

## DR. RAJAN KUMAR

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**Tel:** +91-8882745466 (M)

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**Permanent Address:**

Village - Sarangpuri, PO - Kharenga,  
Distt. - Dhamtari (Chhattisgarh) 493773  
(India)

**Correspondence Address:**

339, Type III  
NIT Campus Hamirpur  
Himachal Pradesh 177005 (India)

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### **CURRENT EMPLOYMENT**

**Assistant Professor, Department of Electrical Engineering**  
**National Institute of Technology Hamirpur, Hamirpur (H.P.), India**

(May 2019 - present)

- Involved in teaching theory and laboratory courses to the undergraduate and postgraduate students.
  - Involved in research and development activities, and guiding Ph.D. and M.Tech. scholars.
  - Handling administrative duties as Assistant Faculty-in-Charge (AFI) and Office-in-Charge (OIC).
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### **EMPLOYMENT HISTORY**

**Deputy Manager (R&D)**

**Su-Kam Power Systems Ltd. (Gurugram, Haryana)**

(June 2017 - April 2019)

- Involved in research and development of battery charger, motor and drive for E-rickshaw.
  - Involved in design and development of single phase-bidirectional grid tie inverter (GTI) for solar PV-grid tie system (Simulation and hardware implementation).
  - Worked on implementation of emergency rescue device (ERD), providing emergency backup to the elevators.
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### **KEY SKILLS**

- Strong background in the field of **renewable energy, electric machines and drives, power converters and power quality.**
- Expertise in modeling, design and simulation of the various DC/DC, AC/DC and DC/AC power electronics converters, and the various machines and drives.
- Extensive hands-on experience in the **analysis, hardware development and testing** of the various power converters, and electric machines and drives (**DC machine, induction**

**motor, brushless DC motor, permanent magnet synchronous motor, switched reluctance motor and synchronous reluctance motor).**

- Exposure to various **digital signal processors** (TMS320F28377S, TMS320F2812, TMS320F28335, AT89C52) and other **real time controllers** (dSPACE DS-1104/1103).
- In-depth understanding of signal processing, control and implementation using **microcontrollers and digital signal processors/controllers**.
- Involved in writing the research proposal, managing and installations of 2 different projects at IIT Delhi,
  - Intelligent control of solar photovoltaic array fed water pumping systems (**Rs. 5500000**, Funded by **Department of Science & Technology**, Govt. of India)
  - Design and development of solar PV based super efficient agricultural pumps and hybrid multidimensional inverters (**Rs. 45000000**, Funded by **Ministry of Power**, Govt. of India & **Ms. Shakti Pumps Ltd.**)
- Good **communication skills** and **team-work spirit**.

### **TECHNICAL SKILLS**

- **Simulation:** MATLAB, PSpice, Multisim.
- **Programming:** C.
- **Real-Time Controllers:** DSPs, dSPACE.
- **Analog/digital circuit design:** Signal conditioning board, Gate driver circuits.

### **EDUCATION**

- 1) **Ph.D. in Electrical Engineering** with specialization in Power Electronics, Electrical Machines and Drives from **Indian Institute of Technology (IIT) Delhi**.  
Duration: 2013-2017 (4 years).
- 2) **M.Tech. in Electrical Engineering** with specialization in Power Electronics and ASIC Design from **Motilal Nehru National Institute of Technology (MNNIT) Allahabad** with CGPA of **7.9/10**.  
Duration: 2010-2012 (2 years)
- 3) **B.E. in Electrical & Electronics Engineering** from **Chhatrapati Shivaji Institute of Technology (CSIT) Durg (C.G.)** with **76.21% marks (Honors)**.  
Duration: 2005-2009 (4 years).
- 4) **Higher Secondary School (Class-XII)** from **Chhattisgarh Board of Secondary Education Raipur** with **80.4% marks** (2005).
- 5) **High School (Class-X)** from **Chhattisgarh Board of Secondary Education Raipur** with **85.5% marks** (2003).

## **HONORS AND AWARDS**

- 1) Participated in **4<sup>th</sup> BRICS Young Scientist Conclave** held in Rio de Janeiro, Brazil during 06-08 November 2019 (Selected as young scientist by the Department of Science & Technology, Govt. of India).
- 2) **Award for Best Industry Relevant Ph.D. Project** in Indian Institute of Technology Delhi, 2018 (Also includes a **cash prize of INR 30,000/-**).
- 3) **Gandhian Young Technological Innovation (GYTI) Award 2017** for an innovation entitled, “Grid Interactive Solar PV Based Water Pumping Using BLDC Motor Drive,” at Rashtrapati Bhavan, New Delhi.
- 4) **Amit Garg Memorial Research Award** for high impact publication in quality journal at the convocation 2017, Indian Institute of Technology Delhi (Also includes a **cash prize of INR 50,000/-**).
- 5) Awarded as **Star Performer** for the research & development of hybrid grid-tie-inverter at Su-Kam Power Systems Ltd. Gurugram in 2017.
- 6) Dr. Ramamoorthy **best paper award** in Power Electronics & Drives on paper entitled, “Solar PV Array Fed Water Pumping System Using SEPIC Converter Based BLDC Motor Drive,” at **Eighteenth National Power System Conference (NPSC)**, Guwahati (India), 18-20 Dec. 2014 (Also includes a **cash prize of INR 10,000/-**).
- 7) **Ministry of Human Resource Development (MHRD) assistantship** from Government of India during M.Tech. (2010-2012) and Ph.D. (2013-2017) programme.
- 8) Awarded for the first position in branch (B.E. second semester).
- 9) Many departmental and university level prizes / appreciation at various **technical, non-technical and cultural events** (2005-2012).

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## **CURRENT RESEARCH WORK**

I am currently guiding a Ph.D. student as co-supervisor and three M.Tech. students as supervisor. I have initiated my research on advanced-position sensorless-brushless DC motor drives. The primary objective is to develop various advanced-position sensorless-speed control methodologies for BLDC motor in view of its industrial-applications. Reduction of sensing elements to reduce the size and cost, torque-ripple-minimization to reduce the acoustics and vibration, enhancing the protection features to make the drive reliable and boosting the dynamic performance to operate the drive efficiently with solar PV generated power, are other objectives of the research.

The development of battery charger for electric vehicles is another area of my current research. Investigation and development of effective power converter topologies for loss minimization, and protection of switching devices are primary concerns. The causes of failure of existing chargers are being analyzed comprehensively in order to increase the robustness of the converters used in the chargers. The power factor correction (PFC)-based chargers can definitely contribute in energy conservation. Therefore, development of such charging system

is ultimate objective. I am also focusing on compensator design for grid integrated-solar photovoltaic system. The implementation of various advanced control techniques to address the power quality issue during power transfer from solar PV system to the utility grid under different operating and environmental conditions, is the current objective.

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### **PH.D. RESEARCH WORK**

**Thesis Title:** Design and Development of Solar PV Fed BLDC Motor Drives for Water Pumping.

**Supervisor:** Prof. Bhim Singh, Electrical Engineering Department, IIT Delhi.

**Abstract:** In this work, various topologies for solar photovoltaic (PV) fed water pumping are developed using a brushless DC (BLDC) motor drive. A reduced sensor based simple, efficient and cost-effective drives with fast dynamic control of speed are investigated. The system possesses a maximum power point tracking (MPPT) of PV array by introducing a DC-DC converter between the PV array and voltage source inverter (VSI) feeding the motor.

The work is extended towards an elimination of DC-DC converter and a single stage PV array fed BLDC motor drive is investigated for water pumping. In order to make a PV water pumping reliable, economical and compact, a position sensorless BLDC motor drive is developed. Furthermore, a grid interacted PV array and its control are demonstrated to get a reliable and fully utilized water pumping with BLDC motor such that the pumping is not affected by an intermittency of PV generation. The simulation, implementation and testing of all the developed topologies and their control techniques, are carried out for validation.

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### **INDUSTRIAL TRAINING / WORKSHOP**

- 10 weeks industrial training at **Bhilai Steel Plant**, Bhilai (under **Steel Authority of India Limited**).
  - 5 weeks industrial training at **Chhattisgarh State Power Generation Company Limited**, Korba (under **Chhattisgarh State Electricity Board**) (500 MW Thermal power station).
  - 1 day visit at **400 kV sub-station**, Raipur (under **Power Grid Corporation of India Ltd.**).
  - 1 day visit at **400 kV sub-station & Load Dispatch Centre**, Bhilai (under **Chhattisgarh State Electricity Board**).
  - 3 days skill development program on Varun (**Solar Water Pumping**) conducted by **National Institute of Solar Energy**, Gurgaon, Haryana (under **Ministry of New and Renewable Energy**, Govt. of India).
  - 1 day workshop on **Shine Rural India with Renewable Technology**, organized by IEEE and IIT Delhi.
  - 1 day hands-on workshop on **DESIGNSPARK PCB** organized by **Rawelcom Services India** at IIT Delhi.
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**PATENTS / PUBLICATIONS / STC & FDP ORGANISED / EXPERT TALKS /  
TECHNICAL PRESENTATIONS**

- **3 Patents.**
- **27 papers** published in various **International Journals** and **Conference Proceedings.**
  - International Journals (IEEE / IET): 9
  - International Conferences: 16
  - National Conferences: 2
- **2 STC/FDP** Organized
- **4 Expert Talks** at various programs and training courses.
- **16 Technical presentations** at various international conferences and technical events.

**PROFESSIONAL AFFILIATIONS**

- Professional Member of **IEEE** (Institute of Electrical and Electronics Engineers).
- Associate Member of Institution of Engineers (India) [**IEI**].
- Reviewer of various international journals such as IEEE, IET and IETE.

**PERSONAL DETAILS**

- **Father's Name:** Shri Umraw
- **Date of Birth:** December 1, 1987
- **Place of Birth:** Bharari, Dhamtari (C.G.), India
- **Nationality:** Indian
- **Language Known:** English, Hindi, Chhattisgarhi (S/W/R)
- **Sex/Marital Status:** Male/Married
- **Hobbies:** Chess & Badminton, writing Hindi poems, listening songs

**REFERENCES**

- |                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                       |
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| <p>1) <b>Prof. (Dr.) Bhim Singh,</b><br/>(FIEEE, FIE (E), FIET, FIETE, FINAE, FINSA, FNSc, FTWAS)<br/>Department of Electrical Engineering,<br/>Indian Institute of Technology Delhi,<br/>Hauz Khas, New Delhi-110016 (India)<br/>Tel: + 91-9811502125 (M)<br/>Email: bsingh@ee.iitd.ac.in</p> | <p>2) <b>Prof. (Dr.) G. Bhuvaneswari,</b><br/>(FIEEE, FIE (I), FINAE, FIET, FIETE, LMISTE)<br/>Department of Electrical Engineering,<br/>Indian Institute of Technology Delhi,<br/>Hauz Khas, New Delhi-110016 (India)<br/>Tel: +91-9912299714(M)<br/>Email: bhuvan@ee.iitd.ac.in</p> |
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I hereby, declare that the information furnished above is true to the best of my knowledge.

Dated: March 31, 2021

(Rajan Kumar)

**LIST OF PATENTS / PUBLICATIONS / STC & FDP ORGANISED / EXPERT  
TALKS/ TECHNICAL PRESENTATIONS**

**Patents (3)**

- [1] Bhim Singh and **Rajan Kumar**, “Water pumping system with solar photovoltaic array fed brushless DC motor and a method thereof,” **Indian Patent No.** 201611002791 Filed on: 25 January 2016.
- [2] Bhim Singh and **Rajan Kumar**, “A grid interactive solar photovoltaic based water pumping system and method thereof,” **Indian Patent No.** 201611033785 Filed on: 03 October 2016.
- [3] Bhim Singh and **Rajan Kumar**, “A Method and System for Single Stage Solar PV Fed Water Pumping Using Sensorless BLDC Motor,” **Indian Patent No.** 201811029383 Filed on: 04 August 2018.

**International Journals (IEEE / IET) (9)**

- [1] **Rajan Kumar** and Bhim Singh, “BLDC Motor-Driven Solar PV Array-Fed Water Pumping System Employing Zeta Converter,” *IEEE Transactions on Industry Applications*, vol. 52, no. 3, pp. 2315-2322, May-June 2016.
- [2] **Rajan Kumar** and Bhim Singh, “Single Stage Solar PV Fed Brushless DC Motor Driven Water Pump,” *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 5, no. 3, pp. 1377-1385, Sept. 2017.
- [3] **Rajan Kumar** and Bhim Singh, “Grid Interactive Solar PV-Based Water Pumping Using BLDC Motor Drive,” *IEEE Transactions on Industry Applications*, vol. 55, no. 5, pp. 5153-5165, Sept.-Oct. 2019.
- [4] **Rajan Kumar** and Bhim Singh, “Solar PV Powered BLDC Motor Drive for Water Pumping Using Cuk Converter,” *IET Electric Power Applications*, vol. 11, no. 2, pp. 222-232, February 2017.
- [5] **Rajan Kumar** and Bhim Singh, “Brushless DC motor-driven grid-interfaced solar water pumping system,” *IET Power Electronics*, vol. 11, no. 12, pp. 1875-1885, October 2018.
- [6] **Rajan Kumar** and Bhim Singh, “Solar PV Powered-Sensorless BLDC Motor Driven Water Pump,” *IET Renewable Power Generation*, vol. 13, no. 3, pp. 389-398, Feb. 2019.
- [7] Bhim Singh and **Rajan Kumar**, “Solar photovoltaic array fed water pump driven by brushless DC motor using Landsman converter,” *IET Renewable Power Generation*, vol. 10, no. 4, pp. 474-484, April 2016.
- [8] Bhim Singh and **Rajan Kumar**, “Simple brushless DC motor drive for solar photovoltaic array fed water pumping system,” *IET Power Electronics*, vol. 9, no. 7, pp. 1487-1495, June 2016.
- [9] Bhim Singh, Anjanee Kumar Mishra and **Rajan Kumar**, “Solar Powered Water Pumping System Employing Switched Reluctance Motor Drive,” *IEEE Transactions on Industry Applications*, vol. 52, no. 5, pp. 3949-3957, Sept.-Oct. 2016.

### International Conferences (16)

- [1] **Rajan Kumar**, Asit Mohanty, Soumya R. Mohanty and Nand Kishor, "Power quality improvement in 3-phase grid connected photovoltaic system with battery storage," *IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, 16-19 Dec. 2012, pp.1-6.
- [2] **Rajan Kumar** and Bhim Singh, "Solar photovoltaic array fed canonical switching cell converter based BLDC motor drive for water pumping system," *Annual IEEE India Conference (INDICON)*, 11-13 Dec. 2014, pp.1-6.
- [3] **Rajan Kumar** and Bhim Singh, "Solar photovoltaic array fed Luo converter based BLDC motor driven water pumping system," *9th International Conference on Industrial and Information Systems (ICIIS)*, 15-17 Dec. 2014, pp.1-5.
- [4] **Rajan Kumar** and Bhim Singh, "Buck-boost converter fed BLDC motor drive for solar PV array based water pumping," *IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, 16-19 Dec. 2014, pp.1-6.
- [5] **Rajan Kumar** and Bhim Singh, "Solar PV Array Fed Cuk Converter-VSI Controlled BLDC Motor Drive for Water Pumping," *6th IEEE Power India International Conference (PIICON)*, 5-7 Dec. 2014, pp.1-7.
- [6] **Rajan Kumar** and Bhim Singh, "BLDC Motor Driven Solar PV Array Fed Water Pumping System Employing Zeta Converter," *6th IEEE India International Conference on Power Electronics (IICPE)*, 8-10 Dec. 2014, pp.1-6.
- [7] Bhim Singh, Anjane K. Mishra and **Rajan Kumar**, "Solar Powered Water Pumping System Employing Switched Reluctance Motor Drive," *6th IEEE Power India International Conference (PIICON)*, 5-7 Dec. 2014, pp.1-6.
- [8] **Rajan Kumar**, Bhim Singh, Ambrish Chandra and Kamal Al-Haddad, "Solar PV array fed water pumping using BLDC motor drive with boost-buck converter," *IEEE Energy Conversion Congress and Exposition (ECCE)*, 20-24 Sept. 2015, pp.5741-5748.
- [9] Bhim Singh, Anjane K. Mishra and **Rajan Kumar**, "Buck-boost converter fed SRM drive for solar PV array based water pumping," *IEEE IAS Joint Industrial and Commercial Power Systems / Petroleum and Chemical Industry Conference (ICSPCIC)*, Hyderabad, India, 2015, pp. 153-160.
- [10] **Rajan Kumar** and Bhim Singh, "BLDC motor driven water pump fed by solar photovoltaic array using boost converter," *Annual IEEE India Conference (INDICON)*, New Delhi, India, 2015, pp. 1-6.
- [11] **Rajan Kumar** and Bhim Singh, "Solar PV-battery based hybrid water pumping system using BLDC motor drive," *IEEE 1st International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES)*, Delhi, India, 2016, pp. 1-6.
- [12] Bhim Singh and **Rajan Kumar**, "Solar PV Array Fed Brushless DC Motor Driven Water Pump," *IEEE 6th International Conference on Power Systems (ICPS)*, New Delhi, India, 2016, pp. 1-5.
- [13] **Rajan Kumar** and Bhim Singh, "Grid interfaced solar PV based water pumping using brushless DC motor drive," *IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, Trivandrum, 2016, pp. 1-6.

- [14] **Rajan Kumar** and Bhim Singh, “Grid Interactive Solar PV Based Water Pumping Using BLDC Motor Drive,” *IEEE 7th Power India International Conference (PIICON)*, Bikaner, Rajasthan, India, 2016, pp. 1-6.
- [15] **Rajan Kumar** and Bhim Singh, “Grid Interfaced Solar PV Powered Brushless DC Motor Driven Water Pumping System,” *IEEE 7th India International Conference on Power Electronics (IICPE)*, Patiala, India, 2016, pp. 1-5.
- [16] **Rajan Kumar** and Bhim Singh, “Position Sensorless BLDC Motor Drive for Single Stage PV Based Water Pumping,” *IEEE 5th International Conference on Computing, Communication and Automation (ICCCA)*, Greater Noida, India, 2020, pp.634-639.
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#### National Conferences (2)

- [1] **Rajan Kumar** and Bhim Singh, “Solar PV Array Fed Water Pumping System Using SEPIC Converter Based BLDC Motor Drive,” *Eighteenth National Power System Conference (NPSC)*, 18-20 Dec. 2014, pp.1-5.
- [2] Bhim Singh, G. Bhuvaneswari, Kirti Mathuria, Arun Kumar Verma, **Rajan Kumar**, Ambrish Chandra and Kamal Al-Haddad, “Performance Analysis of a Common DC Link Series Active Compensator Integrated with Double Series Diode Rectifier,” *Eighteenth National Power System Conference (NPSC)*, 18-20 Dec. 2014, pp.1-5.
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#### Short-Term Courses (STC)/Faculty Development Programs (FDP) Organized (02)

- [1] Organized a Five-Days Online Short-Term Course (e-STC) on “Advancements in Optimization of Power Generation, Drives and Control System” as **Coordinator** during 16 - 20 November 2020 at NIT Hamirpur.
- [2] Organized a Five-Days Online Faculty Development Program (e-FDP) on “Recent Trends in Intelligent Control Techniques for Renewable Energy Systems and Electric Vehicles” as **Treasurer** during 12-16 October 2020 at NIT Hamirpur.
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#### Expert Talks (05)

- [1] Online Faculty Development Program on “Recent Trends and Advances in Renewable Energy Sources,” jointly organized by Rajasthan Technical University Kota and Poornima College of Engineering Jaipur, during 18-22 February 2021.
- [2] Online Short Term Course on “Research Trends in Energy and Power Systems (RTEPS),” organized by Maulana Azad National Institute of Technology Bhopal, India, during 19-23 October 2020.
- [3] Online Short Term Training Program on “Recent Advances in power Electronics and Its Applications,” organized by Jabalpur Engineering College, Jabalpur, India, during 22-26 September 2020.
- [4] Online Short Term Training Program on “Sustainable Energy Systems Design for Remote Villages in India,” organized by National Institute of Technology Raipur, India, during 14-18 September 2020.



- [5] Online Short Term Course on “Emerging Trends in Power and Energy Systems,” organized by Gautam Buddha University, Greater Noida, during 24-28 August 2020.

### Technical Presentations (16)

- [1] Presented a poster entitled, “Solar PV Array Fed Water Pumping System Using Brushless Motor Drives,” in *Open House 2016* event organized by **IIT Delhi**.
- [2] Presented a paper entitled, “Solar PV Array Fed Brushless DC Motor Driven Water Pump,” in *6<sup>th</sup> IEEE International Conference on Power Systems (ICPS)*, 2016.
- [3] Presented a paper entitled, “BLDC Motor Driven Water Pump Fed by Solar Photovoltaic Array Using Boost Converter,” in *12th IEEE India International Conference (INDICON)*, 2015.
- [4] Presented a paper entitled, “PFC bridgeless converter for welding power supply with improved power quality,” in *IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, 2014.
- [5] Presented a paper entitled, “Improved power quality switched mode power supply using buck-boost converter,” in *IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, 2014.
- [6] Presented a paper entitled, “Experimental implementation of a Doubly Fed Induction Generator used for Voltage Regulation at a remote location,” in *IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, 2014.
- [7] Presented a paper entitled, “Performance evaluation of an isolated system using PMSG based DG set, SPV array and BESS,” in *IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, 2014.
- [8] Presented a paper entitled, “Buck-boost converter fed BLDC motor drive for solar PV array based water pumping,” in *IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, 2014.
- [9] Presented a paper entitled, “Solar PV Array Fed Cuk Converter-VSI Controlled BLDC Motor Drive for Water Pumping,” in *6th IEEE Power India International Conference (PIICON)*, 2014.
- [10] Presented a paper entitled, “BLDC Motor Driven Solar PV Array Fed Water Pumping System Employing Zeta Converter,” in *6th IEEE India International Conference on Power Electronics (IICPE)*, 2014.
- [11] Presented a paper entitled, “Power quality improvement in 3- $\Phi$  grid connected photovoltaic system with battery storage,” in *IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES)*, 2012.
- [12] Presented a paper entitled, “Solar PV-Battery Based Hybrid Water Pumping System Using BLDC Motor Drive,” in *IEEE First International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES)*, 2016.
- [13] Presented a paper entitled, “Grid Interfaced Solar PV Powered Brushless DC Motor Driven Water Pumping System,” in *7th IEEE India International Conference on Power Electronics (IICPE)*, 2016.

- [14] Presented a paper entitled, “Power Quality Assessment of Modern Residential Load,” in *7th IEEE India International Conference on Power Electronics (IICPE)*, 2016.
- [15] Presented a paper entitled, “Grid Interactive Solar PV Based Water Pumping Using BLDC Motor Drive,” in *7th IEEE Power India International Conference (PIICON)*, 2016.
- [16] Presented a paper entitled, “Position Sensorless BLDC Motor Drive for Single Stage PV Based Water Pumping,” in *IEEE 5th International Conference on Computing, Communication and Automation*, 2020.
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