuous growth and evolves of vehicle electrification causes the electric power systems to confront new challenges, since the load profile changes, and new parameters are being set. With the number of EVs gradually rising, problems may occur in technical characteristics of the network, like bus voltages and line congestion. Therefore, it is necessary to develop EV management systems so as to prevent such phenomena. The effectiveness of such systems is heavily depended on the early knowledge of future demand.

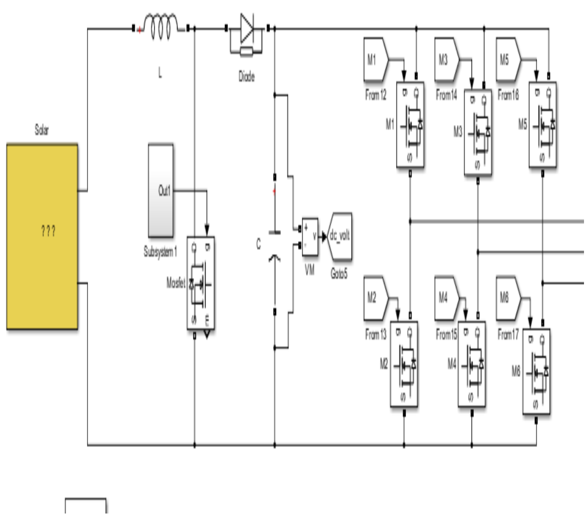

Fig 3. MPPT model.

This knowledge can be provided by accurate EV load forecasting techniques. In this paper, the use of various data mining methods is examined and their performance in EV load forecasting is evaluated. Motor in 1830. The first known electric car was a small model built by Professor in the Dutch town of Groningen in1835. The first EV was built by in 1834 by Thomas Davenport in the U.S., followed by Moses Farmer, who built the first two-passenger EV in 1847. There were no rechargeable electric cells (batteries) at that time. An EV did not become a viable option until the Frenchmen Gaston Planet

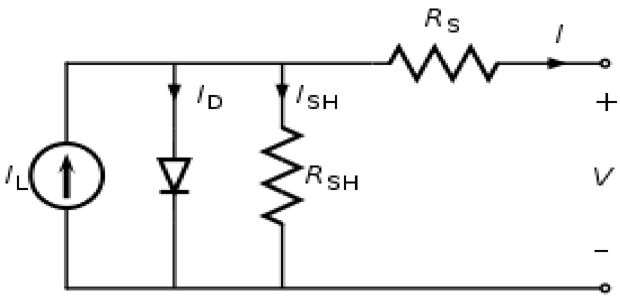

Fig 4. Single Diode Equivalent Circuit Models.

Equivalent circuit models define the entire I-V curve of a cell, module, or array as a continuous function for a given set of operating conditions. One basic equivalent circuit model in common use is the single diode model,

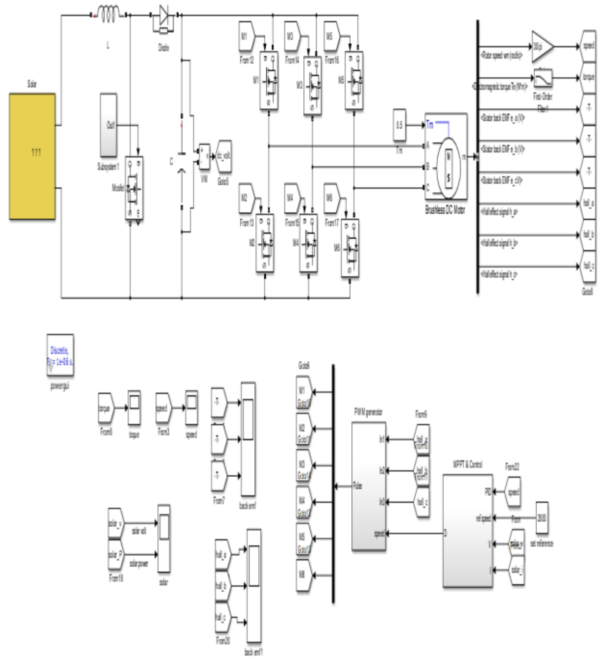

Fig 5. Proposed model with sensor.

Following parameters used in with sensor model given in figure Stator phase resistance Rs (ohm): 0.42 5Armature inductance (H): 0.000835nertia, viscous damping, pole pairs, static friction [J(kg.m^2) F(N.m.s) p() Tf(N.m)]: [0.01197 0.001189 5] initial conditions [wm(rad/s) thetam(deg) ia,ib(A)]:

International Journal of Scientific Research & Engineering Trends
Volume 7, Issue 6, Nov-Dec-2021, ISSN (Online): 2395-566X

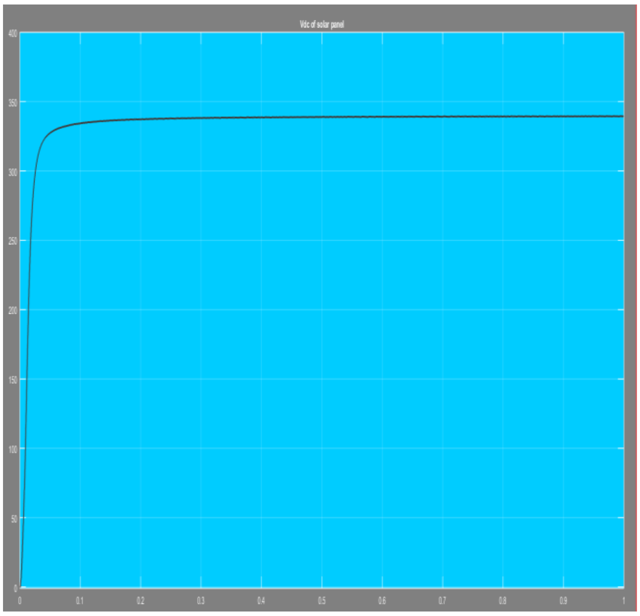
Fig 6. VDC from Solar Panel.

The power delivered by a PV cell attains a maximum value at the points. The short circuit current is measured by shorting the output terminals and measuring the terminal current PV cells are made of semiconductor materials with crystalline and thin films being the dominant materials.

The majority future other thin film materials are likely going to surpass silicon PV cells in terms of cost and performance following classes: crystalline, thin film, amorphous, multi-junction, organic or photochemical .in figure7 show PV characteristics and there are X-Y coordinates voltage Vs current plotted. The maximum power is generated 230 Kw by the solar cell at point of the current-voltage characteristic where product of *V* and *I* is maximum shown in fig 12.

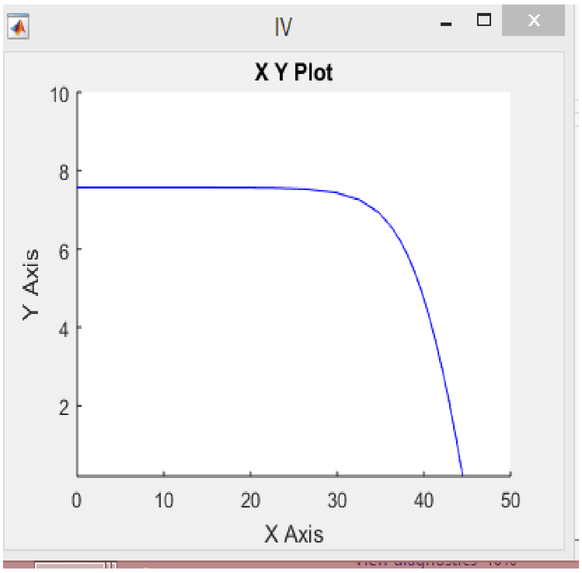

Fig 7. PV Characteristics Waveform.

In figure 4.17 show PV characteristics and there are X-Y coordinates voltage Vs current plotted. The maximum power is generated 230 Kw by the solar cell at point of the current-voltage characteristic where product of *V* and *I* is maximum shown in fig 8 Y Axis plotted 230Kw and x-axis point maximum 44I

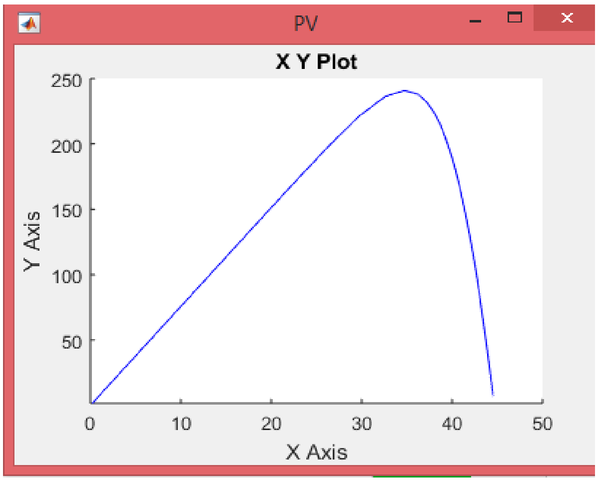

Fig 8. PV Characteristics Waveform.

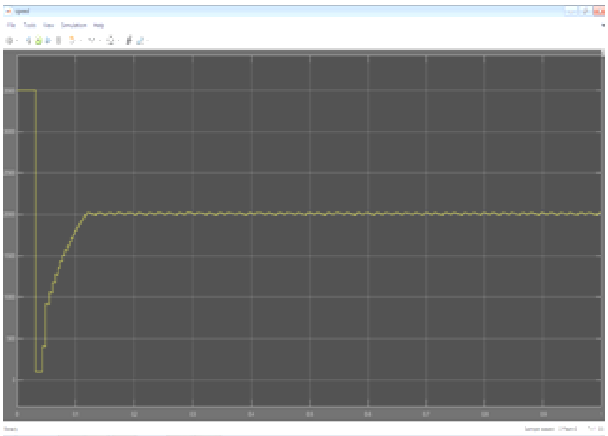
Fig 9. With Sensor Speed.

.

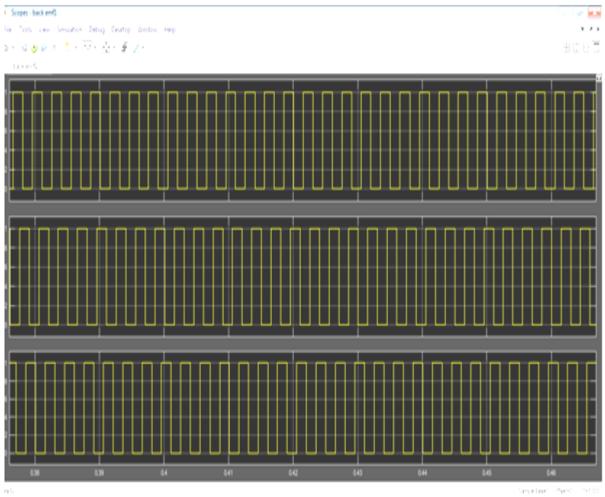
Fig 10. Back Emf.

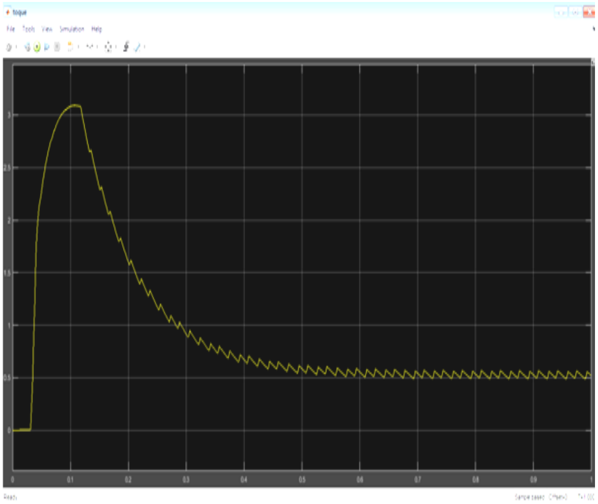

Fig 11. Back Emf.

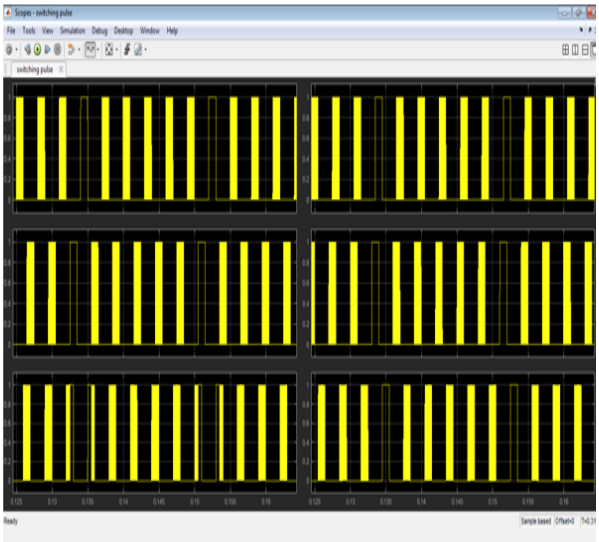

Fig 12. Switching Pulse.

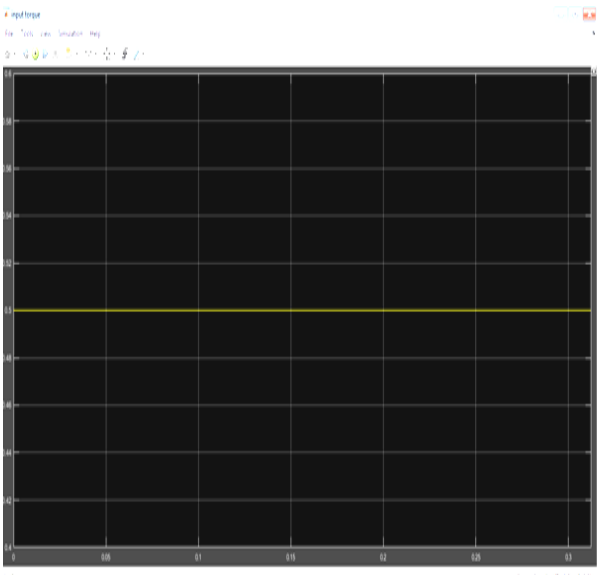

Fig 13. Input Torque.

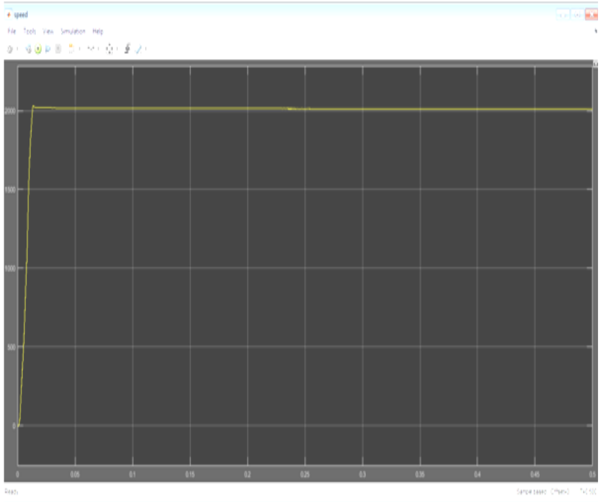

Fig 14. Without Sensor Speed.

IV. CONCLUSIONS

Position control methods for BLDC motors have been presented. The fundamentals of various techniques have been introduced, mainly back-EMF schemes and estimators, as a helpful reference for preliminary investigation of conventional methods. Advances in the position control and applications were additionally talked about. To give knowledge in control method and their benefits a categorization of existing methods and newer methods were presented with their merits and drawbacks.

From the above discussion, it is clears that the control for BLDC motors using position sensors, such as shaft encoders, resolvers or Hall-effect probes, can be enhanced by means of the reduction of these sensors to further reduce cost and improve reliability.

Furthermore, sensor less control is the only option for some applications where those sensors cannot function reliably due to harsh environmental conditions and a superior performance is necessary, mainly back-EMF schemes and estimators, as a useful reference for preliminary investigation of traditional methods. Advance in the position control and applications were also discussed

REFERENCES

[1] Hsiu- Ping Wang and Yen-Tsan Liu, "Integrated Design of SpeedSensorless and Adaptive Speed Controller for a Brushless DC Motor," IEEE Transactions on Power Electronics, Vol. 21, No. 2, March 2006.

[2] .K.S.Rama Rao, Nagadeven and Soib Taib, "Sensorless Control of a BLDC Motor with Back EMF Detection Method using DSPIC," 2nd IEEE International Conference on Power and Energy, pp. 243-248, December 1-3, 2008.

[3] W. Hong, W. Lee and B. K. Lee, "Dynamic Simulation of Brushless DC Motor Drives Considering Phase Commutation for Automotive Applications," Electric Machines & Drives Conference,2007 lEMDC'07 IEEE International, , pp. 1377-1383, May 2007.
[4] B. Tibor, V. Fedak and F. Durovsky, "Modeling and Simulation of the BLDC motor in MATLAB GUI," Industrial Electronics (lSIE), 2011 IEEE International Symposium on Industrial Electronics, Gdansk, pp. 1403-1407, June 2011.
[5] V. P. Sidharthan, P. Suyampulingam and K. Vijith, "Brushless DC motor driven plug in electric vehicle," International Journal of Applied Engineering Research, vol. 10, pp. 3420-3424, 2015.
[6] T.J.E. Miller, Brushless Permanent-Magnet and Reluctant Motor Drives, Oxford, 1989.
[7] K.Rajashekara, A.Kawamura, "Sensorless Control of Permanent Magnet AC Motor," Industrial Electronics, Control and instrumentation, 1994 IECON '94, 20th International Conference on, pp.1589-1594, September 1994.
[8] C. Cui, G. Liu and K. Wang, "A Novel Drive Method for High-Speed Brushless DC Motor Operating in a Wide Range," IEEE Transactions on Power Electronics, vol. 30, no. 9, pp. 4998-5008, September 2015.
[9] Tae-Hyung Kim and M. Ehsani, "Sensorless control of the BLDC motors from near-zero to high speeds," IEEE Transactions on Power Electronics, vol. 19, no. 6, pp. 1635-1645, November 2004.
[10] R.Krishnan, Electric Motor Drives: Modeling Analysis and Control, Prentice Hall, 2001.
[11] .Bimal K. Bose, Modern Power Electronics and AC Drives, Prentice Hall, 2002.
[12] Iizuka, K.; Uzuhashi, H.; Kano, M.; Endo, T.; Mohri,K. , Microcomputer Control for Sensorless Brushless Motor, IEEE Trans. Ind. Appl. 1985, IA-21, 595-601.
[13] Becerra, R.C.; Ehsani, M, High-Speed Torque Control of Brushless Permanent Magnet Motors, IEEE Trans. Ind. Electron. 1988, 35, 402-406.
[14] Hubik, V.; Sveda, M.; Singule, V. ,On the Development of BLDC Motor Control Run-Up Algorithms for Aerospace Application, In Proceedings of the 13th Power Electronics and Motion Control Conference (EPE-PEMC 2008), Poznan, Poland, September 2008; pp. 1620-1624
[15] Bonfe, M.; Bergo, M, A Brushless Motor Drive with Sensorless Control for Commercial Vehicle Hydraulic Pumps, In Proceedings of the IEEE International Symposium on Industrial Electronics (ISIE 2008), Cambridge, England, July 2008; pp. 612-617.