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Good and Simple …

That was the Prime Minister's description of the landmark Goods and Services Tax (GST) adopted at the stroke of mid-night hour in the Central Hall of Parliament on July 1, 2017. While this tax reform is likely to usher in a new economic order, it's the description – 'good and simple' that articulates a much deeper message particularly, in the context of our governance models. For far too long has our administrative machinery been complex – giving the impression that they are more a hindrance than a facility. Aside of its merits, if any, both the perception and reality speak about our public processes being generally procedure driven rather than outcome based. This surely contributes to a very slow pace of our development. It's not uncommon that this complexity often results in intractable situations that adversely impact delivery of public services and other welfare measures. The reforms being currently undertaken by the Government seem designed to make our systems simple and smoother. It's no brainers that such measures would unlock our huge untapped potential. Similarly, in the scientific domain there is need for greater transparency, greater objectivity and simpler administrative rules to augment scientific temper and research output. The scientific establishments ought to be accountable to the stakeholders and can no longer afford to remain isolated. The same goes for the universities which have to evolve as truly egalitarian and world-class institutions. This is important when academic institutions and scientific organizations embark on their growth plans with Government support. At the micro-level, existing institutional processes need to be re-looked at and, if required, modified to facilitate ease-of-doing work. Increasingly, such a paradigm may call for greater adoption of technology and recourse to innovations. Smart and robust technology based solutions can easily be scaled up and, thereby, reduce the scope for 'unnecessary' human intervention. In general, the policy frameworks should not be intricate. Many legacy systems and methodologies may need suitable revisions to make them operationally effective and in tune with the fast moving world.

Anil Wali

What's in this issue?

Dr R Chidambaram, Principal Scientific Advisor, GOI delivering lecture on Developing Sustainability-Nuclear to Rural, on the event of Technology Day at IIT Delhi on May 11, 2017

Parliamentary delegation from UK led by Mr Virendra Sharma visited FITT on February 15, 2017

Tech Tales

Sensors for common man....reliability or cost?

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Humans wherever they decide to live, aim to survive and prosper despite local conditions, natural (like climate) or man-made (like hygiene, services etc.). Unfavourable local conditions can be improved by having better knowledge about these that helps develop solutions for improving facilities. Sensors whether to know the conditions better or as part of the solution administration have an important role in such endeavours. Today sensors have become part of our day-to-day life, may it be electronic equipment, gadgets, automobile or even as human experiences. Broadly classified into categories like electrical, mechanical, optical, electrochemical etc. depending on the sensing scheme being used, typically, sensors comprise of a sensing material (the heart of the sensor), contacts (for taking electrical measurements) and an advanced stage of a sensor called as a transducer which would contain a signal processing circuit which makes the information usable.

In a country like India, sensors can be put to good use in a variety of sectors. The rural sector is in need of simple, low cost and easy to use sensors for water quality monitoring, continuous blood pressure checking, analysis of sugar level in blood, prediction of cancer at an early stage, heart diseases etc. The urban sector has similar requirements for some subgroups (communities) but also has specific requirements such as air quality monitoring, unobtrusive personal health monitoring, toxic gas detection etc.

With such a large use and user base the irony is that most of the sensors are currently fabricated outside India and so importing these and integrating these in the circuitry adds to the cost of the device/equipment. While thinking of such issues we often consider "which is more important 'reliability' or 'cost' of the device?" As researchers, we believe that for initial trials it is 'trade-off' and for long run it should be 'both'. We usually consider trade-offs during initial production in the lab. The sample device is made, tested, validated for field trials. But to provide the same device in large numbers for a long time, it is mandatory for it to be affordable and useful (both).

While there is no dearth in number of materials that have been explored by researchers and scientists for these to be used as a sensitive material, there are some standard properties that are required for a material to be 'sensitive'. These are dependent on materials own natural characteristics and also on its human processing. The topic that evoked a revolution in research (and continues to do so) was introduction of 'nano' scale in various applications. 'Nano' means a dimension in the order of 10^{-9} m but it is not merely the scale that makes nano attractive. Materials when shrivelled to a nano dimension, there is a change from classical to quantum physics and the materials exhibit properties like large surface area to volume ratio, high adsorption capacity, more number of reactive sites and many more! Thus, such nano-materials offer immense opportunities for sensor research [1-2] and are used in various applications like sensors, solar cells, photovoltaics, bio-medical devices etc. [3-6].

At IITD, my research revolves around a similar area where we try and develop scalable, cost effective and sensitive sensors for common citizens. Our work mainly comprises of sensitive nano-materials, integration of these on the silicon chip, testing and validation of sensors in our labs, building of prototypes and thus improving the user-electronic interface. The major research areas of my work are summarized in Figure 1 (the cartoons are taken from the internet).

Figure 1: Gas and bio-sensor research work in IITD

Some very interesting results have been achieved in the area of alcohol and acetone sensing through our work. Usual commercial sensors based on semiconductor oxide operate at higher temperatures (>250 °C). This limits their integration with current CMOS circuitry because of heat dissipation and high power consumption. Also, many wet processes are used for fabrication of sensors however, our technique is based on micro-fabrication standard processes and thus is scalable and reproducible. Our sensors which measure the change in resistance made with a combination of semiconductor oxide or 2D material on porous silicon (PS) operate at room temperature. The materials which have been explored till now include titanium dioxide (TiO_2),

Molybdenum disulphide (MoS_2) and another form of molybdenum (Mo), all with a combination of nano silicon. TiO_2 nanostructure is an attractive choice among other metal oxides nanostructures due to its low cost fabrication, low toxicity, photocatalytic properties, high surface area, easily tunable surface and structural properties. Porous silicon (PS) attracts much interest as chemical sensors due to its unique features like scalable pore size, tailorable surface chemistry, optical reflectivity and photoluminescence spectrum. MoS_2 is a 2D material found in single- and multi-layer forms has been known for its excellent optical and electronics properties.

We have deposited a thin layer of TiO_2 on PS which had shown selective response to ethanol among all volatile organic compounds (VOCs) tested [7]. The limit of detection of the sensor was around 5 ppm which still was required to be pulled down to sub-ppm level. In order to achieve this, TiO_2 nanotubes were grown on PS substrate using anodization technique, for which the thickness of TiO_2 was required to be at least 200 nm [8]. This sensor could sense alcohol selectively in sub ppm range however operated at optimized temperature of 150°C, which is still comparatively lower than thin film sensors. Figure 2(a) and (b) depict the top view of the PS and TiO_2/PS samples respectively. These show a nano-morphology of both PS (~121 nm) and TiO_2 nanotube (diameter ~20nm). Figure 2(c) and (d) display the corresponding cross-sectional view of both showing the depth of PS pores (0.8 µm). The sensor was exposed to various vapours like ethanol, IPA, acetone, benzene and xylene (in humid environment) and was found to be selective for ethanol. Figure 2(e) shows the sensor response to ethanol at varying concentration of ethanol. The device size was very small with active area of 40 x 40 µm^2 [Figure2 (f)] and was packaged onto TO headers for field tests [Figure 2(g)].

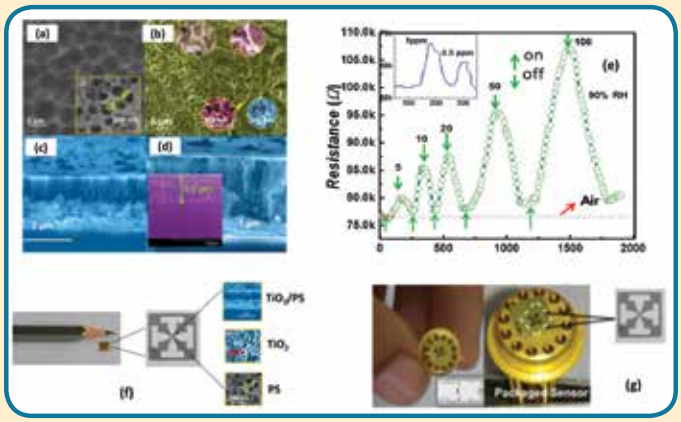

Figure 2: (a)-(d) SEM studies of the material TiO_2/PS, (e) Sensing response curve of TiO_2/PS in presence of varying concentration of ethanol, (f) schematic to show the size of the sensor fabricated, (g) sensor packaged on TO header [8].

Some very impressive results were obtained from MoS_2/PS devices which have also shown high affinity for alcohols at sub-ppm range (Figure3) [9]. The devices were exposed to almost seven different VOCs and only ethanol was shown sensitivity selectively. The most challenging task is formation of uniform nano-morphology of MoS_2 on a larger area. The synthesis techniques described till date by various research groups are mostly for a localized region and thus neither scalable nor reproducible. Whereas, the work presented by our group shows a scalable process with high yield for synthesis of MoS_2 on PS. The sensor had shown long term stability and repeatability.

Another interesting piece of our work relates to detection of acetone at sub ppm level. It is known that if the sugar level in the blood is high, acetone is produced and gets mixed in our breath. If the breath of human being contains <0.8 ppm of acetone, the person is supposed to be healthy however, levels exceeding 1.8 ppm, pertains to a diabetic condition. Our work shows sensitive detection of acetone selectively at room temperature upon using modified form of Mo on nano-silicon [10].

A selective and sensitive behaviour of sensor depends upon various factors, (a) material properties, (b) chemical properties of analytes under test, (c) testing environment (dry wet, humid etc.) and (d) type of sensing (whether optical, electrical, mechanical etc.). The key feature of our sensors is the formation of heterostructures (comprising of combination of metal oxides or 2D materials with nano-silicon). Detailed explanation for the sensing mechanisms have been explained in our recent publications [8-9]. Also, since the processes for fabrication are scalable, thus these can be used for larger platforms as well. Further to add on, the process can be adopted for batch fabrication which can lead to manufacturing of cheaper and affordable devices. Thus, reliability and cost go hand-in-hand and cannot be considered solely.

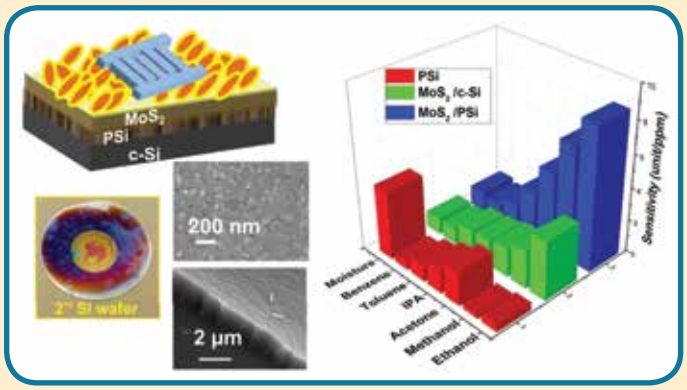

Figure 3: Summary of results obtained from MoS_2/PS devices [9]

Developments at IITD

Our work was recognized as best paper in one of the IEEE conferences (Selective acetone electrical detection using functionalized nano-porous silicon, Priyanka Dwivedi, Saakshi Dhanekar, Samaresh Das presented at 12th IEEE India International Conference (INDICON), 17-20 December 2015, New Delhi, India). One of our works on DC MEMS switch which describes a new idea for fabrication, packaging at wafer scale has been patented [11]. Another of our pioneering work in relation to acetone sensor has been patented and is being moved for PCT filing [10]. This device can detect acetone and can be used for assessing the blood sugar levels. We are now trying to contact some companies

who would be interested in licensing this product. We are also initiating the integration of MEMS with our sensors for enhancing the sensitivity of the device. This work anticipated to fetch much improved and interesting sensing results.

Across the globe, there are several research groups and companies (Honeywell, Fairchild, Maxim, General Electric etc.) putting in persistent efforts to develop improved sensors based on MEMS and VLSI. With continuous efforts of the like-minded research groups in India and across the globe we hope to see a proliferation of affordable and reliable devices that make the quality of our life's better.

I believe: "Research is imagination and making your imagination possible"

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**Acronyms: MEMS: Micro-Electro-Mechanical Systems; TO- transistor outline; VLSI- Very-large-scale integration;.

Social Media Analytics for Businesses: Case of a Pizza launch

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Social Media & Business Use

In today's competitive environment, businesses are continuously exploring ways by which customers can be better engaged to sustain long-term growth. Social Media (SM) platforms offer an easier and more cost-effective way for businesses to reach customers, and consequently strengthen brand awareness through numerous applications and tools. SM platforms enhance the communication power of individuals by providing different avenues without demanding much efforts.

SM is often defined as Internet-based applications that transmit user-generated content. According to Kaplan and Haenlein (2010: 61), SM is "a group of Internet based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of User Generated Content." The number of SM platforms users is continuously increasing at a phenomenal rate. It was predicted that in 2016 there would be around 2.13 billion SM users around the globe, up from 1.79 billion in 2014. Almost two-thirds (64%) of these users use or would use such SM platforms at least once a day through their computers (Nielsen, 2014). While Facebook remains the largest SM platform, users are now taking to other social platforms such as LinkedIn, Pinterest, and Instagram. SM platforms can be differentiated on the basis of technology, content, and functions.

Many businesses use SM platforms as an advertising channel only because they are accessed by the public at large. Hence, the most visible application of SM platforms is online promotion. There are multiple ways SM platforms can be used by the businesses.

Customer Engagement: SM platforms may connect customers and businesses by facilitating conversation and providing user-generated content, thus fostering customer engagement. In addition to this, customers who actively participate in online activities on SM platforms are regarded as highly valuable for a business. SM enables customers as well as non-customers to contribute in marketing mix decisions and value adding. For instance, Max Bupa[1], India's premier health insurance company, uses its engagement platform, Get Help, on Facebook to provide services to customers daily.

Brand Awareness: The social character of brands and the significance of engagement in co-creating brand value reinforce the role of SM platform as a brand awareness channel. Brand reputation is a measure of how users feel about, talk about, and act toward an organization's brand. Applying SM strategies for branding can definitely help businesses. To attract more consumers, businesses are constructing their presence on SM platforms after receiving in-depth information on where and how they or their brands are positioned on SM platforms. For example, India International Jewellery Week (IIJW), an initiative to showcase India's finest jewelry, has built awareness through SM platforms as the biggest international jewelry festival in India.

Marketing & Promotion: SM platforms provide opportunities to expand relationships between users and businesses. They are new marketing tools appropriate for awareness building, influence, and the attainment of marketing objectives that help improve marketing communication effectiveness and make for better marketing impact. An earlier study (Mayzlin, 2006) examined SM content which is a combination of business promotions and user recommendations and found that it could still be influential despite the obvious promotional flavor. For example, Fork You Too, a casual dining cafe in Delhi NCR, had used SM platforms for restaurant marketing campaigns. They created a campaign around Bollywood movie posters with a Fork You Too–style twist on Facebook, Twitter, and Instagram.

Product Design and Development: Users often share their thoughts and feelings on a product or an event through SM platforms. SM platforms have empowered customers to circulate their creations and opinions. It has also become a new method for businesses to collect people's opinions and understand their preferences. User-generated content are embedded with customers' experiences of a product, with information on product engagement (e.g., product features) and other related information (e.g., shopping experiences). The strategic use of SM platforms for developing product features and form user-generated content are comparatively new area that connects marketing and product design and is a fine example of how two formerly distinct business functions are brought together by the advent of SM.

Case Study

In this analysis, the case company was planning to introduce a new pizza product, Dominos exotic Italian pizza, in mid July 2015. We collected Twitter data from February 2015 to October 2015. We did content analysis to derive insights on three themes: ideation, sentiment, and community.

Ideation: Here word connections show the themes associated with the common origin words (Figure 1). We can see how themes are changing. In pre-launch, there are eight major clustering having a major centric word. Like in first cluster, Dominos was the centre word. The connections show the themes like Dominos love, Dominos up, and now apply right job. There is also comparison between Dominos pizza fare and train fare, which infers how users visualize the price of a new product. In other cluster, Italian is the centre word along with the themes like user liked YouTube video and large handmade pan. It means users like the YouTube videos of exotic Italian pizza. They are also happy with the handmade pan using for this pizza. Now this centre word Italian also connected the other centre words like exotic and pizza. In the 'pizza' cluster, users were discussing the gift cards and the KFC pizza. Another discussion is related to hiring of drivers for delivery.

In post launch, word network also contained same centre words like Dominos, pizza, order with the few new exotic and delivery. In 'Dominos' cluster, love to eat and order tracking

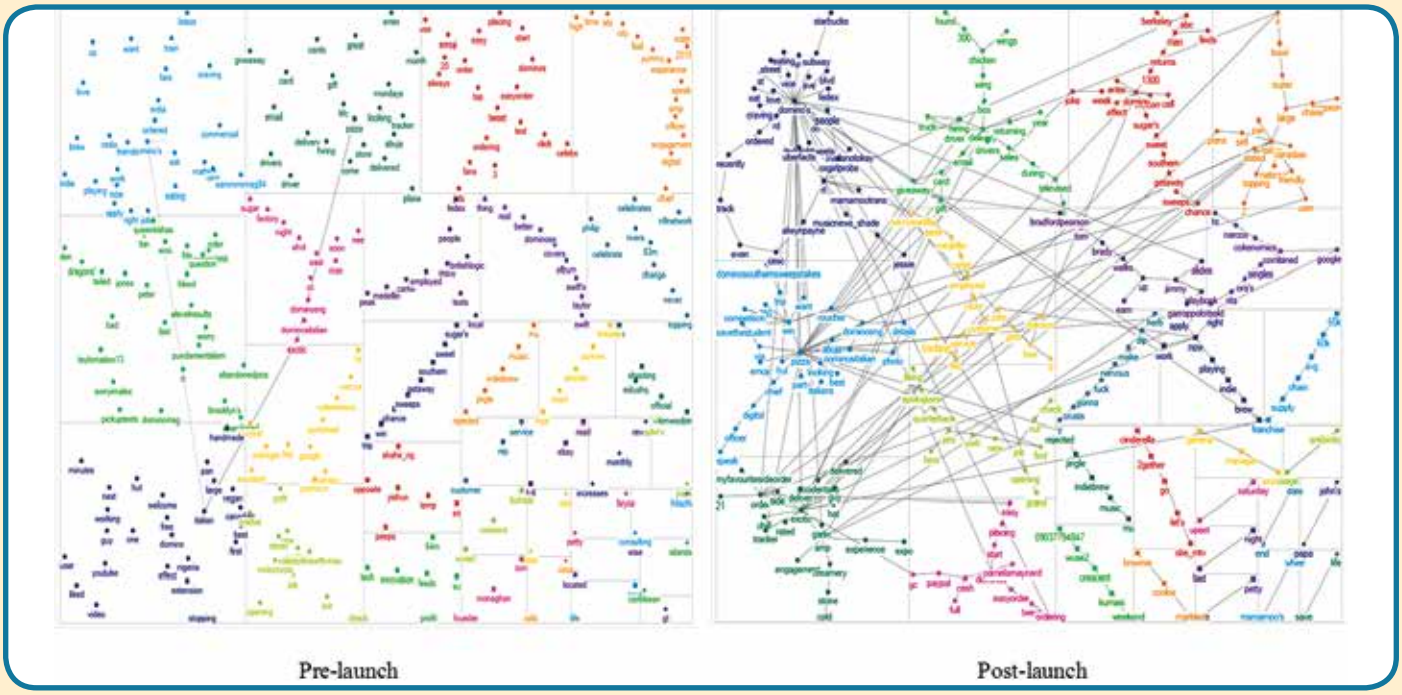

Figure 1: Word network with clusters

There are enough studies on the usage of SM in different business functions, but knowledge on linking user generated content in product design activity is minimal. We attempted to fill this gap. Here we demonstrate a case study analyzing user generated content, Twitter data, in pre and post launch durations of a new product.

are emerging. Another cluster 'pizza' showed the theme of trip voucher win, comparison of pizza hut for competition and looking best Italian pizza party. These two centre words were connected to another one 'exotic'. This cluster contains the themes like order delivery, tracking, chill, garlic creamery and engagement experience.

Sentiment Analysis: After identifying the theme, we need to understand the sentiment of users for the all themes in both time periods. For that, we did the sentiment analysis based on emotions (Figure 2). We found that there are less negative emotions in pre launch than that of post-launch. This indicates that Dominos needs to focus on these negative sentiments. Then we categorized sentiments into various emotions like anger, anticipation, disgust, fear, joy, negative, positive, sadness, surprise, and trust.

In pre-launch, anticipation has the highest score which means customers are expecting more from the Dominos in their products. Joy and Trust as positive emotions have approximately same score showing the brand faith in customers. Customers are enjoying Dominos' products. So it shows that customers are happy with their most of existing product with a lot of expectations in an upcoming product. Anger and Sadness also have a noticeable score to be taken care by the Dominos. Surprise score indicates the presence of unexpected activities by Dominos. However, in post-launch, there is still more anticipation score showing not fulfill of users' expectations. There is also decrease in scores of trust and joy emotions which indicates that users do not find anything better and unique in this product.

Community Detection: It is a critical to identify the trends in product discussion. It also shows the influencer users and their individual networks within the larger one. These specific users and communities play essential role in developing new ideas for exploration for product. Community discussion helps to validate the primary impression and figure concrete insights. As shown Figure 3, there are many communities existed in the whole network. These communities were developed based on the users' discussion about the product.

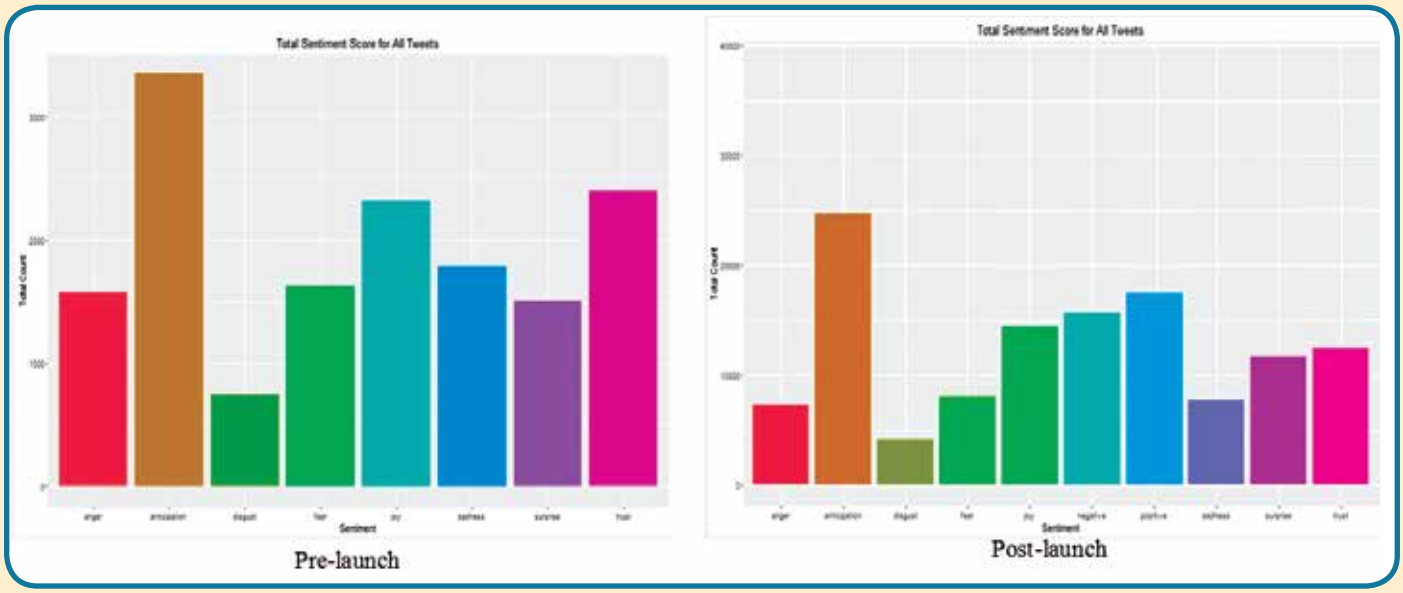

Figure 2: Emotion Classification

Few communities become merged and become the larger community after the product launch. Few communities become bigger because of adding more individual users. There is also an increase in the connections between one to another community. This shows that before launching of the product, users have various concerns to discuss, but after

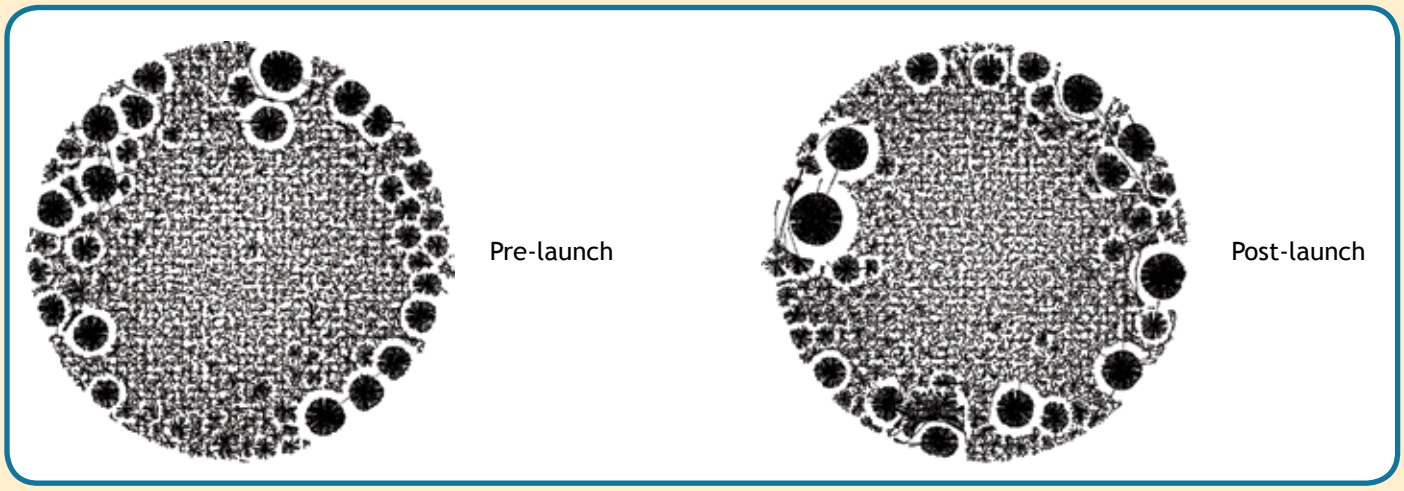

Figure 3: Communities in network

[1] Details of examples can be referred at www.socialsamosa.com

the launch of the product they have very limited but major concerns. In post launch, they are more willing to share their experience to many users.

Concluding Remarks

SM is increasingly becoming an important component that is impacting different business functions. Case study showed SM data can be mined to analyze users' preferences and emotions regarding product-related features. A closer analysis of the new product shall show whether businesses have incorporated the ideas generated by the customers. Some data mining techniques such as clustering, topic modeling, sentiment analysis, and community detection are used to identify the themes (e.g. features) of the product. SM analytics is relatively a low cost method when compared to traditional survey methods of understanding customer feedback. Also, effect of a promotional activity or campaigning can be measured using the same approach with visualization of peak trends and sentiments. Identifying the early adopters in various communities can help businesses to understand their target audience and their collective judgment easily.

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Microfluidics in Point-of-Care applications

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Microfluidics is an emerging field of science and technology that refers the processing and manipulation of a very small volume of fluid (micro to nanoliters or even less) in a miniaturized format, mainly in an enclosed channel with micrometer dimensions. This newly developed technology offers several productive competences during bio/chemical analysis, viz. requirement of very low sample volume, rapid analysis and high resolution separation and detection of the reagents with enhanced sensitivity. Furthermore, the laminar fluid flow in microfluidic devices with high degree of compactness, portability, low-cost analysis and the possibility of simultaneous detection of multiple samples in a single run provide the additional advantages. Microfluidic technology has been evolved mainly due to the involvement of four different fields namely, molecular analysis, microelectronics, molecular biology and bio-defense. The different analytical techniques used during molecular analysis especially capillary electrophoresis [1] and high performance liquid chromatography with end-channel optical/electrochemical detection influence the development of microfluidic devices with compact and more versatile design for precise determination various biological/chemical analytes. Beside this, photolithography and other microfabrication processes used for the preparation of microelectronic and micro-electro-mechanical system (MEMS) help in practical implementation and development of the microfluidic systems. Moreover, the boost in genomic research and different micro-analysis techniques involved in molecular biology particularly DNA amplification and sequencing processes require microfluidic format for high-through output analysis. Apart from that, US Department of Defense conducted a series of research programs after the end of cold war to develop field deployable microfluidic assembly for precise on-site determination of chemical and biological warfare agents that causes rapid advancement in microfluidic technology.

Nowadays, microfluidics receive considerable attention for its incorporation to point-of-care testing (POCT) devices to meet the substantial demands for providing better health care. POCT devices are the analytical tools with portable equipment that can execute prompt detection, diagnosis and treatment of various diseases and are generally found both in clinical laboratories and in the vicinity of a patient. With the help of microfluidics, it is now possible to miniaturize the currently available bio-sensing devices and place near the patient bed side for continuous monitoring of clinically relevant parameters during intensive conditions. Moreover, the recent technology advancement offers the fabrication of micro-reactor, mixer, incubator, valves and pumps that can be effectively used to integrate several laboratory functions in a microchip format termed as "lab-on-a-chip" (LoC) device. After the development of LoC techniques, most of the advance research on clinical diagnosis and treatment has shifted from traditional diagnostic techniques to the scaled down POCT devices. The fabricated POCT devices accomplish the cumulative demands of the medical, chemical, food and environmental sectors for fully automated instruments with possibility of multiple analytes screening in parallel. Furthermore, the minimal electronic or mechanical maintenance

of the developed device with fast and reliable results at adequate costs are highly useful for growing number of patients in emergency units with critical conditions. However, there is a continuous effort to integrate efficient sample pre-processing steps in the device and to enhance the accuracy and resolution of sample detection. The currently available clinical diagnostic methods are time consuming, highly expensive and require large sample volume for detection. With this in view, microfluidic systems incorporated with enzyme/antibody/aptamer sensors or DNA/protein microarrays with on-chip testing facility have high prospective to serve crucial roles in medical diagnostics through highly compact, portable and cost-effective POCT devices.

In this direction, our laboratory at CBME have been utilizing the concept of capillary electrophoresis microchip technology to fabricate PDMS based architecture on glass chip to address several POCT and other analytical applications. For example, we have been generating aptamer (using SELEX method) against a therapeutic protein Lucentis, which is produced in a bioreactor. This is a very expensive chemical used for treatment of macular degeneration in the form of ranibizumab injection. Its bio production can be monitored using our approach through process analytical technique to enhance quality of production and feedback control.

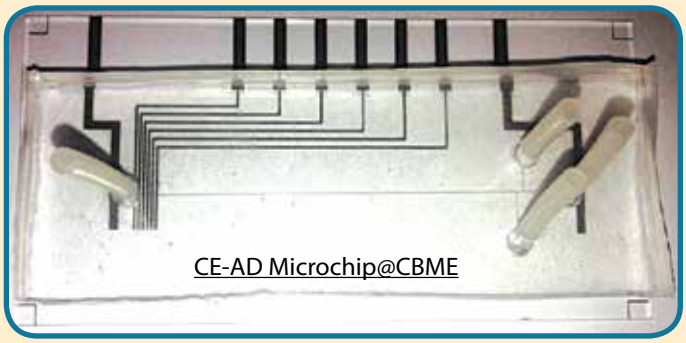

Figure: Capillary Electrophoresis Microchip developed at CBME

We develop such chip by laying microelectrodes on glass chip followed by placing microchannels laid in PDMS polymer [2]. The analytes are separated in the microchannel under influence of electrokinetic forces by application of moderate (100 V) electric field so that analytes are segregated from mixture of other components in complex sample before reaching detection zone, where the immobilized bioreceptor [3], such as enzyme or aptamer are able to catch the analyte specifically before its detection. Further, analyte can be detected using electrochemical means and it is fairly possible to integrate optical detector on the chip to enhance sensitivity of detection. We are further aiming to use such devices for analysis of human metabolites and POCT applications such as liver function test or kidney function test, where multiple analytes can be detected in single go when the device is fabricated in the form of a lab-on-a-chip while integrating multiple modules and channel systems on a single chip. Such approach not only solves the problem of high cost per analysis in Indian scenario, but also needs low sample volume. Since sample pretreatment, separation and detection is carried out on same chip, the sensitivity and accuracy of measurement is also high. Thus, we can say for surety that microfluidics is the way forward for the future of POCT applications. Though not many research groups in India have adopted this technique, but sooner than later this technology has the potential to be part of our household in the similar line as for glucometer, which was once disregarded by Indian clinicians for being less accurate.

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Innovation Centre at Sonipat

The upcoming Innovation Centre at the Rajiv Gandhi Educational City, Sonipat Campus of IIT Delhi, spread over 10 acres, is a state of the art facility with a large auditorium with a seating capacity of about 500 persons and lecture halls and conference rooms for a serene and secluded place to conduct seminars, conventions, symposia or workshops with luxurious residential facilities to accommodate participants and faculty. This innovation center also has space/ facilities for incubation of start-ups (~15,000 sqft space in units of 150 & 350 sqft). It is conceived to provide a physical environment which would serve as a catalyst for a synergistic relationship between academia, industry and start-ups working in diverse technology domains.

FITT invites Call for Proposals under the Biotechnology Ignition Grant BIG Scheme of BIRAC from 1st July to 16th August, 2017. For details: **http://www.birac.nic.in**

Faculty Profiles

Prof Arun Kumar
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Indian Institute of Technology Delhi

Prof Arun Kumar is with the Centre for Applied Research in Electronics (CARE), IIT Delhi. His research interests span the areas of Digital Signal Processing, Human and Machine Speech Communication, Underwater and Air Acoustics, and Multi-Sensor Data Fusion.

An alumnus of IIT Kanpur, Prof Arun Kumar received his BTech degree in 1988, MTech degree in 1990, and PhD in 1995, all in Electrical Engineering from IIT Kanpur. He was a Visiting Researcher at the Electrical and Computer Engineering Department, University of California, Santa Barbara (UCSB), USA, for two years between 1994 and 1996. He joined CARE as an Assistant Professor in 1997. From April 2012 to August 2016, he was Head of CARE. He was also Head of the IDDC of IIT Delhi from May 2015 to August 2016.

Prof Arun Kumar began his research activities in speech technologies for human and machine communication. The 1990s presented for the first time, limitless opportunities for the signal processing engineer with the possibility of realizing sophisticated digital signal processing (DSP) algorithms in real-time using newly developed powerful DSP processors. It was also the time when the Internet and the mobile phone were beginning to take deep roots in society. The convergence of these technologies made possible the embedding of several human speech based applications for enabling natural human interaction with computers and machines. Prof Arun Kumar's PhD work in speech signal analysis and coding for telephony applications led him to work on speech technologies for two years at one of the foremost research groups in the field led by Prof Allen Gersho at UCSB. Thereafter, he joined IIT Delhi where he has pursued research and technology development activities in several related areas such as multi-lingual keyword spotting in speech in Indian languages, text-to-speech synthesis in Indian accent English and Hindi, voice conversion for personalized speech synthesis, automatic objective evaluation of speech quality for quality of service assurance in mobile telephony, and modeling of human auditory signal processing. He developed a new Speech and Audio Processing Laboratory in CARE and also a new Masters level course on Human and Machine Speech Communication that emphasizes on practical hands-on learning.

Since the 1970s, CARE has engaged in R&D in Underwater Acoustic Signal Processing and has developed an enduring association with the prime user organization viz. the Navy. After joining IIT Delhi, Prof Arun Kumar broadened his research activities to underwater and air acoustics applications. In the two decades at IIT Delhi, he has worked with colleagues in the Signal Processing group at CARE on sonar signal processing and passive underwater surveillance algorithms encompassing target detection, localization and classification tasks, design, development and signal processing for underwater and air acoustic vector sensors, low power DSP hardware platforms for autonomous, remote manned/unmanned platforms, and underwater acoustic communication modems. In the last three years, he has also initiated research and technology development work on multi-sensor data fusion techniques for diverse applications ranging from underwater navigation to wearable and mobile devices and IoT.

The approach taken by Prof Arun Kumar in doing technological research has been to take up practically important problems related to national defence requirements and consumer electronics applications for societal benefits that involve digital signal processing. Many of these research problems have their origins in the 50 funded research projects that he has undertaken and supervised at IIT Delhi. These research projects have been sponsored by government organizations such as the Navy, Ministry of Defence, WESEE, DRDO laboratories such as NPOL, NSTL, DEAL, and SASE, Indian industries, and foreign industries from USA and Japan. These projects have led to 18 technology and know-how transfers to industry and government organizations. Several of the technologies have been deployed in the field and are in practical use, for example, the operational High-Speed Very Low Frequency (VLF) Modem for long range communication from land to submerged submarines whose algorithms were co-developed with colleague Prof R Bahl in 2012.

In a demonstration of the synergy that often exists between cutting-edge defence research and the use of resulting technologies for civilian applications and societal benefits, CSR funds provided by NTT Data are being used in an on-going project supervised by Prof R Bahl and Prof Arun Kumar for developing an electronics system for monitoring Ganges river dolphins through multi-sensor data fusion of underwater acoustic signals and camera based visual cues. Technologies developed with students for mobile and wearable devices have

been show-cased in 2016 and 2017 by his industry collaborator, ST Microelectronics, USA, in the Consumer Electronics Show (CES), Las Vegas, USA, that is one of the largest global annual electronics technology and products exhibition.

Prof Arun Kumar is an Inventor on 7 US patent applications (2 granted and 5 pending). He has published more than 100 research papers in peer reviewed journals and conference proceedings. He has supervised 9 PhD theses and is currently engaged in supervising another 12 PhD students. An MTech project on DSP Hardware development received the Best Industry Relevant MTech Thesis Award of FITT and the Alumni First Prize in I2 Tech Open House, and four of the BTech projects supervised by him have received the respective year's Best BTech project award of the Electrical Engineering department of IIT Delhi. Prof Arun Kumar was closely involved in the creation of CARE's MTech Program on Radio Frequency Design and Technology in 2004 including several of its lecture courses and laboratories.

In doing applied research and solving industry relevant technology problems, it was only a natural progression for Prof Arun Kumar to become instrumental in co-founding two technology companies, namely, Voxomos Systems Pvt Ltd and Delsig Systems Pvt Ltd, with which he has been closely associated since start-up. Voxomos Systems operates predominantly in the niche field of speech technology product development with special emphasis on Indian languages, while Delsig Systems specializes in advanced signal processing hardware based solutions and products. He serves on their Board of Directors and provides overall technology guidance to the two companies.

While at IIT Delhi, Prof Arun Kumar has served on several National-level Technical Committees such as Chairman, Monitoring and Advisory Committee for Networked Projects of 8 CSIR Labs on Electronics for Societal Purposes under five-year plan, Member of DRDO's Committee on Underwater Sensor Networks Technology, and Member of DEITY's Working Group on Technology Development for Indian Languages. He is an Editor of the Institution of Electronics and Telecommunication Engineers' flagship journal, the IETE Journal of Research, since 2009 for which he currently coordinates the review of about 400 submitted research manuscripts annually for publication.

In his spare time, Prof Arun Kumar reads across a wide-range of technical and non-technical articles and books. He deeply values the many associations with excellent colleagues and students that have made his pursuits in research, technology development, teaching and mentoring activities all the more worthwhile and satisfying.

Prof Sunil R Kale
Department of Mechanical Engineering
Indian Institute of Technology Delhi

Prof Sunil R Kale is an alumnus of IIT Delhi having completed his BTech in Mechanical Engineering in the year 1977. Thereafter, he joined Tata Consulting Engineers, Bangalore. He served at TCE from 1977 to 1980; the work was related to designing thermal power plant.

In 1980, Prof Kale joined Stanford University, California for his higher studies, obtaining MS in 1981 and PhD in 1984 both in Mechanical Engineering. His PhD research was on particle laden flows. Thereafter, he had a short stint with Hunter Geophysics, California in the mapping of massive hydraulic fractures in oil fields. In 1985, he joined the Department of Mechanical and Aerospace Engineering in West Virginia University as a research faculty. He conducted research on fluidized beds with the Fluidization Research Group. He also conducted research on single particle dynamics at the Morgantown Energy Technology Centre. These studies were related to coal utilization.

Prof Kale joined IIT Delhi in 1989 as an Assistant Professor in the Department of Mechanical Engineering. He was the Dean, Undergraduate Studies from 2006-2009. From 2012-15, he was the Head of the Department of Mechanical Engineering. Prof Kale's R&D interests are in the areas of heat transfer, fluid mechanics, particle-laden flows, energy conversions, combustion and fire dynamics. At IITD, he has taught and developed core courses at the UG level on Thermal Sciences, Energy Conversion, Heat and Mass Transfer and Design, Innovation and Manufacturing. In the Design, Innovation and Manufacturing students were introduced to design principles and innovation starting from need identification up to development of proof of concept product which was displayed in the Open House, IIT Delhi. At the PG level, Prof Kale, taught and developed courses on Experimental Methods for Thermal Engineering (core course) and Multi-phase Flows and Fire Dynamics and Engineering (electives).

He simultaneously taught entire courses on Power Plant Technologies and Experimental Methods in Thermal Engineering in three IITs - Delhi, Ropar and Mandi through NKN including of site visits to power stations. He has also delivered several lectures through the Quality Enhancement in Engineering Education (QEEE) programme on Engineering Drawing, Thermodynamic and Convection of Heat Transfer which have been adopted by engineering colleges across India.

In an ongoing effort, he is leading the development of the Mechanical Core laboratory to emphasis students to learn the science and engineering of experimentation. Prof Kale has carried out research on evaporative cooling, combustion fire dynamics and suppression, ceiling fan aero dynamics, aerodynamics for open-window bus and desert coolers.

He has been associated with TRIPP, IITD for over two decades, where he has conducted research on vehicular emission, bus ventilation and dust entrainment. Prof Kale along with Prof Anjan Ray, Department of Mechanical Engineering, have set-up a Fire Research Facility at IITD with funding received from Bhabha Atomic Research Center, Mumbai. They have also conducted research on water mist fire suppression in collaboration with Centre for Fire, Explosive and Environment Safety (CFEES), a DRDO laboratory. Some of the industries he has collaborated with for R&D include; BHEL, IGCAR, IGL, Dura Line, Usha International and Modern Foods.

Professor SR Kale is mentor Professor at IIT Mandi since 2009. He has been a member at several committees in DST, DSIR, CPCB and BIS.

News and views

Giving Wings To Ideas: FITT

The idea: The industry-interface organisation at IIT Delhi - Foundation for Innovation and Technology Transfer (FITT) - helped create a technology business incubator unit to facilitate research spin-offs, as also to provide a startup platform for new age businesses to leverage the technology expertise at the Institute. USP: "Ours is a developed ecosystem that nurtures technoentrepreneurship by providing end-to-end support solutions. It is a low cost proposition towards achieving their dreams," said Anil Wali, MD of FITT, IIT Delhi… **Source:** TOI, May 7, 2017

IIT Delhi ranked highest among Indian institute in QS world university rankings

As per the latest 'Quacquarelli Symonds (QC) World University Rankings', Indian Institute of Delhi has been ranked highest among other three Indian Universities. IIT-Delhi has jumped from 185 rank last year to 172 this time...

Source:
http://www.qs.com/rankings/

http://www.biospectrumindia.com/news/68/9041/iit-delhi-ranked-highest-among-indian-institute-in-qs-world-university-rankings.html

How IIT-Delhi is coming up with eco-friendly technologies to boost a sustainable environment

A nasal filter that can ease breathing problems, a three-wheeler running on hydrogen, and cement that has a lower polluting effect, all have a common target: protect our precarious environment from further degradation. Scientists at Indian Institute of Technology (IIT) Delhi are experimenting with new technologies, eco-sensitive devices and mapping pollutants to make our environment and ecological habitats sustainable... **Source:** ET, June 4, 2017

A robust IPR regime is necessary for growth

The good news is that intellectual property rights (IPRs) have greater public visibility these days. The bad news is that a lot of it is misguided scepticism.

IPRs are critical to incentivizing innovation, which, in turn, is key to sustaining economic growth and increasing living standards. Scholars around the world have found this statement to hold true based on rigorous empirical testing across a cross-section of countries and time periods… **Source:** Mint, May 2, 2017

IIT Delhi Has a New 3D Bioprinting Innovation & It Might Change the Future of Knee Surgeries

In a first for India, a team of scientists from IIT-Delhi has developed a 3D bioprinted cartilage that is remarkably similar to the natural ones seen in human knees…

Source:
http://www.thebetterindia.com/102746/iit-delhi-3d-bioprinted-catilage/

Technology Transfers @ FITT during 2017

- Biogas technology
- Magnetic capturing of rare cells
- Magnetic enrichment of magnetically marked cells
- Wave based illumination
- A bio-pesticide formulation for termite control
- Composition for enhancement of pathogenicity of Paecilomyces Lilacinus and uses thereof

FITT Footprint

Innovations

Opportunities for IP Licensing

S No	Title	PI/Dept/Centre
1	Method of scheduling of tasks in an IOT network	Prof SR Sarangi, CSE
2	A cell-penetrating peptide sequence	Prof A Chugh, KSBS
3	Molybdenum trioxide and nano silicon chips for acetone detection	Prof S Dhanikar, CARE
4	Compact coiled flow inverters as in-line mixers	Prof KDP Nigam, CHEME
5	A back to back DC-DC-PV battery isolated system to mimic inverter to drive daily appliances	Prof S Mishra, EE
6	Stimuli sensitive polymeric nanosystem for co-delivery of drugs and nucleic acids	Prof V Koul, CBME
7	Gasoline composition comprising alkyl levuliniates and process of making the same	Prof MA Haider, CHEME
8	Apparatus for measurement of heat transfer through thermal protective clothing	Prof P Talukdar, ME
9	System and method for engineering robust laser beams capable of propagating through random media with minimal distortion	Prof KB Khare, PHY
10	Versatile tangential flow membrane based separation equipment	Prof GP Agarwal, DBEB
11	System and method for reduction of torque ripple in double inverter fed wound rotor induction machine	Prof AK Jain, EE
12	Agrobacterium derived cell penetrating peptides as nanocarriers	Prof A Chugh, KSBS
13	Apparatus and process for fabricating natural fiber based flexible thermally bonded yarn for thermoplastic composite reinforcement	Prof R Alagisamy, TT
14	A medicament for the treatment of diseases by biofilm forming microorganisms	Prof Seyed Hasnain, KSBS
15	Larvae and egg detector	Prof R Bose, EE
16	3D printed construct for correcting bone defects and stem cell delivery	Prof S Ghosh, TT
17	Process for enhanced production of recombinant human serum albumin in E. Coli through chaperone assistance	Prof TK Chaudhuri, KSBS
18	Optimization of supplementary battery-assisted energy harvesting node	Prof S Prakriya, EE
19	A nano-adsorbent for removal of lanthanide ions from water and associated methods	Prof AK Ganguli, CHEM
20	A system and method for control and ripple reduction in SRIM based DFIG-DC generation system	Prof AK Jain, EE
21	Recyclable smart mesh for on- demand separation of oily water	Prof JP Singh, PHY
22	Redox flow battery system with improved energy efficiency and method of operating thereof	Prof A Verma, CHEME
23	Nanocomposite photocatalysts	Prof N Khare, PHY
24	A two-step process for extraction of essential oil and curcumin from turmeric rhizomes	Prof SN Naik, CRDT

An Improved Circuit Topology of Modular Multilevel Converter (MMC) for DC to AC Applications

Prof Anandarup Das
Department of Electrical Engineering
Indian Institute of Technology Delhi

MMC is an emerging multilevel converter topology. It has many interesting features which has attracted the industries and the academia. Major manufacturers are engaged in making commercial products (Siemens, ABB and Alstom). The key features of the converter are high degree of modularity, easy scalability in terms of voltage and current, fault tolerant operation due to its modular structure, simple realization of redundancy, transformer-less operation and a common dc bus operation.

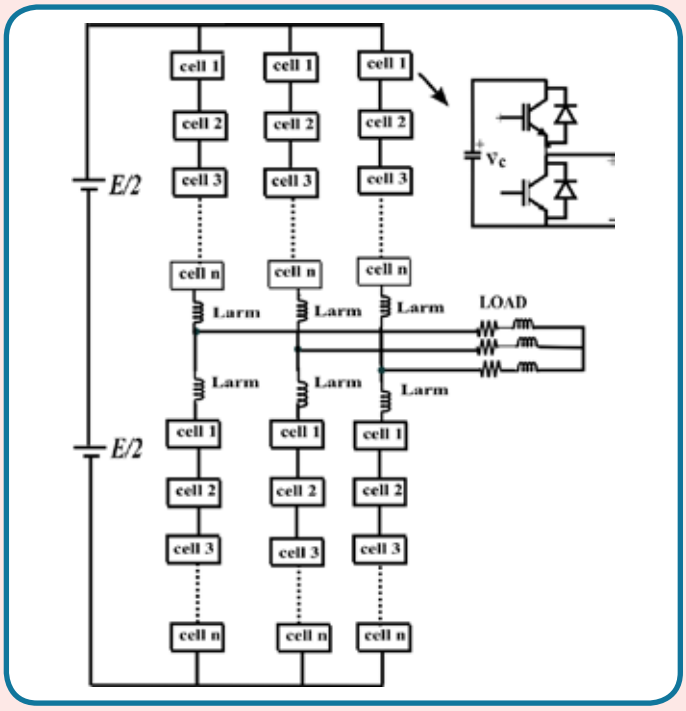

Figure 1: Conventional MMC topology

The conventional MMC topology for DC to AC application is shown in Figure 1. It consists of large number of power cells in cascade. Each power cell can be a half bridge or full bridge circuit consisting of IGBTs. These cells are arranged in groups called arm. Upper arms are connected to positive DC bus and lower arms are connected to negative DC bus. Cell capacitor is used as the energy storing element. The arm inductance (L_{arm}) is connected in series with both upper and lower arms. It is used to limit the circulating current due to instantaneous voltage difference in the cells.

In the proposed circuit topology (Figure 2), the upper arms are having several power cells in cascade and the series inductance (L_{arm}) like a conventional MMC. Each power cell is a half bridge circuit consisting of IGBTs. In lower arms, the power cells are replaced by parallel LC filters. There may be more than one parallel LC filter connected in series to adjust the voltage rating of the filter. In this work one filter is used. The parallel LC filter is tuned at the fundamental frequency. As such, they do not allow the fundamental load current to flow through it and allows the DC and harmonic component of arm current. The proposed circuit topology has the following advantages compared to the conventional MMC:

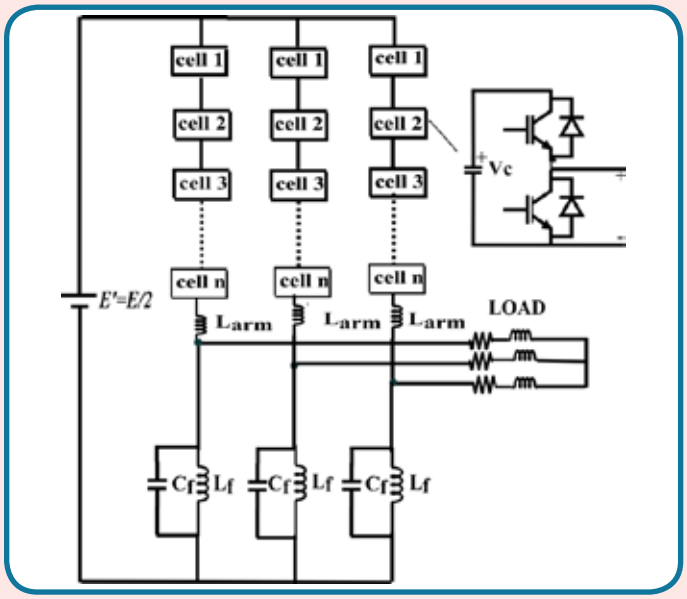

Figure 2: Proposed circuit topology

1. The three lower arms of conventional MMC are replaced by parallel LC filters (band stop filters). This means the number of power switches (IGBTs) are reduced to half with same voltage rating resulting in saving of associated control circuit, gate drive circuit and complexity of the system.

2. DC bus voltage magnitude is reduced to half to produce the same AC voltage as conventional MMC, thereby reducing the size and cost of the rectifier system at the input.

3. The output of the converter is a pure AC voltage without any switching harmonics, which reduces the requirement of filter at AC side or completely eliminates the filter at the AC side. This gives an additional advantage of having lesser number of power cells to produce sinusoidal voltage waveform at the converter output.

This proposed converter can be used as a general DC to AC converter in grid connected applications such as STATCOMs and UPQCs.

Method of Scheduling of tasks in an IOT Network

Prof Smruti R Sarangi, Ms Sakshi Goel & Ms Bhumika Singh
Department of Computer Science and Engineering
Indian Institute of Technology Delhi

The Internet of Things (IoT) is defined as the interconnection of various day-to-day physical devices through a network, thus enabling them to exchange information. These physical devices generally exchange real-time information, which may trigger an action by another physical device, hence, necessitating timely exchange. For example, if a camera connected to the internet is to be made to rotate through some angle, then the timing of the receipt of the message becomes important. If the message reaches the camera way before or way after the time when the rotation was actually needed, then there is no benefit that we get, but we may indeed incur some penalty instead. Energy consumption is an important factor in this scenario, as the number of devices getting connected to IoT networks is growing rapidly, thus generating the need for more powerful and energy hungry compute servers and gateways.

If sensors and the actuators are connected to a single node in an IoT network, then the widely used DVFS (dynamic voltage frequency scaling) technique can be used to reduce power. This involves changing the frequency and voltage of cores in the processor to reduce full system power consumption. With smart scheduling we can reduce net power consumption very effectively. However, if there are a multiplicity of nodes connected in series between the sensors and actuators, then to manage power consumption, it is necessary for the nodes to collaborate with each other.

Figure: (a) Network of IoT nodes

At the Department of Computer Science and Engineering, IIT Delhi, we have devised a mechanism for scheduling tasks associated with a certain deadline in a large IoT network. Each node in the network has multiple cores, and the main aim is to reduce power using DVFS without missing any deadlines. This is achieved by a novel method of passing messages between the nodes that execute the task, so that each node has some information about the amount of time the task would require to execute after leaving the current node. The node can then make appropriate decisions regarding the frequencies and voltages of its constituent cores.

Each node sends the information about the estimated time that a task will require to reach the actuator, including the time required for execution at the current node to the next node on the route. When a node (with a multicore processor) receives the packet, the core on which the task should be run is determined based on the time the task may have to wait in the core's EDF (earliest deadline first) queue and the frequency at which the core is currently operating. The remaining time (the total time available to execute the task) is calculated by taking into account the arrival time of the task, current time, deadline as well as the estimated time information received from the upstream node. The frequencies of cores are then adjusted based on the available slack time, thus reducing the energy consumption. Using this mechanism, we have achieved about 26% reduction in energy consumption in a network consisting of a 1000 sensors.

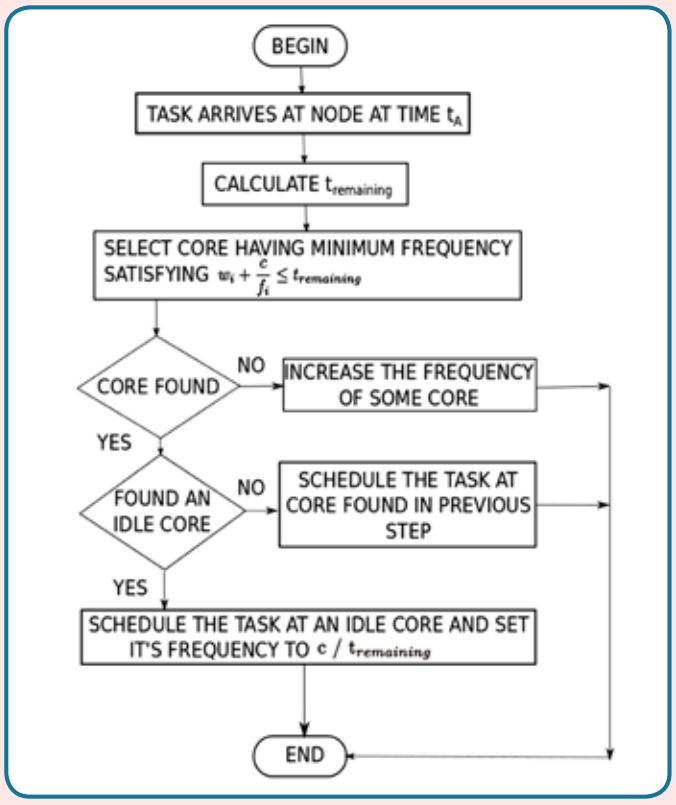

Figure: (b) Flowchart of the proposed mechanism

Some Examples of Development Projects @ FITT

S No	Title	PI/Dept/Centre
1	Characterization of biotech therapeutic products	Prof AS Rathore, CHEME
2	Advance on process of polyurethane foam manufacture	Prof R Khanna, CHEME
3	Advance for development of long-term monitoring techniques using underwater acoustic technology	Prof R Bahl, CARE
4	Stability tests of IITD developed catalysts and materials of constructions for HI decomposition reaction of SI cycle	Prof AN Bhaskarwar, CHEME
5	Separation of asphaltene from solid particles	Prof V Singh, CHEME
6	Development and demonstration of closed loop I-S process in all quartz/glass assembly	Prof S Upadhyayula, CHEME
7	Development and commercialization of biotech therapeutic products	Prof AS Rathore, CHEME
8	Micro-emulsion fuel towards sustainable energy	Prof AN Bhaskarwar, CHEME
9	Feasibility study of monolith reactor technology for process applications	Prof S Roy, CHEME
10	Measurement on chip inductor and development of equivalent circuit	Prof SK Koul, CARE
11	Air pollution status for north Indian cities	Prof S Dey, CAS
12	Investigation on strength loss of high tenacity polyethylene tape yarn in twisted configuration and 3 strand code	Prof R Chattopadhyay, TT
13	Face recognition tool	Prof B Lall, EE
14	Acoustic and structural analysis, design and detailing of a noise barrier boundary wall for Indira Gandhi International Airport (IGI), New Delhi	Prof V Matsagar, CE
15	Low carbon cement – Phase-II	Prof S Bishnoi, CE
16	Study of community design for traffic safety in India	Prof G Tiwari, TRIPP
17	Browning and odor prevention in biofillers using sacrificial compound	Prof S Saha, CPSE
18	Use of multivariate data analysis for process monitoring and improvements	Prof AS Rathore, CHEME

Corporate membership of FITT

FITT invites the industry/industry associations/R&D organizations 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.org

Professional Candidate Registration Programme

Applications are invited from qualified professionals working in industry and research organizations for a unique knowledge augmentation and skill enhancement programmes at IIT Delhi. This involves a semester-long registration for a regular PG course. Course fees ranges from Rs. 15,000/- to Rs. 20,000/- (industry professionals) and Rs. 6,000/- to Rs. 8,000 (academic/government personnel) for a 42 hour lecture course. In the case of a few selected courses, on-site course delivery using the two way audio-video link can be considered. All major disciplines of Science and Engineering, and also relevant courses from the Humanities, Social Sciences and Management streams which are being conducted at IIT Delhi are covered. The course detail can be downloaded from FITT website www.fitt-iitd.org. Eligibility: Degree in Engineering or Masters Degree in Science, Management or any other Post Graduate Degree with relevant industry experience. The two semester sessions in the academic year starts in the month of July and January, the exact dates being notified in advance. Contact: uttamaswal@hotmail.com, kirityroy@yahoo.com

Abbreviations

AM: Department of Applied Mechanics
BSTTM: Bharti School of Telecommunication Technology and Management
CARE: Centre for Applied Research in Electronics
CAS: Centre for Atmospheric Sciences
CBME: Centre for Biomedical Engineering
CES: Centre for Energy Studies
CRDT: Centre for Rural Development and Technology
CPSE: Centre for Polymer Science and Engineering
CE: Department of Civil Engineering
CHEME: Department of Chemical Engineering
CHY: Department of Chemistry
CSE: Department of Computer Science and Engineering
DBEB: Department of Biochemical Engineering and Biotechnology
DMS: Department of Management Studies
EE: Department of Electrical Engineering
HUSS: Department of Humanities and Social Sciences
IDDC: Instrument Design Development Centre
ITMMEC: Industrial Tribology
KSBS: Kusuma School of Biological Sciences
ME: Department of Mechanical Engineering
PHY: Department of Physics
TT: Department of Textile Technology

DID YOU KNOW?

1. When was the 1st scientific journal published?
2. What was the first graphical browser for the World Wide Web?
3. Which manufacturing company produced the first camera phone, that could send photos over a cellular network?
4. What was the first all-metal aircraft?
5. Who was first physician to perform a successful human bone marrow transplant in 1968?
6. Which is India's 1st organic state?
7. What was the 1st patent filed in India?
8. When did India's first I-T Act came into being?
9. With which organization did government of India signed agreement to construct new bridge across Ganga?
10. Who won the French Open 2017?

Answers

1. 1655
2. Mosaic
3. Sharp
4. J-1 Blechesel
5. Robert A. Good
6. Sikkim
7. An efficient Punkah Pulling Machine
8. 1860
9. Asian Development Bank
10. Rafael Nadal

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