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FITT FORUM

Newsletter of Foundation for Innovation and Technology Transfer,
Indian Institute of Technology Delhi, New Delhi

INSIDE

MESSAGE

The ordeal continues…

The month of April and half of May, 2021 was no less than a holocaust when the second Covid19 wave hit us like a tsunami. The healthcare infrastructure cracked to the extent that deficiencies therein could be visible even to the blind! The inherent limitations and systemic inadequacies in health care delivery became embarrassingly exposed. Not that the more developed nations fared any better in the first wave that ravaged them, but it was a brutal wake-up call for us – reminding how much we had to improve from the level where we have reached after all the years of claimed progress. The effects of the third wave got acerbated as preventive steps required to address the vulnerabilities (like putting up oxygen generating plants) were not taken – not even in Delhi. Perhaps the wave came too soon and too fast taking everybody off-guard. What is obviously worrying though is that some avoidable factors became extremely strong predisposing factors that include hotspots created at protest sites around Delhi, inappropriate Covid19 behaviour of many people etc. While the strain and herculean efforts of frontline workers is difficult to acknowledge in words, the very noble and selfless deeds, and innovative mitigating steps taken by many individuals, groups of volunteers and NGOs to address the scourge of pandemic head on with their service and philanthropy would always be remembered in the history of mankind. Now the ordeal can be shortened or eliminated largely if only we decide not to become reckless and go for the jab without delay. Vaccination apart – masking, distancing and washing would continue to remain a strong defensive strategy. And, last but not the least, we have to actually strengthen our core life science research programs to enable good understanding of critical medical issues and development of robust solutions to tame the microbes and the disease.

Anil Wali

RESEARCH TALES

Impacts of Artificial Intelligence in Digital Transformation of Industry 4.0 Firms

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DMS, IIT Delhi

Prof. Nishtha Malik
Jaipuria Institute of Management, Lucknow

A major driving force for an organization's success is a leverageable competitive advantage in the form of its manpower resources. The fourth industrial revolution (I4.0) has brought about a paradigm shift, in business processes. Digital workspace has emerged as a new paradigm and enables employees to work both in physical and cyberspace. It facilitates increased employee productivity. This work format will help employees save on useless commuting, give them more flexibility, enable them to manage work and collaborate without any time and place constraints. Operations management has also witnessed the onslaught of Artificial Intelligence (AI) adoption (Grover et al., 2020).

Although there have been several studies on the adoption of AI and I4.0 technologies, there still remains a gap in existing literature. Prior research has explored the positive impact of AI adoption on human resources as well as the negative aspects in terms of the creation of technostress amongst employees. Robotization often also leads to adverse impacts (Mir et al., 2020). However, there was a perceptible gap in the in-depth practical understanding of positive and negative employee experiences due to AI adoption and the creation of technostress.

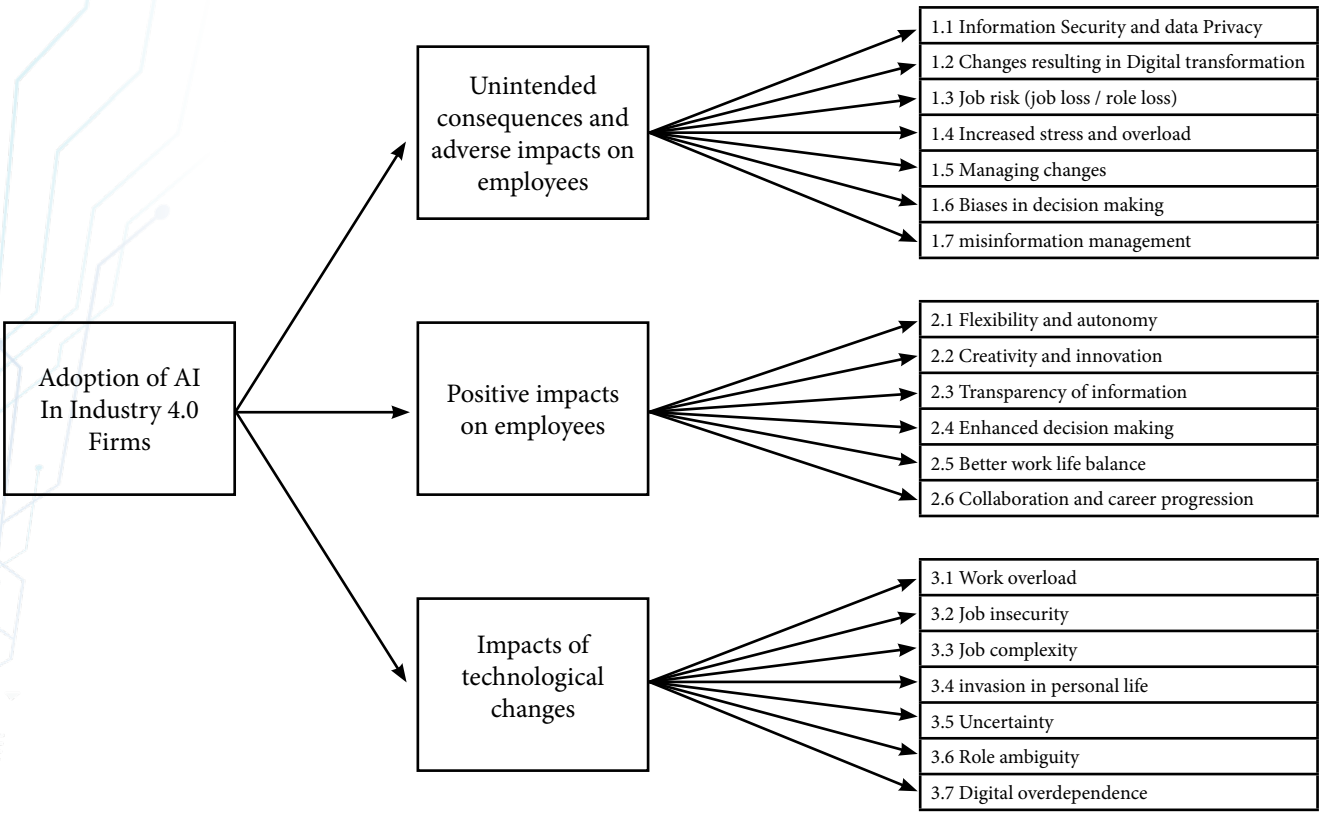
Digitization has resulted in omnipresent technostress in organizations, hence there is a need to design and develop organizational interventions to combat this threat and advantages from its beneficial aspects. As complex technological interventions continue to overwhelm organizational human resources, it is vital to develop a detailed understanding of negative impacts like technostress along with the positive aspects. The objective is to develop deeper insights into challenges related to human development with the onset of I4.0. These challenges confront top managements of organizations at every step such as recruitment, training, career development, and so on. Also, some innovative human resource development strategies need to be deployed, so as to overcome these challenges and arrive at a sustainable human resource development plan in this digital era. Hence the research questions that the study aims to explore are:

- How does AI adoption in I4.0 firms create adverse impacts among employees?
- How does AI adoption in I4.0 firms create positive employee experiences?
- How does AI in I4.0 firms AI applications creates technostress among employees?

The study uses a qualitative approach, where the data consists of open-ended information that we gathered through interviews with working professionals who had experience in working on I4.0 projects in multi-national firms. The average work experience was 7.6 years. The maximum work experience of the respondents' was 18 years. These working professionals belonged to both middle management and senior management within multi-national firms. Interviews were taken until we started getting repetitive responses. Semi-structured interviews were conducted and the respondents were asked about how the adoption of AI in I4.0 can create unintended consequences, adverse impacts; positive employee experiences; technological changes and technostress amongst employees. The data was analyzed using text mining methodologies.

The analysis of the respondents' responses revealed that, a very negative to moderately negative sentiment was harbored by the respondents where digital transformation using AI has been initiated. This is indicative of the fact that respondents believe that the onslaught of I4.0 will have certain negative impacts on the employees and their psychological well-being. The majority of the responses were centered on problem areas and issues encountered by employees, integration of organizational functions with technology results in a potential risk of data leaks and security breaches. The next theme was drastic changes resulting from digital transformations. Another theme that emerged was job risk and insecurity brewing in the employee psyche. Secondly, this research study attempts to comprehend in detail the positive impacts of AI deployment in organizational work processes. The study proposes a hierarchy of factors comprising the positive impacts. These factors are work-related flexibility and autonomy, creativity and innovation, and overall enhancement in job performance. Also, after performing a detailed analysis of the impact of AI usage in creating technostress (amongst employees) gave a hierarchy of factors for the same. These factors are work overload, job insecurity, and complexity. The conceptual model for estimating the impact of AI on employees in I4.0 can be seen in the Figure (Page 4), adapted from Malik et al. (2020).

The current study makes some noteworthy contributions that have implications in the arenas of both research and practice. First, an organization's digitization process is affected by its age and size. Thus, technological interventions like AI need to be implemented at a different pace in startup firms since they possess a greater entrepreneurial spirit with a flatter organizational structure in comparison to traditional organizations. The traditional organizational structure will need to have a step-wise diffusion of technological interventions with a gradual blending and transition of various workflow processes. The human resource aspect of an organization is being driven by the emerging knowledge economy and technological interventions. These changes are the driving force



for evolution of the human resource element of a firm. The job profiles are changing, hence the need for different skillsets and technological competencies.

Second, HR mangers need to focus their efforts on integration of various emerging technologies with the proposed utilitarian benefits supposed to accrue from them. By achieving this integration, I4.0 will be able to achieve the true potential of the technological evolution for accomplishing marked improvement in complex organizational ecosystems. The emerging requisite technical skills are expertise in big data analytics, programming, robotics, and so on. Hence, the organization needs to implement strategic manpower development measures deploying dynamic capabilities involving up gradation of skills and knowledge management

Organizations can implement AI based decision-making either in a sequential or an aggregated manner. AI adoption and deployment is driven by employees' attitude (towards technology) and the infrastructure of the firm. Another factor having an impact is the level of intelligence and education of employees. The organization has to deploy a sequential AI implementation procedure by first selecting data sources, followed by algorithms and finally the training and deployment. Effective management of Big Data could also lead to better insights for governance of digital transformation initiatives (Kushwaha et al., 2021).

With the unlocking of the digital potential, I4.0 has affected the work styles and life of organizational human resources. Hence, employees need to understand in order to support them in the evolving socio-technical organizational relationships.

To summarize the findings of this study provide valuable developmental information for managers in the human resource domain, challenged by digitization issues. It calls for multifaceted organizational support in the form of developing soft skills such as communication skills (helps achieve clarity in communication), problem solving skills (helps take initiatives and arrive at appropriate solutions), team building and team work skills (helps in role definitions and collaborative work), learning skills (helps in always having a learning attitude), analytical thinking skills (helps information comprehension and evaluation and sound decision making), conflict resolution skills (helps in peaceful resolution of conflicting situations), time management skills (helps in enhancing efficiency and effectiveness), creative thinking skills (helps in devising new ways and means to complete tasks), interpersonal skills (helps in interaction with people) and leadership skills (helps in motivation and inspiring people to work for a common cause).

References:

1. Malik, N., Tripathi, S.N., Kar, A.K. and Gupta, S. (2021). Impact of artificial intelligence on employees working in industry 4.0 led organizations. International Journal of Manpower. https://doi.org/10.1108/IJM-03-2021-0173
2. Grover, P., Kar, A.K. & Dwivedi, Y.K. (2020). Understanding artificial intelligence adoption in operations management: insights from the review of academic literature and social media discussions. Annals of Operations Research. https://doi.org/10.1007/s10479-020-03683-9
3. U.B., Sharma, S., Kar, A.K. and Gupta, M.P. (2020). Critical success factors for integrating artificial intelligence and robotics. Digital Policy, Regulation and Governance, 22(4), 307-331. https://doi.org/10.1108/DPRG-03-2020-0032
4. Kushwaha, A. K., Kar, A. K., & Dwivedi, Y. K. (2021). Applications of big data in emerging management disciplines: A literature review using text mining. International Journal of Information Management Data Insights, 1(2), 100017. https://doi.org/10.1016/j.jjimei.2021.100017

Futuristic & Emerging Semiconductor Hardware for Artificial Intelligence (AI): A Case Study on MRAM based use-cases

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EE, IIT Delhi

Introduction & Motivation

Artificial Intelligence (AI) and its manifestations are fast becoming ubiquitous in our daily lives. From targeted advertisements to *Siris* to *Alexas* to *Google Translate* it won't be an understatement to say that all of us knowingly/unknowingly encounter some or the other form of AI every day. There's an important and often underrated aspect in the wonderful story of AI. This aspect relates to the underlying physical electronic computing hardware that powers up the promise of AI algorithms and techniques. The underlying semiconductor platforms such as chips, circuits, ICs, PCBs are the real engines that drive any form of AI in the first place. Traditionally, CPUs (mainstream processors) have been handling all the computational workload for data processing. More recently availability of specialized computational hardware such as GPUs, FPGAs and ASICs have changed the game in terms of parallelism, extreme performance and functionality. There is an entire class of specialised semiconductor IP known as accelerators and co-processors, where the sole job of these units is to efficiently accelerate intense AI-centric computations. Such powerful emerging hardware platforms coupled with the successful scaling of CMOS technology (Moore's law and beyond) are the main reasons behind the current highs of AI and the promise of domains like supercomputing/ high performance computing (HPC). However when it comes to electronics, history has taught us that one cannot afford to be complacent with present state-of-the-art for long. Products that may see light of the day 10-15 years down the line have to cross the R&D phase today. Future of computation lies with a rather more innocuous semiconductor component – known as Memory! Memory has long been the underdog of the world of semiconductors. Too much attention has been paid to Logic devices over the years. However, Memory is one of the most evolved, mature, colourful (many different flavours) and exciting sub-domain in the world of semiconductors. Memory is available in abundance in all digital systems and its quantity is growing every day. Think of the Gigabytes, Petabytes, and so on…Imagine, how powerful systems would become if each of these abundant memory bits start computing apart from their traditional job of simple storage! So far they just store '1s' and '0s'. What if they could add/ subtract/multiply etc. apart from simple storage. The possibilities would become endless, opening doors for massively parallel computational systems where each square nanometre (nm2) of silicon is worth its cost. Silicon real-estate is one of the most valuable and sophisticated manmade real-estate in the universe. Even if one goes by the traditional storage based use case where the memory only stores (and doesn't compute) it is still critical for fields like deep-learning as they feed on gigantic datasets and huge number of parameters! Where is all that information kept? Obviously on physical semiconductor memory! Thus memory is the real deal for the future of machine intelligence and computation. In our research group at IIT-Delhi we work on the vision of building a memory-centric world. We investigate all aspects of different memory technologies starting from materials, physics moving up to devices, circuits, architectures and finally end-applications. We have pioneered multiple new unconventional use cases of emerging memory technology beyond storage, such as- edge-AI, neuromorphic computing, cyber-physical security, sensing and computing.

Case Study of Non-Volatile AI Accelerators using STT-MRAM

Over the last few years we have proposed multiple use-cases of emerging NVM (non volatile memory) technology for dedicated AI hardware. One particular NVM technology of interest here is the STT-MRAM (spin-transfer torque – magnetic random access memory). We have demonstrated merits of STT-MRAM for both AI Inference and training use-cases in recent works [1-4].

In one study published in ACM GLSVLSI [1], we presented the design of a simplified and extensible neural inference engine for IoT systems. In this study, through simulations we performed design-space exploration accessing impact of parameters such as; technology-node and computation block size on overall performance of the neural inference engine. The paper also demonstrated design instance of an optimized neural network known as ELM (extreme learning machine). Comparison between learning performance of simulated hardware against software models of the network showed a low variation of ~1% owing to quantization. Simulated accelerator compute blocks achieved a power-saving of ~30 % when traditional SRAM blocks were replaced with STT-MRAM technology.

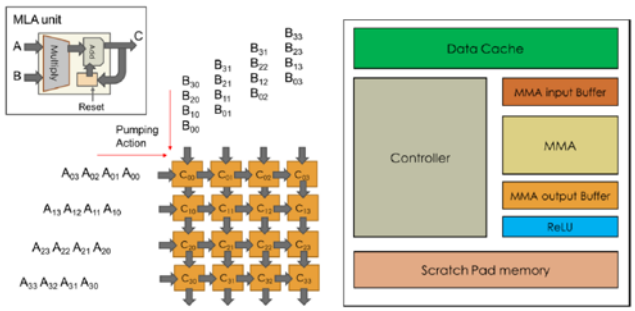
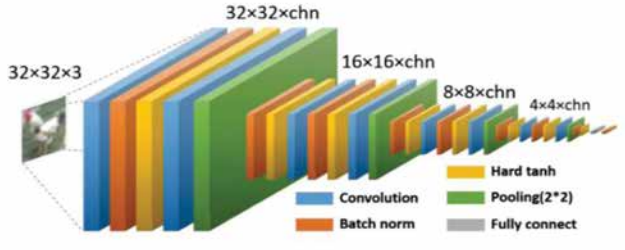


Figure 1: Data flow and blocks of proposed systolic accelerator. Memory blocks including NVM and SRAM were investigated [1].

In another study, published in IEEE DAC [2], carried out in collaboration with Industrial Technology Research Institute and National Chiao Tung University-Taiwan, we demonstrated an advanced class of binary deep convolutional neural networks (NV-BNN) capable of both local and remote learning. This work exploited intrinsic switching probability of MRAM devices for accurate online training of CIFAR-10 dataset (~ 90%). The technique was designed to be endurance friendly for long operational life cycles. The proposed approach provides an attractive architecture for highly scaled < 28 nm future technology nodes and can be used to implement adaptive AI on edge. Using this approach both knowledge transfer from cloud and also learning from local data as per application requirement is possible.

In an industry-academia collaboration with Global Foundries, we demonstrated efficient edge-AI Non-Volatile Inference Accelerators (NVIA) using state-of-the-art STT-MRAM technology. This study published in IEEE IMW [3], demonstrated that performance of Edge-AI-Inference hardware can be enhanced by effectively using emerging commodity MRAM chips and macros



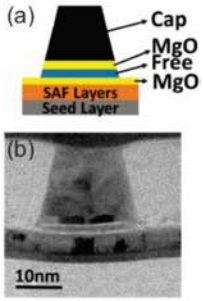


Figure 2: Illustration of proposed NV-BNN architecture. Schematic and TEM image of p-magnetic tunnel junction device exploited [2].

inside accelerators. We found out that IoT-centric 'normallyoff/ low-frequency' AI inference workloads are a winning use-case for the proposed approach. The proposed Non-Volatile AI Inference Accelerator (NVIA) was realized using FPGA and MRAM chips. NVIA was benchmarked on Human Activity Recognition (HAR) dataset as a smart wearable-device use case. Significant power gains, ~ 9X (with an older generation of MRAM) and ~ 750 X (with a more current generation of MRAM), were achieved compared to conventional volatile SRAM.

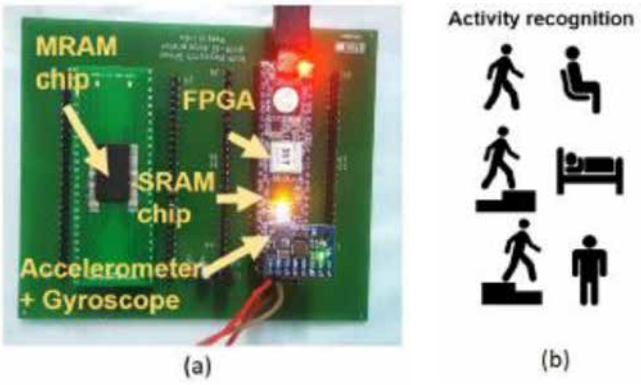


Figure 3: (a) Inference Accelerator test-bench for memory evaluation for NVIA concept. (b) Classes of HAR dataset. [3].

Further, in one of our recently published works in IEEE AICAS [4], we demonstrated the utility of MRAM based non-volatile inference accelerators (NVIA) for harsh environment use-cases. Edge-AI-Inference architectures based on 22nm FD-SOI embedded-MRAM along with quantized neural networks (QNN) were exploited for inference applications in presence of strong external magnetic fields and wide operating temperature (- 40°C to 125 °C) ranges. These conditions are representative of extreme and harsh industrial environment. High test accuracy of ~ 98.99 % with Quantized-Convolutional Neural Network (QCNN) and ~ 89.94 % with Quantized-Multi-layer Perceptron (QMLP) surpassing prior reported literature results on MNIST dataset were achieved. By exploiting BER resilience of QNNs, we were able to demonstrate that MRAM based edge accelerators offer superior magnetic immunity of ≈ 700 Oe at 125 °C without the requirement of any additional error correcting circuits, further leading to a significant energy saving of up to ~ 14 %.

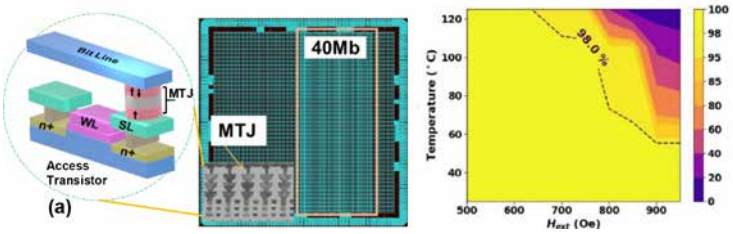


Figure 4: Figure 4: (a) 22nm FD-SOI based 40Mb MRAM macro (Inset: TEM Image of MTJ arrays) and MRAM device schematic. (b) Contour plot showing impact of temperature and external B field on inference accuracy of the binarized CNN [4].

Conclusion

As edge AI is becoming more pervasive the sustainability and energy footprint of the platforms executing AI can no longer be ignored. The four MRAM centric AI accelerator case-studies discussed above are a step in the direction of futuristic energy-efficient NVM driven dedicated semiconductor AI hardware. The results presented in some of the above studies may pave the way for deploying energy efficient and sustainable MRAM based AI accelerators for multiple consumer and enterprise applications such as; IoT, wearables, robotics, healthcare, defense & security, Industry 4.0 etc.

References:

1. Design Exploration of IoT centric Neural Inference Accelerators. Proceedings of the 2018 on Great Lakes Symposium on VLSI (GLSVLSI '18). Association for Computing Machinery, New York, NY, USA, 391–396. DOI: https://doi.org/10.1145/3194554.3194614
2. NV-BNN: An Accurate Deep Convolutional Neural Network Based on Binary STT-MRAM for Adaptive AI Edge, 2019 56th ACM/IEEE Design Automation Conference (DAC), 2019, pp. 1-6.
3. Performance enhancement of edge-ai-inference using commodity MRAM: Iot case study. 2019 IEEE 11th International Memory Workshop (IMW). IEEE, 2019. DOI: 10.1109/IMW.2019.8739709
4. MRAM-based BER resilient Quantized edge-AI Networks for Harsh Industrial Conditions. 2021 IEEE 3rd International Conference on Artificial Intelligence Circuits and Systems (AICAS). IEEE, 2021. DOI: 10.1109/AICAS51828.2021.9458528

Some aspects of the discussed case studies were investigated through multi-institutional collaborations. The IIT-Delhi team was led by Prof. Manan Suri and comprised of research scholar V. Parmar. NCTU & ITRI Taiwan teams were led by Prof. Tuo-Hung. Global Foundries team was led by Dr. Vinayak Naik.

FACULTY PROFILE

Prof. K. A. Subramanian
Department of Energy Science and Engineering, IIT Delhi

Dr. K.A. Subramanian is a Professor and currently the Head of Department of Energy Science and Engineering (formerly known as Centre for Energy Studies (CES)), Indian Institute of Technology Delhi, India. His main research area includes Hydrogen Energy, Alternative fuelled Internal Combustion Engines/Vehicles, Hydrogen Backfire and combustion, Hydrogen Fuel Cell, Zero emission vehicles, Hybrid Systems, and Integrated Energy Systems. After he completed his doctoral work from Department of Mechanical Engineering, IIT Madras, he joined as a Scientist in Indian Institute of Petroleum, Dehradun, and experienced the translational research work focused mainly on industrial applications such as oil & gas and automotive industries that are in transition from conventional energy to alternative / renewable energy. Then, He continues his journey as a faculty member, CES, in IIT Delhi and involves enthusiastically in both academics and research as well as development and demonstration of technologies in the field of utilization of alternative fuels in internal combustion engines with higher energy efficiency and ultra-low / zero emissions, and moulding of the young researchers to valuable human resources. He developed many numbers of courses including Hydrogen Energy, Zero Emission Vehicles, Bioenergy: Resources, Technologies and Assessment, Carbon Capture and Storage and Organic Waste to Energy Conversion Technology. He has guided several doctoral Ph.D. scholars and published several research papers in reputed Journals, two patents filed, and author of two books published by the CRC Press.

Academics: He teaches many courses including Hydrogen Energy, Alternative Fuels for Transportation, Power Plant Engineering, Industrial Energy and Environment Analysis, Energy, Ecology and Environment, and Bioenergy: Resources, Technologies and Applications, Cogeneration and Energy Efficiency, etc. Being a teacher is an advantage for continuous updates in many areas including the allied areas such as Ecology how it interacts with the environment and gets affected by energy sectors. His experiences of teaching and research complement each. It is a great journey with the young minds coming with different aspirations and dreams and getting great satisfaction when achieving their desired goals. A teacher may not have generation gap problems as a chance to close interaction with them for understanding their generation exposure and challenges and huge responsibility (moral duty) like next to their parental role.

Research: Decarbonizing the energy sectors is a major thrust in view of the environment. Hence, cutting-edge technologies and developing manpower power are important to achieve the same. Oil and Gas sectors and automotive industries/power plants work closely for the development of new generation fuels including ethanol, methanol, biodiesel, Fisher-Tropsch Diesel, Dimethyl ether, etc. The production of the new generation fuel with the desired fuel quality is one of the major challenges whereas its utilization in combustion engines with higher efficiency and ultra-low emissions is another challenge. He pursues his research in the area of the utilization of alternative fuels/biofuels in spark ignition/compression ignition engines with aim of higher torque /power output, higher thermal efficiency, and ultra-low emissions. In this line, one of the current research is towards utilization of Dimethyl Ether fuel (lower carbon to hydrogen ratio and high ignition quality/Cetane number) in a Light Commercial Vehicle with the collaboration of reputed oil and automotive industries and the development of the technology has almost been completed and it will soon be flag-off the vehicle on the ground.

The oil and gas industries envisage zero-carbon fuel/energy which is the ultimate target for keeping sustainable energy and the environment. Hydrogen production from renewable energy sources gets more attention as surplus renewable energy could be converted to hydrogen that may increase demand for electricity and accelerating growth of renewable energy sectors, the solution to energy storage problems, improving capacity factor of the power plants, and mitigating the Greenhouse gases (CO_2) in the atmosphere. The Paris Agreement, a legally binding international treaty on climate change, adopted by 196 Parties at COP 21 in Paris (2015), aims to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. An ambitious plan of the target of keeping global average temperature rise below 1.5 / 2° C at end of the middle of this century, hydrogen is one of the important ways to achieve the goal. We at CES work in the area of hydrogen for more than four decades and he is involving in the development of technology for the utilization of hydrogen in spark-ignition engine generator set for electrical power generation. Hydrogen is a by-product from Chlor-alkali, oil refineries, ammonia plants, etc., and the tangible product of hydrogen can be utilized in the engine with the developed technology to produce the electricity and then, the generated electricity (captive power) could be used within the industries. The diesel generators can be replaced with hydrogen generators in cities that are facing air pollution problems. One of the major challenges of hydrogen use in combustion engines is backfire which is a pre-ignition phenomenon leading to safety problems. Addressing backfire is a great technical challenge and it is taken a long time to understand the characteristics of backfire and finally found the measures for control/elimination of the backfire. It is one of the great satisfaction of his research work in the area of hydrogen. We received many awards for our research work on backfire from International Symposium on Fuels and Lubricant (ISFL2018), 11th International Exergy, Energy, and Environment Symposium (IEEES-11), IIT Delhi Alumni Association Annual Research & Innovation Award, etc. He received one of important recognition of one among the Top 2% Scientist by Stanford University, 2020 in the world. He is a member of many numbers of committees including the standing committee on Hydrogen (MNRE), Standing committee on IMEF (NITI Aayog), lead person of Energy Security (NITI Aayog).

Sustainable Development Goal 7 is one of 17 Sustainable Development Goals established by the United Nations General Assembly in 2015 aiming to "Ensure access to affordable, reliable, sustainable and modern energy for all. As energy is in a transition phase from conventional to renewable energy,

appropriate technologies are being developed to address the energy challenges. As any Central Research Facility transforms to National Research Facility targeting multiple benefits to many stack holders including start-ups. Similarly, the industries connect with premium educational institutes like IITD for R&D support of their product/process development. But, the academia-industry needs to be strengthened for the targeted growth. All reputed educational institutes may become seamless R&D to the industries for accelerating the development of indigenous technologies/ products within a shorter period. In this line, great appreciation goes to the Foundation for innovation and Technology Transfer (FITT), IIT Delhi which provides its excellent service for many years for collaboration of academia-industry, technology incubation, start-up, and technology transfer to industries.

Prof. P. Vigneswara Ilavarasan
Department of Management Studies, IIT Delhi

Prof. P. Vigneswara Ilavarasan (PhD – IIT Kanpur) is a Professor and Chair of information systems group at the Department of Management Studies, Indian Institute of Technology Delhi. He is a trained social scientist who studies the interaction between digital technologies, business & society. Presently he is teaching the following courses: Business Research Methods; Social Media & Business Practices; and ICTs [Information and Communication Technologies], Development & Business to the MBA students. Earlier, he had taught these courses: Science, Technology & Society; Electronic Governance; Indian Society for Young Managers; and Industry & Society.

Prof. Vignesh's teaching heavily borrows from the research work undertaken by him. He has published widely in the top international journals and has presented in the leading peer-reviewed international conferences. Following are the present research areas: social media analytics for new product development; digital platforms in urban transport systems; access issues in rural national broadband networks; use of ICTs [mobile phones, social media] by microentrepreneurs; digital literacy programs impact assessment; e-governance participation; future of work; Work & innovation in Indian ICT industry; and Social media adoption & use by businesses.

Prof. Vignesh deploys a wide range of methods for his research work - large scale surveys (a study had 40000 people); in-depth personal qualitative interviews; Twitter analytics; secondary data analysis; content analysis; systematic reviews; and evidence summaries. He is comfortable using tools like SPSS, n Vivo and Weft to handle qualitative and quantitative data.

He is active in collaborating with ministries and external international organizations for research and consultancy projects. The collaborators include PwC, International Development Research Corporation – Canada, CIPPEC – Argentina; Ford Foundation; LIRNEasia – Srilanka, Oxford Analytica - UK, IPTS - European Commission, World Bank, IdeaCorp – Philippines, Ministry of Labour and Employment, Ministry of Information Technology, and Ministry of Tribal Affairs. He works well with large teams comprising of international researchers and policy agents. He has also delivered multiple invited talks by different organizations - Big Data in Decision Making; Digital Marketing 101; Social Media Strategy for Election Commission; Research Grants; and Emerging technologies for banking executives.

He has been a Visiting Research Fellow at United Nations University - School of Computing and Society (Macau) and School of Management, Curtin University (Perth). He is a recipient of the Outstanding Young Faculty Fellowship Award at IIT Delhi and Prof. M.N. Srinivas Memorial Prize of the Indian Sociological Society. He is also a Senior Research Fellow at LIRNE Asia, a leading regional ICT policy and regulation think tank.

At the personal level, Prof. Vignesh is a first learner, hails from a small town in Tamil Nadu, and a native speaker of Tamil. He is happily married (so far) and has one daughter.

Vignesh is open for consulting and training in the following areas (Pro-bono for non-profit sector and start-ups): Digital platforms strategy; Social media & business practices; market/business research methods; small data analytics; impact assessment; digital technologies, development & business. Explore more about him at: https://web.iitd.ac.in/~vignes/ or scan this:

R&D Collaborations

FITT, IIT Delhi have signed an MOU with MG Motors to collaborate on "Research on Connected, Electric, Autonomous Mobility" on March 15, 2021

Hyundai Motor India signed MoU with FITT, IIT Delhi: Extended Kona electric SUV for research and training, January 20, 2021

Some IPR Applications filed during January- June, 2021

Sl. No.	Title	PI	Dept/ Centre/ School
1	Process for de-laminating flexible multilayer laminates	Prof. J Jain	DMSE
2	Appliances control devices	Prof. A Verma	CES
3	Metal-organic framework catalysts, method for preparation thereof and process of direct oxidation using the same	Prof. K Manna	CHY
4	System and method for improving stereo vision accuracy	Prof. SR Sarangi	CSE
5	Sub-terahertz apparatus and method for subsurface malignant tissue imaging	Prof. SK Koul	CARE
6	Croam on,crime off	Prof. L Kumar	EE
7	B-reporter logo	Prof. L Kumar	EE
8	C-type magnet topology for a permanent magnet brushless DC motor	Prof. B Singh	EE
9	A structure of frequency selective surface for multiband spatial filtering and broadband polarization conversion	Prof. SK Koul	CARE
10	A wind, solar, DG and BES based isolated microgrid with coordinated control for remote regions	Prof. B Singh	EE
11	Orthopedic screw	Prof B Kalyanasundaram	CBME
12	Human heel surrogate for barefoot slip risk assessment	Prof. A Chandra	CBME
13	Electrochemical preparation method for vanadium electrolyte and its application thereof	Prof. A Verma	CHEME
14	Single tower with mirror reflection	Prof. DS Mehta	PHY
15	Double tower with mirror reflection	Prof. DS Mehta	PHY
16	Triple tower with mirror reflection	Prof. DS Mehta	PHY
17	Base for mechanical tracking solar tower	Prof. DS Mehta	PHY
18	A field-portable optical microscopic imaging device for air quality monitoring of PM 2.5 and PM 10 and its method of implementation thereof	Prof. DS Mehta	PHY
19	Smart multivariate data compression system and method thereof	Prof. S De	EE
20	Multivariate data compression system and method thereof	Prof. S De	EE
21	Polarization insensitive metamaterial enabled multiband absorber	Prof. SK Koul	CARE
22	A multi-metallic adsorbent for removing mercury (HG) from gas streams	Prof. D Bhatia	CHEME
23	Grid interfaced solar photovoltaic system facilitating automatic protection	Prof. B Singh	EE
24	Electric three wheeler vehicle	Prof. B Singh	EE

25	Circumferentially distributed interior permanent magnet synchronous motor	Prof. B Singh	EE
26	Computational camera with extended field of view	Prof. K Khare	PHY
27	Membrane-less two-phase flow microfluidic electrolysis cell - fuel cell tandem	Prof. S Basu	CHEME
28	Ultrasonic- vibrations aided double-disc chemical-assisted magnetorheological finishing process	Prof. PM Pandey	ME
29	Islanded solar PV-BED DG set for remote areas	Prof. B Singh	EE
30	High yield synthesis of 5-hydroxymethylfurfural in water under microwave condition using solid acid catalyst	Prof. KK Pant	CHEME
31	A contamination free nucleic acid amplification method and kit thereof	Prof. D Kalyanasundaram	CBME
32	Energy efficient industrial exhaust fan induction motor	Prof. B Singh	EE
33	Reconfigurable solar PV-battery supported small hydro based micro-grid	Prof. B Singh	EE
34	A journal bearing with new bore design	Prof. RK Pandey	ME
35	A process and two-step catalytic reactor system for the production of liquid hydrocarbons from plastic waste	Prof. KK Pant	CHEME
36	Marine-derived cell penetrating peptide and implementations thereof	Prof. A Chugh	KSBS
37	Near infrared spectroscopy for protein formulation and uses thereof	Prof. AS Rathore	CHEME
38	Apparatus and method for performing a milling operation	Prof. S Jha	ME
39	Seamless transition control of a micro-grid integrated to 3-Phase AC distribution network	Prof. B Singh	EE
40	A system for evaluating the performance of craniovertebral junction implant	Prof. S Mukherjee	ME
41	Native virus-like particles of SARS-COV-2, methods of generation and purification thereof	Prof. M Banerjee	KSBS
42	Serratia protease-derived recombinant peptide displaying anti-biofilm properties and implementation thereof	Prof. TK Choudhuri	KSBS

TECHNOLOGY PROFILE

Near Infrared Spectroscopy for Real Time Control of Biopharmaceutical Formulations

Prof. Anurag S. Rathore
Centre of Excellence for Biopharmaceutical Technology
CHEME, IIT Delhi

Regulatory agencies across the globe demand that biopharmaceutical drug products meet stringent formulation requirements before being brought into the market. These include the concentration of the biotherapeutic molecule as well as the concentrations of various excipients in the formulation buffer, as these determine the safety and efficacy of the drug product [1]. If these parameters are not within strict limits, the drug can lead to dangerous side-effects when injected into the patient [2]. Thus, monitoring and control of the drug formulation step, typically carried out using tangential flow ultrafiltration, is a critical part of biopharmaceutical manufacturing. However, in current manufacturing setups, there are no real-time tools available for this purpose. Time- and labour-intensive offline analyses using high pressure liquid

chromatography (HPLC) are required to quantify each of the components in the final drug product, with back-and-forth between the analytical lab and the manufacturing setup, leading to overall higher manufacturing costs for biologic drugs that are already extremely expensive and largely unaffordable to the general public.

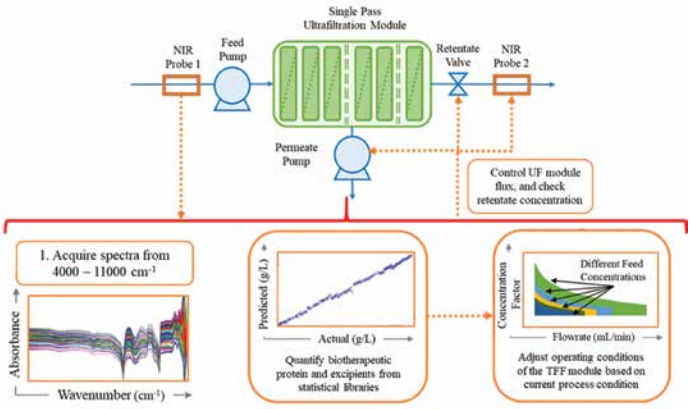


Figure1: NIRS as a novel tool for monitoring and control of biotherapeutic formulations

We have developed a novel methodology using near infrared spectroscopy (NIRS) for real-time monitoring of the composition of the drug product during the formulation step. The approach is simple, requiring only a single NIRS probe immersed in the ultrafiltration recirculation vessel or in-line in the feed/retentate flow streams. The technology involves collection of spectral data every few seconds followed by automated analysis by comparing the current spectrum with calibrated statistical models containing information about the spectral signatures of the different components, from simple salts to complex biotherapeutic proteins. The technology also enables novel control applications, including adjusting the operating parameters of the formulation step to handle process deviations and adjust the composition automatically in real time. The system is a robust quality control approach to ensure that each unit of drug substance produced in a manufacturing facility meets strict quality targets for maximum patient safety. It also greatly simplifies both manufacturing and process development of the drug product formulation step. It is in-line with regulatory guidelines of the US FDA, which encourages the use of such process analytical technologies to create processes under the paradigm of "Quality by Design" rather than "Quality by Testing" [3].

References:

[1] Shire, S.J., 2009. Formulation and manufacturability of biologics. Current opinion in biotechnology 20, 708-714.

[2] Davies, A., Merli, F., Mihaljevic, B., Mercadal, S., Siritanaratkul, N., Solal-Céligny, P., Boehnke, A., Berge, C., Genevray, M., Zharkov, A., 2017. Efficacy and safety of subcutaneous rituximab versus intravenous rituximab for first-line treatment of follicular lymphoma (SABRINA): a randomised, open-label, phase 3 trial. The Lancet Haematology 4, e272-e282.

[3] FDA, 2009. Guidance for industry: Q8 (R2) pharmaceutical development. Center for Drug Evaluation and Research.

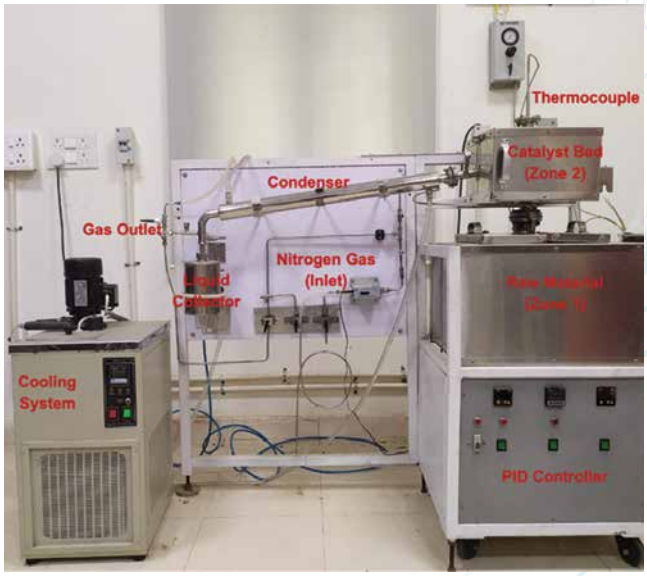
A Process and Two-step Catalytic Reactor System for the Production of Liquid Hydrocarbons from Plastic Waste

Prof. S. N. Naik & Uma Dwivedi
CRDT, IIT Delhi

Prof. K. K. Pant
CHEME, IIT Delhi

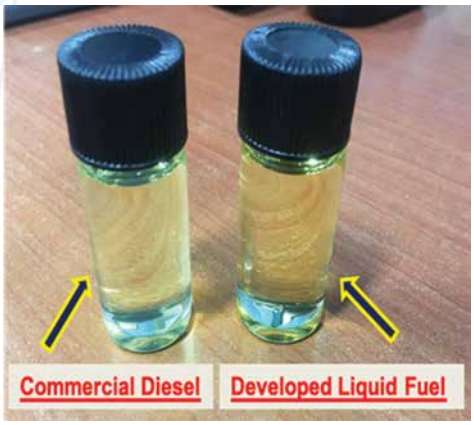
Production of plastic materials has increased tremendously in the past few decades, leading to the parallel rise in the plastic waste generation. However, in an ideal way; advance-polymers meet the requirements for both green chemistry and sustainable development as polymers are considered as the high molecular-mass hydrocarbon materials that possess oil-like energy content. However, the prior arts for the use of plastic waste in the production of value added chemicals by exercising different techniques have presented various problems. This majorly contributes to the problem associated with the coke formation on the surface of the catalyst and thus, inhibiting the catalytic activity for the production of fuel-range of compounds. In order to address this problem, a novel two-step approach has been proposed to control the immediate deactivation of the catalyst and also in tuning the fraction of hydrocarbons formed.

In particular, the invention is based on a technique for efficiently producing high-quality liquid fuel in which instead of plastic melt, hydrocarbon vapours interact with the catalyst surface for the cracking of waste plastics; where the thermo-catalytic



cracking occurs in the presence of zeolite-based catalysts giving higher selectivity towards petroleum range hydrocarbons.

The developed two-step approach leads to the ~100% conversion of waste plastic into value-added products comprising 60 to 75% high-quality liquids having maximum C6-C28 range selectivity (66.39 %). The results suggest that the physical properties of the liquid products formed are comparable with the commercially available liquid fuels (in terms of physical and chemical characteristics) which shows that the liquid formed can be used as an effective alternative fuel blend.



The research group is working on the design of 1 TPD pilot plant for waste plastic conversion into liquid fuel. Based on lab-scale investigations, the pilot-plant techno-economic feasibility is being carried out for commercialization and have installed and demonstrated a 1kg/h plastic waste treatment unit in our campus. Overall, the proposed process will simultaneously cover the issues towards waste plastic management and energy requirements after successful pilot plant design.

References:

1. Media Coverage: Plastic: Recycle, Reuse and Reduce, India Science, Vigyan Prasar, October 21, 2019
2. Press Article: Hindustan Times, September 30, 2019
3. Press Article: Amar Ujala, September 24, 2019
4. Media Coverage: Plastic Waste to Fuel, AajTak Live, September 23, 2019
5. Media Coverage: Plastic Waste to Fuel, Rajya Sabha Television, July 06, 2019
6. President's Gandhian Young Technological Innovation Award (GYTI 2019), July 06, 2019
7. Naik, S. N., Pant, K. K., Dwivedi, U., A process and two-step catalytic reactor system for the production of liquid hydrocarbons from plastic waste. Patent application filed by IIT Delhi (Ref. Number: 201811032378).

Technologies Transferred at FITT- January-June, 2021

Sl No	Title of Technology	PI/ Dept	Client
1	Smart Data Handling	Prof. S De, EE	Silov Solutions Pvt Ltd
2	Aqua Silver technology	Prof. AK Agarwal, TFE	Nanoclean Global Pvt Ltd
3	Rapid Antigen test for detection of Covid 19 (2019-nCoV)	Prof. H Singh, CBME	Standard Analytical Laboratory (ND) Pvt Ltd
4	Development of Low Volume Sampler for monitoring heavy metals in ambient air	Prof. DS Mehta, PHY	Envirotech Instruments Pvt Ltd
5	High-Efficiency Solar Tower Based Photo-voltaic System	Prof. DS Mehta, PHY	EP Sunsol Pvt Ltd
6	Fiber-optic probe based label-free auto-fluorescence imaging and spectroscopy in-conjunction with Raman spectroscopy for fast screening and diagnosis of breast Cancer	Prof. DS Mehta, PHY	GRS India Private Ltd
7	Rapid Antigen test for detection of Covid 19 (2019-nCoV)	Prof. H Singh, CBME	Avecon Healthcare Pvt Ltd

Abbreviations

AM:	Department of Applied Mechanics	CHEME:	Department of Chemical Engineering	DOD:	Department of Design
BSTTM:	Bharti School of Telecommunication Technology and Management	CHY:	Department of Chemistry	EE:	Department of Electrical Engineering
CARE:	Centre for Applied Research in Electronics	CRDT:	Centre for Rural Development and Technology	HUSS:	Department of Humanities and Social Sciences
CAS:	Centre for Atmospheric Sciences	CSE:	Department of Computer Science and Engineering	KSBS:	Kusuma School of Biological Sciences
CART:	Centre for Automotive Research and Tribology	DBEB:	Department of Biochemical Engineering and Biotechnology	MATHS:	Department of Mathematics
CBME:	Centre for Biomedical Engineering	DMS:	Department of Management Studies	ME:	Department of Mechanical Engineering
CE:	Department of Civil Engineering	DMSE:	Department of Material Science & Engineering	PHY:	Department of Physics
CES:	Centre for Energy Studies			TFE:	Department of Textile and Fiber Engineering

and many more...

Some examples of Development/ Investigative Projects at FITT

Sl No	Title	PI	Dept/ Centre/ School
1	Fatigue testing of suspension lug	Prof. P Mahajan	AM
2	RC/RCE auto clave test for corrosion inhibitor sample using high pressure reactor	Prof. KK Pant	CHEME
3	Technical and economical analysis of electrical & mechanical project work executed at site	Prof. S Mishra & Prof. D Rakshit	EE
4	A technology development project on PV adhesive and EVA primer	Prof. S Saha	DMSE
5	Complier-based analysis and optimization for PMEM abstractions	Prof. S Bansal	CSE
6	Unicare lifeline design and computational testing	Prof. J Kumar & Prof. P Khadilkar	DOD
7	Investigation of non volatile memory device and sub-system design computational testing	Prof. M Suri	EE
8	Development of smart contract driven blockchain application	Prof. S Sharma	CSE
9	Material and water audit of Ashoka Pulp & Paper Pvt Ltd	Prof. V Kumar	CRDT
10	Utilization of distillery spent wash pressmud biocompost as a source of renewable fuel	Prof. R Khanna	CHEME
11	Testing and analysis of aluminum composite panels	Prof. J Jain	DMSE
12	Testing of polyurethane samples for grouting	Prof. R Khanna	CHEME
13	Advice on manufacture of zeta-cypermethrin from cypermethrin	Prof. R Khanna	CHEME
14	20 Advanced Model Compression	Prof. Prathosh AP & Prof. B Lall	EE
15	Evaluation of properties of small scale components of different alloys	Prof. J Jain	DMSE
16	Investigating the mechanism of inactivation of non-enveloped viruses using biochemical and in-silico approaches	Prof M Banerjee	KSBS
17	WFP Grant for Public Systems (PSL)	Prof. N Bolia	ME
18	Ocean noise monitoring system	Prof. A Kumar	CARE
19	Smart warehouse IoT design and software implementation	Prof. S Jha	ME
20	Electrochemical testing such as conductivity, coefficient of thermal expansion and fuel cell testing	Prof. A Verma	CHEME
21	Providing analytical design calculation for existing earthing systems for Powergrid Mandola, Ballabhagarh and Bassi substation	Prof. S Mishra	EE
22	Impact assessment of e-Lakshyvahini in Haryana state	Prof. J Kumar	DOD
23	Advice for vision, mission, strategy and other relevant aspects for Shiv Nadar University	Prof. A Sagar	School of Public Policy
24	Strategies for piezoelectric energy harvesting from vehicular movements on roads and its utilization for powering traffic signals	Prof. S Bhalla	CE
25	Performance study of geocell reinforced road pavement at Dholera activation area	Prof. JT Shahu	CE
26	Sustainable geotechnical design of foundations and geo-structures for Dholera smart city project	Prof. T Chakraborty	CE

HAPPENINGS

Electric vehicle, "HOPE" launched by Geliose Mobility, startup at FITT on March 23, 2021

Hon'ble Minister of State for Education Shri Sanjay Dhotre launched a Rapid Antigen Test kit for COVID-19 developed by IIT Delhi, June 25, 2021

Technology Transfer at FITT

Technology transfer of "Aqua Silver" PI- Prof Ashwini K Agarwal to Nanoclean Global in the presence of Dr Anil Wali, MD FITT IIT Delhi and Mr Prateek Sharma, MD, Nanoclean Global Pvt. Ltd at FITT- January 20, 2021

R&D Collaborations

Mr Pravir Krishn, Managing Director, TRIFED and Dr Anil Wali, Managing Director, FITT have signed an MoU to collaborate and enhance the income growth of tribals through the commercial production and sale of Mahua- Nutra-beverage, a value-added product made out of Mahua on March 17, 2021

MOU signed between FITT, IIT Delhi and GRS India Pvt Ltd on June 21, 2021

The Principal Scientific Advisor (PSA) to the Government of India, Prof K Vijay Raghavan launched 'Grassroots Innovation Programme (GRIP)', an initiative by IIT Delhi under which the Institute students will work on finding novel solutions to grassroots societal problems- June 28, 2021

SNIPPETS

FITT invites proposals under the 19th Biotechnology Ignition Grant (BIG) Scheme of BIRAC from August 1, 2021 to September 15, 2021 before 5:30pm.
For details: www.fitt-iitd.in

CORPORATE MEMBERSHIP OF FITT

FITT invites the industry/industry associations/R&D organisations and financial institutions to become corporate members of FITT at a nominal annual subscription. A corporate client can participate in technology transfer and joint R&D programmes of the Institute on a priority basis with FITT providing the interface. Membership form can be downloaded from www.fitt-iitd.in.

NEWS AND ANNOUNCEMENT

Website launched by IIT Delhi to help COVID-19 patients

IIT Delhi alumni have launched a new website to help COVID-19 patients and their families with verified leads on plasma, oxygen cylinders and hospital beds. JIT Delhi alumni have launched a dedicated website to help the families of COVID-19 patients with verified leads on various resources. The website provides live tracking on vacant beds, oxygen availability, plasma, food, videos by renowned doctors and helpline information among others. The website is basically a non-profit app called CovRelief.

The app has been developed by Milan Roy who graduated from IIT Delhi in 2018 and is the co-founder of Edvicer, Swapnil Sharma who graduated from IIT Delhi in 2019 and has 1.5 years of experience in the industry, and Pranit Ganvir who graduated from IIT Delhi in 2018. All the information displayed on the app has been taken from respective government websites

Source: https://www.dqindia.com/iit-delhi-alumni-launch-website-help-covid-19-patients-leads-plasma-oxygen-availability/

Union Minister launches Rapid antigen test kit developed by IIT Delhi

Minister of State for Education Shri Sanjay Dhotre launched a Rapid Antigen Test kit for COVID-19 developed by IIT Delhi today. The Rapid Antigen Test kit has been developed by the IIT Delhi researchers led by Prof. Harpal Singh, Professor at the Institute's Centre for Biomedical Engineering. This kit is used for in vitro qualitative detection of SARS-CoV-2 antigen.The SARS-CoV-2 Ag Rapid Test is a colloidal gold enhanced double antibody sandwich immunoassay for the qualitative determination of SARS-CoV-2 antigen in human nasal swabs, throat swabs and deep sputum samples. It is suitable for general population screening and diagnosis of COVID-19…

Source: Internal, IIT Delhi, June 25, 2021

IIT Delhi launches 'Grassroots Innovation Programme (GRIP)'

The Principal Scientific Advisor (PSA) to the Government of India, Prof K Vijay Raghavan on Monday launched 'Grassroots Innovation Programme (GRIP)' for students, an initiative by IIT Delhi under which the Institute students will work on finding novel solutions to grassroots societal problems identified by them from rural and semi urban areas, including the communities they come from.

Lauding the initiative launched by IIT Delhi, Prof K. Vijay Raghavan expressed hope that GRIP will result in development of several innovative solutions for the society….

Source: Internal, IIT Delhi- June 2021

Up the innovation curve: The latest wave of Deeptech startups in India

While a plethora of challenges remain, most startups in the current wave seem to be adopting the Israeli way of establishing a global connect and customer base for scaling-up, after development, piloting and achieving product-market fit, done affordably in India in comparison to their global counterparts.

India's startup economy has been booming. The last decade has seen significant activity on multiple fronts including the founding of new startups, amount of funding and number of investment rounds, influx of global investors and startups, development of regulatory infrastructure, global mergers and acquisitions, and internationalization. Entrepreneurial success stories abound…

Source: https://www.dqindia.com/innovation-curve-latest-wave-deeptech-startups-india/

IIT-Delhi to start 2-year M.tech. program in electric mobility

The new M.Tech. programme in "Electric Mobility" is multidisciplinary in nature and will cover key aspects related to electric vehicles, drivetrain, chargers and charging infrastructure, battery energy storage systems, Battery Management System, reusability of energy storage elements, reliability, automotive health monitoring, Automotive NVH (Noise, Vibration, and Harshness), vehicle dynamics, autonomous and connected vehicles, vehicular telematics, and materials for electric vehicle, along with hands on practice and design in laboratories.

Source: IIT Delhi Internal, June 12,2021

IIT Delhi collaborates with Hebrew University of Jerusalem, Israel

IIT Delhi and the Hebrew University of Jerusalem, Israel (HUJI) have partnered to support collaborative and interdisciplinary education and research initiatives.

Student exchange is another key partnership priority, which will help students get benefitted from the academic and entrepreneurial environments of the two institutions…. Prof V. Ramgopal Rao, Director, IIT Delhi said, "At IIT Delhi, we lay great emphasis on international collaborations. We are happy to sign this MoU with the Hebrew University and both the institutions have agreed to seed fund researchers in their respective institutions to collaborate with each other. I am sure these interactions will lead to long term partnerships between the two institutions benefiting the two countries."…

Source: IIT Delhi Internal, March 12, 2021

LEADERSHIP AT FITT

Prof. V Ramgopal Rao, Director IIT Delhi, Chairman, FITT

Dr Anil Wali, MD, FITT

Col. Naveen Gopal (Retd.), COO, FITT

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