3.7.2: Number of functional MoUs with institutions/ industries in India and abroad for internship, on-the-job training, project work, student / faculty exchange and collaborative research during the last five years

Any additional information

Ref.: GHK/HR/IC/072/072022   Date: 01/07/2022

TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Ms. Ummul – Aiman Mussa Mohamed,** a student of Microbilogy in Marwadi University, Rajkot has successfully completed training programme at our hospital. 01th June, 2022 to 01st July, 2022. During the period of her training programme with us she was found punctual, hardworking and inquisitive.

We wish her bright future ahead.

For, Gokulam Lifescience Private Limited

Authorized Signatory
HR DEPARTMENT

24x7 X 365 Days   EMERGENCY HELP LINE - 7900 108 108

14, Sadguru Nagar, Nr. Ranchhoddas Ashram, Kuvadava Road, RAJKOT - 360 003 (Guj.) Phone : 0281-2550600, 2550601
Web : www.gokulhospital.com   E-mail : info@gokulamlifescience.in
CIN: U85320GJ2018PTC101169

Ref.: GHK/HR/IC/073/072022

Date: 13/07/2022

TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Ms. Fridaus Nakalema,** a student of Microbiology in Marwadi University, Rajkot has successfully completed Internship programme at our hospital. 13th May, 2022 to 13st July, 2022. During the period of her Internship programme with us she was found punctual, hardworking and inquisitive.

We wish her bright future ahead.

For, Gokulam Lifescience Private Limited

Authorized Signatory
HR DEPARTMENT

Date: 25/02/2022

Ref. No.: FoPT/2022/ 56

To,
HR/Physiotherapy Department,
Shiv Orthopedic Superspeciality & Trauma Hospital,
Rajkot.

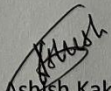**Subject:** Regarding posting of our students for March, 2022

Respected Sir/Madam,

Marwadi Education Foundation has been one of the premier and fastest-growing educational institutions of the Gujarat state. The vision of Faculty of Physiotherapy is to be recognized as the best in education, and clinical practice in the field of Physiotherapy.

With reference to above mentioned subject, following students will come to your Physiotherapy Department daily from 9:30 am to 12:30 pm for the month of March, 2022 for clinical exposure. Kindly allow them.

For any queries, feel free to contact coordinator Dr. Ashish Kakkad on mobile no. 9824415797.

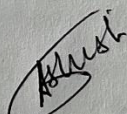Thanking you,

Attachment: Month wise Students' Postings.

Dr. Ashish Kakkad,
Principal
Faculty of Physiotherapy,
Marwadi University,
Rajkot.

Student's details for Shiv Orthopedic Superspeciality and Trauma Hospital

Year: Third B. Physiotherapy
Month: March, 2022

Sr. No.	Roll No	Student Name
1	91901364001	HONEY MEGHABEN MEHTA
2	91901364032	MWASITI M MBWANA
3	91901364009	KHUSHI SACHIN KOTECHA
4	91901364047	SABRINA ALLY DAUD

Dr. Ashish Kakkad,
Principal,
Faculty of Physiotherapy,
Marwadi University,
Rajkot.

Activities

Done Under MoU with

EVOTAR Technologies PVT LTD

Sr No	Activity	Date
1	Meeting	25/3/2021
2	Interaction Related to Industrial Training	14/04/2022
3	Job Placement	02/07/2022

Minutes of the Meeting

with Management of

EVOTAR Technology PVT LTD

Meeting Called by: Liaison Officer for MoU (Prof. Uvesh Sipai)

Meeting Venue: Head Office – EVOTAR Technologies PVT LTD, Ahmedabad

Date of Meeting: 25/03/2021

Agenda:

- To discuss the collaborative activities between EVOTAR and MU
- To look for opportunities for student internship and training
- Recruitment of students as Junior engineers at EVOTAR

Outcome:

- It is decided to do the online webinar and training for the students of MU related to rooftop solar power plant design
- Two-day workshop on PvSyst can be planned at MU by experts from EVOTAR
- Students will gain the opportunity to visit the project sites of EVOTAR for training.

Attendees:

1. Prof. Uvesh Sipai (Liasion Officer from MU)
2. Mr. Yash Bhatt (Liasion Officer from EVOTAR)
3. Mr. Purvarajsinh Jala (Director, EVOTAR)

Photographs:

To,

Prof. Uvesh Sipai

Assistant Professor

Liaison Officer for MoU

Marwadi Univeristy, Rajkot

Subject: Internship Opportunity for MU Students

Dear Prof. Uvesh,

As per our telephonic discussion, I am happy to write this official letter for finalizing the project site for the students of Semesters 4 and 6 of MU.

Students can opt for the internship of two weeks at the project site of EVOTAR. All the logistic requirements should be arranged by the students.

I request you to share this information with the students of Electrical Engineering and ask them to take maximum benefit of it.

Waiting to welcome the students of MU.

Date: April 14, 2022

Purvarajsinh Jala

Director

EVOTAR Technologies Pvt. Ltd.

Recruitment for Evotr

2 messages

Dhaval Popat <dhavalpopat816@gmail.com>   Sat, Jul 2, 2022 at 9:48 AM
To: "uvesh.sipai@marwadieducation.edu.in" <uvesh.sipai@marwadieducation.edu.in>

Respected sir ,

Myself Dhaval Popat and I am currently working as solar
project Engineer in Onix Structure Private Limited since 1
year 6 months.I have completed my B.E. from GTU in
Electrical in 2021. And I am interested for the post of
project Engineer at Evotr. Here i am attaching my resume
for your reference. Kindly find the attachment. Hoping to
hear from you soon.

Thanking you

Dhaval popat
9723077537
dhavalpopat816@gmail.com

📄 **dhavalpopatresume.pdf**
   110K

Uvesh Sipai <uvesh.sipai@marwadieducation.edu.in>   Sat, Jul 2, 2022 at 10:26 AM
To: info@evotartech.com
Cc: HOD EE <hodee@marwadieducation.edu.in>

Dear Mr. Purvarajsinh and Mr. Yash

Kindly consider the following candidate for the recruitment for the post of Project Engineer at Evotar Technologies PVT
LTD. I have also asked him to contact your HR for the same.
Let me know if you have any queries regarding the same.

[Quoted text hidden]
--

Uvesh Sipai
Assistant Professor
Department of Electrical Engineering

📱+91 9726704480   📞+91-281-2924154   🌐marwadiuniversity.ac.in

---

📄 **dhavalpopatresume.pdf**
   110K

Apply for solar power plant company

2 messages

piyush vaghela <piyushvaghela6703@gmail.com>   Sat, Jul 2, 2022 at 10:32 AM
To: uvesh.sipai@marwadieducation.edu.in

📄 **piyushvaghelaCV.pdf**
396K

Uvesh Sipai <uvesh.sipai@marwadieducation.edu.in>   Sat, Jul 2, 2022 at 10:56 AM
To: info@evotartech.com
Cc: HOD EE <hodee@marwadieducation.edu.in>

Dear Mr. Purvarajsinh and Mr. Yash

Kindly consider the following candidate for the recruitment for the post of Project Engineer at Evotar Technologies PVT
LTD. I have also asked him to contact your HR for the same.
Let me know if you have any queries regarding the same.

---------- Forwarded message ---------
From: **piyush vaghela** <piyushvaghela6703@gmail.com>
Date: Sat, Jul 2, 2022 at 10:32 AM
Subject: Apply for solar power plant company
To: <uvesh.sipai@marwadieducation.edu.in>

--

Uvesh Sipai
Assistant Professor
Department of Electrical Engineering

📱+91 9726704480   📞+91-281-2924154   🌐marwadiuniversity.ac.in

📄 **piyushvaghelaCV.pdf**
396K

Apply for Project Engineer at Evotar"

5 messages

Savan Trambadiya <savanmtrambadiya17@gmail.com>   Sun, Jul 3, 2022 at 8:58 PM
To: uvesh.sipai@marwadieducation.edu.in

Name :- Savan trambadiya

📄 **savan resume.pdf**
83K

Uvesh Sipai <uvesh.sipai@marwadieducation.edu.in>   Mon, Jul 4, 2022 at 9:46 AM
To: info@evotartech.com
Cc: HOD EE <hodee@marwadieducation.edu.in>

Dear Mr. Purvarajsinh and Mr. Yash

Kindly consider the following candidate for the recruitment for the post of Project Engineer at Evotar Technologies PVT
LTD. I have also asked him to contact your HR for the same.
Let me know if you have any queries regarding the same.

---------- Forwarded message ---------
From: **Savan Trambadiya** <savanmtrambadiya17@gmail.com>
Date: Sun, Jul 3, 2022 at 8:58 PM
Subject: Apply for Project Engineer at Evotar"
To: <uvesh.sipai@marwadieducation.edu.in>

Name :- Savan trambadiya

--

Uvesh Sipai
Assistant Professor
Department of Electrical Engineering

📱+91 9726704480   ☎+91-281-2924154   🌐marwadiuniversity.ac.in

📄 **savan resume.pdf**
83K

Mail Delivery Subsystem <mailer-daemon@googlemail.com>   Mon, Jul 4, 2022 at 9:47 AM
To: uvesh.sipai@marwadieducation.edu.in

Message blocked

Your message to **info@evotartech.com** has been blocked. See technical

details below for more information.

The response from the remote server was:

`552 5.1.1 <info@evotartech.com> Mailbox delivery failure policy error`

Final-Recipient: rfc822; info@evotartech.com
Action: failed
Status: 5.1.1
Remote-MTA: dns; mx.zoho.com. (136.143.191.44, the server for the domain evotartech.com.)
Diagnostic-Code: smtp; 552 5.1.1 <info@evotartech.com> Mailbox delivery failure policy error
Last-Attempt-Date: Sun, 03 Jul 2022 21:17:03 -0700 (PDT)

---------- Forwarded message ----------
From: Uvesh Sipai <uvesh.sipai@marwadieducation.edu.in>
To: info@evotartech.com
Cc: HOD EE <hodee@marwadieducation.edu.in>
Bcc:
Date: Mon, 4 Jul 2022 09:46:51 +0530
Subject: Fwd: Apply for Project Engineer at Evotar"
----- Message truncated -----

Uvesh Sipai <uvesh.sipai@marwadieducation.edu.in>   Wed, Jul 13, 2022 at 10:41 AM
To: info@evotartech.com

[Quoted text hidden]

📄 **savan resume.pdf**
83K

EVOTAR Technologies PVT LTD <info@evotartech.com>   Wed, Jul 13, 2022 at 2:33 PM
To: Uvesh Sipai <uvesh.sipai@marwadieducation.edu.in>

Dear Uvesh,

Thank you for sharing resume we will call all candidate shortly for interview.

Thanks and Regards

---- On Wed, 13 Jul 2022 10:41:08 +0530 **Uvesh Sipai <uvesh.sipai@marwadieducation.edu.in>** wrote ---
[Quoted text hidden]

Recruitment of Project Engineer at Evotar"

4 messages

YASH SOLANKI <yash.solanki17249@marwadieducation.edu.in>   Sat, Jul 2, 2022 at 6:23 PM
To: Uvesh Sipai <uvesh.sipai@marwadieducation.edu.in>

   Name :- yash yogeshbhai solanki
   Mobile No :-7984318718
   Email :-yash87015@gmail.com

📄 **resume Yash.pdf**
   156K

Uvesh Sipai <uvesh.sipai@marwadieducation.edu.in>   Mon, Jul 4, 2022 at 9:46 AM
To: info@evotartech.com
Cc: HOD EE <hodee@marwadieducation.edu.in>

Dear Mr. Purvarajsinh and Mr. Yash

Kindly consider the following candidate for the recruitment for the post of Project Engineer at Evotar Technologies PVT
LTD. I have also asked him to contact your HR for the same.
Let me know if you have any queries regarding the same.
[Quoted text hidden]
--

Uvesh Sipai
Assistant Professor
Department of Electrical Engineering

📱+91 9726704480   📞+91-281-2924154   🌐marwadiuniversity.ac.in

📄 **resume Yash.pdf**
   156K

Mail Delivery Subsystem <mailer-daemon@googlemail.com>   Mon, Jul 4, 2022 at 9:46 AM
To: uvesh.sipai@marwadieducation.edu.in

Message blocked

Your message to **info@evotartech.com** has been blocked. See
technical details below for more information.

The response from the remote server was:

```
552 5.1.1 <info@evotartech.com> Mailbox delivery failure policy error
```

Final-Recipient: rfc822; info@evotartech.com
Action: failed
Status: 5.1.1
Remote-MTA: dns; mx.zoho.com. (136.143.191.44, the server for the domain evotartech.com.)
Diagnostic-Code: smtp; 552 5.1.1 <info@evotartech.com> Mailbox delivery failure policy error
Last-Attempt-Date: Sun, 03 Jul 2022 21:16:32 -0700 (PDT)

---------- Forwarded message ----------
From: Uvesh Sipai <uvesh.sipai@marwadieducation.edu.in>
To: info@evotartech.com
Cc: HOD EE <hodee@marwadieducation.edu.in>
Bcc:
Date: Mon, 4 Jul 2022 09:46:21 +0530
Subject: Fwd: Recruitment of Project Engineer at Evotar"
----- Message truncated -----

Uvesh Sipai <uvesh.sipai@marwadieducation.edu.in>   Wed, Jul 13, 2022 at 10:41 AM
To: info@evotartech.com
Cc: HOD EE <hodee@marwadieducation.edu.in>

Dear Mr. Purvarajsinh and Mr. Yash

Kindly consider the following candidate for the recruitment for the post of Project Engineer at Evotar Technologies PVT
LTD. I have also asked him to contact your HR for the same.
Let me know if you have any queries regarding the same.

---------- Forwarded message ---------
From: **YASH SOLANKI** <yash.solanki17249@marwadieducation.edu.in>
Date: Sat, Jul 2, 2022 at 6:24 PM
Subject: Recruitment of Project Engineer at Evotar"
To: Uvesh Sipai <uvesh.sipai@marwadieducation.edu.in>

Name :- yash yogeshbhai solanki
Mobile No :-7984318718
Email :-yash87015@gmail.com

[Quoted text hidden]

---

resume Yash.pdf
156K

Activities

Done Under MoU with

Energy Swaraj Ashram, Marwadi University

Sr No	Activity	Date
1	Energy Literacy Training, course	04/01/2021
2	Energy awareness talk	30/12/2021

Energy Literacy Training

Energy Swaraj Foundation (ESF), a not-for-profit organization in collaboration with Energy Swaraj Ashram, Marwadi University has launched the Energy Literacy Mission to make people Energy Literate about the use of solar energy and climate change. The mission aims to train 20 million people in 2022 and 1 billion people by 2030.

The training helps people in understanding energy, its generation, consumption, wastage, carbon footprint, impact on the environment, means to avoid and minimize energy usage, alternatives energy solutions, ways to become carbon neutral, misconceptions on solar energy, and approaches to adopt solar energy solutions.

Highlights of the training are:

● This certified training course worth Rs. 100 is being offered for FREE.

● This training program is available in English and Hindi

● Training is imparted through 12 modules of 12-15 minutes each

● Each module has activity or exercise related to the concept

● The entire training program spans from 4-5 hours

● E-certificate will be given to successful participants who score 60% or above

Energy awareness talk

The Energy Swaraj Foundation is establishing Energy Swaraj Ashrams across the world. It is envisaged that through the active role of these ashrams, households, institutions, communities, and regions can become self-sufficient in generating and fulfilling their own energy needs using solar energy or other renewable energy solutions. Energy Swaraj Ashrams are solar incubation centers in academic institutions.

The Energy Swaraj Foundation supports the Student Solar Ambassadors Workshop, which aims to sensitize the students towards dire consequences of climate change and towards the need to ensure energy sustainability. For this, ESF offers a training course that gives hands-on training in solar lamp assembly.

Marwadi University have completed hands on workshop **more than 100 students** and also run campaigning for Energy literacy program.

Under Energy Literacy program **more than 400 students** including science and engineering students have enrolled themselves.

Under Energy swaraj ashram banner, we are planning to conduct some workshops for graduate and post graduate students related to solar installations and training program.

We are also motivating to the faculty members as mentor to guide the students for "energy literacy program" as well as for different workshops and training purposes.

ENERGY LITERACY PROGRAM: Energy Literacy is an understanding of the nature and role of energy in the world and daily lives accompanied by the ability to apply this understanding to answer questions and solve problems.

An energy-literate person:

- Can trace energy flows and think in terms of energy systems.

- Knows how much energy they use, for what purpose, and where the energy comes from.

- Can assess the credibility of information about energy.

- Can communicate about energy and energy use in meaningful ways.

- Is able to make informed energy use decisions based on an understanding of impacts and consequences.

Meeting Minutes:

Marwadi University and Pal Techno cast for Internship, Placement, and Industry Visit

Date: 21/08/2020

Time: 11:00 AM

Location: Pal Techno cast, Rajkot

Attendees:

Marwadi University:

- Dr. Nikunj Rachchh
- Prof. Kartik Pipalia
- Prof. Anchit Kaneria

Pal Techno cast:

- Mr. Ravi Ghelani

Agenda:
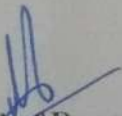
1. Introduction
2. Discussion on internship opportunities
3. Discussion on placement opportunities
4. Discussion on industry visits
5. Next steps and meeting closure

Minutes:

1. **Introduction:** The meeting started with a warm welcome to all attendees. Mr. Ravi Ghelani, the host from Pal Techno cast, briefly introduced the company and its operations. He also introduced the representatives from Marwadi University. All attendees then introduced themselves.

2. **Discussion on internship opportunities:** The group discussed the importance of internships and how they can provide valuable experience to students. Pal Techno cast expressed interest in

providing internship opportunities to Marwadi University students. Marwadi University provided information on their internship program and the criteria for selecting students. It was agreed that Pal Techno cast would provide specific details on the internship opportunities available and Marwadi University would share this information with their students.

3. **Discussion on placement opportunities:** The group discussed the importance of placements and how they can help students secure jobs after graduation. Pal Techno cast expressed interest in offering job placements to Marwadi University students who excel during their internships. Marwadi University provided information on their placement program and the criteria for selecting students. It was agreed that Pal Techno cast would provide specific details on the job placements available and Marwadi University would share this information with their students.

4. **Discussion on industry visits:** The group discussed the importance of industry visits and how they can provide students with an understanding of how companies operate. Pal Techno cast offered to organize industry visits for Marwadi University students to their facility. Marwadi University expressed interest in the opportunity and agreed to coordinate with Pal Techno cast to schedule the visits.

5. **Next steps and meeting closure:** The attendees agreed that the internship and placement opportunities, as well as the industry visits, would provide valuable experience to Marwadi University students. Pal Techno cast agreed to provide specific details on the internship opportunities and job placements available to Marwadi University, while Marwadi University agreed to coordinate with Pal Techno cast to schedule the industry visits. The meeting was adjourned at 12:30 PM.

Head of Department,

Dr. Nikunj Rachchh

Associate Professor,

Mechanical Engineering Department

Marwadi University, Rajkot

सत्यमेव जयते
Ministry of Science & Technology
Government of India

Project Proposal On

"AI-Driven Fault Diagnosis and Fault Adaptive Operation of High-Density Multiphase Drives for Smart Electric Vehicles"

Submitted to

Division : International Cooperation (Bilateral)

Programme or Scheme : CALL FOR INDIA PORTUGAL JOINT PROPOSAL

Submitted by

Project Investigator:

Dr. Ranjan Kumar Behera

INDIAN INSTITUTE OF TECHNOLOGY PATNA-patna

Part 1 : General Information

General Information:

1.Name of the Institute/University/Organisation submitting the Project Proposal :

INDIAN INSTITUTE OF
TECHNOLOGY PATNA

2. State   Bihar

3. Principal Investigrator Name: Dr. Ranjan Kumar Behera

4. Category: SC

5. Type of the Institue :   Academic Institutions(Government)

6. Project Title :   AI-Driven Fault Diagnosis and Fault Adaptive Operation of High-Density
                                                  Multiphase Drives for Smart Electric Vehicles

7. Division :   International Cooperation (Bilateral)

8. Programme Or Scheme :   CALL FOR INDIA PORTUGAL JOINT PROPOSAL

9. Academic Area :   Electrical Engineering,

10. Application Area :   Energy,

11. Goverment National Initiative :   Smart Cities, Smart Village, Innovate India,

12. Type of Proposal :   Proposal Against Call

13. Project Duration :   3 Years and 0 Months

14. Proposal Submit Date :   29/07/2020

15. Project Keywords :   Fault Adaptive Control, Fault Diagnosis, High Performance Drives, Smart
                                                  Electric Vehicles

16. Project Summary :

Project Title AI-Driven Fault Diagnosis and Fault Adaptive Operation of High-Density Multiphase Drives for Smart Electric Vehicles

Objectives of the Project
- Development, design and testing of multiphase induction motor based smart drive system for EVs.
- Diagnosis and prognosis of faults in EVs will be investigated using artificial intelligence AI, signal processing and machine learning techniques.
- Phase or inverter faults adaptive controller design for interrupt-free operation of an electric vehicle
- A novel battery management system will be developed to use range extension in operating conditions outside normal limits during fault conditions.
- Design and testing of a planetary gear system as a power-split device in the power train in developed EV experimental setup.
- Testing with actual four wheelers.

Methodology

In EV, the majority of faults are observed in multiphase motor drive PMMS and IM, inverter, DC link capacitor and battery. Due to compact design of EV, some of the faults and its subsequent phenomenon can seriously compromise safety of the human. At the same time, timely identification of some of the fault, particularly in the EV drive train can ensure safe and stable operation. This has necessitated on-board diagnostics of various faults in the EV. This project aims at diagnosis of the fault and post fault reconfiguration of multiphase induction motor and permanent magnet synchronous machine PMSM that leads to interrupt free operation of the EV. The post fault operation causes uneven power demand from the battery modules and hence improved battery management system is envisaged for long range of the drive while maintaining the heat generation and dissipation in the modules. The AI based algorithms with Deep Learning Models have facilitated the timely and accurate diagnosis of the fault and hence will be incorporated in the proposed work. The implementation of the project with its objectives is explained as follows

For AI-based fault diagnosis and detection algorithm, healthy Multiphase Induction Motor DriveMIMD current, voltage and speed data will be collected for different signature analysis and the corresponding global model will then be designed. Normally, features are extracted in time and frequency domain which, respectively, represent morphological variations real and spectral domain of samples distribution. The evaluation of an AI enabled strategy with fault signatures of MIMD and PMSM will be carried out for local models using different data clustering techniques. Widening the scope of the fault identification, diagnosis, localization, and recommendation for predictive maintenance demands a method or set of algorithms that deals with vast varieties of faults in the aforementioned electrical systems and control devices and renders solutions with utmost accuracy. Therefore, deep learning based neural network models are worth investigating which yet to be explored or very little explored for mentioned fault identification in various components of EV. Depending on the complexity and variability of the signatures of waveforms during the incidents of fault, a machine learning algorithm will be selected. An experimental testbed for the diagnosis of the faults will be implemented in which fault identification will be carried out for Multiphase Induction Motor Marwadi University and 6-phase PMSM University of Coimbra.

After successful detection and discrimination of fault, post fault operation of the drive will be determined. A high performance Direct Torque Control DTC technique which adapts to fault scenario will be developed in which the Multiphase drives fed from two level VSI is considered as supply option. In the post fault scenario, the voltage vectors of VSI based faulty drive will be analyzed under open phase faults. The analysis of voltage vectors ensures satisfactory operation of the MIMD even during the post fault scenario. In addition to this, the post-fault operation with different control algorithms including Model Predictive Control will be studied and comparative analysis will be carried out. At large, the project aims for adaptive control algorithms which ensures high performance operation during pre-fault and post fault scenario and at the same time maximizes efficiency of the drive by reducing losses, reducing torque pulsation and feedback of the energy by regenerative action. This resulting drive system will be developed by specific state of the art software tools and hardware arrangement that is capable of running diagnostic algorithm and real time control of the Multiphase drive in unison. Such hardware arrangement of the drive is partially available at IIT Patna as well as University of Coimbra.

The post-fault operation of the EV drive train produces larger torque ripple resulting in increased power oscillations and/or faster discharge of the battery pack. Hence, A novel battery management system will be developed for interrupt free operation and long range drive with natural cooing system design. New fast control will be developed to use range extension in operating conditions outside normal limits during fault conditions.

Widening the scope of the fault identification, diagnosis, localization, and recommendation for predictive maintenance demands a method or set of algorithms that deals with vast varieties of faults in the aforementioned electrical systems and control devices and renders solutions with utmost accuracy. Therefore, deep learning based neural network models are worth investigating which yet to be explored or very little explored for mentioned fault identification in various components of EV. Hence, exact algorithm and smart interrupt free EV can be explored in this research.

A novel design of smart monitoring of its essential electrical as well as mechanical equipment will be carried out. The on-board diagnostic OBD system for tracking and warning of critical EV faults, including battery SOC level, inverter fault, electric motor fault, acceleration and braking levels will be monitored and displayed in the computer with online tracking system. Also, Design of a planetary gear system as a power-split device in the power train will be developed to transmit the torque smoothly to the wheel. Tested components will be placed in actual 4 wheelers and a comparative evaluation will be carried out for the proposed smart EV system. Also, different fault adaptive techniques will be evaluated with four quadrant operation.

All developed control algorithms, of both the complete drive system and the converter subsystem, for all supply topologies and various operating modes, will be initially tested by real time simulation. The experimental work on the project is complex, since it requires software development for online control and subsequent experimental testing of the developed control algorithms. This stage will make an extensive use of the expertise of the academic staff of IIT Patna, Marwadi University and University of Coimbra. Since the multiphase power electronic converters are now in existence at IIT Patna and multiphase induction machines are available in IIT Patna and University of Coimbra, the main efforts will be directed towards the development and implementation of the AI-based post-fault reconfigure-less

control structure and programs for on-line control of the test rigs.

Deliverable Items / Outcome of the Project

The investigators propose the following major outcomes at the end of project

a.Multiphase 5-phase induction motor based smart EV drive system

b.New fault detection, classification and diagnostic algorithms for interrupt-free operation of EVs.

c.Advanced fault adaptive high-performance controller for EVs

d.A novel battery management system

e.A planetary gear system as a power-split device in the power train

f.Experimental setup, design of EV and testing with international publications/patent.

Key Question

There are few challenges of monitoring online data and executing in real-time is very difficult. With offline data analysis and fault adaptive controller design for interrupt free operation is really challenge for a smart EV design. Another challenge to design a planetary gear system for power split devices is really challenging and it needs optimization techniques. Choosing proper specifications for a smart EV is really complicated. Here this research will address all this. Overall experimental setup will be very complicated.

Applications

This will be used all kinds of EV propulsion system

References

1.Vinod Kumar Yadav, Ranjan Kumar Behera, Dheeraj Joshi, and Ramesh Bansal, "Power Electronics, Drives and Advanced Applications," CRC Press, April 17, 2020.

2.U. R. Muduli, A. R. Beig, K. A. Jaafari, J. Y. Alsawalhi and R. K. Behera, "Interrupt Free Operation of Dual Motor Four-Wheel Drive Electric Vehicle Under Inverter Failure," in IEEE Transactions on Transportation Electrification, doi 10.1109/TTE.2020.2997354.

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Part 2: Particulars of Investigators

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    Date of Birth: 05/06/1975

    Designation :   Associate Professor

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Co-Investigator:

1. Name: Dr. Dr Jimson Mathew

    Gender: Male

    Date of Birth: 25/04/1971

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Category:		General

2. Name: Dr. Rajendrasinh Jadeja

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Institute/University:		MARWADI UNIVERSITY
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3. **Name:** Dr. Dinesh Kumar

Gender: Male

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Institute/University: MARWADI UNIVERSITY

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Foreign Principal Investigator:

1. Name: Dr. Sergio Manuel Angelo da Cruz

   Designation :   Associate Professor

   Department: Director of the Electric Machines Laboratory

   Institute/University: University of Coimbra

   Country: Portugal

   City/Place: Coimbra

   Date of Birth: 01/01/1900

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   Address: Department of Electrical and Comput-er Engineering
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Foreign Co-Investigator:

1. Name: Dr. Andre Manuel dos Santos Mendes

   Designation :   Director

   Department: Director of the Power Electronics Laboratory

   Institute/University: University of Coimbra

   Country: Portugal

   City/Place: Coimbra

Date of Birth:	01/01/1900
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Part 3: Suggested Refrees

Suggested Refrees:

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Application Area:	Energy,
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3. **Name:**   Suresh Chandra Srivastava

Mobile:

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Academic Area: Electrical Engineering,

Application Area: Energy,

State:

District:

City:

Address:

Pin Code:

Part 4: Financial Details

Financial Details:

A. Non - Recurring

A1. Non-Recurring (e.g. equipments, accessories etc.)

S.	Equipments	Qty.	Justification	1 Year	Total
1 .	Battery	20	Battery for driving the inverter	240000	240000
2 .	plenetary gears	1	For power split of motor for vibration free transmitter to wheels of EV	100000	100000
3 .	Sensors	4	For smart EV, sensors and battery monitoring unit is required. Torque sensors and vibration analysis is needed	200000	200000
			Total	**540000**	**540000**

A2. Others Non-Recurring : NA

B. Recurring

B.1 Project Staff

S.	Project Staff	No.	Justification	1 Year	2 Year	3 Year	Total
1 .	JRF	2	JRF is needed to carry out the research expert in electrical machines and power electronics	744000	744000	0	1488000
2 .	Project Assistant	1	helping in the experimental setup and maintain the laboratory	300000	300000	300000	900000
3 .	SRF	2	SRF is needed to carry out the research expert in electrical machines and power electronics	0	0	840000	840000
			Total	**1044000**	**1044000**	**1140000**	**3228000**

B.2 Consumable

S.	Items	Qty.	Justification	1 Year	2 Year	3 Year	Total
1 .	heatsink	2	For power converter design	64000	0	0	64000
2 .	IC and measuring devices	50	Will be used in driver circuit	25000	25000	25000	75000
3 .	IGBTs	15	Discrete components are needed for experimental development for designing of power converter	36000	36000	0	72000
4 .	Wires	20	Discrete components are needed for experimental development for designing of power converter	20000	20000	20000	60000
			Total	**145000**	**81000**	**45000**	**271000**

B.3 Travel

S.	Description	Justification	1 Year	2 Year	3 Year	Total
1 .	Travel is required by the researchers from the both the institute and it is once in a year, some conferance	Traveling to Portugal and conferences	200000	400000	400000	1000000
		Total	**200000**	**400000**	**400000**	**1000000**

B.4 Contingency

S.	Description	Justification	1 Year	2 Year	3 Year	Total
1 .	Paper, pen, cartridge and office requirements	Needed for maintaining project	50000	50000	50000	150000
		Total	**50000**	**50000**	**50000**	**150000**

B.5 Any Other Head : NA

B.6 Overhead

S.	Description	Justification	1 Year	2 Year	3 Year	Total
1 .	Over head of 20% as per institute rule	This for institute overhead	395800	315000	327000	1037800
		Total	**395800**	**315000**	**327000**	**1037800**

Budget Head Summary in (INR)

Budget Head	Year-1	Year-2	Year-3	Total
1- Non-Recurring				
Equipment	540000	0	0	**540000**
2- Recurring				
Project Staff	1044000	1044000	1140000	**3228000**
Travel	200000	400000	400000	**1000000**
Overhead	395800	315000	327000	**1037800**
Contingency	50000	50000	50000	**150000**
Consumable	145000	81000	45000	**271000**
Total	**2374800**	**1890000**	**1962000**	**6226800**

PFMS Details:

PFMS Unique Code Available: Yes

PFMS Unique Code :   IITPAT

Part 5: Current Ongoing Project

Current Ongoing Project: NA

List of Uploaded Documents:-

1. Complete Project proposal

2. Biodata

3. Certificate from PI

4. Conflict of interest

5. Endorsement from head of Institute

6. Quotation for Equipments

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Format for Application
(Proforma for Submission of Joint Projects Proposals – 2020)

**INDIA–PORTUGAL PROGRAMME OF COOPERATION
IN SCIENCE AND TECHNOLOGY**

A. PROJECT IDENTIFICATION

1. Title of the Project:

   AI-Driven Fault Diagnosis and Fault Adaptive Operation of High-Density Multiphase Drives for Smart Electric Vehicles

2. Duration of the Project: 36 Months (3 Years)

3. Main research/thematic area, of the project (Ref. field from subjects mentioned in call): **Energy**

4. Field of science and technology covered by the Proposal (4 Keywords qualifying the scope of proposal)

   Fault Adaptive Control, Fault Diagnosis, High Performance Drives, Smart Electric Vehicles

5. Project Investigators (PI) and Collaborating Institutions:

	Indian Side	**Portugal Side**
Name of PI: Designation: Institution's Address: Tel: Mobile: Fax: E-mail: Date of Birth:	**Dr. Ranjan Kumar Behera** Associate Professor, Dept. Electrical Engineering Indian Institute of Technology Patna, Bihta Campus. Bihta-801106, Patna, Bihar 0612-3028059 9162227357 rkb@iitp.ac.in 05-06-1975	**Sérgio Manuel Ângelo da Cruz, PhD** Associate Professor Director of the Electric Machines Laboratory University of Coimbra / Instituto de Telecomunicações Department of Electrical and Computer Engineering Pólo II - Pinhal de Marrocos 3030-290 Coimbra, Portugal smacruz@deec.uc.pt
Name of Co-PI: Designation: Institution's Address: Tel: Mobile: Fax: E-mail:	**Dr. Rajendrasinh Jadeja** Professor & Dean, Electrical Engineering Department, Marwadi University, Rajkot Rajkot-Morbi Road, At & PO: Gauridad-360003, Gujarat, India +91 281-7123456 +91 9727724686 +91 281-2331170 rajendrasinh.jadeja@marwadieduca-tion.edu.in	**André Manuel dos Santos Mendes, PhD** Director of the Power Electronics Laboratory University of Coimbra / Instituto de Telecomunicações Department of Electrical and Computer Engineering Pólo II - Pinhal de Marrocos 3030-290 Coimbra, Portugal

Date of Birth:	03 July 1977	amsmendes@deec.uc.pt
Name of Co-PI: Designation: Institution's Address: Tel: Mobile: Fax: E-mail: Date of Birth:	**Dr. Dinesh Kumar** Associate Professor, Department of Computer Engineering (AI & Big Data) Marwadi University, Rajkot Rajkot-Morbi Road, At & PO: Gauridad 360003, Gujarat, India +91 281-7123456 +91 8980005447 +91 281-2331170 dinesh.kumar@marwadieducation.edu.in 26 August 1978	

Other Research Team (including young researcher's/ Ph.D. students):

1. Dr. Tapankumar Trivedi, Assistant Professor, Electrical Engineering Department, Marwadi University, Rajkot, India

2. Utkal Muduli, Md. Junaid and Bheemaiah Ch., PhD Scholars, Research Team Member, IIT Patna

3. Research Team Member, Department of Electrical and Computer Engineering, University of Coimbra, Portugal

B. TECHNICAL INFORMATION

1. Abstract (max. 250 words)

Safety and failsafe operation at an onload condition is a major concern for heavy electric vehicles (EVs). To deal with such situation, multiphase machine (MM) drives are best suitable due to their inherent fault-tolerant capabilities. The fault-tolerant operation of MM drives is challenging due to several reasons such as inaccurate fault detection, controller with considerable lag, etc. The main objective of this proposal is to develop and design a high performance multiphase induction motor based smart EV drive system for fault- tolerant operation. For interrupt-free operation, the detection and prediction of faults in EVs will be investigated using artificial intelligence (AI), signal processing and machine learning techniques. An adaptive fault control strategy and smart battery management system will be developed to keep the drive operational after phase or inverter faults and extend the operating range of the drive. In this way the efficiency, robustness and reliability of EVs can be enhanced. The proposed method will address the battery and DC-link and the use of range extension in operating conditions outside normal limits during fault conditions. Finally, a planetary gear system will be designed and tested as a power-split device in the power train. From this proposal a significant contribution towards the scientific community is possible in the field of fast and robust fault detection, and an adaptive post-fault control for the EV of tomorrow.

Objectives of the Project (max. 4 - 5 in numbers)

- Development, design and testing of multiphase induction motor based smart drive system for EVs.

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- Diagnosis and prognosis of faults in EVs will be investigated using artificial intelligence (AI), signal processing and machine learning techniques.

- Phase or inverter faults adaptive controller design for interrupt-free operation of an electric vehicle

- A novel battery management system will be developed to use range extension in operating conditions outside normal limits during fault conditions.

- Design and testing of a planetary gear system as a power-split device in the power train in developed EV experimental setup.

- Testing with actual four wheelers.

2. Expected Major Outcomes:

The investigators propose the following major outcomes at the end of project:

a. Multiphase (5-phase) induction motor based smart EV drive system

b. New fault detection, classification and diagnostic algorithms for interrupt-free operation of EVs.

c. Advanced fault adaptive high performance controller for EVs

d. A novel battery management system

e. A planetary gear system as a power-split device in the power train

f. Experimental setup, design of EV and testing with international publications/patent.

3. Justification for collaboration & brief information about national and international scenario in the proposed area of research (max. one page)

Indian Investigator Justification of Collaboration:

There are significant challenges in the control of fault tolerant multiphase drive for smart EVs which we will seek to surmount by a new design paradigm. The work on interrupt free and long range EV is novel as the use of battery and voltage source converters as interface between the Voltage sources and the EV. This work will advance the technology and encourage the adaptation in real applications in industrial applications and utilization. The author will benefit from the experience of Professor Sergio and this will enhance his ability to publish more journal papers in reputable journals and to enhance his skills in the use and application of AI with fault adaptive control technique. The group at the University of Coimbra will benefit from the hardware expertise of the IIT Patna and his group and encourage future collaborations. During the course of the research, it is planned to write and submit some papers for publication in IEEE Transactions, patent and a prototype design model. The Indian Institute of Technology, Patna has necessary research infrastructure including suitably designed multiphase induction motor drive and high-performance controllers and testbed for fault tolerant operation of electric vehicles. The research team of laboratory also possesses expertise in the domain of high performance controller with fault tolerant operation of EV.

The Electrical Engineering Department of Marwadi University is equipped with necessary experimental prototype of electrical drives, grid connected inverter, power quality conditioner and Hardware in the Loop testbed of grid connected inverter. In addition to this, the laboratory has RT-LAB Hardware in Loop Simulator for testing of complex algorithm of AI enabled smart drive systems. With existing testbed and domain knowledge, investigators will contribute towards AI driven fault diagnosis and adaptive controller design for interrupt free operation of EV drive.

International Status:

As an important way both to enhance the diversity of energy supplies and to reduce air pollution, the development of electric or hybrid electric vehicles, EVs or HEVs, is getting more attention [1]. The rapid development of industrial power electronics and modulation techniques of converters encouraged more research in the area of variable speed drives (VSD). The features of the VSDs attracted researchers to utilize them in traction applications such as electric vehicles (EVs) [2]-[4] and electric ship propulsion [5], [6].

EV propulsion system helps in reducing the air and noise pollution, so the volume of EVs is increasing at a rapid rate [7]–[9]. Nearly (1/3)rd of the ground vehicles is expected to use electric traction by 2030.Currently small electric cars, electric bikes make bulk part of the urban EVs but their usage is only 5%. Recent statistical surveys confirm that many cities are planning for mass movement using large electric cars, electric buses, etc. for the efficient utilization of urban transport system. The market for large rating cars is, therefore, likely to increase in the near future which may lead to new challenges. At present most of the EVs use permanent magnet synchronous motor (PMSM) as the prime mover. The magnets in these motors are made up of rare earth materials which have limited availability. The higher power demand of large vehicles can only be met by large magnets, thus making EVs more expensive. Hence, the current research is focused on the use of alternative motors like the less magnet motors [10], [11], or motors without magnets such as induction motors (IM) [12]–[13] and switched reluctance motors (SRM) [14], [15]. Compared to IM, SRM is more efficient and cheaper but have major disadvantages, like high vibration, noise and torque ripple. IMs are highly robust, simple to construct and cheaper as compared to PMSM but do not match the power density and efficiency of the PMSM at low rating [12]. However, IMs are better alternatives at a higher power rating [12], [14]. Some commercially available EVs use IM [12].

In the beginning, the Tesla Roadster is a battery EV produced by Tesla Motors in California between 2008 and 2012 [16], [17]. The Roadster was the first production automobile to use lithium-ion battery cells and the first production all-electric to travel more than 200 miles per charge. Toyota and Tesla Motors have jointly announced a development of an all-electric 2013 Toyota RAV4 EV-claimed to be the world's most aerodynamic SUV [16]. It is expected to achieve an average range of 100 miles from a full charge and can be completely recharged in about 6 h with a 240 V/40-A charger. Today, a few other EVs such as Tesla Model S, Nissan Leaf, Mitsubishi i-MiEV, and so on are commercially available. In July 2018, Tesla Motors announced the development of pure induction motor (IM) based EVs having dual motor D4WD [16].

National Status:

The NITI Aayog and World Energy Council have suggested policy for Zero Emission Vehicle (2018) in India. While primary focus of the policy is on Battery Chemistry, rapid urbanization and energy security, it is suggested to use lower vehicle weight, better efficiency and lesser energy losses due to braking. This paves the way for high power density machine with electric braking and advanced control methods for multiphase drives. The reliability and high efficiency are undisputed parameters of importance for EV drive trains which can be offered through multiphase machines due to inherent fault tolerant operation and high-power density. The National Mission for Electric Mobility (NMEM) Plan was launched in April 2015, and a Consumer Incentives Scheme" for Electric & Hybrid Electric Vehicles was published in the Gazette of India. It is expected to catalyze the development of the market and by 2020 to reach an annual sales of 6-7 million vehicles. This may lead to savings of 9500 Million Liters of crude oil or Rs. 62000 Cr. Savings by 2020. The DST has joined hands with the Department of Heavy Industry (DHI) to create a Technology Platform for Electric Mobility (TPEM), that will be funded primarily by the DHI, and the program management will be undertaken completely by DST.

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Portugal Investigator Justification of Collaboration:

The Power Systems Research group at Instituto de Telecomunicações – Pólo de Coimbra, with facilities in the Department of Electric and Computer Engineering, University of Coimbra, Portugal has a long experience of around 30 years in the development of fault diagnostic systems and fault-tolerant techniques for electric machines, electric drives and power electronic converters. Skilled human resources and excellent laboratory facilities are available for the development of innovative fault-tolerant electric drives for different fields of application, including electric vehicles. The existing expertise in model predictive control techniques applied to multiphase machines are also valuable assets given the main goals of this research project. With this collaboration, the Portuguese research team can provide to the Indian side valuable data sets (currents, voltages, speed, etc) obtained with different types of multiphase machines in healthy and faulty conditions to be used in AI-based diagnostic systems.

4. Scientific & technical description of the project (up to 500 words):

In order to improve reliability and interrupt-free operation, the current work proposes high performance fault adaptive multiphase machine drives. The configuration ensures stable and safe operation even when one or more phases of the machine are diagnosed with a fault. The pre-fault configuration uses advanced control techniques such as DTC or model predictive control for four quadrant operation and regenerative braking. At the same time, the post-fault configuration suitably adapts to fault scenario and determines the operation to meet reduced torque capability and minimum copper losses. An adaptive strategy ensures smooth transition from pre-fault operation to post-fault operation. The strategy is applied to open-end winding based multiphase machine drives in which a VSI is connected to each end of the stator windings. The proposed configuration reduces the switching losses in the inverter, improves its efficiency and eliminates common mode voltage issues in EV drives.

Each automotive EV needs to monitor its essential electrical as well as mechanical components. Almost all modern EVs now have an onboard diagnostic (OBD) system. OBDs are used to track and warn critical EV faults, including battery SOC level, inverter faults, electric motor faults, and acceleration and braking levels, among others. Hence, fault identification is one of the important tasks in the process to make interrupt-free power supply to the EV propulsion motor. The fault diagnosis in EV operations must be performed timely without considerable lag, so that instant corrective measures can be taken. Signal processing and machine learning techniques are extensively exploited in the detection and diagnosis preparation. However, given the signature variations according to the nature of the faults that may occur in the main components of EVs, some modern artificial intelligence methods need to be investigated. In this direction, a fairly new emerging class of machine learning algorithms, i.e. deep learning, can be examined and implemented for detection and diagnosis. Inputs form voltage, current and speed sensors can be taken into the detection model to determine faults based on self-adapting nature of the deep learning model.

150 words space reserved for Portugal Team

In addition to multiphase induction motor drives, multiphase PMSM drives will also be addressed, when controlled with state-of-the-art model predictive control algorithms, which allow an easy inclusion of restrictions in the control system in order to maximize the drive performance and efficiency under fault-tolerant operation. The most common types of faults like permanent magnet faults, stator inter-turn short-circuits, high resistance connections and open-phase faults will be analyzed and AI-based methods, eventually aided by signal-based methods, will be developed for the timely detection and localization of faults, aiming a fast and smooth transition from faulty to fault-tolerant operation. The drive will be tested in motoring as well as in generating modes, for different torque levels in speed control and torque control modes.

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5. Methodology

Research is designed around a number of tasks that will enable meeting the objectives of the project. The tasks in essence formulate the problems that have been identified in previous section and that require a solution. This section therefore details all the tasks and explains the methodology that will be followed. It should be noted that some tasks will typically run in parallel. Also, to make compliance with the project reporting requirements simpler, all the tasks (excepting the last one, final report preparation) are designed in such a way that they last one year. Successful realization of the project requires information about the available equipment, personnel and the timeline and these data are provided after definition of the tasks and the research methodology.
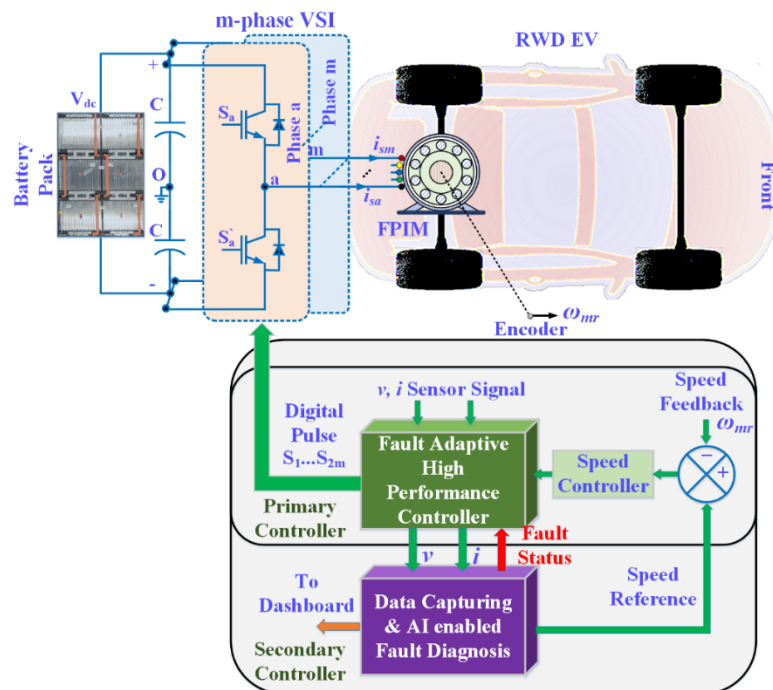
Fig. 1. Block Diagram of the Proposed Fault Adaptive High Performance Multiphase EV Drive System

Research will be conducted along well-defined research themes (RT), that will be explained as follows:

RT1   Designing and testing of multiphase induction motor based smart drive system for EV as shown in Fig. 1. This is basically the development of an AI-based fault diagnostic system able to perform a complete condition analysis of a multiphase drive based on two-level VSIs, as identified in Fig. 2.

RT2   This comprises the study of fault-tolerant operation of two-level VSI-fed MIMD drive which is a supply option for the MIMD described above. RT2 is specifically related to the development of post-fault adaptive control strategies for the proposed MIMD, which is basically the development of DTC and model predictive control techniques. The resulting drive system will be developed by specific hardware arrangements as intermediate steps towards the realization of the closed loop high

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performance control of the MIMD drive.

RT3   This will be achieved by running RT1 and RT2 in parallel. RT3 will be concerned with a comparison of various control techniques with the aim to achieve the best post-fault adaptive control performance at dynamic loading conditions.

RT4   A novel battery management system will be developed for interrupt free operation and long range drive with natural cooing system design. New fast control will be developed to use range extension in operating conditions outside normal limits during fault conditions. Design of a planetary gear system as a power-split device in the power train in developed EV.
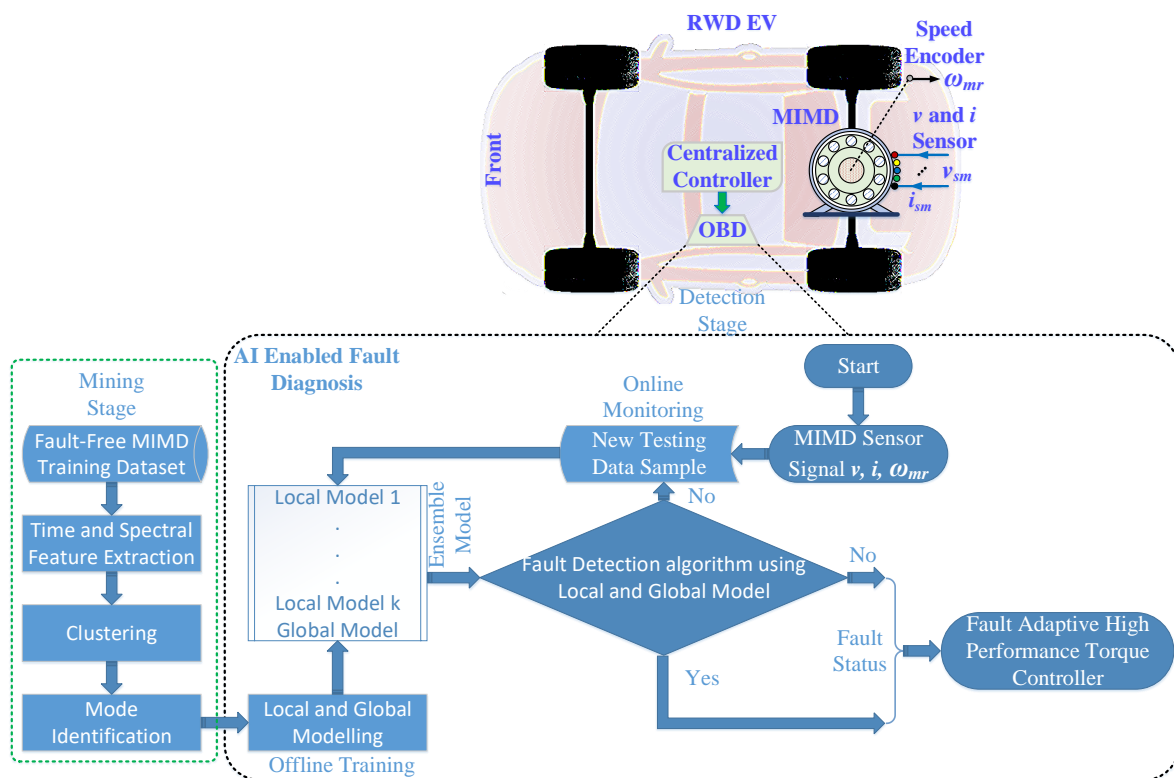
Fig. 2. Flowchart of the Proposed AI-based Fault Diagnosis System

The focus of the project is the investigation, development and realization of high-performance fault-tolerant closed loop controlled multiphase induction motor drives with, preferably, a switching frequency commensurate with high-power, high-voltage requirements. The project will also further contribute to an advanced research, training, and education laboratory that was created, aimed at developing highly qualified workforce in the variable speed drive and power electronics areas. Thus the project has distinct technical and strategic objectives.

The technical objectives (TO) of the project have been introduced in previous section through the survey of the state-of-the-art and are now summarized as follows:

TO1   Analytical review of different fault detection algorithms and proposal of an AI-based fault diagnosis system for MIMD.

TO2   Development and analytical analysis of post-fault voltage vectors for the multiphase two-level

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VSI schemes for open-phase fault conditions.

TO3   Comparative analysis of post-fault DTC operation with different control algorithms and model predictive control for multiphase two-level VSI fed MIMD drives.

The project also has primary strategic objectives (SO), which can be summarized as follows:

SO1   To develop highly qualified and well-trained workforce for EV industry and to further develop a specific laboratory for high power EV drives.

SO2   To publish a number of patent, conference and journal articles on the basis of the research that is to be conducted, including joint published output between the academics of the project partner institutions.

A description of all tasks that are envisaged as necessary to enable the achievement of the listed technical and strategic objectives and successful completion of the project is provided in the continuation of this section. The belonging of the task to a corresponding research track is identified and, for each task, an indication of the appropriate technical and strategic objective(s) to which it contributes to, is given.

T1   For AI-based fault diagnosis and detection algorithm, healthy MIMD current, voltage and speed data will be collected for different signature analysis and the corresponding global model will then be designed. The evaluation of an AI enabled strategy with fault signatures will be done for local models using different data clustering techniques. Development of AI enabled fault detection and post-fault DTC control schemes for MIMD drive, for EV propulsion application using two-level VSI as the supply option. This task will include theoretical considerations and subsequent simulation software development and simulations in parallel along the first two research themes (RT1, RT2). In the basic form, the control scheme illustrated in Fig. 1 will be studied and different means for achieving high-quality current control will be explored.

T2   An experimental testbed of EV drive system will be designed using two-level VSI fed MMID. Verification of the fault diagnosis strategy with implementation of the high performance adaptive DTC control scheme in the experimental rig and its subsequent testing, using different current controller options selected on the basis of the results of T1(RT2), two-level VSI as the supply.

T3   A Comparative analysis will be made of different techniques and revised goals at different scenario. Also, the evaluation of the adaptive control strategy with four quadrant operation and regenerative braking will be implemented.

For tasks T2 and T3 the experimental test rig is developed. These tasks will require development of real-time control software and the implementation will take place using the OPAL-RT platforms. Exhaustive experimental testing will be undertaken for two supply options so that a comprehensive set of results, enabling subsequent comparative analysis in RT3, will be collected.

T4   A novel battery management system will be developed for interrupt free operation and long range drive with natural cooing system design. New fast control will be developed to use range extension in operating conditions outside normal limits during fault conditions. Design of a planetary gear system as a power-split device in the power train in developed EV.

T5   Preparation of the final report in order to provide audit trail and facilitate use of the project results. The final report will summarize the main findings of all research tasks and its form will

depend on the achieved project outcomes (e.g., it may take a form of a compilation of the published output with a suitable introductory explanation chapter, it may contain research reports prepared during the work on the project, and it may also contain chapters of relevant PhD projects, if any were to run in parallel with the project and be thematically related to the project).

All developed control algorithms, of both the complete drive system and the converter subsystem, for all supply topologies and various operating modes, will be initially tested by simulation.

The experimental work on the project (Tasks 2; Technical objectives TO1-TO2) is complex, since it requires software development for online control and subsequent experimental testing of the developed control algorithms. This stage will make an extensive use of the expertise of the academic staff. Since the multiphase power electronic converters are now in existence at IIT Patna and multiphase induction machines are available, the main efforts will be directed towards the development and implementation of the AI-based post-fault reconfigure-less control structure and programs for on-line control of the test rigs.

It is the intention to produce a final report (Task 4), which will summarize the main achievements of the project at IIT Patna. The final report will also provide evidence that all technical and strategic objectives have been met. Conference and journal papers will be prepared as the project progresses, including joint publications. It is anticipated that, similar to the current project and as a consequence of the project novelty, a number of papers will be published during the project running.

Dissemination of project research results is envisaged to take place through presentation of the papers at major international conferences (e.g. IEEE and IET sponsored and organized conferences) and by publishing papers in major international journals. The emphasis will be placed again, just the same as during the work on the current project, on benchmark journals in the areas of the project, IEEE Transactions and IET research journals.

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6. Plan of work

Time Schedule	Responsibilities of Indian Research Team	Responsibilities of Portugal Research Team
1st Year	• Literature Survey and recruitment of project staff • Study of vehicle dynamics and analysis of multiphase IM propulsion system. Simulation study for different kinds of controllers suitable for fault adaptive reconfigurable drives. • Study of different kinds of fault such as inverter, wires, winding and battery system and analysis on fault signature classifications in MIMD system. • Evaluation, detection and classification of fault data with artificial intelligence, deep learning enabled strategy for reliable system integration. • Initial hardware development such as power electronics converters, sensor circuits etc	Update of the literature survey on diagnostic methods for multiphase induction and PMSM drives, taking into account the interaction of the control system into the diagnostic process Modelling and simulation of the different types of faults in 6-phase PMSM drives with a model predictive control strategy. Experimental testing and collection of data with fault signatures in multiphase PMSM drives subjected to different types of fault such as open-phase, high-resistance contacts, inter-turn short-circuits and permanent magnet demagnetization Collaboration in the development of AI enabled strategies using the collected fault signatures
2nd Year	• Study on high performance controller design for MIMD for Evs and analysis on fault-tolerant capability, low per phase power, low torque pulsation, and the reliability. • Study on Post Fault Operation strategy of multiphase drive for EVs and Fault Diagnosis of EV drives and investigation of proposed strategy • Implementation of High-Performance DTC strategy for EV with and without faults. Development of fault adaptive control strategy – Simulation and development of experimental prototype • Verification of fault diagnosis strategy with experimental testbed. Design and Development of fault adaptive control strategy for post fault operation of EV drive	Diagnosis of the different types of faults with artificial intelligence techniques Development of a model predictive control based fault tolerant system for multiphase PMSM drives, and evaluation of the obtained performance, namely its torque ripple suppression ability
3rd Year	• Design of a planetary gear system as a power-split device in the power train	

	• Design of smart monitoring of its essential electrical as well as mechanical equipments. These are on-board diagnostic (OBD) system for tracking and warning of critical EV faults, including battery SOC level, inverter fault, electric motor fault, acceleration and braking levels. • Tested components will be placed in actual 4 wheelers and a comparative evaluation will be carried out for the proposed smart EV system. Also, different fault adaptive techniques will be evaluated with four quadrant operation. • Detailed project report, patent and journal papers will be carried out.	Implementation of model predictive control in the multiphase induction motor drive and comparison of its performance with the DTC-based control system Testing and performance evaluation of the AI-based diagnostic algorithms developed earlier, applied to the MPC-controlled induction motor drive Comparison of different winding arrangements, namely star-, delta- and open-end winding connection, to access the most favorable configuration for fault-tolerant multiphase PMSM drives

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Project reference :	DRI/India/0374/2020
Project title:	AI-Driven Fault Diagnosis and Fault Adaptive Operation of High-Density Multiphase Drives for Smart Electric Vehicles

Task No	Task Denomination	Person*month	Participant responsible for task	Acronyms of partners involved in task
1	Procurement of Equipment, recruitment of project staff and literature study and simulation	1.20	MU(DK,Cont-2), IT(SC), IITP	MU, IITP
2	Study of vehicle dynamics and analysis of multiphase IM propulsion system. Evaluation of an AI enabled strategy with fault signatures	5.40	MU(DK,RBJ, TAT), IT(SC)	MU, IT
4	Development and analytical analysis of post-fault vectors for the multiphase two-level VSI schemes for open-phase fault conditions	7.20	IITP(RKB, Cont-1)	IITP
5	Development of AI enabled fault detection and post-fault DTC control schemes for MIMD drive	5.40	MU(DK,RBJ, TAT), IITP	MU, IITP
6	Comparative analysis of post-fault DTC operation with fault adaptive control algorithms with regenerative braking	5.40	IITP(RKB,Cont-1), MU (RBJ, TAT)	IITP
7	Development of novel battery management system for interrupt free operation and long range drive	1.50	IITP(RKB, Cont-1), MU (RBJ, DK)	IITP
8	Model Predictive Control of Multiphase drives for AI enabled classification with different types of fault.	2.10	IITP(RKB, Cont-1), IT(SC)	IIT P; IT
9	Design of smart EV with MIMD system and comparative analysis with different techniques with revised goals at different scenario	4.20	MU(DK,RBJ,Cont-2)	MU
10	Project Managament and Reporting	2.80	IITP(RKB), MU(DK,RBJ)	IITP, MU
		35.20		

Timeline: Year 1 (months 1–12), Year 2 (months 13–24), Year 3 (months 25–36).

Milestones: M1 (1st Progress Report), M2 (2nd Progress Report), M3, M4 (Final Report).

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7. Infrastructural facilities related to the project activities available in the institutes where the project work will be carried out:

At the Indian Collaborating Institute	At the Portugal Collaborating Institute
Indian Institute of Technology, Patna: • Three Phase Two-level Voltage Source Converter • Three Phase and Five Phase Three level NPC Voltage Source Converter • OPAL-RTLAB-05 User • Induction Motor • Digital storage oscilloscope-5 nos, • Desktop PC -05 nos, • Smart Grid Module • Power Analyser • Programmable DC Power supply • dSPACE control board	• Two 6-phase PMSM prototypes with faults • dSPACE 1103 controller boards • dSPACE MicroLabBox • NI cRIO-9063 platform with FPGA • Semikron SKiiP 613 GD123-3DUL bridges • Encoders with 2048 ppr • Yokogawa Precision Power Analyzers WT3000 • Precision Torque Sensor

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• Multiphase Induction motor drive unit. • Wind power system	
Marwadi University: • OPAL RT-LAB OP-4500 for Rapid Control Prototyping and Hardware In Loop(HIL) Configuration • dSPACE DS1104 real time controller • DLM2024 4-channel MSO • High Current (10-3000A) and High Voltage Probes (6.5 kV) for Low Voltage Applications • Three Phase Open Ended Winding Machine with Generator Coupling • Three Phase Inverter Stacks – 15 kVA	

8. Number of exchange visits required to achieve the Project Objectives (Year wise)

Period	India to Portugal		Portugal to India	
	Number	**Duration**	**Number**	**Duration**
1st Year	1	15-30 Days	1	15 days
2nd Year	1	15-30 days	1	15 days
3rd Year	1	15-30 days	1	15 days

9. Expected results of this cooperation (e.g. joint publications, patents etc.). Are any of the expected results likely to have commercial value? (up to 150 words)

     This research project will open the door for research collaboration between India and Portugal. The major outcome of this project is to develop research skill for researchers, postgraduate and graduate students of Indian and Portugal participating universities. Sharing of technical, social and cultural environments will increase the bonding between India and Portugal for future collaborative work. Paper publication in Referred SCI Indexed International Journals. Patent will be filed in multiphase drive for fault tolerant control for EV. The research project will enhance technical competence at both sides and allow industries to utilize the outcome of project for production in respective countries. Reporting of finding of work at reputed international conferences in the mentioned area. As the EV is going to be main research area today, it will be used by industries.

10. Research History of both PIs:

     The proposed research will be conducted at the Department of Electrical Engineering, Indian Institute of Technology (IIT), Patna. The principal investigator (PI) of the project will work in close collaboration with industry to achieve the set objectives of the project. PI research interest includes power electronics converter design, DTC of inverter fed motor drive (three phase and Multiphase), Wing energy conversion system, Low cost EV design and wireless battery charging system for EVs. PI has a patent, "*An Improved Squirrel Cage Induction Motor with Enhanced Efficiency and Wide Range of Operating Speed for Application in Electric Vehicle*, Indian Patent Application No. 201631013398 of 18.04.2016 in the name of Indian Institute of Technology, Patna. PI have successfully implemented many

projects on high power off highway drives and produced high quality journal publications as a result of outcome of the project. PI have experience of working in the field of modulation and control of power converter. One PhD student will be hired through this grant who will be fully devoted to the proposed project work. The research team at IIT Patna will be instrumental in implementing the project and successfully achieving the set objectives and targets.

The PI of the Portuguese research team has almost 30 years of experience in the development of innovative fault diagnosis techniques for electric machines, electric drives and power electronic converters of different types. In particular, the EPVA is a technique developed by the PI that is currently used by several companies worldwide in the diagnosis of faults in induction machines. The PI provides condition monitoring services for several companies in the pulp and paper, cement, water distribution and wind energy industries, among others. The PI has participated and led several national and international research projects, with a focus on the diagnosis of faults and fault tolerance in electric machines and electric drives, including an international project developed at Alstom Transport in Tarbes, France, where new diagnostic techniques were developed for traction drives of locomotives and high-speed trains. The PI has supervised several PhD and MSc students in research areas related to the one of this research project. Current research interests are well aligned with this project proposal: multiphase machines and drives for safety-critical applications (aviation, offshore wind generators and electric vehicles), including the development of high-performance fault-tolerant control strategies based on model predictive control.

Indian PI
National Projects (ongoing/ completed in last 5 years):

S. Nos.	Project Title	Funding Agency	Approved Budget	Status
1	Modeling, Design and Implementation of Induction Motor Drives for Propulsion Applications	NaMPET, Department IT, Government of India	47 Lakh	Completed
2	High Power AC Drives for Electric Locomotive and General Purpose off Highway Applications	Department of Science& Technology, Government of India	19.6 Lakh	Completed
3	Integrated Automatic Voltage Control of a High Efficient Solar PV System	SERB, Government of India	32.2 Lakh	Completed
4	Teaching Learning Centre for Internet-of-Things Smart Grid and Smart Building	Department of Higher Education, Ministry of Human Resource Development, Government of India	384.00 Lakh	Completed

5	National Resource Centre on Internet of Things	Department of Higher Education, Ministry of Human Resource Development, Government of India	20 Lakh	Completed
5	A software tool for planning and design of smart micro power grids (Jointly with IIT Kharagpur and Guwhati)	Department of Higher Education, Ministry of Human Resource Development, Government of India	188 Lakhs	Ongoing

International Projects (ongoing/ completed in last 5 years): NA

S. Nos.	Project Title	Funding Agency	Approved Budget	Status

Portugal PI

National Projects (ongoing/ completed in last 5 years):

S. Nos.	Project Title	Funding Agency	Approved Budget	Status
1	Datacenter Resilience Increase through Fault Tolerance in UPS systems	Portuguese Foundation for Science and Technology (FCT)	239 999 €	Ongoing
2	Automatic tuning for inductive charging systems under misalignment conditions for urban electric transportation	Instituto de Telecomunicações	199 938 €	Completed
3	Diagnosis and Assisted Mobility for People with Special Needs	QREN – Programa Operacional Regional do Centro (Mais Centro)	180 341 €	Completed

International Projects (ongoing/ completed in last 5 years):

S. Nos.	Project Title	Funding Agency	Approved Budget	Status

11. Bio-data of Indian and Portugal investigators to be attached. [The description should highlight the expertise of the PI(s) and CO-PIs in the proposed field of work supported by citing relevant publications only (to be appended in about 2 pages only)]

Resume of Dr. Ranjan Kumar Behera

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Education:

Degree/Examination	University/Institution	Year	Discipline
Ph.D.	Indian Institute of Technology (IIT) Kanpur, India	2009	Electrical Engineering (Power Electronics and Drives)
M.Tech.	Indian Institute of Technology Kanpur, India	2003	Electrical Engineering (Power Electronics)
B.Tech.	Regional Engineering College (Now **NIT**), Rourkela, Orissa	1998	Electrical Engineering.

Teaching/ industrial/ research experience:

University / Organization	Designation	From	To	Total Period	Nature of Experience
Indian Institute of Technology Patna, India	Associate Professor	27 March 2017	till date	3 year+	Teaching and research
Indian Institute of Technology Patna, India	Assistant Professor	18th May 2009	26th March 2017	7 year and 9 months	Teaching and research
University of Pretoria, South Africa	Visiting researcher	28th May 2016	28th June 2016	1 month	Research on Solar Energy
Tennessee Tech. University, TN, USA	Bhaskar Advanced Solar Energy (BASE) Research Fellow	12th May 2014	08th August 2014	3 months	Research on Solar Energy
Tennessee Tech. University, TN, USA	Visiting scholar	28 July 2008	13 February 2009	6 months	Research on wind/solar power technology

Publications : Book:

Vinod Kumar Yadav, **Ranjan Kumar Behera**, Dheeraj Joshi, and Ramesh Bansal, "*Power Electronics, Drives and Advanced Applications,*" CRC Press, April 17, 2020.

Journal

1. U. R. Muduli, A. R. Beig, K. A. Jaafari, J. Y. Alsawalhi and **R. K. Behera**, "Interrupt Free Operation of Dual Motor Four-Wheel Drive Electric Vehicle Under Inverter Failure," **in *IEEE Transactions on Transportation Electrification***, doi: 10.1109/TTE.2020.2997354.
2. M. J. Akhtar and **R. K. Behera**, "Space Vector Modulation for Distributed Inverter Fed Induction Motor Drive for Electric Vehicle Application," in *IEEE Journal of Emerging and Selected Topics in Power Electronics*, doi: 10.1109/JESTPE.2020.2968942.
3. B. Chikondra, U. R. Muduli and **R. K. Behera**, "An Improved Open-Phase Fault-Tolerant DTC Technique for Five-Phase Induction Motor Drive Based on Virtual Vectors Assessment," in **IEEE Transactions on Industrial Electronics**, doi: 10.1109/TIE.2020.2992018.
4. B. Chikondra, U. R. Muduli and **R. K. Behera**, "Performance Comparison of Five-Phase Three-Level NPC to Five-Phase Two-Level VSI," in *IEEE Transactions on Industry Applications*, vol. 56, no. 4, pp. 3767-3775, July-Aug. 2020.
5. J. Akhtar and R. K. Behera, "Optimal design of stator and rotor slot of induction motor for electric vehicle applications," **IET Electrical Systems in Transportation**, Volume 9, Issue 1, March 2019, p. 35 – 43.
6. S. Payami, R. K Behera, and A. Iqbal, "DTC of Three-Level NPC Inverter fed Five-Phase Induction Motor Drive with Novel Neutral Point Voltage Balancing Scheme," **IEEE Transactions on Power Electronics, vol. 33, No. 2, pp. 1487-1500, Feb. 2018**.
7. S. Payami, and R. K Behera "An Improved DTC Technique for Low Speed Operation of a Five-Phase Induction Motor" Submitted to the **IEEE Transactions on Industrial Electronics, vol. 64, No. 5, pp. 3513, May 2017**.
8. S. Payami, R. K Behera, A. Iqbal and R. Al-ammari, "Common mode voltage and vibration mitigation of a five-phase three-level NPC inverter fed induction motor drive system," **IEEE Journal of Emerging and Selected Topics in Power Electronics,** vol.3, no.2, pp.349-361, June 2015.
9. A. Iqbal, S. Payami, M. Saleh, A. A. Abdallah, **R. K. Behera**, S. Moinoddine, "Five-phase AC/DC/AC Converter with PWM Rectifier," Australian Journal of Electrical & Electronics Engineering, Vol. 10, No. 4, pp. 428-438, 2014.

Conferences: 58 Papers

1. U. R. Muduli, and R. K. Behera, "Constant Switching Frequency DTC SVPWM with Reduced Common Mode Voltage for Two Level Five Phase Induction Motor Drives," in *Proceedings of PEDES'18*, 18-21 December 2018, IIT Madras, India, pp. 1-6.
2. **B. Chikondra and R. K. Behera, "**Comparison of Five-phase Three-level NPC to Five-phase Two-level Voltage Source Inverter," in *Proceedings of PEDES'18*, 18-21 December 2018, IIT Madras, India, pp. 1-6.
3. P. Kumar, R. K. Behera and D. V. Bhaskar, "Novel closed loop speed control of permanent magnet brushless dc motor drive," in *Proceedings of* ICSESP' 2018, C. V. Raman College of Engineering Bhubaneswar, India, March 28-30, 2018, pp. 1.
4. R. K. Behera, Rustam Kumar, Srirama Murthy Bellala, P. Raviteja, "Analysis of Electric Vehicle Stability Effectiveness on Wheel Force with BLDC Motor Drive," *Proceedings of* IEEE 1st International Conference on Industrial Electronics for Sustainable Energy Systems (IESES), 30 Jan. – 02 Feb. 2018, Hamilton, New Zealand
5. M. J. Akhtar and R. K. Behera, "An analytical design of an induction motor for electric vehicle application," *2018 IEEE 12th International Conference on Compatibility, Power Electronics and Power Engineering (CPE-POWERENG 2018)*, Doha, 2018, pp. 1-6.
6. Utkal Ranjan Muduli, Ranjan Kumar Behera, "Electrical Modeling and Characteristics Investigation of Mechanical Shaft Supported by Ball Bearing of a Three-phase induction Motor," in *Proceedings of NSRD'17*, 12-13 December 2017, IIT Patna, India, pp. 1-6.

Awards:
- Two projects received consolation prizes of Rs. 40,000/- at GRIDTECH 2019 held at Delhi.
- Bharat Vikas Award, Institute of Self-reliance, Bhubaneswar 2017,
- Bhaskara Advanced Solar Energy (BASE) Fellowship by the Department of Science and Technology, Govt. of India, and the Indo-U.S. Science and Technology Forum (IUSSTF). For doing advanced research on Grid Interaction including Smart Grids and System Development and Integration at Tennessee Technological University, Tennessee, USA, 2014.
- Selected as the featured engineer of the globe by EE Web: Link-http://www.eeweb.com/spotlight/interview-with-dr.-ranjan-kumar-behera, 2015.
- Young scientists award in engineering sciences for "High Power AC Drives for Electric Locomotive and General Purpose off Highway Applications," Department of Science & Technology (DST), Govt. of India, 2011.

Administrative Responsibility:
Head of the Department (Chairman), Electrical Engineering, IIT Patna (Since, Jan 2016)

Invited Talks: 66

Sponsored Projects: 7, Costs: 900 Lakh (apprx.)

Consultant Projects: 1.2 lakh
Patents and workshops organized:
Patent

An Improved Squirrel Cage Induction Motor With Enhanced Efficiency And Wide Range Of Operating Speed For Application In Electric Vehicle, Indian Patent Application No. 201631013398 of 18.04.2016 in the name of Indian Institute of Technology, Patna.

Conference

Convenor; National Symposium on Rotor Dynamics. *NSRD 2017* at IIT Patna. December 12th to 13th, 2017

Workshop

- Organized short term course on "Recent Advances in Power Electronics for Smart Grid and Electrical Drives" from 3rd to 5th March, 2016.
- Organized One Week Teachers Training program on "Component and Applications of IOT CAIOT)" from 24th to 28th September,2018 under TLC, Indian Institute of Technology Patna, from 24th to 28th September, 2018.

Bio: Dr Jimson Mathew

Dr Jimson Mathew is currently an Associate Professor and Head of the Department in the Computer Science and Engineering, Indian Institute of Technology Patna, India. He received the Masters in computer engineering from Nanyang Technological University, Singapore and the Ph.D. degree in computer engineering from the University of Bristol, Bristol, U.K. He has held positions with the Centre for Wireless Communications, National University of Singapore, Bell Laboratories Research Lucent Technologies North Ryde, Australia, Royal Institute of Technology KTH, Stockholm, Sweden and Department of Computer Science, University of Bristol, UK. His research interests include fault-tolerant computing, computer arithmetic, hardware security, Machine Learning, and IoT Systems and cognitive radio systems.

Sponsored R&D Projects:

1. Development of CDAC Digital Forensic Centre with Artificial Intelligence based Knowledge Support Tools (MeitY and Government of Bihar (91.0Lakhs), Roll Co-Principal Investigator

2. Interoperable Intelligent System and Network Security Framework, Sponsored by MICROSEC, Singapore (Roll- Principal Investigator)

3. Exploration of 8/9 nano-meter process variation immune doping and JFD and circuits (SERB) Roll Co-Principal Investigator.

4. Bosch Intelligent Micro-grid for Asia (16 Lakhs), Sponsored by Bosch, (Roll- Principal Investigator)

Selected Patents

- Single Ended I/O SRAM Cell Design for Nanometer CMOS Technologies (US Patent ref. no. 20090285011). (patent: No. 7706174)(Licensed to a US Company) 2010. Secure Testable S-box Architecture for Cryptographic Hardware Implementation, UK, Patent filed on 6th May 2009 and reference number GB0907728.0, 2011 Cross parity based error tolerant electronic circuit design. In US Patent No. 61/608,694,
- BCH Code Based Dynamically Error Correctable Electronic Circuit Design. In Patent No. 1114831.9.
- Circuit and Method for Read and Written in Complementary Resistive Switch Crossbar Memory.
- Band-Pass Differential Quantizer Based Error Feedback Modulator (Application No. 201741022304) (with J Prakash A V, B. R. Jose, Indian Paten 26 June 2017)

Recent Publications :

Alwyn Mathew, Abhijit Roy, Jimson Mathew. Intelligent Residen tial Energy Management System using Deep Reinforcement Learning."IEEE Systems Journal, 2020.

Alwyn Mathew, Jimson Mathew. \Monocular Depth Estimation with SPN Loss." Elsevier Image and Vision Computing, 2020.

R. Sanodiya, S Saha, Jimson Mathew: Semi-supervised orthogonal discriminant analysis with relative distance : integration with a MOO approach. Soft Comput. 24(3): 1599-1618 (2020)

R. Sanodiya, Jimson Mathew, S. Saha, Michelle Davies Thalakottur: A New Transfer Learning Algorithm in Semi-Supervised Setting. IEEE Access 7: 42956-42967 (2019)

R. Sanodiya, Jimson Mathew, Biju Paul, Bijoy Antony Jose: A Kernelized Unified Framework for Domain Adaptation. IEEE Access 7: 181381-181395 (2019)

R. Sanodiya, S. Saha, Jimson Mathew: A kernel semi-supervised distance metric learning with relative distance: Integration with a MOO approach. Expert Syst. Appl. 125: 233-248 (2019)

S. Kala, Jimson Mathew, Babita R. Jose, Nalesh Sivanandan: Radix-43 based two-dimensional FFT architecture with efficient data reordering scheme. IET Computers & Digital Techniques 13(2): 78-86 (2019)

M. George, Babita Roslind Jose, Jimson Mathew, Pranjali Kokare: Autoencoder-based abnormal activity detection using parallelepiped spatio-temporal region. IET Comput. Vis. 13(1): 23-30 (2019)

M. George, Aswathy Sivan, Babita Roslind Jose, Jimson Mathew: Real-time single-view face detection and face recognition based on aggregate channel feature. Int. J. Biom. 11(3): 207-221 (2019)

R. Sanodiya, Jimson Mathew: A novel unsupervised Globality-Locality Preserving Projections in transfer learning. Image Vis. Comput. 90 (2019)

Rakesh Kumar Sanodiya, Jimson Mathew: A framework for semi-supervised metric transfer learning on manifolds. Knowl. Based Syst. 176: 1-14 (2019)

D. Paul, S. Saha, Jimson Mathew: Fusion of evolvable genome structure and multi-objective optimization for subspace clustering. Pattern Recognit. 95: 58-71 (2019)

S. Kala, B. R. Jose, Jimson Mathew, Nalesh Sivanandan: High-Performance CNN Accelerator on FPGA Using Unified Winograd-GEMM Architecture. IEEE Trans. Very Large Scale Integr. Syst. 27(12): 2816-2828 (2019)

Rajat S. S., R. Jeldi, I. Saha and Jimson Mathew, "Binary Decision Diagram Assisted Modeling of FPGA-based Physically Unclonable Function by Genetic Programming", IEEE Transactions on Computers(2018).

Jos A. V., B. R. Jose, Jimson Mathew, Bijoy A. Jose: "A Differential Quantizer-Based Error Feedback Modulator for Analog-to-Digital Converters. IEEE Trans. on Circuits and Systems 65-II(1): 21-25 (2018)

R. Sebastian, Jos A. V., B. R. Jose, Jimson Mathew:A Differentially Quantized Bandpass Error Feedback Modulator for ADCs in Digital Radio. CSSP 37(10): 4181-4199 (2018)

J Jacob, B R Jose, Jimson Mathew, Bayesian Analysis of spectrum occupancy prediction in Cognitive Radio, Smart Science, (Tailor and Francis), 2016.

C. Abraham, B. R. Jose, and Jimson Mathew, "A dual source switched-capacitor converter with solar energy integration capability" Int. J. Energy Technology and Policy (2015)

C. Abraham, B. R. Jose, and Jimson Mathew, " A Multiple Input Variable Output Switched Capacitor DC–DC Converter for Harnessing Renewable Energy and Powering LEDs, Journal of Low Power Electronics, Vol. 11,1, 2015

Gang G., Jimson Mathew, R. A. Shafik, D. K. Pradhan, M. Ottavi and S. PontarelliLifetime Reliability Analysis of Complementary Resistive Switches under Threshold and Doping Interface Speed Variations, IEEE Transactions on Nanotechnology, 2014 .

Y Yang., Jimson Mathew, D. K. Pradhan, M. Ottavi and S. PontarelliLifetime Novel Complementary Resistive Switch Crossbar Memory Write and Read Schemes , IEEE Transactions on Nanotechnology, 2014 .

Samuel P, M Bandan, Jimson Mathew, D.K Pradhan, "A Multiple Fault Aware Placement Strategy for Standard Cells" ACM Transactions on Design Automation of Electronic Systems, 2016 (under revision)

Mahersh. P, Jimson Mathew, A. Jabir, D. K. Pradhan, "A Low Complexity Multiple Error Correcting Architecture Using Novel Cross Parity Codes Over GF(2^m)", IEEE Transactions on Very Large Scale Integration Systems, IEEE TVLSI 2014..

Y. Yang, Jimson Mathew, R A Shafik, Dhiraj Pradhan, Verilog-A based Effective Complementary Resistive Switch Model for Simulations and Analysis. IEEE Embedded Systems Letters,2014.

Gang Lia,b, Jimson Mathew, Rishad Shafik and Dhiraj Pradhan Multinomial based memristor modelling methodology for simulations and analysis, Journal of Electronics, Tailor and Francis, UK, 2014.

CV of Prof. Rajendrasinh Jadeja

Name: Dr. Rajendrasinh Jadeja

Address: Dean – Faculty of Engineering, Marwadi University, Rajkot Morbi Highway, Gauridad – 360003, Rajkot. (O) Mobile: +91-972-772-4686, Email: rajendrasinh.jadeja@marwadieducation.edu.in

Education:

Degree/Examination	University/Institution	Year	Discipline
Ph.D.	Maharaja Sayajirao University, Vadodara, India	2010	Electrical Engineering
M.Tech.	Institute of Technology, Nirma University India	2005	Electrical Engineering (Power System Apparatus & Control)
B.E.	L. D. College of Engineering, Ahmedabad, Gujarat	1998	Electrical Engineering

Teaching/ industrial/ research experience: Total 18 Years
Present Designation: Professor & Dean – Faculty of Engineering, Marwadi University, Rajkot, India.

Total No. of Journal Publications: 11
Total No. of Conference Publications: 14
Total No. of Books/Book Chapters: 10

List of Publication Relevant to Project:

1. R. Jadeja, Chaturvedi H., Polkowski Z., Verma M., Makwana J. (2020) Flux Optimization of DTC Based Induction Motor Drive Using Recurrent Neural Network. In: Singh P., Panigrahi B., Suryadevara N., Sharma S., Singh A. (eds) Proceedings of ICETIT 2019. Lecture Notes in Electrical Engineering, vol 605. Springer, Cham. https://doi.org/10.1007/978-3-030-30577-2_28

2. R. Jadeja, A. D. Ved, S. K. Chauhan, and T. Trivedi, "A random carrier frequency PWM technique with a narrowband for a grid-connected solar inverter," *Electrical Engineering,* vol. 102, pp. 1-13, 2020

3. T. Kalaria, T. Trivedi, V. Patel, R. Jadeja, and C. Patel, "Comparative Study of PWM Technique for Switching Loss Reduction and Acoustic Noise Reduction in VSI-Fed Drives," in *Intelligent Manufacturing and Energy Sustainability*: Springer, 2020, pp. 147-155.

4. Rajendrasinh Jadeja, "Design and Simulink Modelling of an Adaptive Gain Variation Sliding-Model Control Algorithm for Sensorless Permanent Magnet Synchronous Motor Drive," Materials Today: Proceedings, vol. 5, pp. 596-609, 2018.

5. Rajendrasinh Jadeja, Ashish Yadav, Tapankumar Trivedi, Siddharthsingh Chauhan, and V. Patel, "Hardware Implementation of DSP-Based Sensorless Vector-Controlled Induction Motor Drive," in Artificial Intelligence and Evolutionary Computations in Engineering Systems. vol. 517, ed: Springer Singapore, 2017, pp. 845-859.

CV of Dinesh Kumar

Name: Dr. Dinesh Kumar,

Address: Department of Computer Engineering (AI+BigData), Gauri Gad, Morvi Highway, Marwadi University, Rajkot. Phone: +91-281-7123456 (O); Mobile: +91-898-000-5447, Email: dinesh.kumar@marwadieducation.edu.in, dineshkumar120@gmail.com

Education:

Degree/Examination	University/Institution	Year	Discipline
Ph.D.	University of Coimbra, Portugal	2015	Information Science and Technology
B.Tech.	Indian Institute of Technology Kanpur, India	2002	Electrical Engineering

Teaching/ industrial/ research experience:

University / Organization	Designation	From	To	Total Period (Year)	Nature of Experience
Marwadi University, Rajkot	Associate Professor	June 2014	till date	6	Teaching and research
Polytechnic Institute of Leiria, Portugal	Auxiliary Researcher	July 2020	December 2020	½	Research
RK University, Rajkot	Assistant Professor	June 2013	June 2014	1	Teaching and research
Department of Informatics, University of Coimbra, Portugal	Researcher	July 2004	January 2013	9	Research on Biomedical signal processing, Machine learning, Data analysis

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SCIENCE & TECHNOLOGY

FCT Fundação para a Ciência e a Tecnologia

Department Seismology and Astronomy, University of Barcelona, Spain	Researcher	April 2003	June 2004	1	Seismic signal analysis
Electrical Engineering, Indian Institute of Technology, Kanpur	Project Associate	May 2002	March 2003	0.8	Software development on transmission pricing and wheeling charges

Publications:

1. A Nyandwi, D. Kumar, "Neural Network Approach to Short- and Long-Term Load Forecasting using Weather Conditioning", in Proceeding of IEEE. Int. Conf. on Electrical and Electronics Engineering (ICE3-2020), 2020.

2. K. Patel, B. Parekh, D. Kumar, "Leakage current prediction of composite insulator using artificial neural network", J. of Recent Technology and Engineering, 8 (2), July 2019.

3. D. Kumar, R. B. Jadeja, S. Pande, "Heart murmur detection using Wavelet Bi-cepstrum", in Cogent Engineering, Taylor and Francis, 5 (1), 1-12, 2018.

4. D. Kumar, P. Carvalho, M. Auntunes, R. P. Paiva, J. Henriques, "Noise Detection During Heart Sound Recording Using Periodicity Signatures", in Physiol. Meas. 32 (2011) 599-618, doi: 10.1088/0967-3334/32/5/008.

5. J. Vila, R. Ortiz, M. Trraga, R. Macia, A. Garca, D. Kumar, and A. M. Correig, "Near-Real time analysis of seismic data of active volcanoes: Software implementations of time sequence data analysis", in Journal of Natural Hazards and Earth System Sciences, vol 8, pages 789-794, 2008.

CV of Sérgio Manuel Ângelo da Cruz

Sérgio Manuel Ângelo da Cruz was born in Portugal, in 1971.
A Senior Member of IEEE, he received the Electrical Engineering diploma, the M.Sc. and the Ph.D degrees in electrical engineering from the University of Coimbra, Portugal, in 1994, 1999, and 2004, respectively. He has been with the Department of Electrical and Computer Engineering of the University of Coimbra since 1995, where he is currently an Associate Professor and the Director of the Electric Machines Laboratory. His teaching and research interests cover the areas of power transformers, rotating electric machines, electric drives, and power electronic converters, special emphasis on fault diagnosis, fault tolerance and digital control.

Sérgio Cruz has almost 30 years of experience in the development of innovative fault diagnosis techniques for electric machines, electric drives and power electronic converters. He developed the EPVA, a diagnostic technique that is currently used by several companies worldwide for the diagnosis of faults in electric machines and drives. He provides condition monitoring services and acts as a consultant of several companies in the pulp and paper, cement, water distribution and wind energy industries, among others. He has led and participated in

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several national and international research projects, with a focus on the diagnosis of faults and fault tolerance in electric machines and electric drives, including an international project developed at Alstom Transport in Tarbes, France, where new diagnostic techniques were developed for traction drives of locomotives and high-speed trains. He has supervised several PhD and MSc students in research areas related to the one of this research project. Current research interests are well aligned with this project proposal: multiphase machines and drives for safety-critical applications (aviation, offshore wind generators and electric vehicles), including the development of high-performance fault-tolerant control strategies based on model predictive control. Some representative publications in the research area of the project are:

1. Afrandideh, S.; Eshaghi Milasi, M.; Haghjoo, F. and Cruz, S. M. A.: "Turn to Turn Fault Detection, Discrimination and Faulty Region Identification in the Stator and Rotor Windings of Synchronous Machines Based on the Rotational Magnetic Field Distortion", IEEE Transactions on Energy Conversion, vol. 35, nº1, pp. 292-301, March 2020. DOI: 10.1109/TEC.2019.2951528.

2. Soleymani, Y.; Cruz, S. M. A. and Haghjoo, F.: "Broken Rotor Bar Detection in Induction Motors Based on Air-Gap Rotational Magnetic Field Measurement", IEEE Transactions on Instrumentation and Measurement, vol. 68, nº8, pp. 2916-2925, August 2019. DOI: 10.1109/TIM.2018.2870265.

3. Dehghan, H.; Haghjoo, F. and Cruz, S. M. A.: "A Flux-Based Differential Technique for Turn-to-Turn Fault Detection and Defective Region Identification in Line-Connected and Inverter-Fed Induction Motors", IEEE Transactions on Energy Conversion, vol. 33, nº4, pp. 1876-1885, December 2018. DOI: 10.1109/TEC.2018.2837389.

4. Cruz, S. M. A.; Marques, G. D.; Gonçalves, P. F. C. and Iacchetti, M. F.: "Predictive Torque and Rotor Flux Control of a DFIG-dc System for Torque-Ripple Compensation and Loss Minimization", IEEE Trans. on Industrial Electronics, vol. 65, nº12, pp. 9301-9310, December 2018. DOI: 10.1109/TIE.2018.2818667.

5. Gonçalves, P. F. C.; Cruz, S. M. A.; Abadi, M. B.; Caseiro, L. M. A.; Mendes, A. M. S.: "Fault-tolerant predictive power control of a DFIG for wind energy applications", IET Electric Power Applications, vol. 11, nº6, pp. 969-980, July 2017.

6. Cruz, S. M. A.: "An Active-Reactive Power Method for the Diagnosis of Rotor Faults in 3-Phase Induction Motors Operating Under Time-Varying Load Conditions", IEEE Trans. Energy Conversion, vol. 27, nº1, pp. 71-84, March 2012.

7. Cruz, S. M. A.; Mendes, A. M. S.; Cardoso, A. J. M.: "A New Fault Diagnosis Method and a Fault Tolerant Switching Strategy for Matrix Converters Operating with Optimum Alesina-Venturini Modulation", IEEE Trans. on Industrial Electronics, vol. 59, nº1, pp. 269-280, January 2012.

8. Cruz, S. M. A.; Stefani, A.; Filippetti, F. and Cardoso, A. J. M.: "A New Model-Based Technique for the Diagnosis of Rotor Faults in RFOC Induction Motor Drives", IEEE Trans. Industrial Electronics, vol. 55, nº12, pp. 4218-4228, December 2008.

Bio-data of André Manuel dos Santos Mendes

André Manuel dos Santos Mendes was born in Portugal in 1965.

He has been with the University of Coimbra and with Instituto de Telecomunicações for nearly 30 years, where he currently teaches electric machines and power electronic courses and is the Director of the Power Electronics Laboratory.

Prof. André Mendes was been the Principal Investigator of several national projects in recent years. During these projects, topics such as fault diagnosis, fault tolerance in power electronic converters used in induction motor drives, uninterruptible power sources and static synchronous compensator were investigated. During these projects, several digital control platforms Arm-based with Xilinx Zynq designs, including FPGA, were programmed and used to control different developed prototypes.

From these projects resulted several publications in IEEE and IET journals with high impact factor, dealing with topics closely relatred to the ones mentioned in this application. Some of the published papers are listed below:

- Caseiro, L.; Mendes, A. M. S.; "Real-Time IGBT Open-Circuit Fault Diagnosis in Three-Level Neutral-Point-Clamped Voltage-Source Rectifiers Based on Instant Voltage Error", IEEE Trans. on Industrial Electronics, Vol. 62 , No. 3, pp. 1669 - 1678, March, 2015. https://doi.org/10.1109/TIE.2014.2341558.
- Mendes, A. M. S.; Bandarabadi, M.; Cruz, S. M. A.; "Fault diagnostic algorithm for three-level neutral point clamped AC motor drives, based on the average current Park's vector", IET Power Electronics, Vol. 7, No. 5, pp. 1127 - 1137, May, 2014. https://doi.org/10.1049/iet-pel.2013.0416.
- Caseiro, L.; Mendes, A. M. S.; Cruz, S. M. A. ;"Dynamically Weighted Optimal Switching Vector Model Predictive Control of Power Converters", IEEE Trans. on Industrial Electronics, Vol. 66, No. 2, pp. 1235 - 1245, February, 2019.   https://doi.org/10.1109/TIE.2018.2829689.

C. ADMINISTRATIVE & FINANCIAL INFORMATION

Project Cost (Indian side)

Heads	First Year (in Rupees)	Second Year (in Rupees)	Third Year (in Rupees)	Total (in Rupees)
Manpower	1044000	1044000	1140000	3228000
Consumables	145000	81000	45000	271000
Minor Equipment (if necessary)	540000	0	0	540000
Exchange Visits (including VISA and Medical Insurance) Two visits/ year	200000	400000	400000	1000000
Contingency	50000	50000	50000	150000
Overhead Charges	395800	315000	327000	1037800
Total	2374800	1890000	1962000	6226800

Justification for the budget:

Two JRF needed to carry out the research 31,000 per month (for first two years) and 35,000 per month (3rd year) and one technical assistant helping in the experimental setup Rs. 20,000 per months.

Consumables such as wires, IGBTs, IC, measuring devices, control boards, heatsink etc

Sensors, plenary gears, Battery, smart devices for monitoring and control, loading arrangement etc.

Travel is required by the researchers from the both the institute and it is once in a year.

Contingency is need for managing projects properly.

Overhead is 20% in IIT Patna

Project Cost (Portugal side)

Heads	First Year	Second Year	Third Year	Total (Euros)
Manpower	31.000,00	27.500,00	0	58.500,00
Consumables	0	0	0	0

Minor Equipment (if necessary)	5.000,00	0	0	5.000,00
Exchange Visits (including VISA and Medical Insurance)	2.380,00	2.180,00	2.430,00	6.990,00
Contingency	0	0	0	0
Missions	0	3.000,00	5.500,00	8.500,00
Overhead Charges	9.595,00	8.170,00	1.982,50	19.747,50
Total	47.975,00	40.850,00	9.912,50	98.737,50

Justification for the budget:

The main share of the requested budget will be allocated to Human Resources, for hiring a PhD holder which will work on Tasks "Simulation and Control of 6-Phase PMSMs with Faults", "Experimental Validation and Faulty-Drive Data" and "Diagnosis of Faults with Artificial Intelligence Techniques", during a period of 17 months. These tasks involve a significant amount of work, thus a person with research experience in the field of the project proposal is preferred.

The minor equipment asked is two 2-level voltage source inverters Semikron SKiiP 613 GD123-3DUL which are needed to run the 6-phase PMSM with the windings in an open-winding configuration (we need 4 of these bridges while right now we only have 2 in the lab).

There are 2 exchange visits from a Portuguese researcher to Marwadi University (at the start and conclusion stages of the task "Diagnosis of Faults with Artificial Intelligence Techniques") which will ease the integration of the work carried out in Portugal and India related to the development of AI-based approaches for the diagnosis of faults in multiphase drives. These exchange visits will also foster the sharing of knowledge and cooperation between the two research teams, by including a short tutorial on fault diagnosis on induction and PMSM drives by the Portuguese researchers. Another exchange visit from a Portuguese researcher to IIT Patna during the execution of the task "MPC of 5-phase IM Drives" will allow to ease and speed up the implementation of model predictive control techniques applied to 5-phase induction motor drives. Thus, the knowledge and experience on MPC by the Portuguese team will be shared with researchers at IIT Patna so that another control strategy besides DTC can be tested during the execution of this project. A short tutorial on model predictive control applied to multiphase drives is planned during this visit.

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- Three missions are planned throughout the execution this project: one to Europe, in order to participate and present a paper in an international conference and two other missions to the USA, in order to participate and present papers in another two international conferences.
- Overhead charges at a standard rate of 25% complete the requested budget of the proposal from the Portuguese side.

D. OTHER SOURCES OF SUPPORT
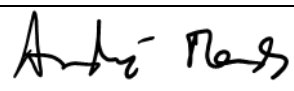
1. Is this research currently being supported by other sources? YES NO If yes, please indicate the sources, amounts and periods of support.

Indian side	Portugal side
NO	NO

2. Has this project been submitted to other agencies for financial support? YES NO If yes, please indicate which agencies, and when.

Indian side	Portugal side
NO	NO

Signatures of the Project Investigators & Co – investigators

Dr. Ranjan Kumar Behera IIT Patna Indian	Dr. Rajendrasinh Jadeja Marwadi University India	Dr. Dinesh Kumar Marwadi University India
Dr. Sérgio Manuel Ângelo da Cruz University of Coimbra Portugal	André Manuel dos Santos Mendes University of Coimbra Portugal	

Indian   **Portugal**

भारत सरकार DEPARTMENT OF SCIENCE & TECHNOLOGY
GOVERNMENT OF INDIA

विज्ञान एवं प्रौद्योगिकी विभाग
DEPARTMENT OF
SCIENCE & TECHNOLOGY

FCT Fundação
para a Ciência
e a Tecnologia

1. **Declaration from the Heads of the Collaborating Institutions:**

   It is certified that

   - the Institutions agree to participate in this Joint Research Project; Entitled: **AI-Driven Fault Diagnosis and Fault Adaptive Operation of High-Density Multiphase Drives for Smart Electric Vehicles**
   - the Institutions shall provide infrastructure & necessary facilities for implementing the joint project;
   - the Institutions assume to undertake financial & other management responsibility for the part of the project work to be carried out at their institution; and
   - The back-up funding for manpower, consumable etc. is available to support this project.

   Signature & Seal of the Head of the Institutions

(signature)	*(signature)*	*instituto de telecomunicações (logo)*
IIT Patna **Indian** Indian Institute of Technology Patna Bihta, Patna - 801103, Bihar	Marwari University **Indian**	University of Coimbra **Portugal**

Resume of Dr. Ranjan Kumar Behera

Name: Dr. Ranjan Kumar Behera,

Address: Department of Electrical Engineering, Indian Institute of Technology (IIT) Patna, Kanpa Road, Bihta – 801103, Patna. Phone: +91-612-302-8050 (O); Mobile: +91-916-222-7357, Email: rkb@iitp.ac.in, kbranjan@gmail.com

Education:

Degree/Examination	University/Institution	Year	Discipline
Ph.D.	Indian Institute of Technology (IIT) Kanpur, India	2009	Electrical Engineering (Power Electronics and Drives)
M.Tech.	Indian Institute of Technology Kanpur, India	2003	Electrical Engineering (Power Electronics)
B.Tech.	Regional Engineering College (Now **NIT**), Rourkela, Orissa	1998	Electrical Engineering.

Teaching/ industrial/ research experience:

University / Organization	Designation	From	To	Total Period	Nature of Experience
Indian Institute of Technology Patna, India	Associate Professor	27 March 2017	till date	3 year+	Teaching and research
Indian Institute of Technology Patna, India	Assistant Professor	18th May 2009	26th March 2017	7 year and 9 months	Teaching and research
University of Pretoria, South Africa	Visiting researcher	28th May 2016	28th June 2016	1 month	Research on Solar Energy
Tennessee Tech. University, TN, USA	Bhaskar Advanced Solar Energy (BASE) Research Fellow	12th May 2014	08th August 2014	3 months	Research on Solar Energy
Tennessee Tech. University, TN, USA	Visiting scholar	28 July 2008	13 February 2009	6 months	Research on wind/solar power technology

Publications : Book:

Vinod Kumar Yadav, **Ranjan Kumar Behera**, Dheeraj Joshi, and Ramesh Bansal, "***Power Electronics, Drives and Advanced Applications,***" CRC Press, April 17, 2020.

Journal

1. U. R. Muduli, A. R. Beig, K. A. Jaafari, J. Y. Alsawalhi and **R. K. Behera**, "Interrupt Free Operation of Dual Motor Four-Wheel Drive Electric Vehicle Under Inverter Failure," **in *IEEE Transactions on Transportation Electrification***, doi: 10.1109/TTE.2020.2997354.
2. M. J. Akhtar and **R. K. Behera**, "Space Vector Modulation for Distributed Inverter Fed Induction Motor Drive for Electric Vehicle Application," in *IEEE Journal of Emerging and Selected Topics in Power Electronics*, doi: 10.1109/JESTPE.2020.2968942.

3. B. Chikondra, U. R. Muduli and **R. K. Behera**, "An Improved Open-Phase Fault-Tolerant DTC Technique for Five-Phase Induction Motor Drive Based on Virtual Vectors Assessment," in *IEEE Transactions on Industrial Electronics*, doi: 10.1109/TIE.2020.2992018.
4. B. Chikondra, U. R. Muduli and **R. K. Behera**, "Performance Comparison of Five-Phase Three-Level NPC to Five-Phase Two-Level VSI," in *IEEE Transactions on Industry Applications*, vol. 56, no. 4, pp. 3767-3775, July-Aug. 2020.
5. J. Akhtar and R. K. Behera, "Optimal design of stator and rotor slot of induction motor for electric vehicle applications," *IET Electrical Systems in Transportation*, Volume 9, Issue 1, March 2019, p. 35 – 43.
6. S. Payami, R. K Behera, and A. Iqbal, "DTC of Three-Level NPC Inverter fed Five-Phase Induction Motor Drive with Novel Neutral Point Voltage Balancing Scheme," *IEEE Transactions on Power Electronics, vol. 33, No. 2, pp. 1487-1500, Feb. 2018*.
7. S. Payami, and R. K Behera "An Improved DTC Technique for Low Speed Operation of a Five-Phase Induction Motor" Submitted to the *IEEE Transactions on Industrial Electronics, vol. 64, No. 5, pp. 3513, May 2017*.
8. S. Payami, R. K Behera, A. Iqbal and R. Al-ammari, "Common mode voltage and vibration mitigation of a five-phase three-level NPC inverter fed induction motor drive system," *IEEE Journal of Emerging and Selected Topics in Power Electronics,* vol.3, no.2, pp.349-361, June 2015.
9. A. Iqbal, S. Payami, M. Saleh, A. A. Abdallah, **R. K. Behera**, S. Moinoddine, "Five-phase AC/DC/AC Converter with PWM Rectifier," Australian Journal of Electrical & Electronics Engineering, Vol. 10, No. 4, pp. 428-438, 2014.
   <u>**Conferences: 58 Papers**</u>
1. U. R. Muduli, and R. K. Behera, "Constant Switching Frequency DTC SVPWM with Reduced Common Mode Voltage for Two Level Five Phase Induction Motor Drives," in *Proceedings of PEDES'18*, 18-21 December 2018, IIT Madras, India, pp. 1-6.
2. **B. Chikondra and R. K. Behera, "**Comparison of Five-phase Three-level NPC to Five-phase Two-level Voltage Source Inverter," in *Proceedings of PEDES'18*, 18-21 December 2018, IIT Madras, India, pp. 1-6.
3. P. Kumar, R. K. Behera and D. V. Bhaskar, "Novel closed loop speed control of permanent magnet brushless dc motor drive," in *Proceedings of* ICSESP' 2018, C. V. Raman College of Engineering Bhubaneswar, India, March 28-30, 2018, pp. 1.
4. R. K. Behera, Rustam Kumar, Srirama Murthy Bellala, P. Raviteja, "Analysis of Electric Vehicle Stability Effectiveness on Wheel Force with BLDC Motor Drive," *Proceedings of* IEEE 1st International Conference on Industrial Electronics for Sustainable Energy Systems (IESES), 30 Jan. – 02 Feb. 2018, Hamilton, New Zealand
5. M. J. Akhtar and R. K. Behera, "An analytical design of an induction motor for electric vehicle application," *2018 IEEE 12th International Conference on Compatibility, Power Electronics and Power Engineering (CPE-POWERENG 2018)*, Doha, 2018, pp. 1-6.
6. Utkal Ranjan Muduli, Ranjan Kumar Behera, "Electrical Modeling and Characteristics Investigation of Mechanical Shaft Supported by Ball Bearing of a Three-phase induction Motor," in *Proceedings of NSRD'17*, 12-13 December 2017, IIT Patna, India, pp. 1-6.

Awards:
- Two projects received consolation prizes of Rs. 40,000/- at GRIDTECH 2019 held at Delhi.
- Bharat Vikas Award, Institute of Self-reliance, Bhubaneswar 2017,
- Bhaskara Advanced Solar Energy (BASE) Fellowship by the Department of Science and Technology, Govt. of India, and the Indo-U.S. Science and Technology Forum (IUSSTF). For doing advanced research on Grid Interaction including Smart Grids and System Development and Integration at Tennessee Technological University, Tennessee, USA, 2014.
- Selected as the featured engineer of the globe by EE Web: Link-http://www.eeweb.com/spotlight/interview-with-dr.-ranjan-kumar-behera, 2015.
- Young scientists award in engineering sciences for "High Power AC Drives for Electric Locomotive and General Purpose off Highway Applications," Department of Science & Technology (DST), Govt. of India, 2011.

Administrative Responsibility:
Head of the Department (Chairman), Electrical Engineering, IIT Patna (Since, Jan 2016)

Invited Talks: 66

Sponsored Projects: 7, Costs: 900 Lakh (apprx.)

Consultant Projects: 1.2 lakh
Patents and workshops organized:
<u>### Patent</u>
An Improved Squirrel Cage Induction Motor With Enhanced Efficiency And Wide Range Of Operating Speed For Application In Electric Vehicle, Indian Patent Application No. 201631013398 of 18.04.2016 in the name of Indian Institute of Technology, Patna.
<u>### Conference</u>

Convenor; National Symposium on Rotor Dynamics. *NSRD 2017* at IIT Patna. December 12th to 13th, 2017

Workshop

- Organized short term course on "Recent Advances in Power Electronics for Smart Grid and Electrical Drives" from 3rd to 5th March, 2016.
- Organized One Week Teachers Training program on "Component and Applications of IOT CAIOT)" from 24th to 28th September,2018 under TLC, Indian Institute of Technology Patna, from 24th to 28th September, 2018.

Bio: Dr Jimson Mathew

Dr Jimson Mathew is currently an Associate Professor and Head of the Department in the Computer Science and Engineering, Indian Institute of Technology Patna, India. He received the Masters in computer engineering from Nanyang Technological University, Singapore and the Ph.D. degree in computer engineering from the University of Bristol, Bristol, U.K. He has held positions with the Centre for Wireless Communications, National University of Singapore, Bell Laboratories Research Lucent Technologies North Ryde, Australia, Royal Institute of Technology KTH, Stockholm, Sweden and Department of Computer Science, University of Bristol, UK. His research interests include fault-tolerant computing, computer arithmetic, hardware security, Machine Learning, and IoT Systems and cognitive radio systems.

Sponsored R&D Projects:

1. Development of CDAC Digital Forensic Centre with Artificial Intelligence based Knowledge Support Tools (MeitY and Government of Bihar (91.0Lakhs), Roll Co-Principal Investigator

2. Interoperable Intelligent System and Network Security Framework, Sponsored by MICROSEC, Singapore (Roll- Principal Investigator)

3. Exploration of 8/9 nano-meter process variation immune doping and JFD and circuits (SERB) Roll Co-Principal Investigator.

4. Bosch Intelligent Micro-grid for Asia (16 Lakhs), Sponsored by Bosch, (Roll- Principal Investigator)

Selected Patents

- Single Ended I/O SRAM Cell Design for Nanometer CMOS Technologies (US Patent ref. no. 20090285011). (patent: No. 7706174)(Licensed to a US Company) 2010. Secure Testable S-box Architecture for Cryptographic Hardware Implementation, UK, Patent filed on 6th May 2009 and reference number GB0907728.0, 2011 Cross parity based error tolerant electronic circuit design. In US Patent No. 61/608,694,
- BCH Code Based Dynamically Error Correctable Electronic Circuit Design. In Patent No. 1114831.9.
- Circuit and Method for Read and Written in Complementary Resistive Switch Crossbar Memory.
- Band-Pass Differential Quantizer Based Error Feedback Modulator (Application No. 201741022304) (with J Prakash A V, B. R. Jose, Indian Paten 26 June 2017)

Recent Publications :

Alwyn Mathew, Abhijit Roy, Jimson Mathew. Intelligent Residen tial Energy Management System using Deep Reinforcement Learning."IEEE Systems Journal, 2020.

Alwyn Mathew, Jimson Mathew. \Monocular Depth Estimation with SPN Loss." Elsevier Image and Vision Computing, 2020.

R. Sanodiya, S Saha, Jimson Mathew: Semi-supervised orthogonal discriminant analysis with relative distance : integration with a MOO approach. Soft Comput. 24(3): 1599-1618 (2020)

R. Sanodiya, Jimson Mathew, S. Saha, Michelle Davies Thalakottur: A New Transfer Learning Algorithm in Semi-Supervised Setting. IEEE Access 7: 42956-42967 (2019)

R. Sanodiya, Jimson Mathew, Biju Paul, Bijoy Antony Jose: A Kernelized Unified Framework for Domain Adaptation. IEEE Access 7: 181381-181395 (2019)

R. Sanodiya, S. Saha, Jimson Mathew: A kernel semi-supervised distance metric learning with relative distance: Integration with a MOO approach. Expert Syst. Appl. 125: 233-248 (2019)

S. Kala, Jimson Mathew, Babita R. Jose, Nalesh Sivanandan: Radix-43 based two-dimensional FFT architecture with efficient data reordering scheme. IET Computers & Digital Techniques 13(2): 78-86 (2019)

M. George, Babita Roslind Jose, Jimson Mathew, Pranjali Kokare: Autoencoder-based abnormal activity detection using parallelepiped spatio-temporal region. IET Comput. Vis. 13(1): 23-30 (2019)

M. George, Aswathy Sivan, Babita Roslind Jose, Jimson Mathew: Real-time single-view face detection and face recognition based on aggregate channel feature. Int. J. Biom. 11(3): 207-221 (2019)

R. Sanodiya, Jimson Mathew: A novel unsupervised Globality-Locality Preserving Projections in transfer learning. Image Vis. Comput. 90 (2019)

Rakesh Kumar Sanodiya, Jimson Mathew: A framework for semi-supervised metric transfer learning on manifolds. Knowl. Based Syst. 176: 1-14 (2019)

D. Paul, S. Saha, Jimson Mathew: Fusion of evolvable genome structure and multi-objective optimization for subspace clustering. Pattern Recognit. 95: 58-71 (2019)

S. Kala, B. R. Jose, Jimson Mathew, Nalesh Sivanandan: High-Performance CNN Accelerator on FPGA Using Unified Winograd-GEMM Architecture. IEEE Trans. Very Large Scale Integr. Syst. 27(12): 2816-2828 (2019)

Rajat S. S., R. Jeldi, I. Saha and Jimson Mathew, "Binary Decision Diagram Assisted Modeling of FPGA-based Physically Unclonable Function by Genetic Programming", IEEE Transactions on Computers(2018).

Jos A. V., B. R. Jose, Jimson Mathew, Bijoy A. Jose: "A Differential Quantizer-Based Error Feedback Modulator for Analog-to-Digital Converters. IEEE Trans. on Circuits and Systems 65-II(1): 21-25 (2018)

R. Sebastian, Jos A. V., B. R. Jose, Jimson Mathew:A Differentially Quantized Bandpass Error Feedback Modulator for ADCs in Digital Radio. CSSP 37(10): 4181-4199 (2018)

J Jacob, B R Jose, Jimson Mathew, Bayesian Analysis of spectrum occupancy prediction in Cognitive Radio, Smart Science, (Tailor and Francis), 2016.

C. Abraham, B. R. Jose, and Jimson Mathew, "A dual source switched-capacitor converter with solar energy integration capability" Int. J. Energy Technology and Policy (2015)

C. Abraham, B. R. Jose, and Jimson Mathew, " A Multiple Input Variable Output Switched Capacitor DC–DC Converter for Harnessing Renewable Energy and Powering LEDs, Journal of Low Power Electronics, Vol. 11,1, 2015

Gang G., Jimson Mathew, R. A. Shafik, D. K. Pradhan, M. Ottavi and S. PontarelliLifetime Reliability Analysis of Complementary Resistive Switches under Threshold and Doping Interface Speed Variations, IEEE Transactions on Nanotechnology, 2014 .

Y Yang., Jimson Mathew, D. K. Pradhan, M. Ottavi and S. PontarelliLifetime Novel Complementary Resistive Switch Crossbar Memory Write and Read Schemes , IEEE Transactions on Nanotechnology, 2014 .

Samuel P, M Bandan, Jimson Mathew, D.K Pradhan, "A Multiple Fault Aware Placement Strategy for Standard Cells" ACM Transactions on Design Automation of Electronic Systems, 2016 (under revision)

Mahersh. P, Jimson Mathew, A. Jabir, D. K. Pradhan, "A Low Complexity Multiple Error Correcting Architecture Using Novel Cross Parity Codes Over GF(2^m)", IEEE Transactions on Very Large Scale Integration Systems, IEEE TVLSI 2014..

Y. Yang, Jimson Mathew, R A Shafik, Dhiraj Pradhan, Verilog-A based Effective Complementary Resistive Switch Model for Simulations and Analysis. IEEE Embedded Systems Letters,2014.

Gang Lia,b, Jimson Mathew, Rishad Shafik and Dhiraj Pradhan Multinomial based memristor modelling methodology for simulations and analysis, Journal of Electronics, Tailor and Francis, UK, 2014.

CV of Prof. Rajendrasinh Jadeja

Name: Dr. Rajendrasinh Jadeja

Address: Dean – Faculty of Engineering, Marwadi University, Rajkot Morbi Highway, Gauridad – 360003, Rajkot. (O) Mobile: +91-972-772-4686, Email: rajendrasinh.jadeja@marwadieducation.edu.in

Education:

Degree/Examination	University/Institution	Year	Discipline
Ph.D.	Maharaja Sayajirao University, Vadodara, India	2010	Electrical Engineering
M.Tech.	Institute of Technology, Nirma University India	2005	Electrical Engineering (Power System Apparatus & Control)
B.E.	L. D. College of Engineering, Ahmedabad, Gujarat	1998	Electrical Engineering

Teaching/ industrial/ research experience: Total 18 Years
Present Designation: Professor & Dean – Faculty of Engineering, Marwadi University, Rajkot, India.

Total No. of Journal Publications: 11
Total No. of Conference Publications: 14
Total No. of Books/Book Chapters: 10

List of Publication Relevant to Project:

1. R. Jadeja, Chaturvedi H., Polkowski Z., Verma M., Makwana J. (2020) Flux Optimization of DTC Based Induction Motor Drive Using Recurrent Neural Network. In: Singh P., Panigrahi B., Suryadevara N., Sharma S., Singh A. (eds) Proceedings of ICETIT 2019. Lecture Notes in Electrical Engineering, vol 605. Springer, Cham. https://doi.org/10.1007/978-3-030-30577-2_28
2. R. Jadeja, A. D. Ved, S. K. Chauhan, and T. Trivedi, "A random carrier frequency PWM technique with a narrowband for a grid-connected solar inverter," *Electrical Engineering,* vol. 102, pp. 1-13, 2020
3. T. Kalaria, T. Trivedi, V. Patel, R. Jadeja, and C. Patel, "Comparative Study of PWM Technique for Switching Loss Reduction and Acoustic Noise Reduction in VSI-Fed Drives," in *Intelligent Manufacturing and Energy Sustainability*: Springer, 2020, pp. 147-155.
4. Rajendrasinh Jadeja, "Design and Simulink Modelling of an Adaptive Gain Variation Sliding-Model Control Algorithm for Sensorless Permanent Magnet Synchronous Motor Drive," Materials Today: Proceedings, vol. 5, pp. 596-609, 2018.
5. Rajendrasinh Jadeja, Ashish Yadav, Tapankumar Trivedi, Siddharthsingh Chauhan, and V. Patel, "Hardware Implementation of DSP-Based Sensorless Vector-Controlled Induction Motor Drive," in Artificial Intelligence and Evolutionary Computations in Engineering Systems. vol. 517, ed: Springer Singapore, 2017, pp. 845-859.

CV of Dinesh Kumar

Name: Dr. Dinesh Kumar,
Address: Department of Computer Engineering (AI+BigData), Gauri Gad, Morvi Highway, Marwadi University, Rajkot. Phone: +91-281-7123456 (O); Mobile: +91-898-000-5447, Email: dinesh.kumar@marwadieducation.edu.in, dineshkumar120@gmail.com

Education:

Degree/Examination	University/Institution	Year	Discipline
Ph.D.	University of Coimbra, Portugal	2015	Information Science and Technology
B.Tech.	Indian Institute of Technology Kanpur, India	2002	Electrical Engineering

Teaching/ industrial/ research experience:

University / Organization	Designation	From	To	Total Period (Year)	Nature of Experience
Marwadi University, Rajkot	Associate Professor	June 2014	till date	6	Teaching and research
Polytechnic Institute of Leiria, Portugal	Auxiliary Researcher	July 2020	December 2020	½	Research
RK University,	Assistant	June 2013	June 2014	1	Teaching and

Rajkot	Professor				research
Department of Informatics, University of Coimbra, Portugal	Researcher	July 2004	January 2013	9	Research on Biomedical signal processing, Machine learning, Data analysis
Department Seismology and Astronomy, University of Barcelona, Spain	Researcher	April 2003	June 2004	1	Seismic signal analysis
Electrical Engineering, Indian Institute of Technology, Kanpur	Project Associate	May 2002	March 2003	0.8	Software development on transmission pricing and wheeling charges

Publications:

1. A Nyandwi, D. Kumar, "Neural Network Approach to Short- and Long-Term Load Forecasting using Weather Conditioning", in Proceeding of IEEE. Int. Conf. on Electrical and Electronics Engineering (ICE3-2020), 2020.

2. K. Patel, B. Parekh, D. Kumar, "Leakage current prediction of composite insulator using artificial neural network", J. of Recent Technology and Engineering, 8 (2), July 2019.

3. D. Kumar, R. B. Jadeja, S. Pande, "Heart murmur detection using Wavelet Bi-cepstrum", in Cogent Engineering, Taylor and Francis, 5 (1), 1-12, 2018.

4. D. Kumar, P. Carvalho, M. Auntunes, R. P. Paiva, J. Henriques, "Noise Detection During Heart Sound Recording Using Periodicity Signatures", in Physiol. Meas. 32 (2011) 599-618, doi: 10.1088/0967-3334/32/5/008.

5. J. Vila, R. Ortiz, M. Trraga, R. Macia, A. Garca, D. Kumar, and A. M. Correig, "Near-Real time analysis of seismic data of active volcanoes: Software implementations of time sequence data analysis", in Journal of Natural Hazards and Earth System Sciences, vol 8, pages 789-794, 2008.

CV of Sérgio Manuel Ângelo da Cruz

Sérgio Manuel Ângelo da Cruz was born in Portugal, in 1971.
A Senior Member of IEEE, he received the Electrical Engineering diploma, the M.Sc. and the Ph.D degrees in electrical engineering from the University of Coimbra, Portugal, in 1994, 1999, and 2004,

respectively. He has been with the Department of Electrical and Computer Engineering of the University of Coimbra since 1995, where he is currently an Associate Professor and the Director of the Electric Machines Laboratory. His teaching and research interests cover the areas of power transformers, rotating electric machines, electric drives, and power electronic converters, special emphasis on fault diagnosis, fault tolerance and digital control.

Sérgio Cruz has almost 30 years of experience in the development of innovative fault diagnosis techniques for electric machines, electric drives and power electronic converters. He developed the EPVA, a diagnostic technique that is currently used by several companies worldwide for the diagnosis of faults in electric machines and drives. He provides condition monitoring services and acts as a consultant of several companies in the pulp and paper, cement, water distribution and wind energy industries, among others. He has led and participated in several national and international research projects, with a focus on the diagnosis of faults and fault tolerance in electric machines and electric drives, including an international project developed at Alstom Transport in Tarbes, France, where new diagnostic techniques were developed for traction drives of locomotives and high-speed trains. He has supervised several PhD and MSc students in research areas related to the one of this research project. Current research interests are well aligned with this project proposal: multiphase machines and drives for safety-critical applications (aviation, offshore wind generators and electric vehicles), including the development of high-performance fault-tolerant control strategies based on model predictive control. Some representative publications in the research area of the project are:

1. Afrandideh, S.; Eshaghi Milasi, M.; Haghjoo, F. and Cruz, S. M. A.: "Turn to Turn Fault Detection, Discrimination and Faulty Region Identification in the Stator and Rotor Windings of Synchronous Machines Based on the Rotational Magnetic Field Distortion", IEEE Transactions on Energy Conversion, vol. 35, nº1, pp. 292-301, March 2020. DOI: 10.1109/TEC.2019.2951528.
2. Soleymani, Y.; Cruz, S. M. A. and Haghjoo, F.: "Broken Rotor Bar Detection in Induction Motors Based on Air-Gap Rotational Magnetic Field Measurement", IEEE Transactions on Instrumentation and Measurement, vol. 68, nº8, pp. 2916-2925, August 2019. DOI: 10.1109/TIM.2018.2870265.
3. Dehghan, H.; Haghjoo, F. and Cruz, S. M. A.: "A Flux-Based Differential Technique for Turn-to-Turn Fault Detection and Defective Region Identification in Line-Connected and Inverter-Fed Induction Motors", IEEE Transactions on Energy Conversion, vol. 33, nº4, pp. 1876-1885, December 2018. DOI: 10.1109/TEC.2018.2837389.
4. Cruz, S. M. A.; Marques, G. D.; Gonçalves, P. F. C. and Iacchetti, M. F.: "Predictive Torque and Rotor Flux Control of a DFIG-dc System for Torque-Ripple Compensation and Loss Minimization", IEEE Trans. on Industrial Electronics, vol. 65, nº12, pp. 9301-9310, December 2018. DOI: 10.1109/TIE.2018.2818667.
5. Gonçalves, P. F. C.; Cruz, S. M. A.; Abadi, M. B.; Caseiro, L. M. A.; Mendes, A. M. S.: "Fault-tolerant predictive power control of a DFIG for wind energy applications", IET Electric Power Applications, vol. 11, nº6, pp. 969-980, July 2017.
6. Cruz, S. M. A.: "An Active-Reactive Power Method for the Diagnosis of Rotor Faults in 3-Phase Induction Motors Operating Under Time-Varying Load Conditions", IEEE Trans. Energy Conversion, vol. 27, nº1, pp. 71-84, March 2012.
7. Cruz, S. M. A.; Mendes, A. M. S.; Cardoso, A. J. M.: "A New Fault Diagnosis Method and a Fault Tolerant Switching Strategy for Matrix Converters Operating with Optimum Alesina-Venturini Modulation", IEEE Trans. on Industrial Electronics, vol. 59, nº1, pp. 269-280, January 2012.
8. Cruz, S. M. A.; Stefani, A.; Filippetti, F. and Cardoso, A. J. M.: "A New Model-Based Technique for the Diagnosis of Rotor Faults in RFOC Induction Motor Drives", IEEE Trans. Industrial Electronics, vol. 55, nº12, pp. 4218-4228, December 2008.

Bio-data of André Manuel dos Santos Mendes

André Manuel dos Santos Mendes was born in Portugal in 1965.

He has been with the University of Coimbra and with Instituto de Telecomunicações for nearly 30 years, where he currently teaches electric machines and power electronic courses and is the Director of the Power Electronics Laboratory.

Prof. André Mendes was been the Principal Investigator of several national projects in recent years. During these projects, topics such as fault diagnosis, fault tolerance in power electronic converters used in induction motor drives, uninterruptible power sources and static synchronous compensator were investigated. During these projects, several digital control platforms Arm-based with Xilinx Zynq designs, including FPGA, were programmed and used to control different developed prototypes.

From these projects resulted several publications in IEEE and IET journals with high impact factor, dealing with topics closely relatred to the ones mentioned in this application. Some of the published papers are listed below:

- Caseiro, L.; Mendes, A. M. S.; "Real-Time IGBT Open-Circuit Fault Diagnosis in Three-Level Neutral-Point-Clamped Voltage-Source Rectifiers Based on Instant Voltage Error", IEEE Trans. on Industrial Electronics, Vol. 62 , No. 3, pp. 1669 - 1678, March, 2015. https://doi.org/10.1109/TIE.2014.2341558.
- Mendes, A. M. S.; Bandarabadi, M.; Cruz, S. M. A.; "Fault diagnostic algorithm for three-level neutral point clamped AC motor drives, based on the average current Park's vector", IET Power Electronics, Vol. 7, No. 5, pp. 1127 - 1137, May, 2014. https://doi.org/10.1049/iet-pel.2013.0416.
- Caseiro, L.; Mendes, A. M. S.; Cruz, S. M. A. ;"Dynamically Weighted Optimal Switching Vector Model Predictive Control of Power Converters", IEEE Trans. on Industrial Electronics, Vol. 66, No. 2, pp. 1235 - 1245, February, 2019. https://doi.org/10.1109/TIE.2018.2829689.

CERTIFICATE FROM THE INVESTIGATOR

PROJECT TITLE: **AI-DRIVEN FAULT DIAGNOSIS AND FAULT ADAPTIVE OPERATION OF HIGH-DENSITY MULTIPHASE DRIVES FOR SMART ELECTRIC VEHICLES**

1. We agree to abide by the terms and conditions of the DST grant.
2. We did not submit this or a similar project proposal elsewhere for financial support.
3. We have explored and ensured that equipment and basic facilities will actually be available as and when required for the purpose of the project. We shall not request financial support under this project, for procurement of these items.
4. We undertake that spare time on permanent equipment will be made available to other users.
5. We have enclosed the following materials:

	ITEMS	NUMBER OF COPIES
(a)	Endorsement from the Head of the Institution (on letter head)	One
(b)	Certificate from Investigator	One
(c)	Certificate from Investigator regarding conflict of interest	One
(d)	Name and address of experts/institution interested in the subject/ outcome of the project	One
(e)	Copies of the proposals	Three

Date: 27/07/2020………   Date: **25/07/2020**   Date: **25/07/2020**

_____   _____   _____

Dr. Ranjan Kumar Behera   Dr. Rajendrasinh Jadeja   Dr. Dinesh Kumar
Principal Investigator   Co-Investigator   Co-Investigator

Date: ……27/07/2020………   Date: …27/07/2020………

_____   _____

Dr. Sérgio Manuel Ângelo da Cruz   Dr. André Manuel dos Santos Mendes

Principal Investigator   Co-Investigator

FOR REVIEWER & COMMITTEE MEMBER or APPLICANT or DST OFFICER ASSOCIATED/ DEALING WITH THE SCHEME/ PROGRAM OF DST

Issues of Conflicts of Interest and ethics in scientific research and research management have assumed greater prominence, given the larger share of Government funding in the country's R & D scenario. The following policy pertaining to general aspects of Conflicts of Interest and code of ethics, are objective measures that is intended to protect the integrity of the decision making processes and minimize biasness. The policy aims to sustain transparency, increase accountability in funding mechanisms and provide assurance to the general public that processes followed in award of grants are fair and non-discriminatory. The Policy aims to avoid all forms of bias by following a system that is fair, transparent and free from all influence/ unprejudiced dealings, prior to, during and subsequent to the currency of the programme to be entered into with a view to enable public to abstain from bribing or any corrupt practice in order to secure the award by providing assurance to them that their competitors will also refrain from bribing and other corrupt practice and the decision makers will commit to prevent corruption, in any form, by their officials by following transparent procedures. This will also ensure a global acceptance of the decision making process adopted by DST.

Definition of Conflict of Interest:

Conflict of Interest means "any interest which could significantly prejudice an individual's objectivity in the decision making process, thereby creating an unfair competitive advantage for the individual or to the organization which he/she represents". The Conflict of Interest also encompasses situations where an individual, in contravention to the accepted norms and ethics, could exploit his/her obligatory duties for personal benefits.

1. **Coverage of the Policy**:

a) The provisions of the policy shall be followed by persons applying for and receiving funding from DST, Reviewers of the proposal and Members of Expert Committees and Programme Advisory Committees. The provisions of the policy will also be applicable on all individuals including Officers of DST connected directly or indirectly or through intermediaries and Committees involved in evaluation of proposals and subsequent decision making process.

b) This policy aims to minimize aspects that may constitute actual Conflict of Interests, apparent Conflict of Interests and potential Conflict of Interests in the funding mechanisms that are presently being operated by DST. The policy also aims to cover, although not limited to, Conflict of interests that are Financial (gains from the outcomes of the proposal or award), Personal (association of relative / Family members) and Institutional (Colleagues, Collaborators, Employer, persons associated in a professional career of an individual such as Ph.D. supervisor etc.)

2. **Specifications as to what constitutes Conflict of Interest**.

Any of the following specifications (non-exhaustive list) imply Conflict of Interest if,

(i)   Due to any reason by which the Reviewer/Committee Member cannot deliver fair and objective assessment of the proposal.

(ii)   The applicant is a directly relative# or family member (including but not limited to spouse, child, sibling, parent) or personal friend of the individual involved in the decision making process or alternatively, if any relative of an Officer directly involved in any decision making process / has influenced interest/ stake in the applicant's form etc..

(iii)   The applicant for the grant/award is an employee or employer of an individual involved in the process as a Reviewer or Committee Member; or if the applicant to the grant/award has had an employer-employee relationship in the past three years with that individual.

(iv)   The applicant to the grant/award belongs to the same Department as that of the Reviewer/Committee Member.

(v)   The Reviewer/Committee Member is a Head of an Organization from where the applicant is employed.

(vi)   The Reviewer /Committee Member is or was, associated in the professional career of the applicant (such as Ph.D. supervisor, Mentor, present Collaborator etc.)

(vii)   The Reviewer/Committee Member is involved in the preparation of the research proposal submitted by the applicant.

(viii) The applicant has joint research publications with the Reviewer/Committee Member in the last three years.

(ix)   The applicant/Reviewer/Committee Member, in contravention to the accepted norms and ethics followed in scientific research has a direct/indirect financial interest in the outcomes of the proposal.

(x)   The Reviewer/Committee Member stands to gain personally should the submitted proposal be accepted or rejected.

\# The Term "Relative" for this purpose would be referred in section 6 of Companies Act , 1956.

3. **Regulation**:

The DST shall strive to avoid conflict of interest in its funding mechanisms to the maximum extent possible. Self-regulatory mode is however recommended for stake holders involved in scientific research and research management, on issues pertaining to Conflict of Interest and scientific ethics. Any disclosure pertaining to the same must be made voluntarily by the applicant/Reviewer/Committee Member.

4. **Confidentiality**:

The Reviewers and the Members of the Committee shall safeguard the confidentiality of all discussions and decisions taken during the process and shall refrain from discussing the same with any applicant or a third party, unless the Committee recommends otherwise and records for doing so.

5. **Code of Conduct**

5.1 To be followed by Reviewers/Committee Members:

(a) All reviewers shall submit a conflict of interest statement, declaring the presence or absence of any form of conflict of interest.
(b) The reviewers shall refrain from evaluating the proposals if the conflict of interest is established or if it is apparent.
(c) All discussions and decisions pertaining to conflict of interest shall be recorded in the minutes of the meeting.
(d) The Chairman of the Committee shall decide on all aspects pertaining to conflict of interests.
(e) The Chairman of the Committee shall request that all members disclose if they have any conflict of interest in the items of the agenda scheduled for discussion.
(f) The Committee Members shall refrain from participating in the decision making process and leave the room with respect to the specific item where the conflict of interest is established or is apparent.
(g) If the Chairman himself/herself has conflict of interest, the Committee may choose a Chairman from among the remaining members, and the decision shall be made in consultation with Member Secretary of the Committee.
(h) It is expected that a Committee member including the Chair-person will not seek funding from a Committee in which he/she is a member. If any member applies for grant, such proposals will be evaluated separately outside the Committee in which he/she is a member.

5.2 To be followed by the Applicant to the Grant/Award:
(a) The applicant must refrain from suggesting referees with potential Conflict of Interest that may arise due to the factors mentioned in the specifications described above in Point No. 2.
(b) The applicant may mention the names of individuals to whom the submitted proposal should not be sent for refereeing, clearly indicating the reasons for the same.

5.3 To be followed by the Officers dealing with Programs in DST:
While it is mandatory for the program officers to maintain confidentiality as detailed in point no. 6 above, they should declare, in advance, if they are dealing with grant applications of a relative or family member (including but not limited to spouse, child, sibling, parent) or thesis/ post-doctoral mentor or stands to benefit financially if the applicant proposal is funded. In such cases, DST will allot the grant applications to the other program officer.

6. **Sanction for violation**

3.1 **For a) Reviewers / Committee Members and b) Applicant**
   Any breach of the code of conduct will invite action as decided by the Committee.

3.2 **For Officers dealing with Program in DST**
   Any breach of the code of conduct will invite action under present provision of CCS (conduct Rules), 1964.

7. **Final Appellate authority**:
Secretary, DST shall be the appellate authority in issues pertaining to conflict of interest and issues concerning the decision making process. The decision of Secretary, DST in these issues shall be final and binding.

8. **Declaration**
I have read the above "Policy on Conflict of Interest" of the DST applicable to the Reviewer/ Committee Member/ Applicant/ DST Scheme or Program Officer # and agree to abide by provisions thereof.

I hereby declare that I have no conflict of interest of any form pertaining to the proposed grant *
I hereby declare that I have conflict of interest of any form pertaining to the proposed grant *

* & # (Tick whichever is applicable)

Name of the Reviewer/ Committee Member or Applicant or DST Officer

(Strike out whichever is not applicable)

30/7/20
(**Signature with date**)

INDIAN INSTITUTE OF TECHNOLOGY PATNA

डॉ श्रीपर्णा साहा
सह–अधिष्ठाता, अनुसंधान एवं विकास
Dr. Sriparna Saha
Associate Dean, Research & Development

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Phone: +91-612-3028291,
Email: adean_rnd@iitp.ac.in

ENDORSEMENT FROM THE HEAD OF INSTITUTION

PROJECT TITLE: "**AI-Driven Fault Diagnosis and Fault Adaptive Operation of High-Density Multiphase Drives for Smart Electric Vehicles**"

1. Certified that the Institute welcomes participation of **Dr. Ranjan Kumar Behera, Associate Professor, Department of Electrical Engineering, IIT Patna and Dr. Sérgio Manuel Ângelo da Cruz, University of Coimbra, Portugal as the Principal Investigator and Dr. Rajendrasinh Jadeja, Marwadi University, Gujarat, Dr. Dinesh Kumar, Marwadi University, Gujarat, Dr. Jimson Mathew, Associate Professor, Department of Computer Science & Engineering, IIT Patna and Dr. André Manuel dos Santos Mendesas, University of Coimbra, Porugal** the Co-Investigator for the project and that in the unforeseen event of discontinuance by the Principal Investigator, the Co-Investigator will assume the responsibility for the fruitful completion of the project (after obtaining consent in advance from DST).

2. Certified that the equipment, other basic facilities and such other administrative facilities as per terms and conditions of the grant, will be extended to investigator (s) throughout the duration of the project.

3. Institute assures financial and other managerial responsibilities of the project.

4. Certified that the organization has never been blacklisted by any department of the State Government or Central Government.

Name and Signature of Head of Institution

Date: 23/07/2020

Place: Patna

REMARKS:In regard to research proposals emanating from scientific institutions/laboratories under various scientific departments the Head of the institution is required to provide a justification indicating clearly whether the research proposals falls in line with the normal research activities of the institution or not and if not, the scientific reasons which merit its consideration by DST.

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CIVIL SERVICES

Date – 20/12/2020

To Whomsoever It May Concern

This is Certified that **Mr. Hazem Ghazi** (Roll Number 91800105041), **Mr. Amit Kushwaha** (Roll Number 91800105042), **Mr. Sara Alsafdi** (Roll Number 91800105048) and **Mr. Kifah Khatar** (Roll Number 91800105049), the students of Civil Engineering Department, Marwadi University, Rajkot have satisfactorily completed their internship for the period of 10-11-2020 to 10-12-2020.

During their internship, we found them punctual, hardworking and dedicated to the work with good moral character.

We wish them all the best for bright future.

Mr. Gopal Barai,
Managing Director,
Shraddha Civil Services.

"Arihant", Plot no. 4/A, Yogi Darshan Society, Kalawad Road, Rajkot – 360007
Mo.: +91 942 916 902 6 & +91 982 422 356 5 E-mail : shraddhacivilservices@gmail.com

MAHAVIR
TESTING & CONSULTANCY SERVICES

Date – 11/01/2021

<u>To Whomsoever It May Concern</u>

This is Certified that **Mr. Mandip Kalariya** (Roll Number 91800105018), **Mr. Saad Zaid** (Roll Number 91800105028), **Mr. Ravirajsinh Parmar** (Roll Number 91800105016) and **Mr. Yazan Muhanna** (Roll Number 91800105051),the students of Civil Engineering Department, Marwadi University, Rajkot have satisfactorily completed their Training for the period of 04-01-2021 to 09-01-2021.

During their Training, we found them hardworking, sincere and dedicated to the work with good moral character.

We wish them all the best for bright future.

Mr. Mayank Kanani,
CEO,
MTCS.

Invitation

to Scientific Workshop

Date:5/24/**2022   1.00-4.00 pm (CET)**

Place: **MS Teams platform**

Program

Time	
1.00-1.15 pm.	**Opening** - *László Balázs PhD*
1.15 – 1.30 pm.	**Greetings on behalf of the Institute** - *Andrea Keszi-Szeremlei PhD*
1.30-1.50 pm.	**Szilvia Kovács**: Electromobility and Society
1.50-2.10 pm.	**Cathérine Enorédia Odorige PhD**: New Media and its Ability to Engender Effective Communication among Development Actors
2.10-2.30 pm.	**Krisztina Sitku**: Universities' Third Mission: Community Engagement
2.30-2.50 pm.	**Dr. Guarav Kumar Badhotiya – Dr. Vijay Lahri**: Faculty Research Profile and Areas for Research Collaboration
2.50-3.10 pm.	**Meda Srinivasa Rao PhD – Vaishali Jain PhD** (Finance)
3.10-3.30 pm.	**Meeta Joshi PhD** (Industrial Psychology)
3.30-3.50 pm.	**Bhumika Achhnani PhD – Sunali Bindra PhD** (HR&Allied Area)
3.50-4.00 pm.	**Questions - Answers**
4.00-4.10 pm	**Closing remarks**

Contact details of the workshop:

https://teams.microsoft.com/l/meetup-join/19%3ameeting_MWZiNDQ3ZTUtNmU4Yy00Y2NkLWI4ZDgtYjgwNWM5YTlmNTAy%40thread.v2/0?context=%7b%22Tid%22%3a%22e346c365-76c4-4d56-ae1e-a0d3ed94e76f%22%2c%22Oid%22%3a%2271bfc396-5e0c-4c22-9421-c9bd88dd1e95%22%7d

We are looking forward to joinging the envent!

Dunaújváros, May 23, 2022.

László Balázs PhD
Deputy Rector for Academic Affairs
Rector's Office

Andrea Keszi-Szeremlei PhD
Director of the Institute
Institute of Social Science