كلية الهندسة
College of Engineering
QATAR UNIVERSITY جامعة قطر

ELECTRICAL ENGINEERING DEPARTMENT NEWSLETTER

EED NEWSLETTER

INSIDE THIS ISSUE:

Editorial Team:
- Prof. Adel Gastli
- Prof. Farid Touati
- Dr. Khawla Alzoubi
- Eng. Mohamed Elsayed

Message from the Head of the Department

Dr. Nasser Al-Emadi
Head of the Department

Year 2018 has end and left two mixed feelings in my heart. In one hand, I feel sad because of the demise of one of our best faculty member Prof. Mohieddine Benammar who passed away while struggling with his cancer. Despite his sickness, Prof Mohieddine was a very active and talented academician who has made lot of achievements for the Department, College, University, Society and Profession. He was loved by his students and colleagues. Peace be on his soul and we pray God to forgive his sins and award him his heavens.

On the other hand, I feel very proud and happy of the department great achievements. Indeed, during this year, the Department has developed and submitted a proposal for a new Mechatronics program, which is a multi- and inter-disciplinary undergraduate program involving computer and mechanical engineering disciplines in addition to electrical and electronics engineering. This proposal is still under review by the University higher administration. Besides, the department was able to publish 106 Journal papers and 66 conference papers in addition to 4 patents and 1 books and book chapters. The Department maintained its quality assurance process by assessing its Students' Outcomes according to its assessment plan and new ABET accreditation requirements.

I congratulate all the faculty, staff and students in the department for their great achievements wishing them a good continuation.

I hope that you will enjoy reading this new issue of our newsletter.

EE Program Ranking

- Qatar University (QU) was chosen as one of the top 400 universities worldwide in electrical and electronic engineering in Quacquarelli Symonds' (QS) World University Ranking by subject. QS ranks world's top universities in individual subject areas, covering 48 subjects as of 2018.
- The 2019 Times Higher Education (THE) Subject Ranking, QU ranked as 176-200 in Engineering and Technology.
- Shanghai Ranking's Global Ranking of Academic Subjects 2018, QU Ranked as 48 in Telecommunication Engineering.

QS WORLD UNIVERSITY RANKINGS by subject

THE WORLD UNIVERSITY RANKINGS

ACADEMIC RANKING OF WORLD UNIVERSITIES SINCE 2003

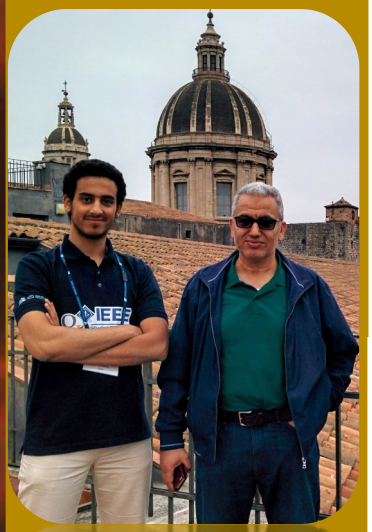
Loss of an Imminent Faculty Members: Prof. Mohieddine Benammar

It is with deep sadness that the Electrical Engineering Department (EED) has lost on Saturday 3rd of November 2018 December one of its imminent faculty members and bright scholars Prof. Mohieddine Benammar. The Later was a leader in electronic instrumentation and was a great contributor to his field, mentor to his students, research assistants and postdocs, and colleague to the EED faculty and staff.

We extend our heartfelt condolences to his family and we pray to Allah to grant him the highest place in paradise.

Words from one of his Students and Research Assistant

Engr. Sharief Saleh



Back in 2012, I was a mechanical engineering freshman student. I was very disoriented as I was considering shifting my discipline to computer or electrical engineering. This disorientation remained, until one friend suggested to meet the head of EE department and ask for his opinion. This marked the first day I met Professor Mohieddine Benammar, the former head of the EE department. My memories of this day are still vivid, as he spent 45 minutes with me discussing what electrical engineers do! Right after that meeting, I found myself, involuntarily, registering for "Circuits I" and "Digital Systems" for the next fall. Fast forward to 2014, I had my first course with him, "Electronics Engineering", where I was stunned by the way he taught the course! He was full of energy, excitement and passion! You can literally see it in his eyes! He was more concerned with students understanding his lectures than memorizing them. He was also open minded, as I remember one time, by the mid of the semester, he uploaded the course project, which I did not like much. So, I went to his office, and told him that straight way. I was struck by his openness as he told me in an excited tune, "Very well! Why not having another project for you. Gather your group at my office in 20 minutes and let us discuss a new project that I have for you!". Prof. Mohieddine had also supervised my Senior Design Project, during which I discovered, by chance, that he was battling with cancer for four years already! It was very surprising to me as he was thriving both physically and spiritually during the past 1.5 years, in which I was very close to him. Prof. Mohieddine was very supportive and pushed us to our limits. He taught us the bases of troubleshooting, as he was extremely talented troubleshooter. The project was published in a conference as a research paper. The conference took place in Sicily, Italy, 2016. During our stay period in Italy, he was more of a father to us. He advised us to network with other professors and literally took us by the hands to introduce us to them. Two years later, he supervised my Master thesis. As always, he was incomparably knowledgeable & insightful! We used to discuss ideas in the morning and then I would stay days at the university all night to prove our ideas correct, that delighted him a lot. I remember one night, 9:45 PM, when I proved that the central idea of my thesis; one of his finest ideas, was actually working, I wrote him a letter mentioning, "Your idea is 100% working!!", and attached it to his office door for him to see it the first thing in the morning. He told me then, "You remind me of my self back when I was pursuing my PhD, I used to come early in the morning while they were opening the doors of the university and go back home while the security guards were pushing me out of it late in the night".

Prof. Mohieddine had a strategic vision regarding every decision we took in my thesis. In addition, he was persistently optimistic. As whenever we got stuck at some point he used to say, "No Sharief, there should be a solution!", and kept trying until it worked. I learned a LOT from his attitude. Prof. Mohieddine was also my mentor during his last NPRP project this year, 2018. It was the same year which he resumed back his chemotherapy and it had taken its toll on him. Yet, he persevered even harder! He had an enormous strength as he stood tall! He manifested his kindness and cheerfulness by supporting us through hardships that we go through in our project or in our personal lives. His manners resembled his pure parental attitude through love, patience and support. Two weeks before his tragic demise, I was in a meeting with him when he showed me a very old box, dating back to 1989, that contained the sensors he developed during his PhD. He illustrated the design steps and

> **"Life is all about trade-offs"**
>
> **Prof. Mohieddine**

difficulties he passed by. Out of a sudden, I turned to him with a sparkling eyes and said, "Prof. Mohieddine, I love you a lot, and I really want to be like you one day :')". I really meant every single word, and it was not the first time to express how much I loved him during the past years after all. He smiled as he replied, "InshAllah you will be better than me Sharief". That was very motivational. Lastly, again, as it all started 6 years ago, during one of my last meetings with him, he changed my mind and saved me from the disorientation state I was in once more and convinced me to venture into the worlds of artificial intelligence and machine learning.

Prof. Mohieddine was not only a professor, instructor, mentor or supervisor... He was a father, a real one indeed! I was by his side during his last moments at the hospital, and Allah knows how hard these moments were for me and for all attendants… After all, it is hard to lose a "father". He left peacefully leaving behind an arsenal of students that believes in the power of knowledge as the main driving force for change.

Words from a Close Friend and Colleague

Prof. Lazhar Ben-Brahim

We were so disheartened by the

sad demise of our colleague Prof. Mohieddine. It is a big loss for his family, colleagues, students, the EE Department, the college and the university as a whole. For me it was a loss of a brother, a friend, and a colleague.

We arrived in Doha in 1997, he came from Tunisia and I came from Japan. We both joined the college of Technology (later named as Qatar College of technology). We were very close friend since that time, we were neighbors and colleagues at work. We served in the college of Technology for 8 years. In 2005, we joined the College of Engineering were Dr. Mohieddine served up to his death on November 3rd 2018.

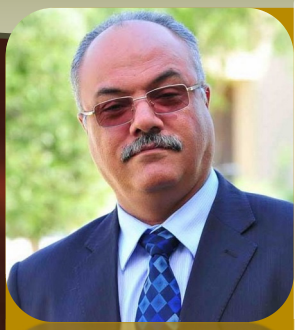
He was Head of the Department of Electrical Engineering, Qatar University, and we served together as chairs of Industrial Electronics for six years, a position funded by RasGas company at Qatar University. Dr Mohieddine have made outstanding contributions to the electrical and electronics engineering profession in general and has developed several techniques for use in instrumentation, sensors, and other fields. All this has been published in over 100 papers in top journals and conferences, and eight U.S./U.K. patents. He won many award from the Qatar health ministry for developing several successful electronics medical equipment for Hamad Medical Hospital.

Beside his scientific contribution to the research field, Prof. Mohieddine managed the EE Department where he had an impact and created an environment of trust and happy workplace for all staff. He led by example and put efforts into showing the very best practice, and well behaving. He praised his good staff and always believe that the staff are most valuable resource for the department, therefore, he used to defend them whenever needed. Prof. Mohieddine was a humble man, listening to the opinion of colleagues, students and other and accepting criticism when necessary and learning from all of it. I cannot say in words what he has done for the QU. I think we lost him but we did not lose him as a model in our life.

In 2012, Dr. Mohieddine was diagnosed with cancer. Since that time it was a "struggle for life", that is what he used to call it. He went through several treatment but the cancer spread over all his body. For almost 6 years, you hardly notice that he is sick and he never slowed down in his teaching, research, service activities and efforts. He rarely missed meetings and lectures. He was working hard and with enthusiasm until the last working day of his life Thursday 1st of November 2018. That is why his death came as a shock. We met briefly on Wednesday and Thursday. On Saturday morning November 3rd, my colleague Dr Sadiq Mahdi (Head of Mechanical Department) called me to ask about Dr. Mohieddine health as he saw in the morning the ambulance in front of his house. I picked the phone and called him, but no answer, I called his family and they told that he is in the emergency. I went there with other colleagues around 9 am. He was in critical condition. We stayed close to him the whole day and he passed away at around 4pm. It was one of the saddest moment in my life as I lost one of my best friends in this life. In 21 years of working together and having daily interaction, I still remember him for his generosity, warm spirit and kind friendship. We were very fortunate to have worked with him in the department and we warmly remember his enthusiastic and skillful support to the department. He was a very kind person who was always willing to give his time and knowledge to help in promoting research and education and hope that we can continue his good work. He will be greatly missed by family, friends, students, and colleagues.

Finally, we ask Allah, to forgive our brother Mohieddine and elevate him among those who are guided. Send him along the path of those who came before, and forgive him and us. Enlarge for him his grave and shed light upon him in it.

New Undergraduate Program Proposal



Prof. Adel Gastli

**Professor
Electrical Engineering Department at Qatar University**

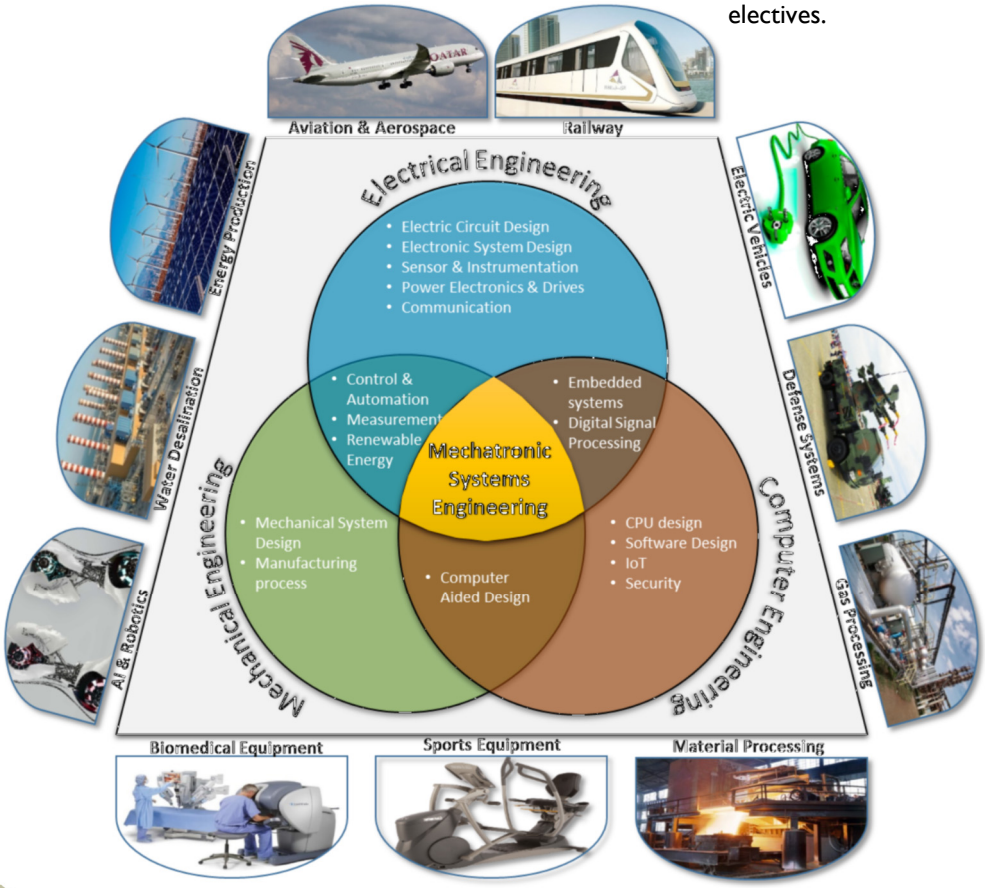
BSc in Mechatronic Systems Engineering

The Electrical Engineering Department in collaboration with the Computer Science and Engineering and Mechanical and Industrial Engineering Departments is proposing a new multidisciplinary undergraduate engineering program: **Mechatronic Systems Engineering**. This program integrates electric, electronics, mechanics, computer science and control theory. Through this proposed program, students will actively engage with the industry to do joint projects. Such interactions allow students to form relationships with the industry early, which provides them with a head start, even before they graduate and prepare them for the Fourth Industrial Revolution (Industry 4). Indeed, it is necessary to transform the ways we teach and communicate research to reflect the new age of digital disruption that we are now living in. In adapting to Industry 4, we will be best placed to produce graduates who have the skills to adapt to and take on the new opportunities and challenges.

Program Proposed Structure

A minimum of 131 credit hours are required to complete the major in Mechatronic Systems Engineering, including the following:

- A minimum of 33 credit hours in core curriculum requirements.
- A minimum of 27 credit hours of college requirements.
- A minimum of 59 credit hours of major requirements.
- A minimum of 12 credit hours of major electives.



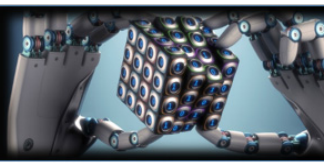
"Students learn to use their knowledge from different fields of engineering and put everything together to **produce a mechatronics system controlled by automation to help people work more efficiently and increase the quality of life**. Mechatronics systems are perfect to handle 3D (Dirty, Dull, Dangerous) jobs, which will help a company improve productivity, reduce risk to humans and ultimately enhance profits."

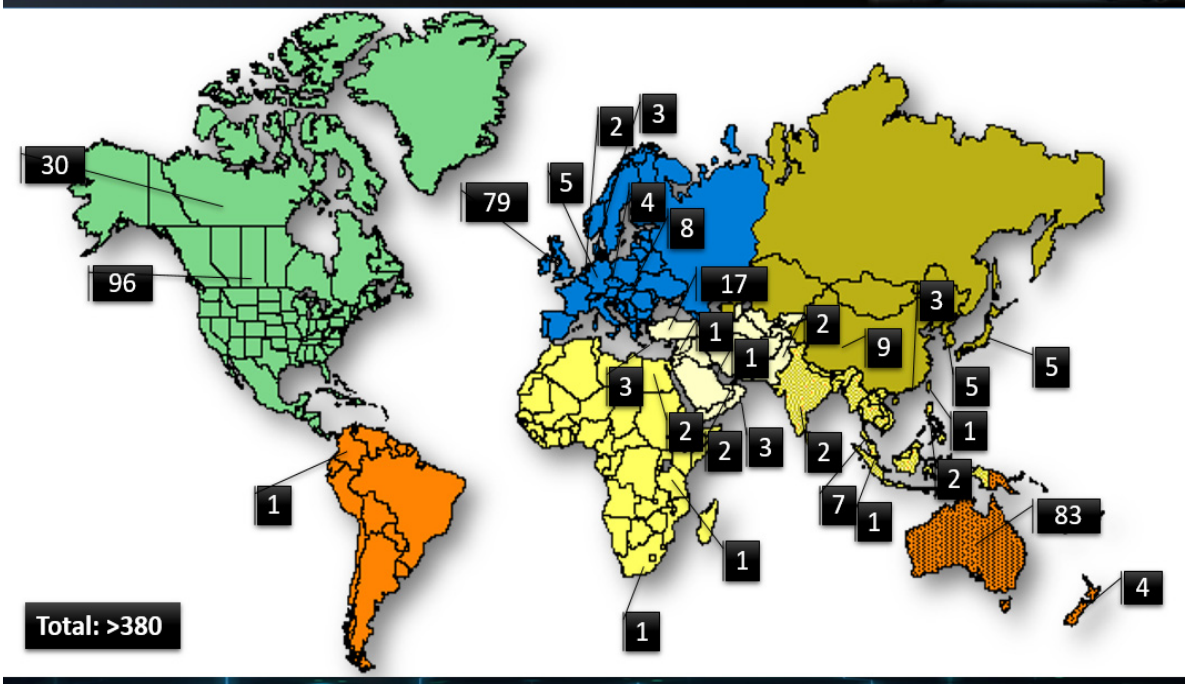
By Monash University Malaysia Pro Vice Chancellor and president Professor Andrew Walker

ABET

ABET already accredited 26 Mechatronics Engineering Programs around the world.
(e.g. One at Sultan Qaboos University, Sultanate of Oman)

MECHATRONICS ENGINEERING PROGRAMS AROUND THE GLOBE





Proposing New Major Elective Courses

Dr. Ahmed Massoud

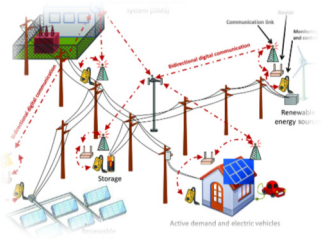
Associate Professor Electrical Engineering Department at Qatar University

In order to cope with new trends and emerging technologies in the fields and branches of electrical engineering, the Department of Electrical Engineering proposes new major elective courses to the Electrical Engineering program. The main objectives of these proposed major electives courses are:

1. To cope with the new trends and emerging technologies in the electrical engineering arenas.
2. To serve the mission of Qatar University correspondingly the mission of both the College of Engineering and the Department of Electrical Engineering.
3. To support the needs and requirements of the labor market in Qatar.
4. To be in-line with Qatar National Vision 2030.
5. To be in-line with the changes introduced by the Engineering Accreditation Commission of ABET.

The proposed courses are listed as follows:

- Renewable Energy Sources in Distribution Systems.: This



course addresses the following topics: Conventional electrical distribution systems. Advanced energy distribution systems challenges. Loads nature. Harmonics in electrical distribution systems. Voltage regulation in electrical distribution systems. Fault current levels. Distributed generation. Inverter-based distributed generation. Fault current limiter. Grid-connected converters for renewable energy sources. Island mode of operation. Island detection.

- Optical Electronics in Modern Communications: This course

covers thorough engineering analysis and components for a proper design of optical fiber communications systems. Learn about system evolution and architectures, optical fibers, optical sources, optical receiver operation, digital transmission systems, WDM concepts and components, optical amplifiers, optical networks (SONET/SDH), measurements in optical systems (attenuation, dispersion, optical spectrum analyzers). Students for term-projects, homework, and free design projects will intensively use CAD tools for design and simulation of optical component and systems.

- Solar Electricity System Design: This course addresses

the following topics: Concepts of solar electricity systems in general and photovoltaic systems in particular and their impacts as engineering solutions in global, economic, environmental, and societal contexts. Technical design, economic analysis, environmental impacts, hazards, and viability of photovoltaic system applications.

- Transportation Electrical Systems : This course covers selected topics in the field of transportation engineering (e.g., railway, aviation, marine, etc.) that deal with concepts, new trends, prac-

tical issues, and applications from electrical engineering aspects

- Fundamentals of Secure Communications: This course addresses the following topics: Communication security mechanisms based on cryptography: security evaluation criteria and the mathematical constructs

underlying cryptographic primitives; Fundamental security challenges in wireless communications: the physical layer, modulations, and higher layers protocols; Applied aspects practice with hands-on exercise labs.

- Optimization and Machine Learning: This introductory course aims to present an overview of crucial concepts, methods, and algorithms in optimization and machine learning, starting with fundamentals of optimization (in the concept of ML), supervised and unsupervised learning, classification, and linear regression. The focus will then be drawn on more recent topics such as Evolutionary Optimization, Support Vector Machines, Artificial Neural Networks, and Convolutional Neural Networks. The course will give the student the basic ideas and intuition behind modern machine learning methods as well as a bit more formal understanding of how, why, and when they work. Selected applications will be covered in data mining, 1D/2D signal analysis, and pattern recognition.

- Satellite Communications: This course covers the following: Introduction to satellite systems: types of satellites, satellite orbits, orbital mechanics, frequencies, constellations; Electro-Magnetic propagation: plane wave propagation, polarization; Link budget: orbit effects, atmospheric effects; Antenna design; Transceiver design: satellite modulations, transponder multiplexing, satellite receivers, noise and interference figures, uplink and downlink designs; Satellite applications: GPS, DVB-S2, CubeSat.

- Protection of Power Systems: This course addresses the following topics: Type of Faults, Symmetrical and unsymmetrical faults, Sequence networks, Instrument transformers, circuit breakers and fuse , Protection strategies, zones of protection, Distance Protection, Differential protection, Generator Protection, Transmission line Protection, radial system protection, Overcurrent Protection, and coordination.

Proposal of Graduate Certificate in Smart Grids

Dr. Nader Meskin

Associate Professor Electrical Engineering Department at Qatar University

Program Overview

The graduate certificate on smart grids is intended to be a one-year program that contains essential foundational courses in the emerging field of smart grids with the main aim of post-bachelor preparation for the engineering of modern smart grid power systems and to educate engineers to meet the challenges of the future grid. The program covers the communication, control, and renewable energy sources and power system technologies that are essential for understanding the evolving power grids toward more smart grids. It will also cover the fundamental of renewable energy resources and their grid-integration in order to have a reliable grid. Students should pass all offered four courses (i.e. A total of 12 credits).

Educational Goals of the Program

This certificate is designed for electrical engineers and it is ideal for power industry engineers who aim to move up within their organization or other engineers who want to enter the power industry.

Needs for the Program

The importance of the national electric grid cannot be overstated as it constitutes a key driver for the economic growth, and a critical component of the country energy security. Upgrading the electrical power grid becomes a necessity due to: 1) the change of electricity generation mix (renewable-energy target stated in QNV 2030); 2) the uprising information and control technologies; and 3) better management of the demand side to reduce consumption.

The objectives of the future (known also as smart) grid are to fulfill the following points:

- Increase sustainability through additional clean energy and energy-efficient resources;
- Promote energy affordability to maintain economic prosperity;
- Improve grid reliability for daily operations and resilience to different hazards;
- Enhance security from an increasing and evolving number of threats; and
- Support grid flexibility to provide an array of emerging services.

The ultimate aim of the proposed graduate certificate is to prepare and educate the engineers for the up-coming challenges in having a smart grid infrastructure in the state of the Qatar.

Most of the world existing electricity power systems that have been serving us for a long time will soon reach their limitations. The majority of those traditional electricity power grids are neither designed in purpose to comply with rapidly climate changes and the demand for a high energy-efficiency nor use the latest technologies. That is why smart grid will be soon put into practice in Qatar and


Qatar Smart Grid

many other countries in the region. Smart Grid uses new technologies to reduce the environmental impact of power grid, energy conservation and increase efficiency, renewable energy utilization. The emerging clean-energy smart grid environment in the electric power sector has necessitated that related educational programs evolve to meet the needs of employers. In order to prepare the next generation of power engineering professionals to meet the challenges ahead in the electric power sector, a graduate certificate in Smart Grids is proposed that includes core power engineering principles coupled with emerging aspects of smart grid technologies and clean energy integration.

Relation to the University Mission and Strategic Plan

Qatar University mission states that "Qatar University is the national institution of higher education in Qatar. It provides high quality undergraduate and graduate programs that prepare competent graduates, destined to shape the future of Qatar. The university community has diverse and committed faculty who teach and conduct research, which addresses relevant local and regional challenges, advances knowledge, and contributes actively to the needs and aspirations of society". The proposed graduate certificate program contributes to the three main pillars of QU's mission (1) the provision of high quality graduate programs; (2) research addressing the local and regional challenges; and (3) contributing to the needs and the aspirations of the society.

The certificate program will contribute to the university's mission by supporting, the first three key performance areas:

- Maximize student success in becoming competent graduates by providing high quality education.
- Address contemporary challenges and advance knowledge through quality research.
- Integrate Qatar University with the community to support social, economic and cultural development.

Kahramaa Green Car Charging Stations

Faculty Achievements & Activities

Dr. Nizar Zorba

Professor Electrical Engineering Department at Qatar University

Unmanned Aerial Vehicles

The electrical engineering department at Qatar University has hosted a visit from an executive from Boeing based in Qatar to discuss on recent advances in Unmanned Aerial Vehicles (UAV), and on their application for Air Quality monitoring in Qatar. On the basis of a joint project between Boeing and Qatar University, the students have developed a UAV and mounted a wide range of sensors to it. Boeing provided funding to the project as well as guidance and mentoring by Mr. John C. Wilson from Boeing Global Services. A detailed presentation about the current state of the art as well as the recent developments have been tackled. Then they moved to a discussion about the employed hardware and future targets to make the designed UAV more commercial and implemented in realistic systems. Many students attended the presentations and discussions showing high interest in the presented topics.

Dr. Atif Iqbal

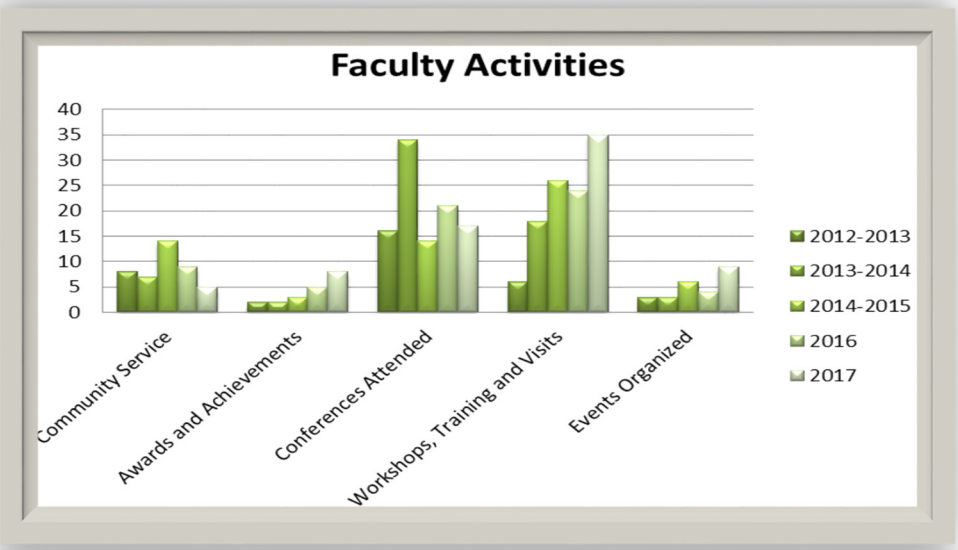
Associate Professor Electrical Engineering Department at Qatar University

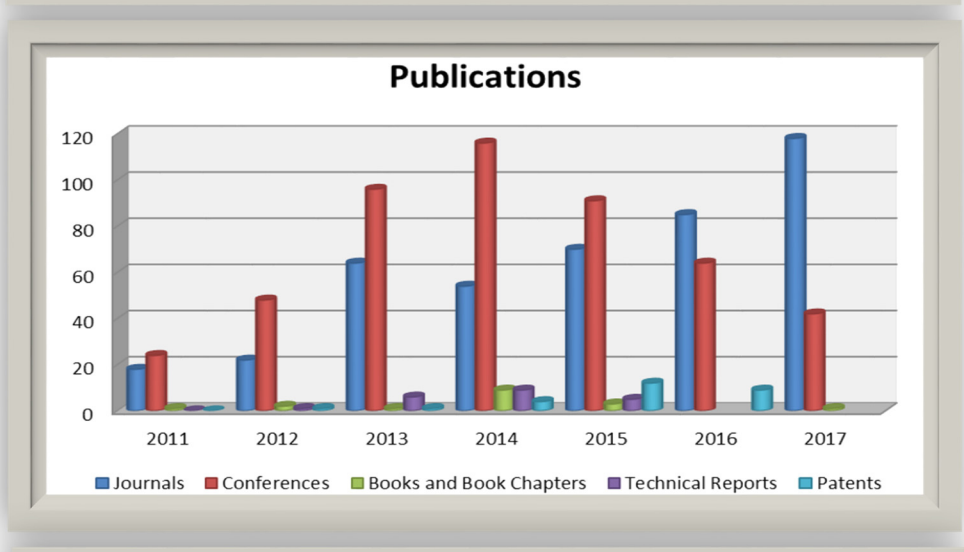
Interaction with Media

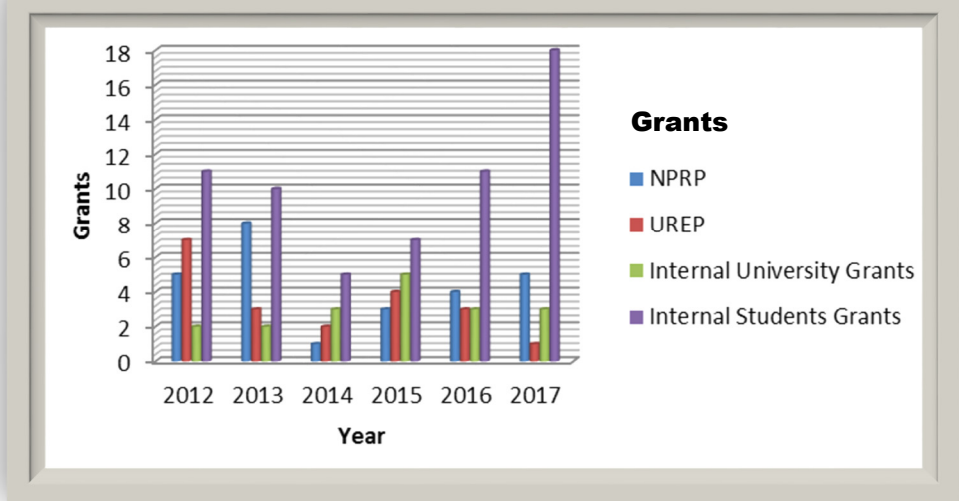
Dr. Atif Iqbal was invited by Qatar Radio Urdu Service FM 107 in their half an hour talk show called , 'Haqeeqat" [Truth] on 1st Nov. 2017 (broadcast time 8:00 to 8:30 PM). The program was sponsored by Gulf times and hosted by Mr. Saifur Rahman. The topic of discussion was "Impact of Qatar Blockade on research in Qatar".

The background of different research funding opportunities available in Qatar was highlighted and a positive impact of the present crisis was addressed. How the research culture has been evolved in Qatar and how it is helping in the nation building and achieving the 2030 Qatar vision of transforming gas based economy to knowledge based economy was discussed. The ranking and visibility of higher education institutions in Qatar especially focusing on Qatar University achievements was highlighted. The UREP and the internal grants provided by Qatar University to develop research culture was presented. The blockade has forced the researchers and students in Qatar to focus more on innovation and applied research with product development in order to move towards the self-sustained society with long term benefit. The support provided by the govt. of Qatar and Qatar University was praised. The food security issue was also in the discussion and soil-less technology of agriculture was further discussed. It was highlighted that the blockade has impacted positively on the research culture in Qatar.

Faculty Activities' Statistics







Students' Achievements & Activities

Field Trip to Iberdrola

QUIEEESB visited Iberdrola, a leading multinational electric utility company in Qatar Science Technology Park. The presenters showed promising research fields such as smart grids and micro grids. The trip benefitted our students in many aspects in electrical engineering and enhanced their knowledge about the smart grids.

Arduino Day

With the collaboration with QBIC FabLab, QUIEEESB organized the Arduino Day event in QBIC FabLab. The event hosted participants from all ages and all technical backgrounds in Arduino environment, and did many activities and challenges where the participants had to solve using Arduino. One of the challenges was to design a smart outlet socket that is connected to cloud and measure the power consumption and notify the user about it.

Es'hailSat Talk

QUIEEESB hosted a talk by Dr. Majid Mubarak Al-Naimi, Executive Director of Network Operations at Es'hailSat, who presented an interesting talk about the Es'hailSat 2 satellite.

QU Student Clubs Forum

In September 2018, IEEE student branch participated in the Students Clubs Forum organized annually by the Student Activities Department. The booth visitors were introduced to the club and the advantages of its membership. Also, new members were registered and informed about the upcoming

IEEE Day 2018

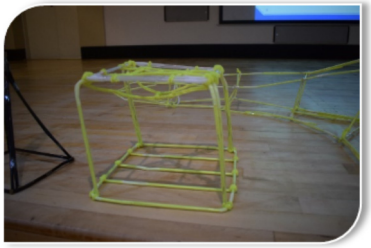
On 2nd of October 2018, QU IEEE Student Branch and IEEE Qatar Section celebrated the annual IEEE day with its members to share technical ideas and inspire undergraduates under the theme "Leveraging Technology for a Better Tomorrow". The event gathered around 60 professionals and undergraduates from the Electrical Engineering, Computer Engineering and Computer Science departments. The event included social activities, speeches, a photo contest, and a cake cutting ceremony.

Loydence Academy STEM Fair

IEEE student branch took part in the STEM fair held at Loydence Academy. The members succeeded in attracting the kids and accomplish both the academy's and the club's goal to increase kids' curiosity towards technology.

Teacher in Service Program (TISP)

QUIEEESB organized an event with the coordination of Katara that introduces the teachers to hands-on activities, which can be used in classrooms to teach students about Engineering principles. These activities are aligned with edustudents in many fields, not only math and sciencecation standards. Participants showed enthusiasm for the activities and challenges they were given to solve, and at the end they rewarded a trainer certificate.



KataraTech

QUIEEESB participated in KataraTech which is a forum held by Katara to discuss the latest technological aspects to enhance youth skills. In IEEE student branch booth, the activities of IEEE student branch and its aims were presented to the visitors.

Undergraduate Students' Publications

- A. Aldisi, A. Alsalemi, Y. Alhomsi, I. Ahmed, F. Bensaali, G. Alinier and A. Amira, "Design and Implementation of a Modular ECMO Simulator," Qatar Medical Journal: 4thAnnual ELSO-SWAC Conference Proceedings, vol. 2017, 62, pp. 1-2. DOI: http://dx.doi.org/10.5339/qmj.2017.swacelso.62
- A. Alsalemi, M. Aldisi, Y. Alhomsi, I. Ahmed, F. Bensaali, G. Alinier and A. Amira, "Using Thermochromic Ink for Medical Simulations," Qatar Medical Journal: 4th Annual ELSO-SWAC Conference Proceedings**.** vol. 2017, 63, pp. 1-2. DOI: http://dx.doi.org/10.5339/qmj.2017.swacelso.63
- A. Alsalemi, M. Al Disi, I. Ahmed, Y. Alhomsi, F. Bensaali, A. Amira and G. Alinier, "'Developing Cost-Effective Simulators for Patient Management: A Modular Approach", 4thInternational Conference On Advances in Biomedical Engineering, Lebanon, October 2017.
- A. Alsalemi, Y. Alhomsi, M. Al Disi, I. Ahmed, F. Bensaali, A. Amira and G. Alinier, "Real-Time Communication Network using Firebase Cloud IoT Platform for ECMO Simulation", 2ndInternational Symposium on Real-time Data Processing for Cloud Computing. In conjunction with the 10thIEEE International Conference on Cyber, Physical, and Social Computing, Exeter, UK, June 2017.
- A. Farhat, A. Al-Zawqari, A. Al -Qahtani, O. Hommos, F. Bensaali, A. Amira and X. Zhai, "OCR-based Hardware Implementation for Qatari Number Plate on the ZynqSoC," 9thIEEE GCC Conference and Exhibition, Bahrain, May 2017.
- A. Alsalemi, Y. Alhomsi, M. Al Disi, I. Ahmed, F. Bensaali, A. Amira and G. Alinier, "Real-Time Communication Network using Firebase Cloud IoT Platform for ECMO Simulation", 2nd International Symposium on Real-time Data Processing for Cloud Computing. In conjunction with the 10th IEEE International Conference on Cyber, Physical, and Social Computing, Exeter, UK, June 2017.
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Students' Achievements & Activities (Cont.)

Technical Sites Visits

Visit to Ooredoo

The IEEE student branch at Qatar University has organized a visit to local network provider Ooredoo to see their new equipment on 4G+ and pre-5G as well as their expected benefits from them. The team first visited Ooredoo headquarter in West Bay-Doha to listen and discuss with the innovations team at Ooredoo about recent advances in their network, where the students had the opportunity to visit the OASIS lab. Then they moved to a major cellular site to get in touch with equipment and how old ones are being replaced by new ones. More than 15 students attended the visit and showed high interest in the presented topics.

Visit to Siemens

Male students of QUIEEESB visited a substation for Siemens company, where the students have witnessed for the first time the components of typical power system in the grid. The visit began with safety instructions, because the place is still under construction. Then the site engineers introduced the transformers and the safety of placing the transformer. The next stop was the circuit breaker room, followed by the control unit where they were introduced the LV panels that monitor the behavior of the substation. The site engineers also quizzed the students at each stop, and they gave them cinema tickets as a prize for the winners.

Visit to Doha Cables

Two groups of students (one Male and one Female) with their instructors Prof. Adel Gastli and Eng. Mazen Faiter, have visited Doha Cables Factory on April 27, 2017 as part of their Electric Power Distribution course activities. The visit took place during the whole morning and students were able to see all the steps of power cables manufacturing and their testing procedures. The student appreciated very much this visit as it complements what they have studied during the course lectures about power cables.

Visit to QU Main Power Substation

Part of their Electric Power Distribution

Course, the students have visited the QU main power substation on April 25, 2017, to see in real world what they've studied in the class. The students were also able to visit the chillers' room for the centralized (district) cooling at QU. The students were able to look inside the switchgear panels and the variable speed drives.

PhD Graduates

Dr. Khaliqur Rahman

Dr. Khaliqur Rahman was born in Uttar Pradesh, India, in 1986. He received the B.Tech. and M.Tech. degrees from Aligarh Muslim University (AMU), Aligarh, India, in 2008 and 2010, respectively, and the Ph.D. degree from the Qatar University, Qatar, in December 2018. He was a Lecturer from July 2010 to June 2012, with the Faculty of Electrical Engineering, Aligarh Muslim University, Aligarh, India. He is currently working as a research assistant at Qatar University, Qatar. His current research interests include the areas of power electronics, and advanced variable-speed drives.

Thesis Title: Modeling and Control of Multiphase Matrix Converters for Motor Drive Applications .

Supervisors: Drs. Atif Iqbal and Nasser Al-Emadi

High power density power electronic converters are required in drives with high reliability, without the constraint of frequency and operating voltages. For high power applications, multiphase (more than three-phase) system is a viable option where the number of phases is increased as per the requirements. Presently, back-to-back converters (AC-DC-AC) are generally used to control voltage and frequency. These converters suffer from the drawback of bulky energy storing capacitors, which are likely to have poor performance and are prone to failures. These problems of the drive system can be resolved by using a matrix converter (direct AC-AC converter) as it gives the desired output voltage and frequency without using a large energy storage capacitor.

The work is focused on a multiphase matrix converter and its control strategies for high power motor drive applications. The space vector pulse width modulation scheme is applied to control the operation of the multiphase matrix converter. The modulation is done for five-phase and seven-phase matrix converters. Similar to all PWM control schemes, the space vector PWM scheme also results in high-frequency common mode voltage, which produces motor shaft voltage. This shaft voltage causes the flow of current mainly through the bearings of the motor which causes their premature failure and hence, reduces the overall reliability of the drive system. Thus, the common mode voltage is required to be reduced or eliminated in a motor drive system.

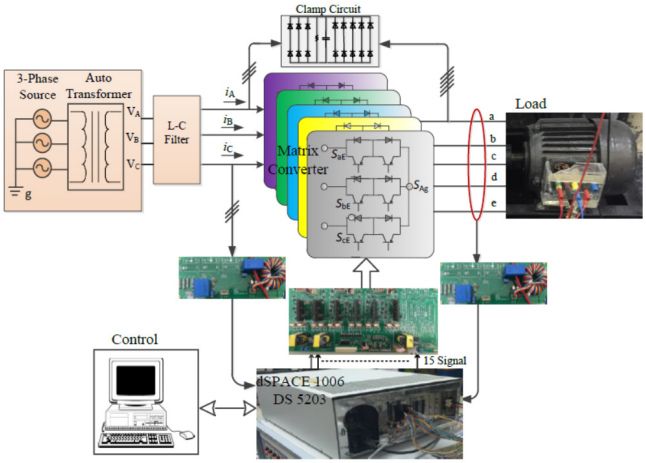


Figure 1: Prototype of three-to-five phase MC fed drive system

To reduce the common mode voltage either common mode filter can be used or the modulation strategy can be modified. Former approach leads to an increase in the overall size and cost of the drive system. Thus, the later approach is implemented to reduce the common mode voltage where modified SVPWM techniques are suggested for a drive system. In these techniques, zero voltage vectors are the main contributor of common mode voltage and they are replaced by active voltage vectors which reduce the common mode voltage. The theoretical analysis is verified through simulation as well as experimental investigations on the prototype of the matrix converter developed in the laboratory.

The developed matrix converter control is employed to feed the multiphase drives. In high-performance electrical drive system, the flux and torque of the motor should be controlled independently for the faster dynamic response. Direct torque control and vector control (field oriented control) are two approaches mainly used for high-performance applications of induction motor drives. The classical direct torque control technique is more robust to motor parameter variations as this technique only requires the stator resistance information. It gives a faster response than vector control. Consequently, the direct torque control technique has

been applied for a five-phase induction motor. The direct torque control scheme is implemented and verified using simulation and experiments. The gate signal required to control the matrix converter is generated by assuming the independent control of virtual vectors of the matrix converter voltage vectors. The proposed technique is simulated in MATLAB/Simulink environment and built into dSPACE 1006, employed in combination with FPGA board DS 5203 for experimental verification. The conditions of eliminating the xy-plane flux are met and the dynamic response of the motor is tested for different speed and load torque conditions.

List of Publications:

1. K. Rahman, A. Iqbal, and R. Al-Ammari, "Space vector model of a three-phase to five-phase AC/AC converter," in IEEE AFRICON Conference, 2013.
2. A. Iqbal, S. Moinoddin, and K. Rahman, "Finite state predictive current and common mode voltage control of a seven-phase voltage source inverter," Int. J. Power Electron. Drive Syst., vol. 6, no. 3, 2015.
3. K. Rahman, A. Iqbal, A. A. Abduallah, R. Al-ammari, and H. Abu-Rub, "Space vector pulse width modulation scheme for three to seven phase direct matrix converter," in 2014 IEEE Applied Power Electronics Conference and Exposition - APEC 2014, 2014, pp. 595–601.
4. K. Rahman, M. V. Aware, A. Iqbal, R. Al-Ammari, and H. Abu-Rub, "Common-mode voltage control through vector selection in three-to-five phase matrix converter," in IEEE International Symposium on Industrial Electronics, 2014.
5. K. Rahman, N. Al-Emadi, A. Iqbal, and S. Rahman, "Common mode voltage reduction technique in a three-to-three phase indirect matrix converter," IET Electr. Power Appl., vol. 12, no. 2, pp. 254–263, Feb. 2018.
6. K. Rahman, A. Iqbal, N. Al-Emadi, and L. Ben-Brahim, "Common mode voltage reduction in a three-to-five phase matrix converter fed induction motor drive," IET Power Electron., vol. 10, no. 7, pp. 817–825, Jun. 2017.
7. K. Rahman, A. Iqbal, N. Al-Emadi, L. Ben-Brahim, R. Al-ammari, and H. Dehghani Tafti, "Common mode voltage reduction in open-end multi-phase load system fed through matrix converter," in 2016 IEEE Energy Conversion Congress and Exposition (ECCE), 2016, pp. 1–6.

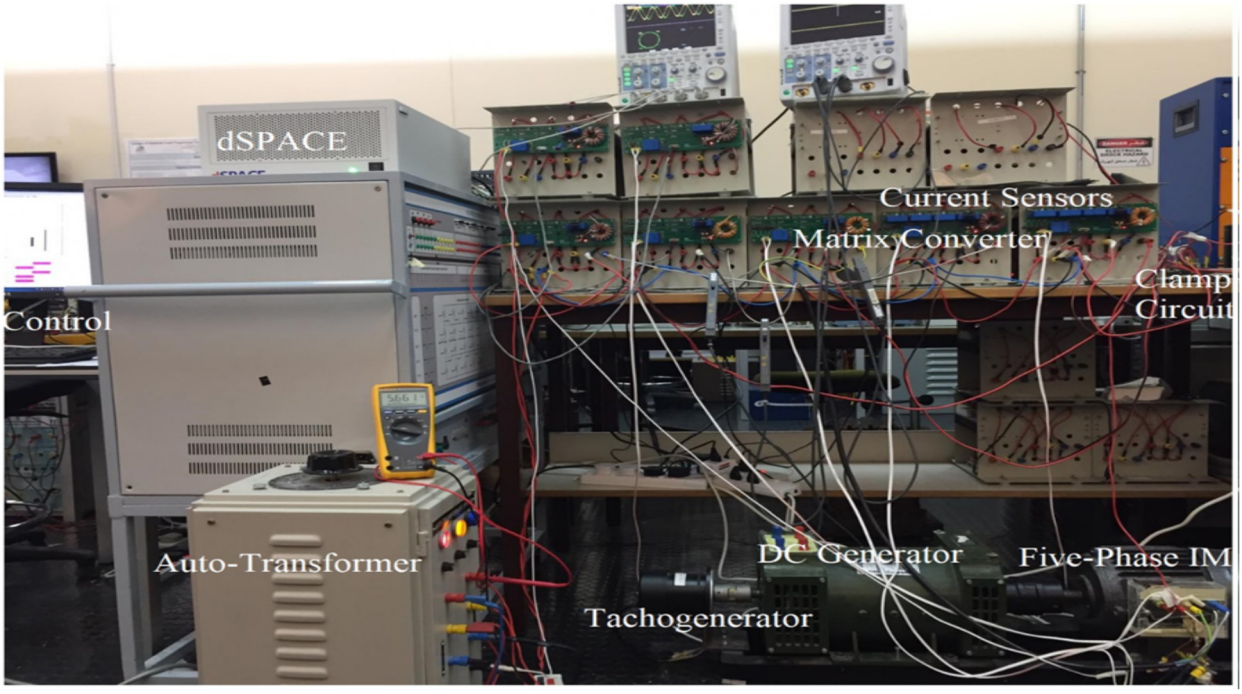


Figure 2: Direct torque control of five-phase induction motor fed from three-to-five phase matrix converter

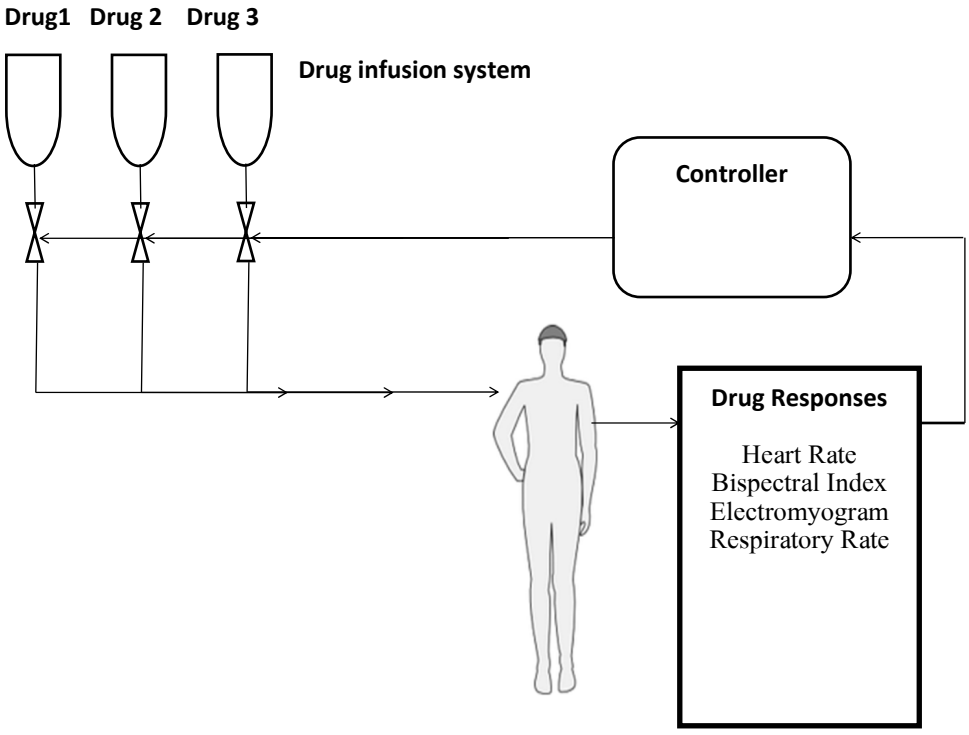
PhD Graduates

Dr. Regina Padmanabhan

Thesis Title: Multi-objective Closed-loop Control of Intravenous Drug Administration for Anesthesia and Cancer Chemotherapy .

Supervisors: Dr. Nader Meskin

Recent research activities in clinical pharmacology has emphasized on the necessity for ensuring patient safety by maximizing the desired drug effect and minimizing the drug induced side effects. This is particularly important when developing control paradigms for drug dosing applications that involve potent drugs as in the case of anesthesia administration and cancer chemotherapy treatments. Hence, we develop different controller design approaches for intravenous drug administration in which the controller accounts for multiple clinical objectives simultaneously such as drug interaction, drug overdosing and underdosing, significant variabilities in the drug response(s) of different patients, nonlinearities and disturbances in the system, and major drug induced side effects such as immunosuppression or hemodynamic instability. We first use the concept of Q-learning to develop a general framework for designing controllers for drug dosing applications. Then, we illustrate the use of the proposed Q-learning based controller in anesthesia administration and cancer chemotherapy treatment to achieve multiple clinical objectives by accounting for system complexities. Next, we present an integral reinforcement learning (IRL)-based controller design method for the continuous infusion of a sedative drug to maintain the required level of sedation. Finally, motivated by the nonovershooting property of the eigenstructure based feedback controller design, a nonovershooting tracking controller is also proposed for the continuous infusion of multiple drugs that have interactive effects. We address the "right dose" problem of personalized medicine and precision medicine which is one of the important objectives in the health pillar that comes under Qatar National Research Strategy.



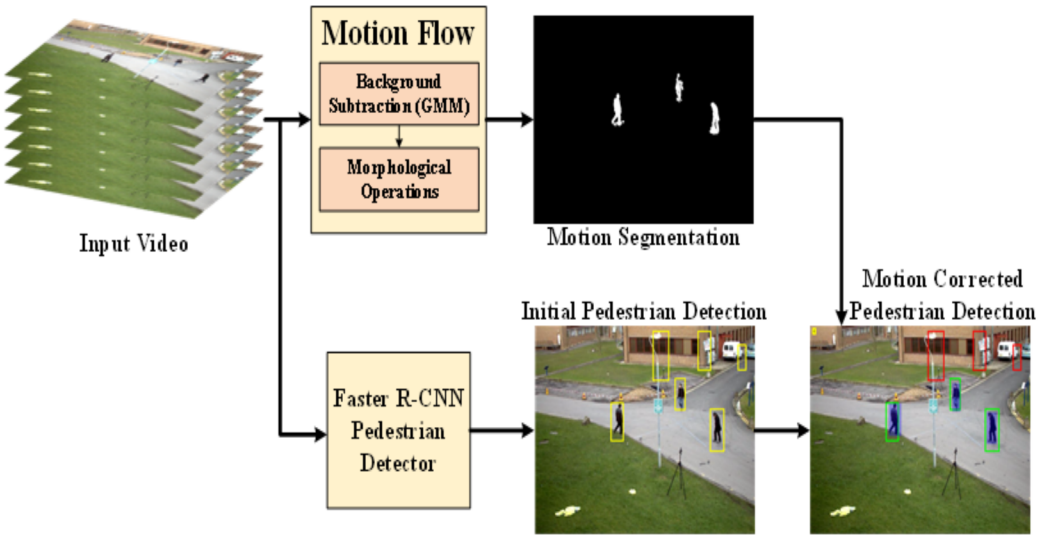
Ali Farhat

MSc Graduates

Thesis Title: Pedestrian Detection using Motion Saliency Aided Convolutional Neural Network

Supervisor: Dr.

Pedestrian and crowd analysis is one of the oldest problems in the area of computer vision and image processing. Researchers have proposed several algorithms that analyzes crowds for different purposes aiming to improve their security and safety. The recent advancements in the areas of machine learning and computer devices resulted in a revolution in the proposed algorithms for such problem. The use of Convolutional Neural Networks in the proposed algorithms boosted the performance of the state-of-the-art algorithms. This research project studies the impact of integrating of motion saliency along with the CNN based pedestrian detector. A detailed literature review was conducted to draw the pathway of the project, discussing different approaches of motion flow algorithms and CNN based detectors. Background subtraction based on Gaussian Mixture Model motion flow algorithm was used to extract the motion saliency information. Faster R-CNN based on AlexNet was considered and integrated with the motion flow algorithm. Two different approaches of integration were proposed and tested: (1) Motion Masked Faster R-CNN method, where the motion information is used to generate a mask for the scene, keeping the regions of interest where motion is found and people may be available; (2) Motion Corrected Faster R-CNN method, where the motion information is utilized after the Faster R-CNN detector locates all pedestrian in the frame to correct the false detections. The report discusses the hardware and software setups used in this thesis project to develop and implement the proposed detectors. PETS2009 dataset was used to test the proposed detectors, which are trained on Caltech pedestrian dataset. It was found that the integration of motion information improves the precision of the Faster R-CNN detector by 7% - 30%, where the error rate dropped by 6% - 34%. A detailed discussion of further improvements pathways is provided in the report. Limitations of current implementation of the proposed detectors are discussed. The evaluation of the proposed detectors is compared to state-of-the-art detectors in the literature. Models' performance was discussed, noting the challenges that lowered their performance and how to overcome them.



Suchithra Kunhoth

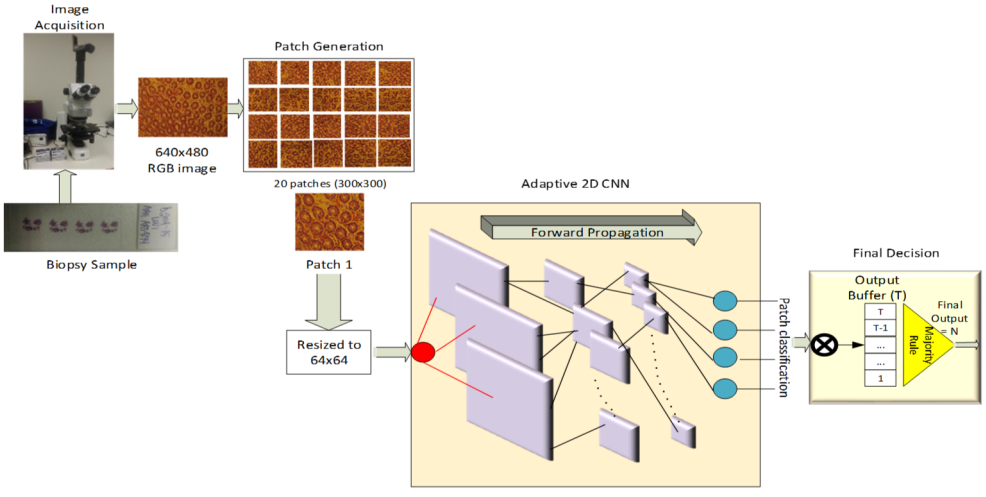
MSc Graduates

Thesis Title: Cancer detection and identification on scarce and low- resolution data

Supervisor: Dr.

Machine learning algorithms have been contributing immensely in the biomedical sector with the innovation of several automatic and semi-automatic diagnostic devices. They are well suited for applications such as the diagnosis of cancer, which is a prevalant and devastating disease nowadays. A computer-aided diagnostic system can detect and classify various tumor tissues and thereby ensures a reliable and rapid screening procedure. In this thesis study, we perform comparative evaluations among several recent approaches for cancer detection and identification on a scarce and low-resolution biopsy image dataset. The biopsy samples comprise of normal as well as cancerous colorectal tissues, collected from the Al-Ahli hospital, Qatar. We have built two separate image datasets, multispectral and optical from the collected samples.

A Multispectral image based tumor identification system was developed using rotation invariant Local Phase Quantization technique and Support vector Machine (SVM) classifier. The comparative evaluations demonstrate that it could outperform Local Binary Pattern for the feature extraction and Random Forests (RF) in classification of the colorectal tumor tissues. We compared the classification accuracies yielded with the two image modalities- multispectral and RGB and the former one exhibited higher accuracy. Furthermore, we have presented a band selection strategy to eliminate the redundant bands from the multispectral imagery. As the main contribution of the thesis, we propose a compact and adaptive CNN approach for the detection and identification of the tumor tissues on the RGB image dataset. Its performance is compared against the SVM classifier with three different kernel types and five state-of-the-art texture feature extraction methods. The proposed systematic approach with adaptive and compact CNNs and the top performing conventional method with the best texture feature have achieved the highest identification accuracies with respect to the task of discriminating four classes of colorectal tissues. However, the proposed method has achieved the highest cancer detection performance, around 94.5%, as compared to the best detection score of 87% achieved by the best conventional method. This is despite the fact that the proposed method used low-resolution image data (64x64 pixels) in contrast to the original patch resolution (300x300) used by the conventional methods. Finally, the proposed approach can further exhibit a superior computational complexity and minimal false alarms. The promising results throw light on the competence of adaptive CNNs for cancer detection in low-resolution images from a lim-



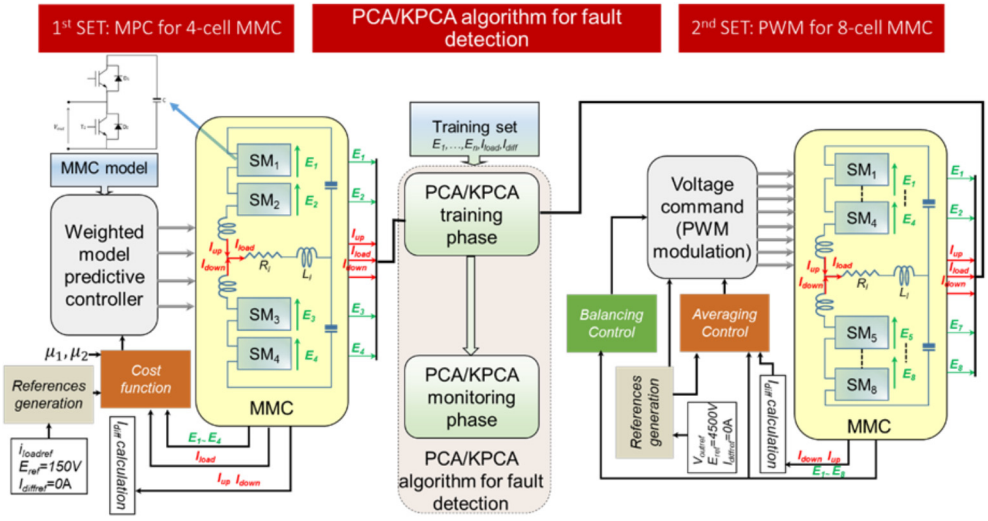
Mahdi Houchati

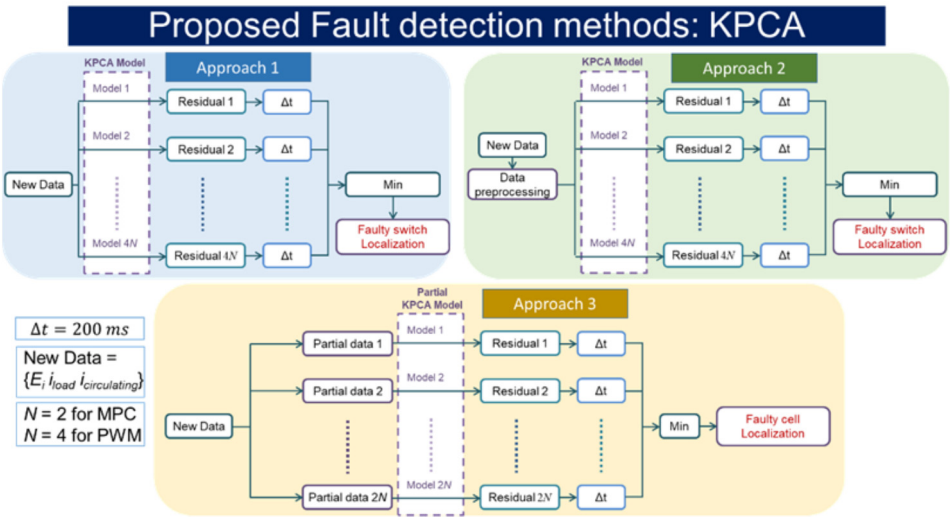
MSc Graduates

Thesis Title: Fault Detection and Localization in Modular Multilevel Converter

Supervisor: Profs. Lazhar Ben-Brahim & Adel Gastli

The Modular Multilevel Converter is gaining wide acceptance in both industrial and research communities for medium and high power applications. However, the increasing need for a higher number of active power switches raised more reliability issues. In this study, detection and localization of open circuit faults are studied in depth. Two multivariate statistical techniques, namely the principal component analysis and the kernel principal component analysis are proposed for fault detection and localization. To study the effectiveness of the proposed methodologies, two converters with different sizes and control techniques are considered in the simulations. The results show that both techniques are capable of accurately detecting the anomalies that can disrupt the normal behavior of the converter. However, only the kernel principal component analysis, can efficiently localize the faulty cells.





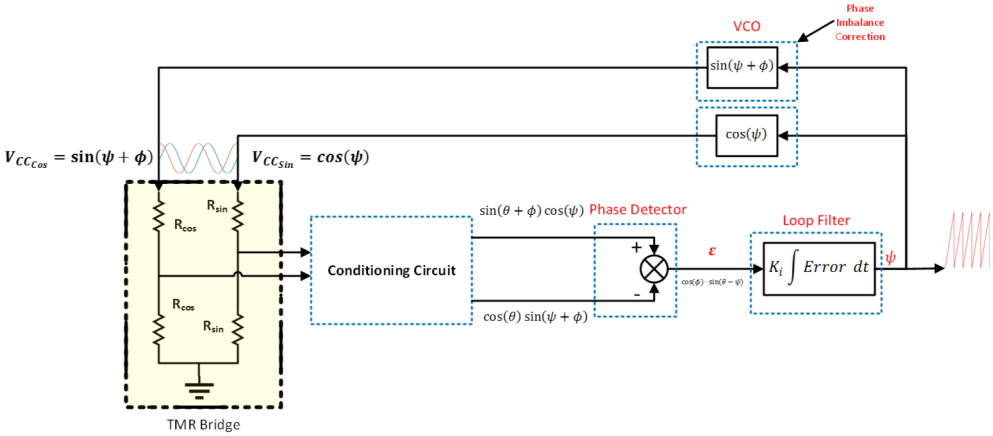
Suchithra Kunhoth

MSc Graduates

Thesis Title: Development of Novel Instrumentation Incorporating Magnetoresistive Encoders for The Measurement of Angular Position and Speed

Supervisor: The Late Prof. Mohieddine Benammar

As rotation dependent technologies emerge, the need of having a feedback about their rotational behavior became a necessity in order to control their angular position and speed. Many types of sensors based on various operation principles are available in the market to provide such feedback. One of these sensors are sinusoidal magneto resistive (MR) type sensors. Such sensors have many merits over other angular position sensors, yet extracting the angle of interest, □, from their signals is not a trivial task, as they encode the angle into two orthogonal sinusoidal signals. Also, these signals also suffer from imbalances and imperfections in practice, which will need adequate compensation. Towards extracting the angle from the sensor signals and minimizing the effects of their imperfections, a novel closed loop technique based on the well-known Phase Locked Loop (PLL) technique is proposed. The enhanced PLL eliminates the need of analog multipliers; needed in the Phase Detector (PD) stage, through the exploitation of the resistive nature of the MR sensors. Subsequently, novel imbalance correction techniques are proposed to suit the proposed enhanced PLL converter.



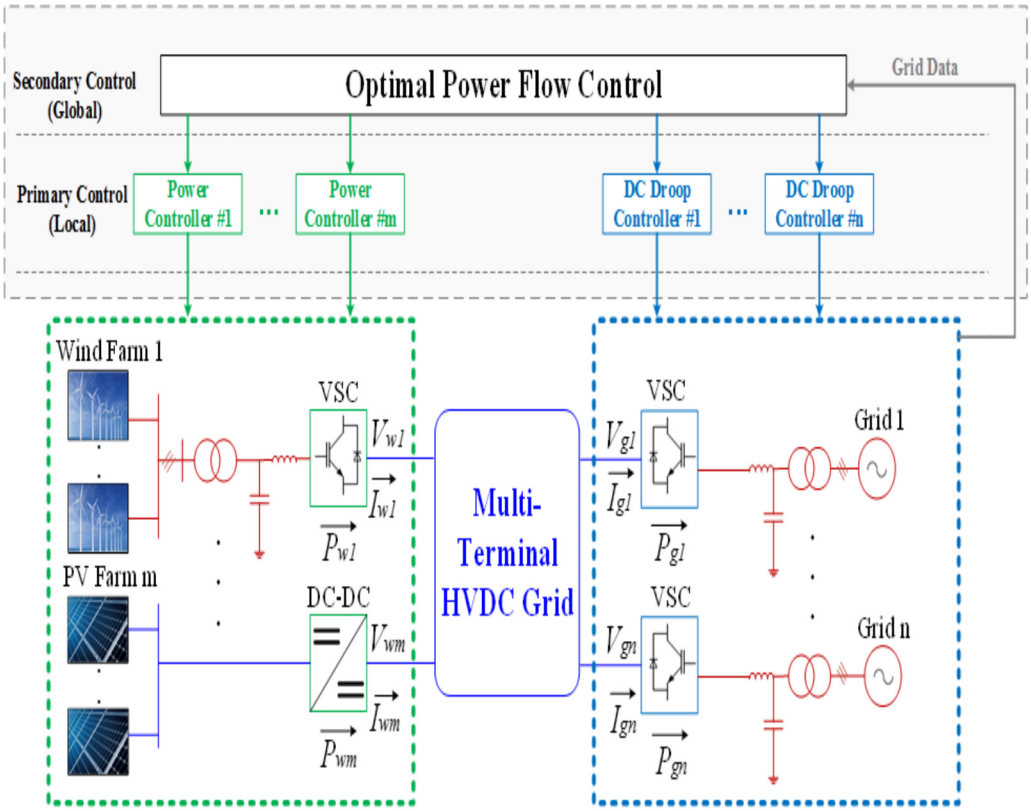
MSc Graduates

Sawsan Sayed

Thesis Title: Multi-Terminal HVDC Network with Optimal Power Sharing For High-Power Renewable Energy Sources

Supervisor: Dr. Ahmed Masoud

The significant increase of high-power renewable energy sources has introduced Multi-Terminal High-Voltage Direct Current (MTDC) grids as a prominent approach for transmitting power with high reliability, security, and efficiency. Nonetheless, MTDC systems introduce several challenges pertinent to operation. The thesis investigates Optimal Power Flow (OPF) in MTDC networks to minimize the transmission power loss via DC voltage control. A generalized approach for minimum transmission power loss in radial and mesh MTDC networks is presented, which is supported with an optimization approach. Moreover, a study is presented elucidating the effect of transmission line resistance uncertainty and the power injection variation on the droop characteristic settings for radial MTDC networks. Cyber threats with malicious attack on the communication system in the MTDC network hierarchical control layers are considered particularly during power variations. CIGRE B4 model is used in this work to investigate the presented concepts through Matlab/Simulink platform.



MSc Graduates

Mena Elmenshawy

Thesis Title: High-Voltage Isolated DC-DC Transformers for High-Power Renewable Energy Sources

Supervisor: Dr. Ahmed Masoud

It is expected that high-voltage DC-DC converters will play a vital role in future energy grids, due to the significant increase in installing HVDC transmission lines. However, voltage levels and configurations are not standardized in HVDC networks. Accordingly, high-voltage high-power DC-DC converters are required for the construction of new HVDC transmission interconnection.

One of the attractive DC-DC converter topologies used in high-voltage high-power applications is multimodule DC-DC converters. In this converter, each submodule operates at a single device rated voltage and participate with a portion of the total power. Accordingly, such converters can operate with high switching frequency, leading to a considerable reduction in the overall size and weight. In addition, the modularity concept is applied to the full stage and not only to the power electronics stage. To clarify, the two DC-AC converters, as well as the intermediate transformers, are modular based structure. Moreover, bidirectional power flow, as well as soft switching operation, can be achieved. This thesis will focus on Dual Active Bridge (DAB) since it can be employed in high-voltage high-power applications. For simplicity purposes, the analysis carried out in this thesis will consider only unidirectional power flow. However, the same analysis can be applied for bidirectional power flow.

In this thesis, a high-voltage isolated DC-DC converter for high-power renewable energy sources applications such as PV plants and wind farms will be analyzed through addressing different scenarios. In addition, various DC-DC converters topologies are surveyed where the merits and demerits of each type are highlighted. Moreover, the small signal analysis of a Full-Bridge Phase-Shifted (FB-PS) DC-DC converter is studied to expand the study for different multimodule connection. The main contribution of this thesis can be summarized in providing a generalized small signal analysis applicable for any multimodule connection and presenting different scenarios for Input-Series Input-Parallel Output-Series Output-Parallel (ISIP-OSOP) DC-DC converter.

The control of the ISIP-OSOP DC-DC converter is studied considering a control scheme presented in the literature for multimodule converters. The overall output voltage is controlled using a PD controller to ensure stable control and equal power sharing. However, to guarantee uniform input voltage and input current sharing, PI controllers are used considering parameter mismatch.

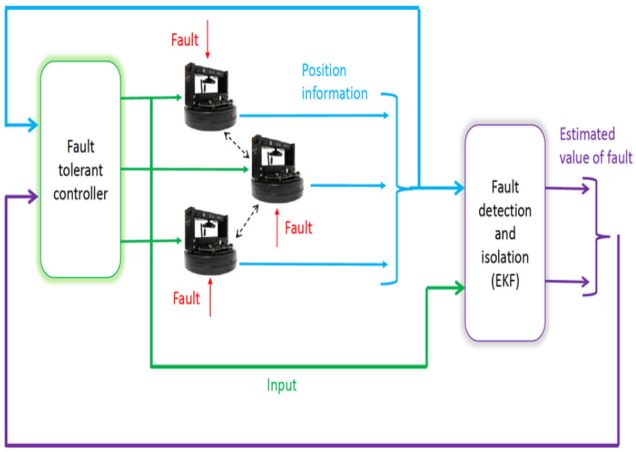
MSc Graduates

Parisa Yajdredi

Thesis Title: Actuator Fault Diagnosis and Fault Tolerant Control of Single and Multiple Differential Drive Mobile Robots

Supervisor: Dr. Nader Meskin

Due to exponential increase in usage of wheeled autonomous mobile robots in different industries such as manufacturing, health care, and military there exist stringent requirements for their safe and reliable operation in industrial/commercial environments. Accordingly, development of fault tolerant controller is one of the important issues to be tackled in order to enhance the safety and reliability of mobile robots. The main aim of this project is to develop an actuator fault tolerant controller for both single and multiple -mobile robot applications with the main focus on differential derive mobile robots. The actuator loss of effectiveness fault is modeled on the kinematic equation of the robot as a multiplicative gain in the left and right wheels angular velocity.



Two different approaches are proposed in this project to detect, isolate, and tolerate loss of effectiveness actuator fault. A fault tolerant controller using multiple-model based is used a bank of Extended Kalman Filter (EKF) to detect, isolate, and identify faults where each Extended Kalman filter corresponds to a specific fault severity value. The conditioned probability of each fault severity value, given the measurement history is calculated iteratively by using Bayes law. The second fault diagnosis method proposed in this project is joint state and parameter estimation in which, the augmented discrete time nonlinear model of the robot is considered and an extended Kalman filter technique is used to estimate the actuator loss of effectiveness gains as the parameters of the system, as well as the states of the system. The estimated gains in both methods are used in the controller to compensate the effect of actuator faults on the performance of mobile robots. In addition, the proposed FTC method using joint state and parameter estimation is extended for the leader-follower formation control of mobile robots in the presence of fault in either leader or followers. Multi agent mobile robot system is designed to track a trajectory while keeping a desired formation in the presence of actuator loss of effectiveness faults. An extended Kalman filter is used for each robot to estimate parameters and states of the system and as the fault is detected in any of the followers, the corresponding controller compensates the fault.

At last but not least, an actuator fault tolerant controller is developed for a single mobile robot with the ability to avoid obstacles using orbital obstacle avoidance algorithm. Toward this goal, a go to goal controller based on error on position is designed for the mobile robot to reach a desired destination. The joint state and parameter approach is used to estimate the gains. Meanwhile, the robot can detect any obstacle with color specification using Kinect sensor mounted on the robot and avoid collisions with orbital obstacle avoidance feature.

MSc Graduates

Thesis Title: High-Voltage Isolated DC-DC Transformers for High-Power Renewable Energy Sources

Mena Elmenshawy

Supervisor: Dr. Ahmed Masoud

It is expected that high-voltage DC-DC converters will play a vital role in future energy grids, due to the significant increase in installing HVDC transmission lines. However, voltage levels and configurations are not standardized in HVDC networks. Accordingly, high-voltage high-power DC-DC converters are required for the construction of new HVDC transmission interconnection.

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Students & Alumni Success Stories

Engr. Najla Al-Thani

Undergraduate Student's Journey

In the modern world, great revolution is taking place in the development of electrical and electronic devices; which is the backbone of every invention. Electrical engineering is an essential, and exciting field to study. Since I was a child, I was very interested in things related to technology, and this is what led me to choose this as a major. I found that the best way to pursue my passion is to join the electrical engineering program at Qatar University. Moreover, the department of electrical engineering is considered to be one of the best departments in the college of engineering of the university and being a part of it is an honor. In addition, it has not only developed me from the basis of electrical engineering, but it has enriched my life in many ways as well. Furthermore, I have been learning many valuable skills about this various world, which will enhance my future experience. Therefore, College life is unlike the school life, in college, you meet people with the same interests as you are, and professors that care about you achieving your goals whether inside the lecture halls or outside. In addition, in college, everything is your responsibility. For instance, submitting your assignments, reports, and projects. Unlike the school, no one will remind you of the deadlines and submission dates. Therefore, good time management is the key to deal with the intense semester loads. Furthermore, college gives the independence and freedom to choose the department that suits your field of interest, and this makes you define your future career. Nonetheless, College isn't the place where you study all the time to get grades and graduate, it also a place to build your personality. For me, my college education really matters, and it is something that presents something so precious and priceless. Caring about my future and what I want to become made me the student that I am today, and Qatar University has given me the opportunity to define my future plan by providing such a strong program with great professors that I have learned so much from. In the end, I would like to express my condolence for losing one of the greatest professors and one of the EED pillars, Prof. Mohieddine Benammar. He will never be forgotten as he lives in our hearts. I took one course with Prof. Mohieddine. However, he had a significant impact on me as he always motivated his students to give their best and never give up.

Engr. Leila Gastli

Fresh Graduate Journey

Ever since I was a child, I have passionately wanted to play a significant role in serving humanity, specifically in the health sector. Later, I realized that to have a momentous improvement in the well-being of people, it is mostly through technology and innovative engineering solutions. Since then, my goal was to be capable of developing technologies to facilitate medical procedures and improve the quality of patients' lives.

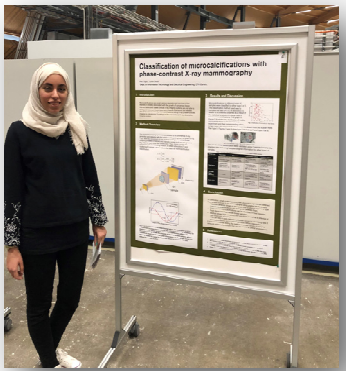
Last June I have finished my bachelor's in electrical engineering at Qatar University and got accepted to do my master's in biomedical engineering at ETH Zurich, which is the Swiss Federal Institute of Technology in Zurich. The university is ranked among the top 10 universities in the world. The mother tongue of Zurich is German; however, the master program is fully in English and holds many international students from various countries in Europe and countries like Turkey, USA, Canada, China, Iran etc. The 164 years old university is also commonly known since Albert Einstein had graduated from it.

During my time in QU I had the chance to experience applications of electrical engineering in the medical field. In fact, our senior design project was in collaboration with medical doctors from Hamad Heart Hospital and it was to design an intelligent system for heart diagnosis using echocardiography.

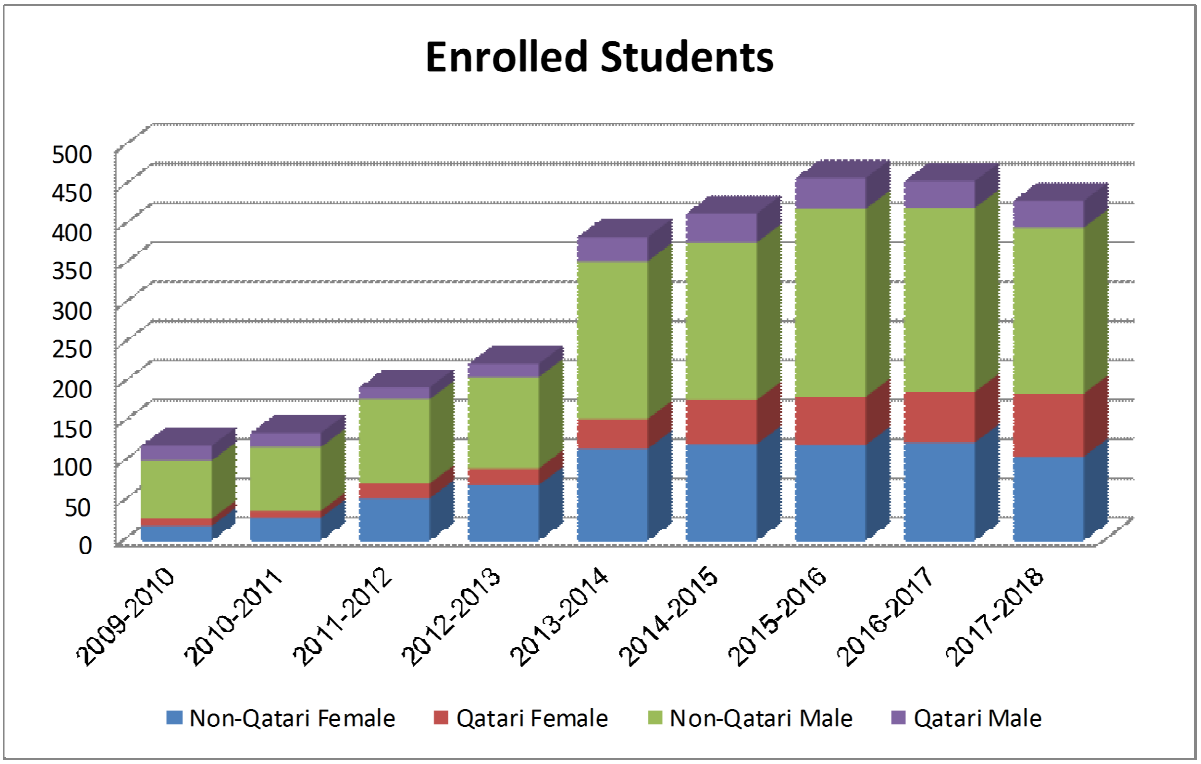
Now in ETH Zurich, my specialization is Biomedical Imaging which includes ultrasound imaging. Moreover, I am currently in a project in the Computer Vison Lab for optimizing the image reconstruction process in Speed-of-Sound imaging. Imaging also involves areas like optical physics, quantum physics, electromagnetics, signal and image processing. It also requires good background in programming. The accredited engineering program in QU has helped me develop a strong base in some of these areas. In addition, it has prepared me to solve multidisciplinary problems.

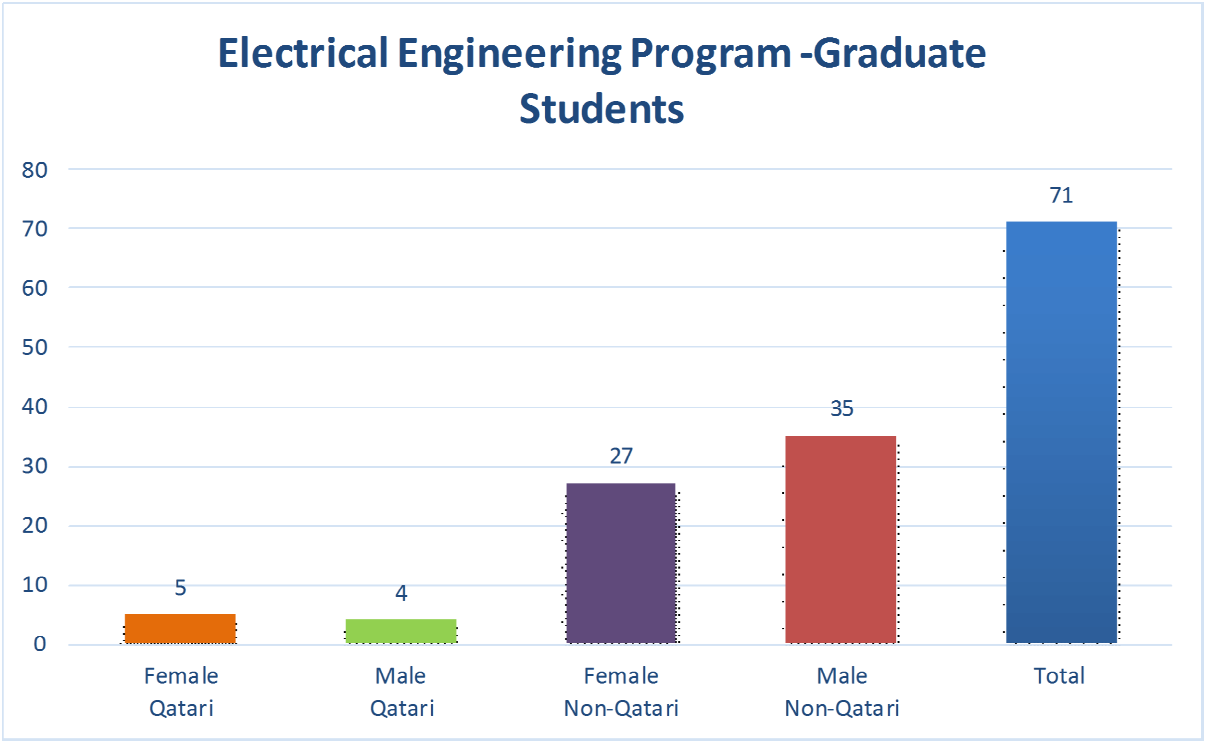
There isn't a noticeable difference between the teaching of most professors there and in Qatar University. They're up to date with new technologies and make sure we are aware of them. However, going from bachelor's to master's seemed like large step to me especially that I am doing it in a slightly different field.

There are some difficulties moving to a totally different community, however, coming from Qatar where it is a multicultural society it helped me overcome this. In addition, Zurich is a very international city and the Swiss society is friendly and they respect people from all nations.



Undergraduate Students' Statistics





Editorials from EE Faculty

Demand and Inside of Green Vehicular Power Train: Curiosity, Power Converters and Challenges

Dr. Atif Iqbal
Associate Professor

Atif Iqbal, Fellow IET (UK), Fellow IE (India) and Senior Member IEEE, PhD (UK)- Associate Editor IEEE Tran. On Industry Application, Editor-in-Chief, I'manager journal of Electrical Engineering, Associate Professor at Electrical Engineering, Qatar University and Former Full Professor at Electrical Engineering, Aligarh Muslim University (AMU), Aligarh, India. Recipient of Outstanding Faculty Merit Award AY 2014-2015 and Research excellence award at Qatar University, Doha, Qatar. He received his B.Sc. (Gold Medal) and M.Sc. Engineering (Power System & Drives) degrees in 1991 and 1996, respectively, from the Aligarh Muslim University (AMU), Aligarh, India and PhD in 2006 from Liverpool John Moores University, Liverpool, UK. He has been employed as a Lecturer in the Department of Electrical Engineering, AMU, Aligarh since 1991 where he served as Full Professor until Aug. 2016. He is recipient of Maulana Tufail Ahmad Gold Medal for standing first at B.Sc. Engg. Exams in 1991 from AMU. He has published widely in International Journals and Conferences his research findings related to Power Electronics and Renewable Energy Sources. Dr. Iqbal has authored/co-authored more than 300 research papers and one book and three chapters in two other books. He has supervised several large R&D projects. His principal area of research interest is Modeling and Simulation of Power Electronic Converters, Control of multi-phase motor drives and Renewable Energy sources.

Abstract

Abstract: In the present day, the Internal Combustion (IC) engines are step by step being changed by electric motors for low emission of greenhouse gases, control flexibility, and superior efficiency. The Green Vehicles (GV) either works partially or fully on the electrical energy. The battery or ultra-capacitor is either charged from IC engines in Hybrid Electric Vehicle (HEV) or from the utility grid line in Plug-in Electric Vehicle (PEV). Power electronic converters play a vital role in the Grid-vehicle-Wheel or Wheel-vehicle-Grid energy conversion process. In this article, various power trains of Green Vehicles, power converter roles and their challenges are discussed and enumerated.

Demand and Inside of Green Vehicular Power Train: Curiosity

Visualize clean environment and fresh air in the dawn; you are driving to Qatar University. You are navigating the busy side lane of streets that have ample of huge traffic when you get jolted out of your music mood by price signs for fuel. Surprised, you are instantly comforted by the silence of your green electric car and the realization that you haven't had to buy even a drop combustible liquid. Moreover, you can easily recharge your vehicle at the readily available nearby stations in between home to office. All right, that's a fairy tale. However, many parts of it could be close to reality if we had the political will to design, create, and support a new way of transportation. The efficiency of a conventional IC engine is approximately 25% and the energy is wasted after combustion as heat and Greenhouse Gases (GHG). The development in the Green Vehicle (GV) could be a benefit to the grid, by leveling out every day electricity demand and possibly even storing renewable energy in batteries of Green cars [1, 2]. The main benefits of GV are their simple operation, increased efficiency, clean Environment solution, flexible control, ease of control, and high starting torque. The GVs are classified into different types according to the combination of sources: Battery operated Green Electric Vehicles (B-GEVs), Fuel Cell Green Electric Vehicles (FC-GEVs), Hybrid Green Electric Vehicles (H-GEVs), Plug-in Green Electric Vehicles (P-GEVs) [1-5]. In B-GEVs, the battery provides power to drive the train of the vehicle and the rechargeable battery storage unit acts as a fuel tank. Consequently, the range of a B-GEV depends on the capability of the battery unit. Typically, B-GEVs travel distance 100-250 km, once it is fully charged. In B-GEVs, combustion engines are replaced by an electric motor to propel which makes it pollution free vehicle. The typical structure of the vehicular power train of B-GEV is shown in Fig. 1(a). In FC-GEVs, both fuel cell and the battery provide electrical power to drive the train of a

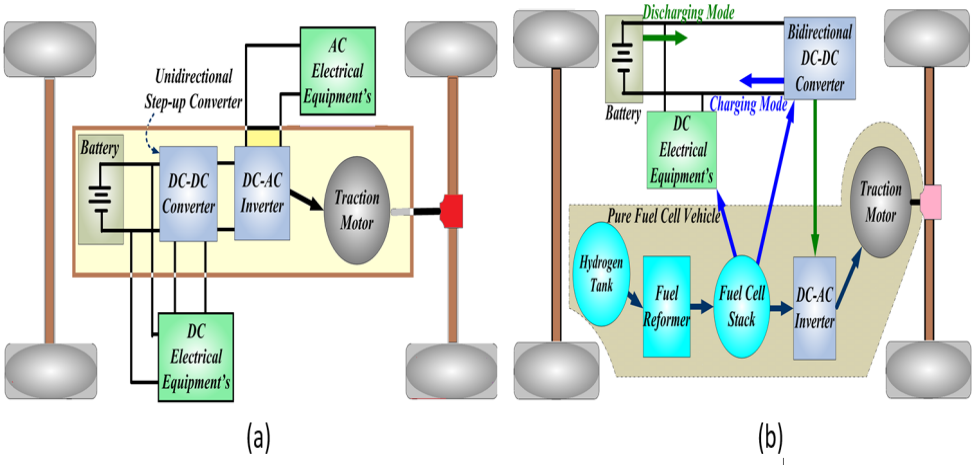


Fig. 1: Typical vehicular power train (a) B-GEV, (b) FC-GEVs.

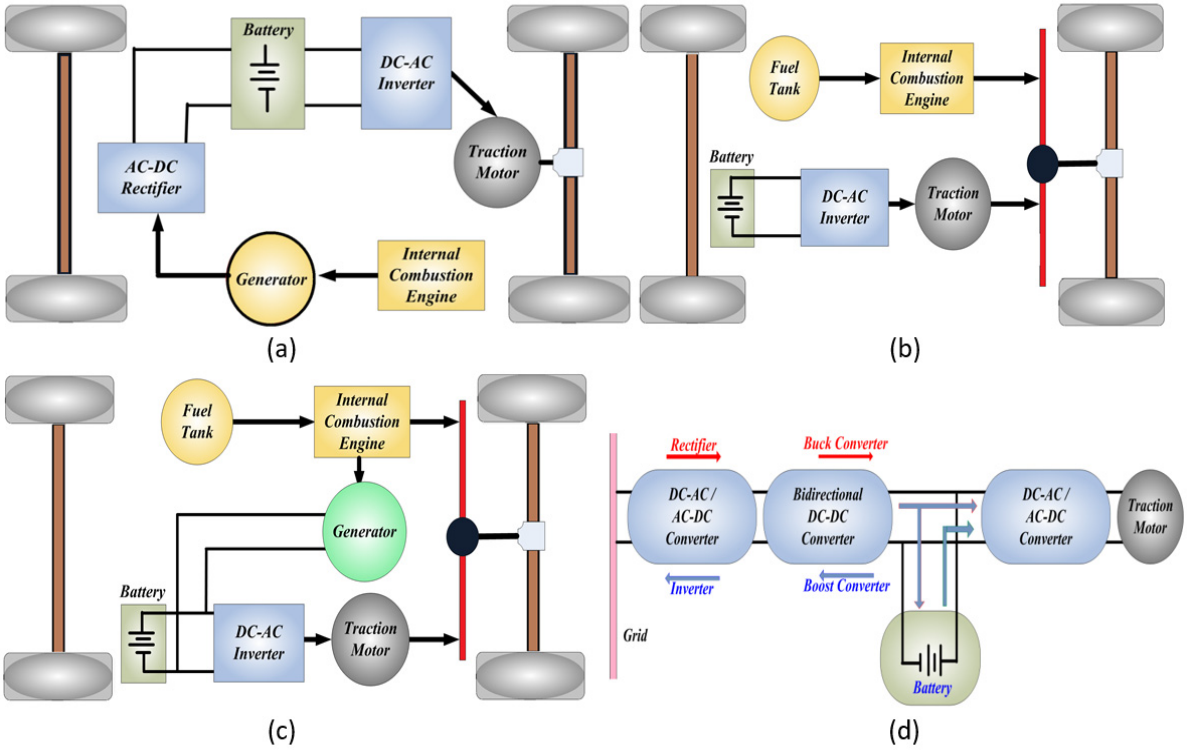


Fig. 2: Typical vehicular power train (a) series H-GEVs, (b) parallel H-GEVs, (c) series-parallel H-GEVs, (d) P-GEVs [1]-[5]

vehicle and as per the demand of power, hydrogen combined with oxygen to generate electricity and surplus electricity can be saved into battery or ultra-capacitors. The typical structure of the vehicular power train of B-GEV is shown in Fig. 1(b).

The Hybrid Green Electric Vehicles (H-GEVs) are classified into three categories: series H-GEVs, parallel H-GEVs, and series-parallel H-GEVs. In series H-GEVs, the battery is the main source of power to drive the train. The IC engine runs at an optimal speed to drive the generator and charge the battery. In parallel H-GEVs, both IC engine and battery act as a source to drive the train of the vehicle. The series-parallel H-GEVs combine the features of series H-GEVs and parallel H-GEVs. In series-parallel H-GEVs, IC engine is straight connected to the mechanical shaft as compared to series H-GEVs and the generator is introduced in between IC engine and the battery as compared to parallel H-GEVs to drive the vehicle and to charge the battery, respectively. The typical structure of the vehicular power train of series H-GEVs, parallel H-GEVs, series-parallel H-GEVs is shown in Fig. 2(a)-(c), respectively. The Plug-in Green Electric Vehicles (P-GEVs) is a type of HEV in which the battery is charged from an external source. In P-GEVs, the battery injects the energy into the grid line to conquer the overload problem and to offer subsidiary services. The typical structure of G-PEV is shown in Fig. 2(d).

Power Converter for GVs and Challenges

Due to recent advancement in vehicular and power conversion technologies, Power Electronics Converters (PECs) and motor drive play a central role to controls the flow of electrical energy within the vehicle or from the external charging station or grid to the vehicle and vice versa [6]-[8]. This makes EVs pollutant free, more efficient, and increase the durability and performance of the vehicle. In a conventional ICE vehicle, 6 V to 12 V is needed to start up and to run other electric equipment. The hydraulic system such as brake and mechanically driven system such as steering are being replaced by an electrically driven system which makes it more efficient and safe. The luxurious load is introduced in advanced automobile systems which demand the higher power with different voltage rating. Hence, the power electronics converters are responsible for the advancement in EVs.

In GEVs, the bidirectional DC-DC converter is a key conversion unit and works in two modes between the high voltage and low voltage side. The Power Conversion circuitry act as a boost converter from low voltage to high voltage side direction and a buck converter from high voltage to low voltage

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Editorials from EE Faculty

Demand and Inside of Green Vehicular Power Train: Curiosity, Power Converters and Challenges (Continued)

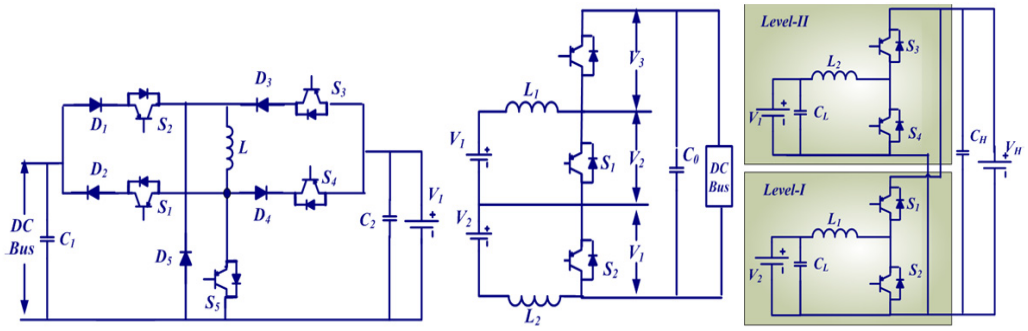

Fig. 3 Power Converter Units for Green vehicles (a) Universal Bidirectional DC-DC Converter (b) Double input single output three switches DC-DC converter, (c) Parallel four switch DC-DC converter

side direction. The universal bidirectional DC-DC converter is shown in Fig. 3(a). The converter operates in both buck and boost mode with a non-inverting output. Multistage non-isolated converters are also adopted for bidirectional power flow. The circuitry of a universal bidirectional DC-DC converter and a multistage converters is shown in Fig. 3(a)-(c).

The Clever power management schemes are needed to maximize the efficiency in conversion of battery energy into the mechanical drive to the wheels for increasing mileage capability on a single charge. The weight, size, and cost of an EV, as well as drivable distance on a single charge, is directly related to the efficiency of its electronic power conversion system. Silicon carbide (SiC) power elements are capable of operating very well in the high-temperature environment experienced in automobiles. In a battery or fuel mode, PECs play the major role to improve the efficiency by selecting a proper power converter. The main challenge is a selection of PECs, switching strategies of converters, system integration and packing of the individual unit. The efficiency of PEC depends on the number of components, control strategies, EMI effect. The durability of EVs depends on the life of the electrical unit present in EVs. The lifespan of PEC depends on the semiconductor devices. The converter should withstand high vibration and thermal condition at extreme condition. The challenges lie in the selecting proper converter with high efficiency, rigidness, low cost and small in size with high power density. The fast and high power industrial motion control is a challenging trend in the automobile system. The PE technique is combined with Digital Signal Processing (DSP) to achieve the high performance of EVs. Today's advanced EVs is more focusing on to make high comfort EVs. The multistage or multi-output DC-DC converter provides different rating power supply for DC appliances. Apart from power conversion and propelling control, monitor the condition of traction motor to detect any failure like stator, rotor and bearing faults are essential. In advance EVs, ABS system and airbags requires high power actuator. The challenge is reducing the cost of the vehicle by selecting less number of power conversion units.

Conclusion

The demand and inside of the GEVs powertrain are discussed. Currently, it can be concluded that series-parallel H-GEVs is a good choice with a combination of two energy sources for propelling and other auxiliary function. With the advancement, the demand for supply with different power rating increases which are not fulfilled by one battery or two battery structure. The bidirectional DC-DC converter plays a vital role in the DC-DC conversion process of GEVs. The proper selection of the conversion unit is necessary to improve the efficiency, durability, performance and cost reduction.

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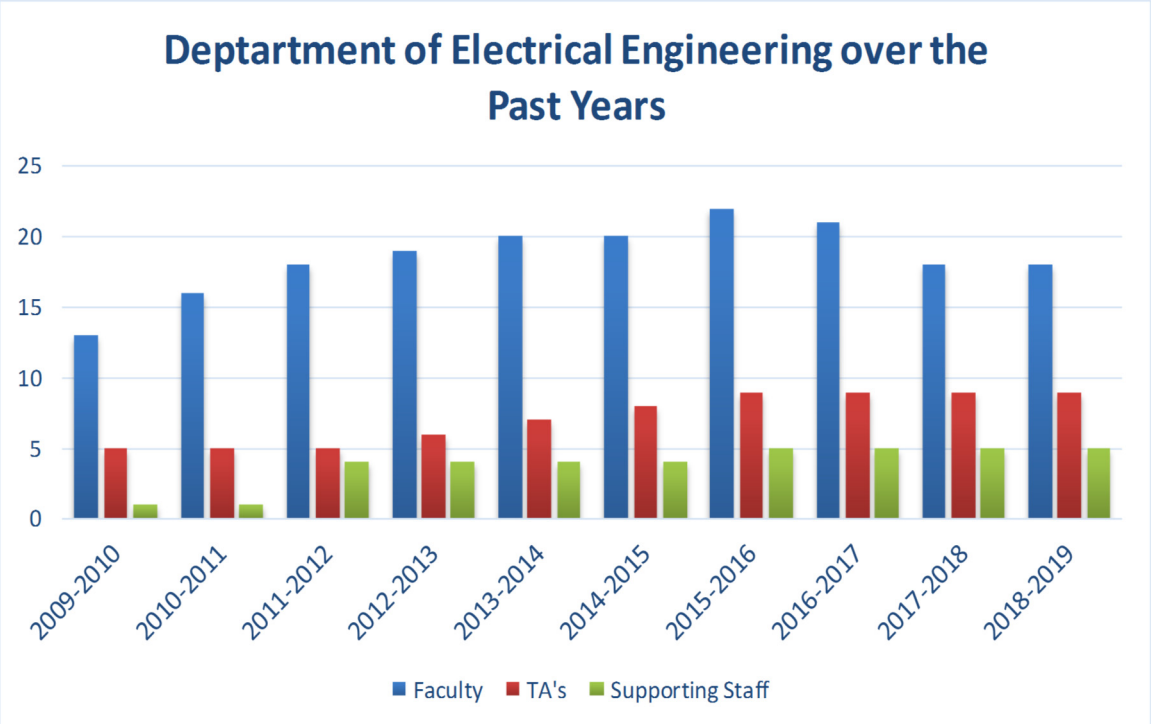
Department Staff Statistics



Editorials from EE Faculty

Dr. Tamer Khattab

Associate Professor Electrical Engineering Department at Qatar University

QU-CUBESAT

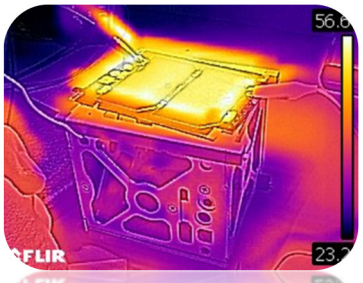
"Space exploration and space technology have always been the driver to many scientific and technological discoveries that push the boundaries of advancements in diverse fields. Thanks to the CubeSat initiative, access to space technology turned from a farfetched dream into a conceivable reality to many research and academic institutions around the world. A team from the Department of Electrical Engineering lead by Dr. Tamer Khattab and composed of faculty, engineers, graduate students and undergraduate students, has decided to put Qatar University (QU) on the prestigious league of ambitious institutions in the quest for space technology through the CubeSat initiative, which started at the Department of Electrical Engineering. QU will be among the leading institutions in the Region and the first in Qatar to design, build, launch and operate a pico-satellite. The objective of the new initiative is to conceive a multidisciplinary students' based mega project focused on building, launching and operating a miniaturized pico-satellite system and a satellite ground station according to the CubeSat standardized (http://www.cubesat.org) project in addition to an experimental rocket launching facility. The first QU built CubeSat satellite is called QUBSat -I.

QUBSat-I main mechanical frame & solar panels

More than 70% of the require human resources, expertise as well as lab and facilities are already available at QU. The remaining required resources and expertise are covered through strong partnerships with world renowned partner universities as well as local and international industries. As part of the project umbrella, QU will also establish an Experimental Rocket Launching initiative by the Department of Mechanical Engineering. The overarching aim of the CubeSat and Rocket Launching project is to establish the QU Spacecraft Design Lab, which will act as a nucleus towards two more strategic objectives; namely, establishing Qatar's first Aerospace Engineering Program at QU and establishing Qatar's Space Agency at the national level.

The project idea, initiated by Dr. Tamer Khattab, an Associate Professor at the Department of Electrical Engineering, will position Qatar University as a technology and educational leader in the region. It will also position the State of Qatar on the map of space exploring nations. Moreover, the technological and knowledge base outcomes from the project and the human skill development provided by the project are well aligned with Qatar vision for 2030.

CubeSat is a standardized design for pico-satellite systems, which allows economically efficient implementation and launching of small-scale satellites with specific predefined missions. The system standardizes the different satellite subsystems' components as well as its dimensions and shapes. The former enables the use of commercial off-the-shelf (COTS) components to implement the desired satellite system. Thus, enabling simpler and more cost effective implementations. The latter enables batch launching of several satellite systems in one launching vehicle. Thus significantly reducing the launching cost per satellite system and making it more feasible for experimental purposes.

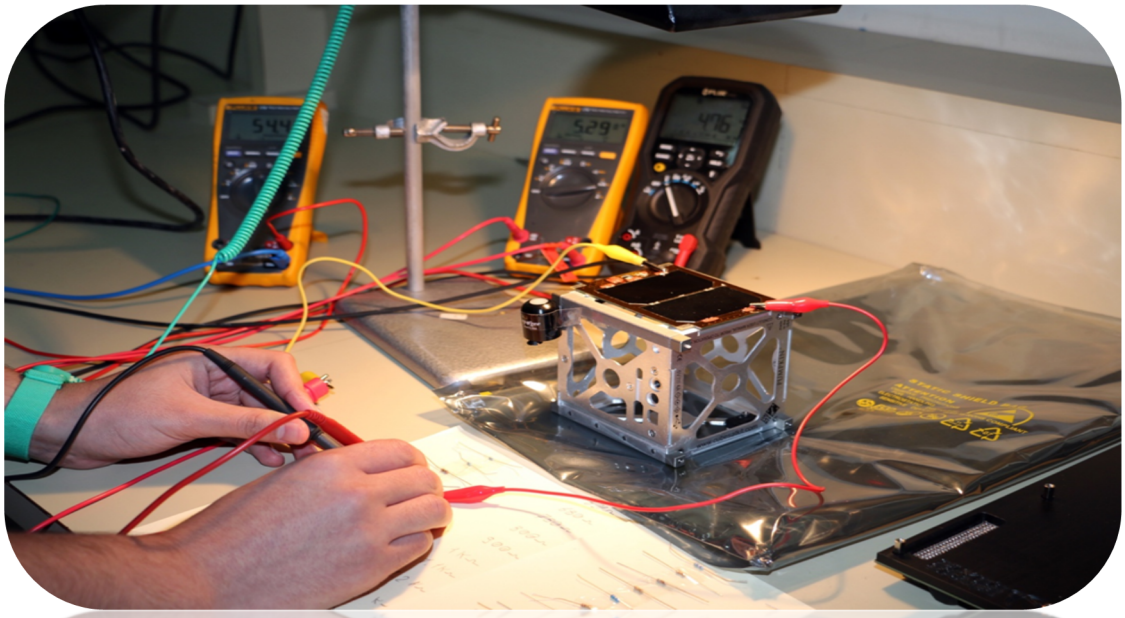


Thermal analysis of QUBSat-I

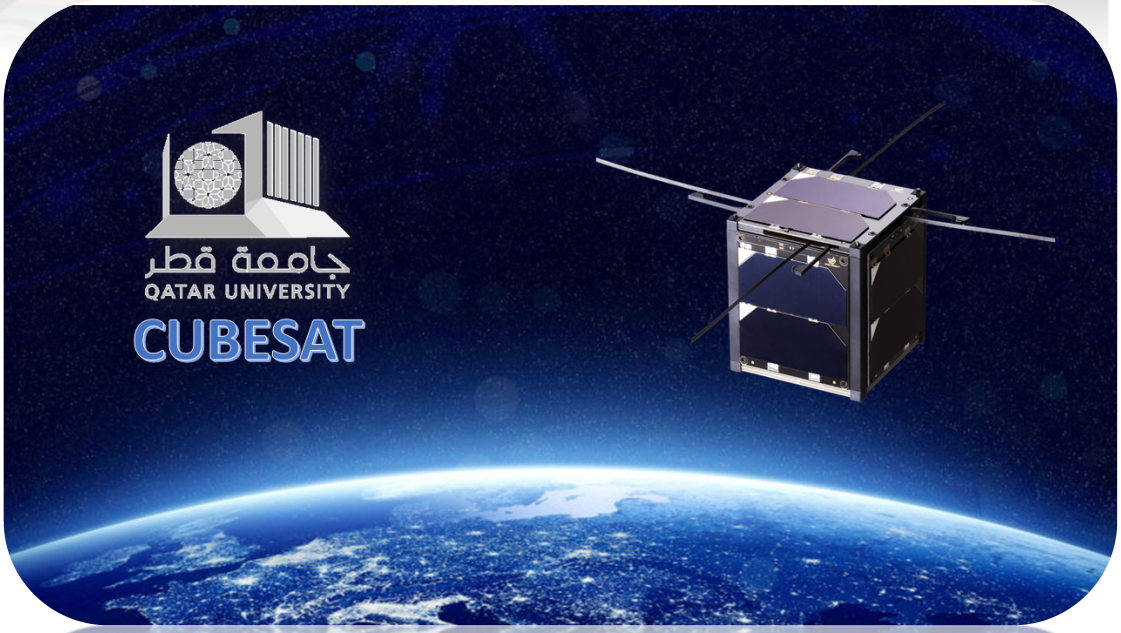
Due to the above mentioned unique characteristics of the CubeSat system, in addition to the fact that the design and

Core QUBSat-I team members at Electrical Engineering.

implementation of a CubeSat system requires multi-disciplinary work at least between electrical, computer, and mechanical engineering programs (other disciplines can be involved based on the mission), CubeSat system design and implementation requirements fulfill the objectives of a mega capstone design project for engineering students. Moreover, the project is also a key enabling vehicle for project based learning and integration of research activities with undergraduate curriculum.



Electrical testing of QUBSat-I solar panels



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Vision:

The Department of Electrical Engineering will be the recognized national leader in electrical engineering education and research at the local and regional levels; its program will be the preferred electrical engineering program in Qatar, and its graduates will be the top choice for local employment.

Mission:

The Department of Electrical Engineering supports the mission of the College of Engineering and that of Qatar University through high quality teaching, research, and services that benefit the Electrical Engineering students and the State of Qatar. The department produces graduates with strong engineering skills necessary for contemporary areas of electrical engineering and who are well prepared for successful engineering careers or for pursuing graduate studies.

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