“The common facts of today are the products of yesterday’s research”
- Duncan MacDonald

The philosophy behind the name…
You may notice that “AN” is smaller than other letters in the title. It signifies something important. GYANVESHAH is a name built by combining two words – GYAN and ANVESHAH (with the common AN being merged into one) with GYAN meaning knowledge, and ANVESHAH meaning search or pursuit. That brings us to the tagline “In pursuit of knowledge”.

GYANVESHAH

(IN PURSUIT OF KNOWLEDGE)
At Muthoot Institute of Technology & Science, initiatives are taken to motivate the students and the faculty/staff of the institute, to update the knowledge mapping with the emerging technology trends and to handhold them towards research aspects. This kind of effort has been put in order to adapt with the dynamic growth of science or technology. With this, everyone is encouraged to do academic or industrial research thus involving in innovation or development, and to use the knowledge for consultancy with the industries. Research & Consultancy cell of all disciplines are working together to achieve this goal. The R&C cell of this college also takes initiatives in publications in conferences/journals organising conferences, seminars and workshops.

The R&C cell is pursued with the following objectives:

- To promote undergraduate research
- To establish the research culture among faculty and thereby design and develop new technologies in their respective areas.

Research & Consultancy cell has the additional responsibility of recommending and forwarding the requests for attending workshops/STTPs/Seminars/FDPs to the higher authorities and also the recommendation for the reimbursement of fee for presenting papers/attending conferences.
Greetings from MITS R&C Cell! The second edition of our much awaited technical magazine ‘Gyanveshan’ is on course and we have made tremendous strides to bring this edition, filled with inspiration and information as intended. As we have started a new phase of our journey towards excellence after procuring the NBA accreditation in four branches with exemplary scores, it gives us immense pleasure and pride to announce the release of the second edition of ‘Gyanveshan’. The first edition of the magazine was excellent with respect to contents, varying articles and information updates on latest technologies. The decisive purpose of this magazine is to promote the research culture among the stakeholders of MITS, especially among faculty. Let me use this opportunity to congratulate and thank the authors for sharing their thoughts and knowledge through their enticing articles. Let me also use this opportunity to thank the Executive Director, Principal and Vice Principal for their boundless support to make this happen.

Dr. Abhilash Antony
Faculty Chair, R&C Cell
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Human Learning and Machine Learning – How they differ?

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Is there any similarity in learning process between humans and machines. Human learning process varies from person to person. Once a learning process is set into the minds of people, it is difficult to change it. But, in Machine Learning (ML), it is easy to change the learning method by selecting a different algorithm. In ML, we have well defined processes to understand and estimate the accuracy in learning. Estimation of human learning is usually done through examinations and it cannot be considered as a measure of intelligence. Let us examine the difference between human and machine learning process in detail.

Humans acquire knowledge through experience either directly or shared by others. Machines acquire knowledge through experience shared in the form of past data. We have the terms, Knowledge, Skill, and Memory being used to define intelligence. Just because you have good memory, it does not mean that you are intelligent. And just because you are intelligent, it does not mean you should have a good memory. However, there are exceptions to these rules. Humans begin learning by memorizing. After few years, he realizes that mere capability to memorize is not intelligence. Then he practices on transforming the data stored in memory to knowledge and applies them to develop skills to solve problems faced in real life. A person with good memory and more knowledge without the required skills cannot be considered intelligent. Search engines replaces human memory and these days the focus is on acquiring intelligence by making use of data available on the web. In humans, learning speed depends on individuals and in machines, learning speed depends on the algorithm selected, computing power, and the volume of examples used in training.

Skill is a manifestation of intelligence possessed by humans. And intelligence is the ability to apply knowledge. Human intelligence sustains, but his knowledge fades as new technologies emerge. Humans without knowledge in particular subjects can apply their intelligence to solve problems in new domains. But machines can solve new problems only if their intelligence has been updated with retraining on data acquired from the changed scenarios. This is a fundamental difference between human intelligence and machine intelligence.

Both humans and machines make mistakes in applying their intelligence in solving problems. In ML, overfitting memorizes all examples and an overfitted model lacks generalization capability and it fails to work on never seen before examples. In most of the Asian countries, the education system does overfitting of students by over coaching and tuitions on technical subjects enabling them to solve only example problems. These example problems are answered in examinations without need for applying intelligence. These students can solve the problems which they have already seen and they are not able to handle general problems properly with accuracy because their knowledge is not generalized. This is the major reason for missing skill levels among university recruits. In short, vast majority of students become overfitted learning models and their employability is in question.

In ML, Transfer Learning is a technique that reuses a model that was created by machine learning experts and that has already been trained on a large dataset. Transfer learning leverages information extracted from one set of distributions. In humans, transfer of knowledge to students is often done by teachers and tuition providers. This may not make the students intelligent. But in the case of machine learning, transfer learning makes the transferee as intelligent as the transferor. In the case of humans, transfer learning only transfers the knowledge and it depends on the inherent intelligence level of the transferee to enhance his/her problem solving skills. To summarize, overfitting is a curse to humans and machine learning systems. Machine intelligence is limited to the areas in which they are trained. But human intelligence is independent of his domain of training. An intelligent human being will be able to solve problems related to unforeseen domains, whereas a machine will not be able to do that.

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The Future of Learning: Post COVID Era

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The future of learning will be not only about content but also how it’s delivered. We need to focus on teaching students “how to learn” instead of just “what to learn.”.

The other day I was listening to a Talk show and analysis hosted by the indefatigable Prannoy Roy on NDTV. The show interestingly was hosted on the Cisco Webex platform and the participants included Nobel Laureates of the likes of Amartya Sen, Abhijit Banerjee, and eminent Professors of Economics from Harvard, Stanford and Cornell. Every other economist in the panel was harping on the maladies facing the world, post COVID and possible interventions the Govts should adopt in the short term as well as in the long term. The choice between lives and livelihood thus presents grim prospects for the road ahead. The CEO of Cisco, who was also part of the show, forecasted the future of work with new WFH (work from home) models emerging from the present lockdown; interesting pointers to better productivity, wider acceptance of emerging platforms like telemedicine etc.

From economics and work place to teaching and learning the scenario is no different. The coronavirus and ensuing lockdown currently in effect means that rethinking education is an existential challenge. Schools and universities are shut. Exams may be cancelled. At this moment of extreme peril, and in the spirit of turning crisis into opportunity, educators like us need to reimagine how to operate in a world of remote presence, social distancing and considerable economic stress.

In 2008, Clayton Christensen published “Disrupting Class: How Disruptive Innovation Will Change the Way the World Learns”, laying out his vision for how every type of educational institution would need to reshape itself for a hyper-connected world of hyper-personalized engagement.

That same year, the Khan Academy launched modern digital tools to upgrade ancient practices. Stanford University Computer Science Professor, Sebastian Thrun launched Udacity soon thereafter, following a revelation that the highest performing student in his class only ranked 148th when he made course work and an associated exam available online to anyone and everyone. Down the line there have been hugely successful stories of Andrew Ng and Coursera, edX, Udemy, Baiju’s, Unacademy to name a few...

It’s in this context that I came across two white papers recently; Cognizant Technology Solutions’ “Latest Thinking: Perspectives on the The ABCs of Learning for the Future to Work” and Accenture’s Techvision 2020: “We the post Digital People”. The Accenture white paper identifies 5 technology trends to watch out for: 1. Innovation DNA-DARQ technologies like Distributed Ledger, AI,

Extended Reality and Quantum Computing 2. Robots beyond controlled environments 3. Dilemma of Smart Things 4. AI and me or human machine interaction and 5. The ownership of data and experience

Cognizant’s Centre for the Future of Work surveyed top businesses and higher education institutions globally, to gain insight into the changes these entities are making in their training and educational programs, and the challenges they face in preparing tomorrow’s workforce.

Presenting in brief a few aspects of their detailed study carried out across 600 business executives and 260 Higher Education Institutes:

Wherever we work we’ll soon need to know how to collaborate with AI systems. While automation will eliminate some jobs, many more will be created or changed. For instance, welders, joiners and mechanics at German auto-parts maker Bosch have been trained in basic coding skills so they can use robots to assist them in their work.

Crucial questions include: How will we identify the most relevant skill areas? How can we overhaul our content and curriculum? How can we redefine our teaching and training approaches?

They have hence developed a future of learning equation that incorporates the elements of change required: skills identification, overhauled approaches to content/curriculum and training/teaching, and an environment supportive of self-learning. The speed at which these elements are executed will determine how effectively businesses prepare a workforce fit for the future of work.

I. THE FUTURE OF LEARNING EQUATION

The Future of Learning = (Skills + Content + Training / Self-learning) x Speed

Source: Cognizant Center for the Future of Work

Skills that make humans more human: Companies are increasingly placing a premium on job applicants who demonstrate skills like flexibility, self-motivation, empathy, resilience, creativity and communication capabilities, as they know “humaness” will become a competitive advantage when working with intelligent systems. Institutes that don’t consider real-world contexts can’t help students develop the competencies they need to be successful.

Robotics/AI skills to work intimately with intelligent systems: Business leaders and educators agree that AI/robotics skills will be critical in the future. However, not every individual will need to become a machine language expert. Two types of AI skills will emerge in the future: skills to build machines, and skills to collaborate with them. AI/robotics are becoming disciplines in themselves and are emerging as majors, minors, areas of emphasis, certificate programs and courses in many colleges and universities.

These courses need to be complemented with problem-solving components in order to produce workers who can use technology to address real-world problems.

Ethics to build trust with AI systems: Ethics will be important for the future of work. Machines being built today are unlike any built before, and nobody knows the possible unknown consequences that could result from intelligent machine failures or mishaps. There will be a need for highly-
skilled professionals to ensure the integrity, security, objectivity and proper use of intelligent machines.

The need to tweak STEM education: Institutes need to supplement their STEM streams with design thinking, entrepreneurship, creativity and social science skills. The seven top characteristics of successful Google employees were all human-centric: being a good coach, communicating and listening well, having empathy and being a good critical thinker, among others.

II. CONTENT – FROM STATIC TO DYNAMIC

Stop creating, start curating: To enable more continuous content updates, businesses and Institutes will need to see themselves more as curators of content rather than creators of content.

Skill-based curriculum is no longer a choice: One of the biggest challenges facing educators today is developing curriculum that is fit for both current and future jobs. Another way HEIs can address the curriculum issue is by complementing traditional degrees with badges and certifications from employers. The same approach can be applied to soft skills.

Textbooks will go Netflix: Students today learn differently from how their parents did. In a digital-only world, they will expect content that responds to them. AI-driven hyperpersonalization can help determine shortcomings and steer students to content that can quickly provide remedial help and mastery over time.

Training - invisible, immersive and personalized: Tomorrow’s learning experience will be more active, interactive and frictionless. A thoughtful combination of approaches will allow business leaders and educators to capture and reinforce deeper learning.

AR/VR will make learning immersive: By applying AR/VR technology to education, anything is possible: a room full of history students exploring the wreck of the Titanic, a group of medical students opening a heart to improve their comprehension, a class of astronomical students landing on the moon as astronauts.

Face-to-face training will become a thing of the past: While instructor-led, face-to-face training is still the number-one approach followed by businesses today, this technique will be reduced significantly in the next five years in favor of virtual training, e-learning and other online media.

AI the next giant leap in personalized training and learning: AI will help teachers break free from the one-size-fits-all approach and focus on learning that matters. For example, Deakin University in Australia has created a platform that combines chatbots, AI, voice recognition and a predictive analytics engine to create an intelligent virtual assistant that provides students with advice. AI assistants can also help teachers provide real-time feedback on students’ performance, strengths and weaknesses so that teachers can determine the exact skills gaps and learning needs of each student and provide supplemental guidance accordingly.

While AI will not replace teachers, it will guide them to be better educators.

The need for speed to accelerate the future of learning: Skills have become like mobile apps that need frequent upgrades. Large majority of educators are concerned about their ability to deliver learning with greater speed, agility and flexibility.

Self-learning: empowering people to take control of their learning: With the need for skill development more urgent than ever, businesses and educators are beginning to realize the importance of holding individuals responsible for staying relevant with changing skills demands.

III. CONCLUSION

To conclude, tomorrow’s learning experience will be more active, interactive and frictionless, and take place in an environment that transcends all barriers of the classroom and the world outside.

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Adopted from two white papers:

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A Very Short Introduction to Free Software

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IV. INTRODUCTION

For the past three years, Android Smartphone segment has maintained a steady global market share beyond 85 percent [IDC Smartphone Market Survey 2019]1. The remaining share of around 15 percent is held by iOS, a proprietary product manufactured by Apple Inc.

A near equivalent story can be seen from the global webserver market share, where Microsoft occupies only 17 percent share [Netcraft Survey Dec 2019].

The top line software products in both the cases cited above have Linux (Free Software) as their kernel software2 guaranteeing non-stop performance year after year. In many mission critical or banking applications, non-availability of service for a few minutes might be enough to even sink the business.

To appreciate why the world’s businesses and consumers prefer Free and Open Source Software (FOSS), one needs to analyse the principles governing Free Software.

V. LEVELS OF FREEDOMS

‘Free Software is about freedom, not price’ is a quote often repeated by Richard Stallman, founder and former President of Free Software Foundation, responsible for creating the laws that govern creation and subsequent maintenance of Free Software3. There are four levels of freedom that Free Software is guaranteed to respect.

At Level 0, is the freedom to use the software for any purpose. Both Free Software and Proprietary Software (non-free software) extend freedom to use it for any purpose to their users.

At Level 1, is the freedom to study and analyse the software, so that users can help themselves. Such a freedom is not available in proprietary software, as access to software sources4 is prohibited. Software sources remain with the developer of the product. In the case of Free Software, access to source code is extended to user, so that a professional user can even examine or inspect the code and convince themselves that the software doesn’t do anything that it is not supposed to do. Inserting spy-code that can work like a trojan horse to an unsuspecting user is not a difficult thing to do with proprietary software. Since a large section of public make heavy use of internet-based financial transactions, relying software applications to ferry login particulars between institutions, merchants or banks, it is very risky to repose complete trust with the underlying software.

At Level 2, is the freedom to copy and distribute copies of software. Sharing software helps to consolidate human relations with friends or neighbours. Such a freedom is not available with proprietary software. Sharing is an essential social trait that elevates human species from the rest. Its through sharing of knowledge that human race has progressed this far, and success of modern education itself is a glowing example. If sharing is prohibited, then a society would cease to make any tangible advancement. We would end up creating barriers to knowledge hampering progress, and end up having a skewed distribution of knowledge within people.

If you have an apple and I have an orange, and if we exchanged these, between us, we still have an apple and orange5. But if you have an idea and I have another idea and if exchanged these, both of us will have two ideas each6. This fundamental principle of unconditional sharing of valuable ideas had been ingrained in our society in the past. However, promoters of proprietary software want this habit to be stopped, through creation of artificial licenses which act as laws prohibiting sharing. A few proprietary software producers even label such acts of sharing software as piracy, equating software users to pirates at sea.

At Level 3, is the freedom to contribute and publish the software under the same conditions. With such a freedom, if you want to build further on an existing piece of free software, you will have such rights not only to contribute but also to release the amended software under same license conditions. Essentially a talented programmer or an institution can help the community through such acts of publishing. One can even mix software from compatible licenses and produce an entirely new software work - which is often identified as a hack7. Proprietary software doesn’t give access to software source, and hence, such a freedom cannot be imagined here.

VI. COMPARISONS

Its evident here that Free Software can be engineered and used, while non-free software can only be used. Engineering incorporates analysing, modifying or updating existing work. Android-OS can be engineered and used, while iOS can only be used. Octave or Scilab can be engineered and used, while Matlab can only be used. The distinction between engineering

1Source code of Android Operating System is periodically released by AOSP (Android Open Source Project consortium)
2The innermost software that does all the critical communication with the hardware accepting queries from higher layer applications and returning responses.
3The GNU General Public License (GPL) is a free, copyleft license used primarily for software. The GNU GPL allows users to change and share all versions of a program. GPL is provided through the Free Software Foundation, a nonprofit corporation that works to provide free software for the GNU Project.
4Source code used to compile and build the software product
5George Bernard Shaw who made this statement, was an Irish playwright, critic, polemicist and political activist who was very active during the last quarter of nineteenth century and the first half of twentieth century.
6Programmers capable of this art are called hackers, and are a respected lot in the software community. Some media houses erroneously identify those who crack proprietary software (crackers) with hackers.
a product and using it gets clear when we look at automobile sector. Expertise in using automobiles - imagine taxi drivers, here - for instance, cannot be equated to the skill of engineering an automobile. If an automobile engineer is limited to only roles of using an automobile, would it be professionally the right thing to do? If civil engineers are prohibited from studying an existing bridge or dam or a building, would it be professionally justified? To limit someone to a user-level activity may not be a crime in itself. But to limit an engineer to a user-level-activity certainly is a retrograde move. Such a move goes against conventional wisdom of professional education. It would be an action aimed at intellectually stunting a generation, and as members of academic institutions, we need to be cautious when we inadvertently step in the shoes of a proprietary software promoter.\(^7\)

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“Automated Water Level Monitoring and Management”- Transformation ‘4.0’

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I. INTRODUCTION

Dams and related water bodies of any country plays a vital role in the water resources management and directly contributing to the energy level management of particular provision. Also dams are having crucial role in the flood management system of the country. Most of the dams are constructed for more than one purpose and their benefits associated. It is necessary to implement some sort of communication between the metering systems and computer models to provide support in managing the complex systems of the hydro power plants. Generally, the dams are monitored through traditional surveillance techniques. While dealing with the traditional water level monitoring systems, gauging process is one of the most commonly adopted techniques across the world. Figure 1 shows the conventional gauge set up installed in a dam.

II. TRANSFORMATION OF CONVENTIONAL TO INNOVATIVE AND IMPLEMENTATION

A new system for dam water monitoring and management should be established which can provide water level in real time and can allow us to come to quick conclusions regarding the safety operations of the dams. The entire system consists of a set of sensors, communication networks and a cloud based software package.

During implementation each dam was considered as a single node and many such nodes lead to base station where the water levels and monitored. The ultrasonic sensor has to be interfaced with a micro controller through which information is relayed to the local base station. After gathering the information from ultrasonic sensors, the base station sends the data to the central command centre via cloud. The data from each base station is uploaded to the cloud and the central command center can check the real time water level using this data proper decisions are initiated from the concerned authorities. Figure 2 shows the schematic representation of data collection and data retrieval of the entire process.

The process of data transfer could be in various modes like short range communication, long range communication and far field communication depending on the distance to which the data required to transmit. Figure 3 represents the ultrasonic water level sensor components.

III. APPLICATION AND SCOPE

The suggested method will ease the process of water level management on a large scale. By installing a central command center we can reduce the manpower required for the system. Since this is a fully automated project, any kind of human intervention has been avoided and human errors are
eliminated in the system. During times of natural disasters like floods, this method will be very helpful as we don’t need to have any human to control near the actual site of the dam. Any command required for the gate opening closing can be given from remote center. This also reduces the response time as the water level data near command center is real time and the decisions are taken almost instantaneously.

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Compressed Sensing

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I. INTRODUCTION

Digital revolution is driving the development and deployment of new kinds of sensing systems with ever-increasing fidelity and resolution. Heart of this revolution is Analog-to-digital conversion (ADC) Any physical information can be converted into digital electrical signal, so that enabling digital processing by sophisticated software algorithms. Working of Analog-to-digital converter is purely based on Shannon–Nyquist Theorem. It says a continuous time signal, images, videos, and other data can be represented in its samples and can be recovered back when sampling frequency is greater than or equal to the twice the highest frequency component of message signal. Twice the highest frequency present in the signal of interest is known as Nyquist rate.

As a result of Nyquist theorem, the amount of data generated by sensing systems (samples) become too high. It is too costly, and physically impossible, to build devices capable of acquiring samples at the necessary rate. To overcome this difficulty, we often depend on compression, which aims at finding the most concise representation of a signal that is able to achieve a target level of acceptable distortion. Data compression is based on the principle sparse approximation. By a sparse representation, we mean that for a signal of length n, we can represent it with k << n nonzero coefficients; by a compressible representation, we mean that the signal is well-approximated by a signal with only k nonzero coefficients. Both sparse and compressible signals can be represented with high fidelity by preserving only the values and locations of the largest coefficients of the signal. This process is called sparse approximation. Sparse approximation forms the foundation of transforming coding schemes that exploit signal sparsity and compressibility, including the JPEG, JPEG2000, MPEG, and MP3 standards. [1][2]

II. CONCEPT OF COMPRESSED SENSING

Compressibility raises very natural question: “why go to so much effort to acquire all the data when most of what we get will be thrown away? Can’t we just directly measure the part that won’t end up being thrown away?”[3]. Great personalities Emmanuel Candès, Terence Tao and David Donoho gave answer of this question, which leads to the technology compressed sensing. This technology design compressed data acquisition protocols which perform as if it were possible to directly acquire just the important information about the signals/images – in effect not acquiring that part of the data that would eventually just be “thrown away” by lossy compression.

III. APPLICATIONS

Some of the recent applications of Compressed sensing listed out below.

A. Photography

Photography is one of the major milestones in the field of compressed sensing. Now we are taking Images with size of Mbs in mobile camera. When we sending the images using WhatsApp or any other methods, app will compress the image. If we are using Compressed sensing in the camera, then the digital photos can take with compressed data or less samples.

Compressed sensing is used in single-pixel cameras from Rice University.[4] Bell Labs employed the technique in a lens less single-pixel camera that takes stills using repeated snapshots of randomly chosen apertures from a grid. Image quality improves with the number of snapshots, and generally requires a small fraction of the data of conventional imaging, while eliminating lens/focus-related aberrations.[5]

Compressed sensing is used in a mobile phone camera sensor. The approach allows a reduction in image acquisition energy per image.[6]

B. Magnetic Resonance Imaging

Compressed sensing has been used[7][8] to shorten magnetic resonance imaging scanning sessions on conventional hardware. Compressed sensing addresses the issue of high scan time by enabling faster acquisition by measuring fewer Fourier coefficients. This produces a high-quality image with relatively lower scan time. Another application (also discussed ahead) is for CT reconstruction with fewer X-ray projections. Compressed sensing, in this case, removes the high spatial gradient parts – mainly, image noise and artifacts. This holds tremendous potential as one can obtain high-resolution CT images at low radiation doses (through lower current-mA settings).

C. Electrocardiogram (ECG)

Electrocardiogram (ECG) signals can be approximated by a linear combination of a few coefficients taken from a Wavelet basis, compressed sensing-based approach for ECG signal compression[9]. ECG signals generally show redundancy between adjacent heartbeats due to its quasi-periodic structure. This redundancy implies a high fraction of common support between consecutive heartbeats. Compressed sensing to exploit the common support between samples of jointly sparse adjacent beats.

IV. CONCLUSION

Nyquist rate is so high that we end up with far too many samples. So that hardware requirement becomes too costly, or even physically impossible, to build devices capable of acquiring samples at the necessary rate. To address the logistical and computational challenges involved in dealing with such high-dimensional data, Compressed sensing can be use. It requires a small number of non-adaptive linear projections of a sparse signal for error-free reconstruction of the original signal.

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Electrospinning is a fiber production method based on the application of electrical forces on a droplet of a polymer solution, ultrathin polymer nanofibers with diameters down to a few nanometers can be prepared using this technique. A broad range of polymers including polyamides, polylactides, cellulose derivatives, water soluble polymers such as polyethylene-oxide, polymer blends or polymers containing solid nano-particles or functional small molecules can be electrospun. A typical electrospinning setup (Figure 1) is mainly composed of a high-voltage power supply, a needle spinneret, and a grounded conductive collector.

Using various electrospinning techniques a wide variety of micro and nano materials can be produced, it includes nanofibers, nanobelts, Janus nanofibers, hollow nanofibers, coaxial nanofibers and coaxial ribbons. The main advantages of electrospinning are the simplicity and low cost of the processing system, the short time required to prepare continuous 1D structures and its versatility, enabling the production of fibers and membranes with a wide range of morphologies and materials.

Electrospun membranes has found wide application (Figure 2) in air filtration, oil water separation, water treatment, food and packing technology, protein adsorption, Waterproof and breathable clothing, sensors, carbon dioxide capture, super capacitors, Li-ion batteries and in biomedical field such as drug delivery, wound dressing and tissue engineering.

The developments of electrospinning technology have seen a dramatic increase over the last decade. Although the efforts taken in modifying and redesigning the basic electrospinning set-up with reference to the spinning techniques, the challenges in up scaling electrospinning are still a significant barrier. Leading materials companies works in the area of electrospun nanofibers attempting to address the challenges of productivity, profitability and environmental responsibility and have created new systems, adapted from conventional electrospinning, to mass produce nanofibre at higher rates. The only sector which extensively uses electrospun nanofiber for commercialised products is the air filtration membranes. However in the technology market, the potential of the nanofiber in other sectors is not explored much. To overcome this, as an initial step, it is essential for the nanofiber manufacturers to showcase the full potential of nanofibers in various diverse sectors to the global market as early as possible by collaborating with research organizations and academics. This collaboration is very much required during early stage development in order to avoid a significant amount of rework/redesign and additional costs to upscale the technology. There is no doubt that the electrospun nanofibers will emerge in more diverse shapes and sizes and will find its application in a variety of domains such as sound adsorption, battery applications and from cosmetics to catalysis.

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Embedded Earth Retaining Structure

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I. INTRODUCTION

Effective and productive utilisation of underground space is essential to meet modern day demands of infrastructural development. Tunnels, water pipelines, underground transports, etc. demand constructions deep below the ground level. Of the various solutions available, diaphragm walls are considered as an ideal solution to meet this requirement since it provides rigidity and structural stability. Selection of appropriate wall and support configurations has substantial impact on economy, time and performance. Unsatisfactory implementation of such retaining systems during or after construction may cause heavy causalities. Practical significance of excavation induced deformations is large due to its potential damage to adjacent structures. Hence, reliable estimates of excavation related responses are vital for construction and implementation of diaphragm wall projects.

II. TYPES OF DIAPHRAGM WALLS

Diaphragm walls are one among the various embedded retaining walls used in practice like; steel sheet piles, king post wall, contiguous broad pile, secant pile wall, etc. These are generally reinforced concrete walls with thickness varying from 500 mm to 1500 mm. Its depth can go up to 50 m. The types of diaphragm walls are: i) conventional reinforced concrete diaphragm walls, ii) precast panel diaphragm walls and iii) post-tensioned diaphragm walls. This is also categorised as: structural walls, load bearing walls and cut off walls. The construction processes of diaphragm walls include trench excavation, slurry filling, concrete tremieing, reinforcement cage installation, etc.

Even though, diaphragm wall is the most appropriate solution for deep excavation, it is not much utilized in the cities of our country. The specifications illustrated in the various national codes are used for the design, analysis and detailing of diaphragm walls. IS: 9556-1980 R2003 is the Indian code giving specifications for the design and construction of diaphragm walls. But, in this code the details regarding the analysis, design and methodologies are not adequate. The dynamic load effects are also not considered. Therefore, advanced studies are required for incorporating the missing parameters in the analysis and design of diaphragm walls.

III. METHODS OF ANALYSIS

Depending on the nature and complexity of the project, any of the three methods mentioned here can be used for the analysis of embedded retaining structures like diaphragm walls. They are: i) classical methods, ii) beam on elastic foundation method and iii) finite element method. Cantilevered and single propped walls can be analysed using classical methods. Anchored walls can also be analysed using this method with certain assumptions. The classical methods are comparatively easier and quick to compute. Beam on elastic foundation method is applied by assuming the wall as flexible and resting on an elastic medium like soil. Finite element method is the advanced and powerful method used for the analysis of diaphragm walls. This method can provide better predicitions for bending moment and deformations. Soil structure interactions can be accurately modelled using this method.

IV. DESIGN AND DETAILING

It is mandatory to use IS: 456-2000 for the design of all the reinforced concrete structures and the code of practice for diaphragm walls, IS: 9556-1980 also specifies the same for the design of diaphragm walls. The axial load – moment interaction diagrams are used to determine the reinforcement quantities. The reinforcement cages are designed to span vertically without structural continuity between wall panels. Main retaining wall (diaphragm wall), guide wall, crown beam, horizontal strut, wale, end brace, corner brace and centre post are the components to be designed. The design considerations of these components are adequately specified in IS: 9556. The details of diaphragm wall are given in Fig. 1.

V. CONCLUSION

Diaphragm wall is an embedded earth retaining structure. The application and use of diaphragm walls are explained in this article. Even though it is an important structure to retain earth in deep excavations, the inadequacy of the Indian national code for the analysis, design and detailing of diaphragm walls are discussed. The existing methods for the analysis and the design of the walls are also mentioned here. It is necessary to conduct studies on the parameters which influences in the design of diaphragm walls and has to be incorporated in the national code.

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Estimation of Distribution Algorithms (EDAs), also known as Probabilistic Model Building Genetic Algorithms (PMBGAs), incorporate probability into heuristic search procedures and are relatively new developments in genetic and evolutionary computation research [1]. They exploit a feasible probabilistic model built around superior solutions so far found within the problem domain. The basic steps in EDAs are as follows:

1. Select superior candidate solutions from an initial randomly generated population.
2. Estimate the probability distribution from the selected solutions.
3. Generate new candidate solutions or offsprings from the estimated probability distribution.

It may be noted that the steps (2) and (3) differentiate the EDAs from genetic algorithms by replacing the crossover and mutation operators. EDA creates a probabilistic model of the sampled population and the new generation is based on this model. The main challenge faced by EDA is how to estimate an accurate distribution and thus create a probabilistic model that can represent the structure of the given problem effectively.

I. THE GENERAL EDA PROCEDURE

Estimation of distribution algorithms (EDAs) [2, 3, 4] are a set of relatively new algorithms that explore the solution space by sampling the probabilistic model constructed from the favourable solutions evolved till now. They are considered to be variants of genetic algorithms in which the reproduction operations, crossover and mutation are replaced with probabilistic sampling. EDAs belong to the class of population-based stochastic optimization algorithms. As in other population-based algorithms, the EDAs also start with an initial random population sampled from the set of all permissible solutions. The members of the population are then ranked according to their fitness value - higher the fitness, better the solution. The subset of most promising solutions is selected from this ranked population using a selection operator. Then the algorithm constructs a probabilistic model from the selected set of promising solutions. The new set of solutions for the next generation is sampled from this model and the algorithm repeats until the termination criterion is satisfied and returns the best solution found over the generations. The common termination criteria adopted are a maximum number of iterations, homogeneous population, or lack of improvement in the solutions for a certain number of iterations. Figure 1 shows the flowchart for general EDA.

II. UNIVARIATE MODELS

The easiest way to estimate the probability distribution to represent the promising solutions selected from a population is to assume that the variables of the problem are independent. Thus, the probability distribution of any variable in the problem should be independent of the values of all other variables. The EDA which assumes no dependence between the variables is called univariate EDA and is represented in Figure 2. Consider a candidate solution \( X = (x_1, x_2, \ldots, x_n) \) of a problem. In the univariate model, the probability of \( X, \pi(X) = \pi(x_1) \times \pi(x_2) \times \ldots \times \pi(x_n) \), where \( \pi(x_i) \) is the probability of the variable \( x_i \). The main univariate EDAs are the univariate marginal distribution algorithm, the population-based incremental learning algorithm and the compact genetic algorithm (5, 7).

Based on this general procedure, researchers have developed a number of different algorithms for various categories of optimization problems. The basic categorization of EDAs is done based on the complexity of the probabilistic models demonstrating the relationship between the variables. The broad categories of EDAs consist of univariate, bivariate and multivariate models. There are multiple algorithms in each of these categories and a short review of them is given in the succeeding subsections. The different aspects of EDAs have been studied by many and can be obtained from the works of Hauschild and Pelikan [5], Ceberio et al. [6], Pelikan et al. [7] and Santana et al. [8].
III. BIVARIATE MODELS

The algorithms discussed in the previous sections perform very well for problems where the interactions between the variable is less. But most of the real-life problems have variables which are interdependent. These algorithms fail for those problems in which the independence assumption is not valid. In many cases, the second order statistics is sufficient to represent the interdependencies among the variables. The algorithms explained in the following subsections are established on the concept of pairwise dependencies. The different models of the bivariate EDAs are represented in Figure 3.

IV. MULTIVARIATE MODELS

The tree-based bivariate models are sufficient to solve problems with bivariate interactions between variables. But in many real-life situations, the tree-based models are insufficient to represent the model interactions as there exist multiple or highly overlapping dependencies between the variables. In multivariate EDAs, the probability distribution model developed should be of the order two and hence the complexity of the probabilistic structure is high. As a result, the computational effort required to find the structure is also greater. Figure 4 represents the graphical models of some popular multivariate EDAs [5].

REFERENCES


Innovate for Efficiency: The Industrial Blueprint for Energy Savings

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Do you know that almost half the world’s energy is used for industrial activity? Growing urbanization and rapid development have created demand for new roads, buildings and homes, household goods, automobiles and the like. All these use steel, cement and chemicals which are energy-intensive products. In 2017, the industrial sector used half the world’s electricity and as much energy as consumed jointly for residential use and transportation.

While power is imperative for development, countries such as India need to strike a balance between making energy affordable and accessible to a growing population while at the same time bringing down energy costs through greater efficiency in operations and reducing the environmental risks associated with it.

I. PAT: Trading Energy Surplus for Shortfall

The Perform, Achieve and Trade (PAT) scheme launched by the Bureau of Energy Efficiency (BEE) (Govt. of India, Ministry of Power), which ran its first cycle from 2011-2014, was a step in the right direction to make industries energy-efficient. It focused on eight industries – thermal power plants, fertilizers, cement, aluminium, pulp and paper, iron and steel, textiles and chlor-alkali – all of which are known energy guzzlers.

Each of these were assessed and given energy-reduction targets. At the end of the three years, those who over-achieved the targets were awarded Energy Saving Certificates (ESCerts), which translate into 1 metric tonne of oil (MTOe).

Industries that were unable to meet their reduction targets had to purchase ESCerts from the achievers to meet their excess demand. The Indian Energy Exchange (IEX) created an online trading mechanism to enable this trading of energy surplus and shortfalls. The first cycle, itself, resulted in energy savings of 6.68 MTOe by the end of 2014-15.

II. Why India Needs New Energy Technologies

The energy sector is the largest source of GHG emissions globally and can, therefore, play an imperative role in bringing these levels down and slowing down the process of climate change. Reducing the ecological footprint of businesses is even more crucial for countries like India, where, according to World Bank data, the pressure on natural resources including water, air, soil and forests is expected to be the highest in the world by 2020. This is primarily because India has one of the highest densities of economic activities in the world, due to which a large percentage of the population relies on natural resources for their livelihoods.

The need of the hour is to innovate cleaner energy technologies which boost industrial productivity while reducing carbon footprint.

III. The Big Savings Case Study

Energy giants such as ExxonMobil have helped industry leaders such as Bhushan Power & Steel, JK Cement, Dalmia Cement and Apollo Tyres reduce their energy consumption by deploying the right kind of technological interventions in their processes. These solutions range from a shift to low-carbon fuels to using energy-efficient lubricants like the Mobil SHC Elite Series, Mobil SHC 600 Series, Mobil DTE 10 Excel series, Mobil SHC Pegasus 30 among others. Additionally, industry heavyweights can also look at solutions like vacuuming CO₂ from the atmosphere using the Global Thermostat solution, cogeneration, carbon capture and storage technology.

About 60% of machine failures are attributed to poor or improper lubrication practices. A recent study by Massachusetts Institute of Technology (MIT) estimated an annual loss of $240 billion across industries in the USA due to downtime and repairs needed in machinery because of poor lubrication.

Lubricants play an important role in machine reliability and preserving its functions because they form a guard layer between machine components like gears, bearings and engines to protect them from severities of use such as extreme temperatures and corrosion. They are regular additives in the process of machine functioning.

A leading steel manufacturer, Bhushan Power and Steel Limited (BPSL) has four plants located across the country. During an assessment of the hydraulic system at BPSL’s Jharsuguda plant, which was running on a zinc-based oil, it was found that several valves had failed due to high temperatures and continuous running. This led to annual productivity losses of approximately 180 tonnes.

Experts from ExxonMobil’s Field Engineering Services (FES) offered a solution in the form of high-performance hydraulic oil, Mobil DTE 10 Excel 46 and patented used-oil analysis process, the Mobil Serv Lubricant Analysis (MSLA) to enhance productivity and improve the efficiency of the hydraulic system. The switch to the new lubricant led to an increase of hydraulic efficiency by 3.2% and annual savings of about INR 73,68,197 as the productivity jumped by 180 tonnes per year.

Additionally, CO₂ emissions were also recorded to have plummeted by 34 tonnes a year, which led to a marked improvement in the company’s carbon footprint.

“The results that Mobil DTE 10 Excel 46 delivered for BPSL has demonstrated our technology leadership which has not only enabled a high degree of equipment protection but also eliminated servo valve failure, improved efficiency and led to savings,” said Shankar Karnik, General Manager Industrial, ExxonMobil Lubricants Private Limited.
As the world looks towards new technologies to reduce carbon emissions, it’s up to industry leaders to find innovative ways to counter the environmental costs of progress and development. And making industrial processes technologically advanced, energy-efficient and policy-focused is a significant leap in that direction.
“Whatever nature has in store for mankind, unpleasant as it may be, men must accept, for ignorance is never better than knowledge.”

— Enrico Fermi

Nature has in store the solutions for a lot of our problems. Love the nature and spend time to study and analyse the nature of nature, and then its mysteries will slowly unfold before you giving answers to many of our unanswered questions!

Natural computing, also called as natural computation, embraces three classes of methods: 1) those that take inspiration from nature for the development of novel problem-solving techniques; 2) those that are based on the use of computers to synthesize natural phenomena; and 3) those that employ natural materials (e.g., molecules) to compute [1].

Natural phenomena as diverse as self-replication, the functioning of brain, Darwinian evolution, group behaviour, the immune system, cell membranes, morphogenesis and much more have all inspired the development of different computation models. These include cellular automata, neural computation, evolutionary computation, swarm intelligence, artificial immune systems, membrane computing and amorphous computing [1]. A major subset of natural computation which relies heavily on the fields of biology, mathematics and computer science is termed as Bio-inspired Computing [2].

Concept of cellular automaton was originally discovered in the 1940s by Stanislaw Ulam and John von Neumann while they were contemporaries at Los Alamos National Laboratory [3]. Way back in 1970, the British mathematician John Horton Conway devised a cellular automaton ‘The Game of Life’ very popular even today. It theoretically has the power of a Universal Turing Machine: anything that can be computed algorithmically can be computed within Life [4]. Cellular automaton can be used for computer processors, cryptography, error correction coding and in the simulation of a variety of real-world systems including biological and chemical ones [3].

Artificial neural networks (ANN) are computing systems that are inspired by, but not necessarily identical to, the biological neural networks that constitute a brain. Such systems "learn" to perform tasks by considering examples, generally without being programmed with any task-specific rules, the first of its kind being modelled in 1943 by Warren McCulloch and Walter Pitts. ANNs have been used on a variety of tasks, including computer vision, speech recognition, machine translation, social network filtering, playing board and video games and medical diagnosis [5].

Evolutionary computation is a family of algorithms for global optimization inspired by biological evolution, and the subfield of artificial intelligence and soft computing studying these algorithms. The use of evolutionary principles for automated problem solving originated in the 1950s. Evolutionary programming introduced by Lawrence J. Fogel, evolution strategies by Ingo Rechenberg and Hans-Paul Schwefel, genetic algorithm by John Henry Holland, and genetic programming are considered sub-areas of evolutionary computation [6].

Swarm intelligence (SI), introduced by Gerardo Beni and Jing Wang in 1989, is the collective behavior of decentralized, self-organized systems, natural or artificial. SI systems consist typically of a population of simple agents or boids interacting locally with one another and with their environment. Examples of swarm intelligence in natural systems include ant colonies, bird flocking, hawks hunting, animal herding, bacterial growth, fish schooling and microbial intelligence. The use of swarm techniques for controlling unmanned vehicles, planetary mapping, interferometry, data mining, telecommunication networks, crowd simulation etc. is being investigated. The application of swarm principles to robots is called swarm robotics [7].

Artificial Immune Systems (AIS) are a class of computationally intelligent, rule-based machine learning systems inspired by the principles and processes of the vertebrate immune system. The algorithms are typically modelled after the immune system's characteristics of learning and memory for use in problem-solving. AIS emerged in the mid-1980s with articles authored by Farmer, Packard and Perelson (1986) and Bersini and Varela (1990) on immune networks. The common techniques include clonal selection algorithm, negative selection algorithm, immune network algorithms and dendritic cell algorithms [8].

Membrane computing (MC) is an area within computer science that seeks to discover new computational models from the study of biological cells, particularly of the cellular membranes. It is a sub-task of creating a cellular model. MC deals with distributed and parallel computing models, processing multisets of symbol objects in a localized manner. The model was first conceived by Gheorghe Păun in 1998 [9].

A colony of cells cooperates to form a multicellular organism under the direction of a genetic program shared by the members of the colony. A swarm of bees cooperates to construct a hive. Humans group together to build towns, cities, and nations [10]. Amorphous computing, introduced at MIT in 1996, is the development of organizational principles and programming languages for obtaining coherent behavior from the cooperation of myriads of unreliable parts that are interconnected in unknown, irregular, and time-varying ways [11].

A few of recent bio-inspired algorithms are: Genetic Bee Colony (GBC) Algorithm, Fish Swarm Algorithm (FSA), Cat Swarm Optimization (CSO), Whale Optimization Algorithm (WOA), Artificial Algae Algorithm (AAA), Elephant Search Algorithm (ESA), Chicken Swarm Optimization Algorithm (CSOA), Moth flame optimization (MFO), and Grey Wolf Optimization (GWO) algorithm [12].
REFERENCES

Abstract—Luminescent solar concentrators (LSC) are panels made of polymers which are doped with fluorescent dye or quantum dots. In space limited urban areas where deploying solar cells on large scale is inconvenient, LSC panels can be installed on vertical structures to collect maximum solar radiation. These structures which collect solar radiation, guide the light towards the edges of the panel where solar converters are located. Solar converters for large scale deployment make use of photovoltaic or nano-antenna technology. Here, the nano-antenna technology has the advantage of being able to work in night hours by making use of infrared radiation re-emitted by earth. It is possible to increase the efficiency of LSC by employing novel approaches which makes use of stimulated emission. In this way, LSC can increase the share of solar energy use in urban areas.

Keywords—Solar radiation, photovoltaics, nano-antennas, luminescent solar concentrators

I. INTRODUCTION

With depletion in oil and gas reserves, and global warming caused due to increasing use of fossil fuels, major economies of the world are opting for renewable energy to meet a share of their energy needs. Solar radiation is a major source of renewable energy. Researches on solar cells are continuing to increase the efficiency of these devices. With over one kilowatt of radiation falling per square meter, this is a major resource to be tapped for energy requirements of the future. The energy produced by a photovoltaic device depends on the intensity of light falling on it. Devices which can increase the intensity of light before it falls on a solar converter are called solar concentrators. There are various types of lens and mirror structures which can concentrate light towards a solar converter. Alternatively, large panels spread over a wide area can be used for collecting light. These panels known as luminescent solar concentrators (LSCs) or fluorescent solar collectors (FSCs) are glass or plastic panels doped with fluorescent material [1]. These panels which are attached to walls or roofs of buildings collect light and guide them by total internal reflection towards the edges of panel where the solar cells are located. This method of light collection is found to be useful for increasing the efficiency of the installed system since the costly solar cells are used wisely to increase the power production capacity of the system. In this paper, the role of luminescent solar concentrators in solar power generating system is considered.

II. PHOTOVOLTAICS

Solar energy can be converted into electricity by various means. Considering the economic aspect of conversion, it is worthwhile to consider two technologies which have the potential for scaling up – photovoltaics and nanoantennas. In photovoltaic effect, a potential is developed across dissimilar materials when electromagnetic waves incident on it. After the semiconductor revolution in 1950s, silicon based p-n junction solar cells turned out to be the most commonly employed photovoltaic cell. Fig. 1 shows the basic structure of a p-n junction solar cell. Here, the n region is very thin compared to p region. This design allows the light falling on the n region to reach the p-n junction. There the photons interact with lattice atoms to create electron-hole pairs. Due to the presence of depletion region, the electrons created drift towards n region, whereas the holes created drift towards p region. In this way, a solar cell is able to produce a potential difference across the n and p regions. When an external circuit is connected, the electrons follow through it to produce a current. The amount of current generated is proportional to intensity of light falling on the solar cell. So, it is essential to increase the intensity of light falling on the solar cell to draw maximum current from it. In next section it is shown that luminescent solar concentrators can be used for achieving this goal. To reduce the light lost by reflection, the front surface of the solar cell is having an antireflection coating. The front surface also contains ohmic contact in the form of fingers to draw current. This design helps to retain the light falling area of the solar cell by allowing minimum obstruction. Solar cells are connected together to form solar panels which generates enough power to run electric devices. The power produced from a solar cell is DC whereas most of electrical appliances run on AC. Due to this reason; DC is converted to AC using an inverter before it is supplied to an appliance.

III. NANO-ANTENNAS

Just like antennas which operate in microwave and radio wave frequencies, it is possible to construct antennas which operate in infrared and visible regions of electromagnetic spectrum. These antennas which are considerably smaller in dimension are known as nano-antennas (abbreviated as nantennas). The alternating current generated from nano-antennas should be converted to direct current before it can be stored in a battery. For conversion from AC to DC, a rectifier (diode) is attached along with the antenna. This combination of antenna and diode is usually referred to as rectenna. Nano-antennas can be connected together to generate enough power required for running electric devices. An array of square spiral
nano-antennas which can serve this purpose is shown in Fig. 2. The central part of nano-antenna consists of a metal-insulator-metal (MIM) diode [2]. This diode whose operation is based on quantum mechanical tunneling offers faster rectification which is required in optical frequency ranges. Compared to photovoltaics which operates only during daytime, nano-antennas designed for infrared frequency ranges can also operate during night by making use of long-wave infrared (LWIR) radiation emitted by earth. In this way, nano-antennas offer a viable technological front for round-the-clock energy harvesting. Moreover, compared to photovoltaics which have a maximum efficiency of 30%, this technology has slated a theoretical conversion efficiency of 100%. Efforts are under way to make use of this technology to transform heat energy wasted into electricity.

In order to rectify the drawbacks of LSC, novel approaches are being adopted. In one such effort, stimulated emission is used to reduce reabsorption. In this technique, a diode laser is used to overwhelm the spontaneous emission process in favor of stimulated emission. The laser diode has emission corresponding to the emission peak of the dye molecule in LSC. When solar radiation falls on the LSC, the efficiency can be significantly increased if the emission is stimulated. The laser diode acts as a mediator here for converting the process from spontaneous to stimulated emission. Since stimulated emission produces coherent radiation, the intensity is very high. This helps in increasing the efficiency of LSC. A part of the output power from the solar cell can be used for working of the laser diode which makes the system self-sufficient [3].

IV. LUMINESCENT SOLAR CONCENTRATORS

From an economical perspective, light harvesting becomes effective only when large areas are covered for solar energy conversion. It is not cost-effective to deploy solar converters for large areas since it requires a lot of money. An alternative would be the use of luminescent solar concentrators. This device consists of panels made of plastics such as PMMA which is doped with fluorescent dyes or quantum dots. When solar radiation falls on these panels, fluorescent dye is excited which results in fluorescence emission. Due to the presence of air medium outside, a part of fluorescent radiation which undergoes total internal reflection reaches the edges of the panel where solar cells are located. These transparent panels which can collect solar radiation from large areas such a vertical structures of buildings are useful for making solar power economical. Based on band gap of the luminescent material, the color of the panel will be different. This adds to aesthetic appeal as for collecting light from different parts of solar spectrum. Schematic representation of the working of LSC is shown in Fig. 3. Due to small Stokes shift, that is, the separation between absorption and emission peaks, fluorescent dyes have the disadvantage of reabsorption of emitted light. Though quantum dots are able to overcome this limitation, their quantum yields, are not appreciable. Efforts are underway to increase the quantum yield and Stokes shift required for a suitable LSC material.

V. CONCLUSION

With increase in energy demand, major economies of the world are considering solar power for meeting a part of their energy needs. For converting solar energy into electricity, the technologies employed should have considerable efficiency to compete with fossil fuels. Two widely adopted scalable technologies which supports in this regard are photovoltaics and nano-antennas. As of now, the cost of solar power is quite high when compared to non-renewable energy. This can be considerable reduced by deploying luminescent solar concentrators. These planar structures doped with fluorescent dye or quantum dots have the ability to concentrate light towards solar converters located at the edges of the panel. Compared to solar converters, these polymer structures can be manufactures inexpensively at a fraction of the cost. Moreover, they can be installed in vertical structures in urban areas to collect maximum solar radiation from the available space. In this way, this technology will be useful for adopting solar power in a big way by reducing the cost of installing solar cells.

REFERENCES

The two major schools of thought in financial market for analysing and forecasting the future trends in a stock price is Fundamental analysis and Technical analysis. In fundamental analysis securities are evaluated by measuring the intrinsic value of a stock. Fundamental Analysis helps to ‘Predict the future value of a business based on its current and historical financial data, gauge a company’s performance against its competitors and determine if a company’s credit standing is in jeopardy’[1]. Technical analysis is a tool which can be used to forecast the probable future price movement of a security such as a stock, commodity, indices or a currency pair based on the data of price action over a period of time.

The fundamental analyst researches on vital details starting from the economic and industry perspective to the financial health and transparency of the management. Vision, business model, motivation, earnings, expenses, assets, and liabilities of the companies are all aspects looked into by fundamental analysts. Some tools used in fundamental analysis are Earnings per share (EPS), Price to Earnings ratio (P/E), Debt to Equity ratio, Dividend yield, Return on Equity (ROE) etc[1]. EPS indicates the profitability of the company, higher its value the higher the profitability. Stocks with higher growth forecast will have higher P/E and vice versa. ROE indicates the ability of a company to generate profits from shareholders equity. These financial ratios of a company must always be compared with another in the same industry to know the prevailing values[6]. Thus, by cross examining the balance sheet of a company and analysing the fundamentals of a company will help an investor to make appropriate investment decisions.

The very existence of technical analysis is on the belief that the past or current price action in the market is the most reliable indicator of future price action. A technical analyst always believe that price is influenced by the forces of supply and demand and tries to identify these zones for a potential trade opportunity. As put forward by Dow, the basis of technical analysis is based on the following assumptions, (a) Price discounts everything, (b) Price movements follow trend and (c) “How” is more important than “Why”. [7]

The movement of price can be pictorially represented using graphical method by plotting charts. There are numerous chart styles such as line chart, bar chart, area chart, candlestick charts, Heikin Ashi charts, Renko etc[2]. Each type of chart provides different information on the aspects of price movement. The fundamental step to be taken by a technical analyst is to develop the ability to read charts of a security ‘‘in the right manner’’. The analyst with the right view will be rewarded by the market and rest will lose. Yes! It’s a challenge to decipher the movement of the underlying very precisely and “how” turns out to be a million-dollar question to many. Like in any profession this requires hard work, practice and skill. The story can not only be seen but also visualised as it unfolds, once interpretation of the price and volume action is learnt.

In technical analysis there are various ways for price predictions and forecasting. Some of them are trend analysis, proper identification of chart patterns [5], use of technical indicators, Fibonacci retracements, momentum indicators, demand and supply zones etc. In this article some of the technical analysis tools will be discussed in charts with examples of stocks/ commodity traded in the exchange. The examples will justify the potential a good technical analyst has to possess so as to reap benefits from the market on buying/ selling a security at the right time.

Technical Indicators - Technical indicators are mathematical or heuristic calculations based on the price, volume, or open interest of a security or contract. Some of the common technical indicators include the moving averages, Relative Strength Index (RSI), Stochastics, Price Rate of Change, moving average convergence-divergence (MACD), ADX and Bollinger Bands. A moving average (MA) is a lagging indicator in technical analysis that helps smooth out price action by filtering out short-term price fluctuations [4]. Figure 1 shows a trade set up based on moving averages, volume and breakouts for the scrip Reliance Industries. The price action for nearly 5 years is shown. The chart itself is self-explanatory with zones for buy and sell marked within.

![Fig. 3. Candlestick chart of Reliance Industries](image)

Globally investors have always shown affinity towards gold for both investment and ornamentation. Fig 2 shows the Gold chart traded in the exchanges and study is done using MA and ADX[3,4]. Good knowledge of understanding this will enable an investor to buy, sell or accumulate Gold at the right time.

To conclude in layman terms, the shares of the company with good earnings and quality management will be bought and retained but shares of bad companies will be dumped. The price action is a tug of war between the bulls and bears of the market. It is also backed by human psychology – greed and fear, one of the primary forces driving the market. The price
movement of a stock is dependent on numerous factors and the two methods discussed in this article have been devised to forecast the future price based on two different perspective. It might have been convinced by now that the supremacy of the two schools of thought will be a live debate among its believers. How much ever they analyse, traders are superstitious believing that ‘Market is Supreme’!

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Indian power sector is facing challenges related to unreliable and ageing grids, increase in demand in proportion to population explosion, renewable sources integration and carbon footprint. Rural electrification is a major area of concern for a developing nation like India. A solution to meet the said challenges is distributed generation on a decentralized mode. They can also be used to develop cleaner, sustainable and efficient energy to the people, especially to grid isolated areas. The power sector in India is dominated by thermal power stations, mainly coal fired, which account for about 70% of the generated electricity. The Indian energy sector has a centralized system with mostly fossil generation. The centralized grid is not reliable in most parts of the country. Electricity Supply Monitoring Initiative (ESMI) by Prayas Energy group provides analysis reports of grid outage statistics across various urban and rural locations across the country (“Prayas Energy Group”, 2017). This database shows an average 35 and 39 hours of power interruption in Bengaluru and Kampur in the month of May 2017. Rural areas have a higher rate of grid outage. Outskirts of Maharashtra state experienced an average 49 hours of grid outage in May 2017. Coal fired and thermal power plants are the main sources of centralized power for the country. The huge power plants are installed far away from the load points. Generated power is carried through heavy rated transmission lines with ancillary services like transformers and substations. The transmission network is usually operated at 33 or 66kV and the distribution network consists of 11kV feeders. These feeders carry power to the load points such as urban and rural areas, villages and industries. At the load points, transformers are installed to reduce 11kV to 415 V or 240V depending on the requirement of three phase or single-phase supply. The power which reach the rural areas suffer transmission losses, due to the large line length and thereby cause decrease in efficiency. Grid reliability is another major issue in rural areas. These factors force the rural community to detach from the centralized network. In case of grid extension options, there will be high capital outlay.

Decentralized microgrids help improve the reliability of the grid. They are a combination of distributed energy sources, storage units and loads. Distributed energy sources can be a combination of one or more renewable sources with fossil power like diesel generator. They have a clearly defined electrical boundary. They can operate in grid dependent, grid back up or isolated mode. Microgrids can be classified on the basis of mode of operation, type, generation source, operating scenario and size. Microgrids using solar and wind resources with battery storage is a viable option for power shortage, especially for rural electrification. Moreover, implementation of microgrids will open up options for grid exchange for grid connected systems when there is excess generation. Such systems can find secondary applications in Electric Vehicle Charging stations to increase sustainability factor. A detailed classification of microgrids is shown in Fig.1 below.

Rural electrification is a major task in India as many parts of the country still don’t have access to grid power. There are many small and medium enterprises in the country which have focused their investment to microgrids, thereby improving the living conditions in the rural sector. The concept of solar PV Minigrids was started in the 1990s in the Sunderban Delta region in Sagar Island, West Bengal. The solar power plant with 25kW (Peak) was established in 1996 by WBREDA. Thereafter, mini-grids connected to solar PV, biomass or small hydro, have been implemented in various states, notably Bihar, Chhattisgarh, Lakshadweep, Madhya Pradesh, Odisha, Uttar Pradesh, Uttarakhand and West Bengal. Depending on their capacity, mini-grids provide electricity for households, small commercial activities, for community requirements such as the supply of drinking water, street lighting, vaccine refrigeration, and schools. In 2001, there were about 25000 remote villages in the country which cannot be connected by grid. Renewable energy based minigrids or stand alone systems are to be used for the electrification of the remote villages, though many of them have been connected to grid, with advancements in technology.

The two most successful models of mini-grids implemented by government agencies in India are those implemented by WBREDA and CREDA. The private sector has also been implementing variants of mini-grids in many states. The private companies operate mainly in villages where there are supply-constraints from the grid due to inadequate generation.

The following sections brief the important micro/minigrids in the country.

A. West Bengal Renewable Energy Development Authority (WBREDA)

WBREDA has set up more than twenty mini-grids based on solar power plants with an aggregated capacity of around 1 MWp supplying stable and reliable electricity to around 10,000 households in West Bengal. The average size of each power plant is 25-100kW (peak). The energy provision is 2-5 light points x 11W CFL and fan point. The supply duration is 5-6 hours a day. The details of the proposed expansion of the Sunderban Minigrid implemented by WBREDA are tabulated in Table 1.

<table>
<thead>
<tr>
<th>TABLE I.</th>
<th>SUNDERBAN MINIGRID CONFIGURATION</th>
</tr>
</thead>
</table>

Micro / Minigrids in India

Jani Das,
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<table>
<thead>
<tr>
<th>Technology Used</th>
<th>Installed Capacity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Power Plant</td>
<td>300kW</td>
<td>Serving more than 1500 consumers</td>
</tr>
<tr>
<td>Solar Home Lighting</td>
<td>3200 kW</td>
<td>6000 Nos serving about 30000 consumers</td>
</tr>
<tr>
<td>Bio Mass Gasifier</td>
<td>1000kW</td>
<td>Serving around 1000 consumers</td>
</tr>
<tr>
<td>Wind farm</td>
<td>1000kW</td>
<td>Grid Connected</td>
</tr>
</tbody>
</table>

B. Chattisgarh State Renewable Energy Development Agency (CREDA)

CREDA, on the other hand, has electrified around 35,000 households across more than 1400 villages and hamlets with low capacity (1-6kWp) solar mini-grids in Chhattisgarh. The project is publicly supported and the first plant was commissioned in 2004. And presently it supports over 1439 villages & hamlets serving about 35,000 households. The energy provision is 2x11W CFLs and the supply duration is 5-6 hours a day.

C. Husk Power Systems, Bihar

Husk Power Systems (HPS), a company based in Bihar, has electrified around 300 villages and hamlets since 2007 through establishing 80 plants, benefitting nearly 200,000 people. The total aggregate generation capacity is more than 3 MWe. In addition to the biomass gasification units, HPS is also reportedly covering un-electrified households in their operational areas through solar DC Minigrids. Each system serves about 400 households and commercial users for 6-8 hours daily using a three phase 220 V system. The hybrid minigrid consisting of Biomass Power Plant of 32kW and a solar power plant of 5kW was set up at Tamkuha, West Champaran District, Bihar which has 1100 households with a population of 5400.

D. Mera Gaon Power

Mera Gaon Power is again another example of an innovative business venture by the private sector providing low-cost micro-grid power solutions to rural India. The company is based in Uttar Pradesh and is solar PV based. It has 120-800 W (peak) rated units which charges 15000 households. The supply duration is 7 hours/day. The emphasis of Mera Gaon Power is to provide service-specific micro-grids designed to meet the lighting and mobile charging requirements of rural people totalling to a power requirement of 4W per household.

VI. CONCLUSION

Microgrids are emerging technologies for catering to power shortage problems. They are long term solutions for the carbon footprint and limited fossil fuel reserves in India.
My Research Journey Experience!

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I. PRELUDE

It is a challenging task to explain a ‘technical content in a non-technical way’. With the intent to keep this article interesting, I have only glimpsed through my research journey in as much as possible non-technical way. I hope it is entertaining and useful for the readers.

To begin with, ‘What is research?, ‘How to go about research?’ are the few questions that will haunt everyone who enter this domain. Incidentally, even I didn’t know it at the beginning of my research program. One of the senior member in the interview panel told me, ‘Research is not doing any project or make any product. Research is your own contribution of an idea or thought to the existing technical knowledge base’. Though got selected for the research program, I came out of the hall wondering how am I going to contribute to the ‘existing technical knowledge base’.

‘To identify the problem is the biggest problem in a research’ – a friend of mine quoted this line when I was returning to my research lab after lunch. Hearing this, my thoughts went on as below, ‘When there are no problems, why the hell identify one and find a solution’. Then I took a pause. ‘No, this is not the way I think. This will lead me no where’. I re-oriented my thoughts in a constructive way. ‘To identify a problem in a technical area, I need to know that area/field thoroughly. So I need to credit all the courses related to that area/field and so on ...’. With such confused and muddled thoughts, I entered my Guide’s cabin that day. Looking at my disturbed state of mind, he told me, ‘Research is nothing but a rigorous intellectual exercise’. His words truly lightened my heart. Because I concluded, ‘Research is not adding anything to the existing knowledge base’ or ‘identifying a problem’, rather ‘Research is just some exercise’ – felt relieved. I made up my mind and body for the rigorous intellectual exercise that I have to undergo and blindly followed my guide.

II. THE APPROACH TO RESEARCH

My guide was very unique not only in the way he related with us, but also to the whole process of research, as such. With all respect and reverence for my guide, I would like to share his approach and methodology towards research which is memorable here. Although I credited only 3 of his courses, (to know about the research area/field) under him in the first semester, I experienced the burden of crediting double the course work (6 courses) in that semester. Such were his assignments. Every week, there will be surprise quizzes at the end of the lectures. The quiz sessions used to extend into our lunch hours. No escape possible. Invariably my marks in all the quizzes used to be zero always. It will also be displayed on the notice board along with all other students’ marks outside my guide’s cabin. The highest mark in the list will be ‘1’ or ‘2’. Few intelligent tech geeks in the class would have scored that mark. You might wonder, ‘If quizzes are such severe what about the end semester exams?’ Time, memory and food were never a constraint in our end semester exams.

How? Time is always indefinite. I remember writing exams from 5pm to 3am. I heard in later sessions students have reached up to a whole day (24 hours) of writing exam. Memory - no need to remember anything. As my guide’s exams are always open book exams. Also, no need to worry about food, as there will be plenty of supply of tea, samosas and dinner packs at regular intervals during exams. As always, the air conditioned environment ensures that students don’t fall asleep with all the above said comfort, rather squeeze their brain to find the answers to the questions asked.

Whenever we go down in our energy levels, our guide used to rejuvenate us by giving regular dinners and taking us for outings like cinema, tours etc. On the other hand, in the technical front, other than the credit courses, he will engage us in long technical meetings in the evenings. We were given full freedom to debate and express our views in that forum. Every day evening there will be discussions on research papers published in top class technical conferences. Our guide made us interact with the top tech Gurus of our field all over the world by inviting them to our place at regular intervals. By doing all this, my guide made us all feel that we have a technical family to cater to constantly, other than our personal families.

Finally, I would say, the weeklong tough assignments, everyday technical inputs and presenting research papers frequently by making slides, proposing and defending our ideas in front of eminent stalwarts’ across the globe etc., helped me in identifying a problem more quickly than expected. Proposing the solution and establishing the environment to validate the proposal took the remaining time.

III. MY ACTUAL RESEARCH

I shall explain my research very briefly here. Interested readers may refer the thesis for the nitty-gritties.

We all know that, within the past few decades our electronic devices (for eg. Mobile, PCs) have been continuously shrinking in size with its functional capability and complexity growing up steadily. This is mainly due to the scaling down of the CMOS devices which are the basic building blocks of any electronic unit. As a result, reliability is emerging as a critical concern for manufacturers. One of the major contributions for the reliability threat is what is called ‘soft error’ or ‘transient fault’.


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A. What are Soft Errors?

Soft errors or transient faults are caused when the voltage level of a digital signal is temporarily disturbed by an unintended mechanism such as radiation, thermal or electrical noise. Whenever high energy particles usually neutrons hitting the silicon layer of an integrated circuit, leaves a cylindrical track of electron-holes pairs as shown in Figure 1. The resultant ionization track traverses or comes close to the depletion region of a digital gate, and the electric field rapidly collects the charge carriers at the gate’s node. Due to this, there can be a flip in the logic value of latches or logic storage structures from ‘0’ to ‘1’ or ‘1’ to ‘0’. This can lead to temporary inaccuracies in the data computations occurring within the processor and results in a single-event upset (SEU). As the name suggests, transient faults do not cause permanent damage to the chip. If a soft error is detected, it may be corrected by rewriting correct data in place of erroneous data.

B. Proposed Solutions

Two fault tolerant architecture solutions were proposed for the current day processor design and evaluated to combat soft errors in them.

The first solution is a microarchitectured solution called REMO that combines the best features of space and time redundancy shown in Figure 2. Here, every instruction that runs on the processor is re-executed. The result of re-execution is compared with the original execution result of each instruction at regular intervals. If there is any mismatch between the two results due to bit-flip of soft error, then the fault recovery routine is invoked.

This provides very high fault coverage at very low performance penalty. As hardware inclusion needed for the proposed processor architecture is very less, it introduces extremely low power consumption overhead and area overhead to the system, despite redundancy. Also it has very low error detection latency.

The second solution is a hybrid approach called REMORA that combines the best features of hardware (architectural level) and software (application level) approaches of fault tolerance shown in Figure 3. Here, along with the hardware modification, the code that runs on the processor hardware is also tampered to insert signatures in them. These signatures are dynamically generated in the hardware and compared the software signatures inserted. If there is a bit-flip due to soft error, it will result in the mismatch of the signatures and the error recovery routine is called. The issue of unprotected code is alleviated completely in the software approach.

IV. CONCLUSION

Finally, with a gleam on my face, I conclude that, I identified a problem namely soft error, proposed a solution (REMO & REMORA) and contributed my thought to the existing knowledge base (REMO has 6 citations so far). Also, in the end, did a rigorous intellectual exercise validating my results and completed my research work. Thanks to my guide in particular and all others who were involved in this process, for showing me the way.
Nanomaterials are well suited for water purification, disinfection and wastewater treatment applications as they have a large specific surface area, high reactivity, high degree of functionalization, size dependent properties, affinity for specific target contaminants, etc. Membranes and filters synthesized using nanomaterials have selective permeability, good flux rates, increased durability, reliability in purification and reusability, and thus are energy saving and cost effective. Several nanomaterials with size of less than 100 nm include magnetic nanoparticles, heterogeneous nanophotocatalysts, and polymeric nanoparticles.

The unique properties of nanoadsorbents such as small size, catalytic potential, high reactivity, large surface area, ease of separation, and large number of active sites for interaction with different contaminants make them ideal adsorbent materials for the treatment of wastewater. Even though numerous methods are available for the removal, adsorption technique offers high flexibility in design and operation thereby generating high quality treated effluent. Due to their strong magnetic properties, magnetic nanomaterials act not only as an adsorbent to remove target compounds from contaminated water, but also as a magnetic element to attract and retain the nanoparticles, which can be removed from solutions. This magnetic separation, which may replace centrifuge separation technologies, has less complicated technical requirements and low regeneration cost, thus making adsorption treatment economically attractive for industrial users.

Nanofiltration is a high-pressure membrane treatment process which is highly efficient in the removal of organic and inorganic substances, bacteria and viruses and the need for subsequent disinfection of water is minimal. Nanocatalysts can effectively be used for chemical oxidation of organic and inorganic pollutants in water in advanced oxidation processes based on formation of highly reactive radicals that react easily with pollutant molecules forming less toxic substances, or converted into ecologically acceptable final products.

Materials like chitosan, silver nanoparticles, titanium dioxide, fullerene nanoparticles, carbon nanotubes, etc. have excellent adsorption and catalytic properties proven with great antimicrobial activity as well. These nanomaterials are mild oxidants and are relatively inert in water, without any creation of harmful by-products. Zerovalent iron (nZVI) nanomaterial is proven to be a highly efficient technology for the removal of various organic and inorganic pollutants, including chlorinated solvents, pesticides, nitroamines and nitroaromatics, organophosphates, inorganic anions, arsenic, uranium, numerous metals, etc. due to its low production costs, positive environmental effects, and high reactivity with contaminants, high mobility with porous medium, appropriate life span and negligible harmful effects. Their nanostructure allows them to act as colloids during the remediation of contaminated groundwater.

Materials in nano size range exhibit distinct properties and effective process parameters because of the large number of particles, high surface area to volume ratio, specificity for pollutants, magnetic separation, and surface interactions. Nanomaterials often exhibit some special properties, such as a surface effect, small size effect, quantum effect, and macro quantum tunnel effect. These properties contribute to their extraordinary adsorption capacity and reactivity, both of which are favorable for the removal of heavy metal ions. Application of nanoparticles is gaining attention in wastewater treatment. Recent studies suggested that nanosized metal oxides exhibit high sorption to heavy metal ions due to high capacity and selectivity which results in the complete removal of heavy metal ions. Nanocomposites over many metal compounds have high toughness, high specific stiffness, high specific strength, gas barrier characteristics, flame retardancy, corrosion resistance, low density, and thermal insulation and are extensively used for waste water treatment.

REFERENCES

The University of Queensland Australia researchers set a world record for the conversion of solar energy to electricity via the use of tiny nanoparticles called quantum dots that can produce electricity even during cloudy and wet weather conditions [2]. The new class of quantum dots is flexible and printable. Professor Wang and team [1] achieved near 25 percent improvement in efficiency over the previous world record. This opens up a huge range of potential applications, including the possibility to use it as a transparent skin to power cars, planes, homes and wearable technology. Eventually it could play a major part in meeting the United Nations’ goal to increase the share of renewable energy in the global energy mix. Conventional solar technologies use rigid, expensive materials whereas quantum dots are semiconductor particles with typical diameter of 2–10 nm which pass electrons between one another and generate electrical current when exposed to solar energy in a solar cell device. The development represents a significant step towards making the technology commercially-viable and supporting global renewable energy targets.

I. A QUANTUM DOT SOLAR CELL

A quantum dot solar cell (QDSC) is a solar cell design that uses quantum dots as the absorbing photovoltaic material [3,4]. It attempts to replace bulk materials such as silicon, copper indium gallium selenide (CIGS) or cadmium telluride (CdTe). Quantum dots have bandgaps that are tunable across a wide range of energy levels by changing their size. This property makes quantum dots attractive for multi-junction solar cells, where a variety of materials are used to improve efficiency by harvesting multiple portions of the solar spectrum. In a conventional solar cell, light is absorbed by a semiconductor, producing an electron-hole pair; the pair may be bound and is referred to as an exciton. This pair is separated by an internal electrochemical potential (present in p-n junctions or Schottky diodes) and the resulting flow of electrons and holes creates electric current. The Shockley-Queisser limit, which sets the maximum efficiency of a single-layer photovoltaic cell to be 33.7%, assumes that only one electron-hole pair (exciton) can be generated per incoming photon. Multiple exciton generation (MEG) is an exciton relaxation pathway which allows two or more excitons to be generated per incoming high energy photon. In traditional photovoltaics, this excess energy is lost to the bulk material as lattice vibrations (electron-phonon coupling).

Quantum dots (QD) can be made from tiny crystals of semiconductor material, around 10 nanometers in size. The electron-hole pairs in this structure are confined, resulting in a quantization of energy levels analogous to those of an atom. Hence quantum dots are often dubbed ‘artificial atoms.’ Like an atom, a QD’s energy levels can be manipulated using lasers and magnetic fields. The fluorescing wavelengths can be tuned by altering the crystal size. Semiconductor quantum dots are attractive for quantum information processing because the technology for integration with modern electronics already exists.

They are so named because, due to their nanoscale size, quantum effects play a significant part in their light emitting properties. Quantum dots emit light via this mechanism: under external stimulus, some of the electrons of the dot material absorb sufficient energy to escape their atomic orbit. This creates a conductance region in which the electrons can move through the material, effectively conducting electricity. As these electrons drop back into atomic orbit, energy is released in the form of light, the color of which depends on the amount of energy released.

Quantum dots are semiconductor nanoparticles that glow a particular color after being illuminated by light [5]. The color they glow depends on the size of the nanoparticle. When the quantum dots are illuminated by UV light, some of the electrons receive enough energy to break free from the atoms. This capability allows them to move around the nanoparticle, creating a conductance band in which electrons are free to move through a material and conduct electricity. Many semiconductor substances can be used as quantum dots, such as cadmium selenide, cadmium sulfide, or indium arsenide. Nanoparticles of these, or any other semiconductor substance, have the properties of a quantum dot. In normal solar cells, a photon of light generates one electron. Experiments with both silicon quantum dots and lead sulfide quantum dots can generate two electrons for a single photon of light. Therefore,
using quantum dots in solar cells could significantly increase their efficiency in producing electric power.

Although quantum dot solar cells have yet to be commercially viable on the mass scale, several small commercial providers have begun marketing quantum dot photovoltaic products. Investors and financial analysts have identified quantum dot photovoltaics as a key future technology for the solar industry.

REFERENCES

Almost 2 billion people updating their status 293,000 times per minute showcase the amount of data, “Big data”, generated from social media. Extracting values from these unstructured data was a tedious task. Deep learning architectures help to train machines to learn and classify data by themselves. Websites and applications which help users to create and share data in a public network contribute towards the title social media. Most popular social media sites like Facebook, WhatsApp, Instagram, Twitter and Pinterest can be analysed effectively using deep learning architectures. Social media analysis opens a path towards combining data from different platforms and then extracting useful information or creating decisions based on that. Main terminologies used under the term social media includes social network analysis, big data, dynamic networks etc.,

Social media [1] can be classified based on criterions like video sharing, photo sharing, blogging, friendship and professional. Role of deep learning in social media data analysis can be classified into mainly 4 areas like user behavior analysis, business analysis, sentiment analysis and anomaly detection. Above areas are represented diagrammatically by Fig:1 in a detailed manner. Applications or problems can be implemented through framework specific to deep learning. TensorFlow, PyTorch, Sonnet, Keras and MXnet are all popular deep learning frameworks. A major part of Facebook’s deep learning technology is built on the Torch platform, a development environment concentrated on deep learning technologies and neural networks.

Deep learning is a subfield of machine learning technique that evolved after machine learning, which trains computers to behave like humans: learn from experience. Deep learning models can ensure accuracy, sometimes more than human-level performance. Resources such as big data as training and test dataset and model such as neural network as training model helps to achieve high level of accuracy, Most well-liked deep learning architectures includes Deep Belief Network, Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), Auto-encoder, Restricted Boltzman Machines and Deep belief networks.

Applications which are more specific to social media data analysis and deep learning are described below.

**How much are we exposed to alcohol in electronic media? Development of the Alcoholic Beverage Identification Deep Learning Algorithm (ABIDLA) [2]:** ABIDLA provides screening of all kinds of electronic media for images of alcohol. With the help of specifically developed software, three coders annotated 57,186 images downloaded from Google. Complemented by 10,000 images from ImageNet,

**Knowledge of words: An interpretable approach for personality recognition from social media [3]:** Personality qualities can be easily recognized by examining the contents of user-generated text.

**A deep learning approach for detecting traffic accidents from social media data[4]:** Traffic accidents can be detected using social media data.

**Using a combination of human insights and ‘deep learning’ for real-time disaster communication[5]:** Though social media requests may help save lives, these posts are hard to find due to noise on public social media than clear signals of who needs help. VGG-16 convolutional neural network/multilayer perceptron classifiers are used for classifying the importance and time period for a given image.

**Analysis without DL:**

Social media data analysis without intelligence always results in a slow process. Intelligence produces accurate results through powerful methods.

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Sonopill: A miniature robot that could check colons for early signs of disease

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Abstract—Engineers have shown it is technically possible to guide a tiny robotic capsule inside the colon to take micro-ultrasound images. Known as a Sonopill, the device could one day replace the need for patients to undergo an endoscopic examination, where a semi-rigid scope is passed into the bowel—an invasive procedure that can be painful.

Keywords—Sonopill

I. INTRODUCTION

Known as a Sonopill, the device could one day replace the need for patients to undergo an endoscopic examination, where a semi-rigid scope is passed into the bowel—an invasive procedure that can be painful.

Micro-ultrasound images also have the advantage of being better able to identify some types of cell change associated with cancer.

The Sonopill is the culmination of a decade of research by an international consortium of engineers and scientists. The results of their feasibility study have been published on June 19th in the journal Science Robotics.

The consortium has developed a technique called intelligent magnetic manipulation. Based on the principle that magnets can attract and repel one another, a series of magnets on a robotic arm that passes over the patient interacts with a magnet inside the capsule, gently manoeuvring it through the colon.

The magnetic forces used are harmless and can pass through human tissue, doing away with the need for a physical connection between the robotic arm and the capsule.

An artificial intelligence system (AI) ensures the smooth capsule can position itself correctly against the gut wall to get the best quality micro-ultrasound images. The feasibility study also showed should the capsule get dislodged, the AI system can navigate it back to the required location.

Professor Pietro Valdastri, who holds the Chair in Robotics and Autonomous Systems at the University of Leeds and was senior author of the paper, said: "The technology has the potential to change the way doctors conduct examinations of the gastrointestinal tract."

"Previous studies showed that micro-ultrasound was able to capture high-resolution images and visualise small lesions in the superficial layers of the gut, providing valuable information about the early signs of disease.

"With this study, we show that intelligent magnetic manipulation is an effective technique to guide a micro-ultrasound capsule to perform targeted imaging deep inside the human body.

"The platform is able to localise the position of the Sonopill at any time and adjust the external driving magnet to perform a diagnostic scan while maintaining a high quality ultrasound signal. This discovery has the potential to enable painless diagnosis via a micro-ultrasound pill in the entire gastrointestinal tract."

Sandy Cochran, Professor of Ultrasound Materials and Systems at the University of Glasgow and lead researcher, said: "We're really excited by the results of this feasibility study. With an increasing demand for endoscopies, it is more important than ever to be able to deliver a precise, targeted, and cost-effective treatment that is comfortable for patients.

"We hope that in the near future, the Sonopill will be available to all patients as part of regular medical check-ups, effectively catching serious diseases at an early stage and monitoring the health of everyone's digestive system."

II. SONOPILL

The Sonopill is a small capsule—with a diameter of 21mm and length of 39mm, which the engineers say can be scaled down. The capsule houses a micro ultrasound transducer, an LED light, camera and magnet.

A very small flexible cable is tethered to the capsule which also passes into the body via the rectum and sends ultrasound images back to a computer in the examination room.

The feasibility tests were conducted on laboratory models and in animal studies involving pigs.

Diseases of the gastrointestinal tract account for approximately 8 million deaths a year across the world, including some bowel cancers which are linked with high mortality.

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Trigonometry Based Rational Approximation to Pi

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Abstract—Pi is a well-known irrational number because of its popular application in geometric use cases of circles, spheres, etc. A common approximation is given in the form of 22/7, which is easy to use, but not based on any trigonometric principles. Here, a series of trigonometric principles are used to create an approximation that will result in Pi being represented as a rational number. The same is verified for accuracy at different levels of approximation.

I. INTRODUCTION

Pi is a value commonly used to find the circumference, area, and volume of spherical bodies. It is represented by the value approximated as 3.1415926535897932384626433, and it is not directly representable as a rational number. A popular rational representation is 22/7, which computes to 3.14286. We attempt to generate a proper approximation based on a number of trigonometric results.

II. BACKGROUND

One of the earliest approximations for Pi was proposed by Archimedes, which was based on polygon approximation. The general approach taken is given in Figure 1.

The advantage of having polygons as an approximation is that we can measure the length of each edge in a much better fashion, compared to a circle which has infinitely many points. We extend the same concept to a more precise measurement.

III. APPROXIMATION TO POLYGONS

The approximation works by breaking the circle to sectors, and joining the endpoints of sectors to form polygons. The edges can then be added up to get the circumference.

The general organization is as in Figure 2.

In Figure 2, the section ABDCA forms a sector with angle \( \alpha \). Segments BD and DC will form sides of the polygon which we inscribe in the circle. As the \( \alpha \) decreases, the segments will touch the circle more, and will approximate better. Considering the construction here, the right triangle ABDEA can be considered. The point E is chosen to exactly bisect the segment BC. Consequently, angle DAB will be \( \alpha/2 \). Since AB is a radial segment, its length will be equal to the radius of the circle \( r \). If the length of segment ED (which is the distance of the chord from the circle’s perimeter) is taken as \( x \), the segment AE will span length \( r-x \) (since segment AD is a radial segment). Now, the following can be computed. We assume \( \alpha/2 = A \) for simplicity.
\[ 2\pi r = \frac{360}{A} \sqrt{x^2 + r^2 \sin^2(A)} \]  
\hspace{1cm} \text{(8)}

which in-turn gives

\[ \pi = \frac{360}{2A} \sqrt{x^2 + r^2 \sin^2(A)} \]  
\hspace{1cm} \text{(9)}

This can be thought of as a highly approximated expression for \( \pi \). For sake of convenience, we will assume a circle of unit radius (since the value of \( \pi \) is independent of the radius). This allows us to rewrite (9) as follows.

\[ \pi = \frac{180}{A} \sqrt{x^2 + \sin^2(A)} \]  
\hspace{1cm} \text{(10)}

When (10) is checked, there is one value which is still unknown. The value \( x \) is the distance of the chord from the circle’s perimeter. If we can shrink the sector well enough, we can avoid using that parameter, since the reflected edges will closely follow the circle’s perimeter. Hence, the equation is reframed.

\[ \pi = \frac{180}{A} \sqrt{\sin^2(A)} \]  
\hspace{1cm} \Rightarrow \pi = \frac{180}{A} \sin(A) ; A \rightarrow 0 \]  
\hspace{1cm} \text{(11)}

Equation (11) will offer a reasonable estimate for the value of \( \pi \). If we plot the values generated using the expression for different angles from 0° to 90°, we get Figure 3.

![Fig. 3. Plot generated for angle A](image)

The plot evidently shows that Equation (11) gives poor results as the reference angle \( A \) increases. Hence, for good approximation, we have to choose a value for \( A \) which is as close to 0 as possible.

This can be improved further if we avoid the assumption we added in (11). In this case, we need to calculate the value of \( x \) and incorporate it into (10). From the layout in Figure 2, we can see that the value of \( x \) is the length outside segment AE. Thus we get

\[ x = r - (r-x) \]  
\hspace{1cm} \text{(12)}

From \( \Delta ABE \), \( \cos(A) = (r-x)/r \)  
\hspace{1cm} \text{(13)}

Taking (12) and (13), we get

\[ x = r - r \cos(A) \]  
\hspace{1cm} \text{(14)}

Taking the assumption of unit radius in (10), we can simplify (14) further.

\[ x = 1 - \cos(A) \]  
\hspace{1cm} \text{(15)}

Now we can expand (10) and incorporate the value of \( x \). We get

\[ \pi = \frac{180}{A} \sqrt{x^2 + \sin^2(A)} \]  
\hspace{1cm} \Rightarrow \pi = \frac{180}{A} \sqrt{(1 - \cos(A))^2 + \sin^2(A)} \]  
\hspace{1cm} \Rightarrow \pi = \frac{180}{A} \sqrt{1 - 2\cos(A) + \cos^2(A) + \sin^2(A)} \]  
\hspace{1cm} \Rightarrow \pi = \frac{180}{A} \sqrt{2 - 2\cos(A)} \]  
\hspace{1cm} \text{(16)}

The data is plotted similar to Figure 3. The new plot is given in Figure 4.

![Fig. 4. Plot after including value of x](image)

We can see that (16) is much more precise.

IV. Conclusion

A trigonometry-based approximation to pi has been proposed, and it has been verified to perform well under prescribed conditions. This will further help explain interconversions between degree and radian system.
Synthesis and characterisation of nitrogen/nitrogen-zirconium doped cobalt ferrite nanoparticles

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Abstract: Nitrogen/nitrogen-zirconium doped cobalt ferrite nanoparticles were synthesised by coprecipitation/wet impregnation methods. X-ray diffraction studies reveal single phase cubic spinel structure with varying crystallite size of 15-24nm. Energy dispersive X-ray spectroscopic studies indicate the successful incorporation of metal and non-metal elements into the ferrite lattice.

V. INTRODUCTION

Nanoferrites are important materials with wide variety of applications such as high density information storage devices, transformer cores and biomedic applications like targeted drug delivery, magnetic resonance imaging, enzyme immobilization, hyperthermia etc. due to their structural, magnetic, electric and dielectric properties [1]. Among ferrite materials, cobalt ferrite, a hard magnetic material with an inverse spinel structure, has attracted a great deal of attention due to its moderate saturation magnetisation, high coercivity, high electrical resistivity, high chemical stability and mechanical strength. The properties of nanoferrites are found to strongly depend on the method of preparation, reaction conditions, composition of ferrites, cation distribution etc. Incorporation of metal elements in the lattice sites of Co and Fe is a common method for altering the properties of cobalt ferrites, which result in versatile applications. In recent times, a few reports are available in the literature studying the effect of non-metal doping in ferrites. The present work discusses the preparation and characterisation of N doped cobalt ferrite and Zr/N doped cobalt ferrite by facile coprecipitation and wet impregnation methods using urea and zirconyl nitrate as sources. The effect of non-metal doping during ferrite synthesis and post synthesis is also given importance in the study.

VI. EXPERIMENTAL

CoFe$_2$O$_4$, N/Zr doped cobalt ferrite were synthesised by co-precipitation method. The precursor solutions Co(NO$_3$)$_2$·6H$_2$O, Fe(NO$_3$)$_3$·9H$_2$O, ZrO(NO$_3$)$_2$·H$_2$O and urea (0.1M) were taken in stoichiometric proportions and dissolved in deionised water separately. These solutions were mixed in a magnetic stirrer until homogeneous. At 80°C 5M NaOH solution was added drop wise with continuous stirring in the solution pH of 8-10 range, followed by stirring for two hours. After cooling, the obtained precipitate was repeatedly washed with distilled water, filtered, dried at 110°C for 24 hours in an oven, powdered well and sintered at 700°C for four hours. These samples are designated as CF (CoFe$_2$O$_4$), CFU (N doped CoFe$_2$O$_4$) and CZFU (N/Zr co doped CoFe$_2$O$_4$). To study the effect of N doping after the ferrite formation, doping was carried out by wet impregnation method. Cobalt ferrite and zirconium doped cobalt ferrite (Co$_{0.5}$Zr$_{0.5}$Fe$_2$O$_4$), prepared by co-precipitation method were mixed with 1M urea solution and heated at 300°C in a muffle furnace till dry. The prepared samples are denoted as CFU$_N$ (N doped after CoFe$_2$O$_4$ formation) and CZFU$_N$ (N/Zr co doped after CoFe$_2$O$_4$ formation) respectively.

VII. RESULTS AND COMPARISONS

The phase formation of synthesized samples was investigated by powder X-ray diffraction. Fig. 1 shows the XRD patterns of calcined CoFe$_2$O$_4$ and doped samples. The peaks found in all the samples can be indexed as (111), (220), (311), (222), (400), (422), (511) and (440) planes of cubic spinel phase of CoFe$_2$O$_4$ (JCPDS card No:22-1086) . The reflections from different planes are unchanged with Zr/N doping. The broad diffraction peaks indicates the ultrafine nature and small crystallite size of samples. The crystallite size of the synthesized samples calculated by the Scherrer formula [2] and lattice parameters calculated by d-spacing using the relation $a = \frac{d_{hkl}}{(h^2+k^2+l^2)^{1/2}}$ [3]. Crystallite size varies from 15nm – 24nm. It is found that the lattice parameter varies from 8.3406 Å to 8.3732 Å with increase in crystallite size.

![Fig. 1. X-ray diffraction pattern of calcined CoFe$_2$O$_4$ and doped samples](image)

The estimated lattice parameter of 8.3691 Å for CoFe$_2$O$_4$ well agrees with that reported in literature [4]. Some distortion in crystal lattice can be evidenced by the additional peaks around 20 value of 51º in CZFUD and CZFUOA.

![Fig. 2. SEM image of Zr and N doped cobalt ferrite](image)
The physical texture and morphology of the synthesized materials were studied using scanning electron microscopy. The images are shown in Fig.2. The crystal grains are clearly visible in all samples. In SEM images the particles are highly agglomerated. The agglomeration of particles might be due to the reason that particles at nanoscale have a larger surface to volume ratio, which results in highly interfacial surface tension. Another reason is the magnetic nature of particles. The decrease in crystallite size with increasing dopant ions may be due to the less surface energy available from the nanopowders.

The EDS (Energy-dispersive X-ray spectroscopy) spectra (Figure 3) of all the synthesized nanoparticles confirms the composition of the constituent elements and also the stoichiometric ratio. The samples have expected stoichiometry with no trace of impurity. In doped cobalt ferrite, the EDS spectra exhibit the presence of Fe, Co, O, Zr and N. It must be mentioned that EDS is a semi-quantitative investigation and though the exact amount of cations could not be detected, it shows a fairly reasonable consistency between the atomic percentage of Fe, Co and O in doped nanoparticles.

VIII. CONCLUSIONS
N and N/Zr doped CoFe2O4 nanoparticles were successfully prepared by coprecipitation and wet impregnation methods. Characterization by XRD reveals the formation of single phase cubic spinel structured nanoparticles for all samples. EDS studies prove the existence of doped elements Zr and N in the cobalt ferrite lattices. In CZFUAN, Zr and N are effectively codoped. SEM images reveal homogeneous size distribution with agglomeration due to magnetic properties. Wet impregnation is an effective method for the doping of non-metals after the ferrite formation.

REFERENCES
A Study of Group Theory and its relation with Nature

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Sets are the most elementary mathematical structure on which group theory is constructed. Groups are one of the algebraic structures built on sets. Groups are a collection of elements which form a set with a well-defined binary operation. Basically, a group is closed with existence of a unique identity and inverse element, under the binary operation and satisfies the associative law.

IX. MAPPINGS OF GROUPS

If there exists at least one preimage for every image then the mapping is said to be surjective or onto mapping. For a map \( f: A \rightarrow B \) we know that the range \( f(A) \subseteq B \) and if the range is equal to the codomain then the mapping is onto or surjective.

If all of the preimages have a unique image then the mapping is said to be injective or one-to-one mapping. Briefly, \( g: Q \rightarrow P \) then if \( g(a^*) = g(a') \) implies \( a^* = a' \).

If the mapping is both injective and surjective then the mapping is said to be bijective. Hence the cardinality of the domain and codomain is the same i.e. for every element in \( X \) there exists a unique element in \( Y \) and vice versa.

Equivalently the maps on groups are termed as Epimorphism, Monomorphism and Isomorphism.

Consider a group \((G, \cdot)\) and a proper subset \(H\). Then if the subset \(H\) along with the same binary operation \((H, \cdot)\) satisfies the axioms of a group then \((H, \cdot)\) is called a subgroup of \(G\).

A Cyclic Subgroup \(\mathbb{Z}_3\) of order 3 is \(\{e, a, b\}\) with operation below.

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A Klein-4 group is a discrete group of order 4 is \(\{e, a, b, c\}\) with operation

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Consider the group \(G\) and a subgroup \(H\). The left coset is defined as the set of elements obtained by picking an element \(g \in G, h \in H\) but \(gh \in G\) i.e. \(gH = \{gh : g \in G, h \in H\}\) Similarly a right coset is given by \(Hg = \{hg : g \in G, h \in H\}\). Left cosets and Right cosets are in general not the same but if \(gH = Hg\) then the subgroup is called a Normal Subgroup.

An interesting consequence of subgroups being normal is that the cosets of a normal subgroup form a coset space in which each coset acts like a group element and the set of all such cosets which are closed under a specific kind of binary operation forms a group called the Factor or Quotient group.

X. MODULAR ARITHMETIC

The structure behind modular arithmetic was factor groups, namely the factor groups of the additive group of integers. The binary operation among integers \(Z\) is a commutative operation the additive group of integers \((Z, +)\) forms an abelian group. Normal subgroups are \(t\mathbb{Z}\) where \(t \in \mathbb{Z}\) and the cosets of \(t\mathbb{Z}\) are given \(t\mathbb{Z} = \{0 + t\mathbb{Z}, 1 + t\mathbb{Z}, 2 + t\mathbb{Z}, \ldots\}\).

Applications of Modular arithmetic is widely used in applied and theoretical mathematics. In theoretical mathematics it is one of the foundations of number theory and in applied mathematics it is used in computer algebra, cryptography etc. An example that we could relate to is that arithmetic modulo 7 is used in writing algorithms that determine the day of a week. In fact arithmetic modulo is used in algorithms determining days, dates and months.

The set of mappings from the set to itself forms a group. In the case when the mapping permutes the elements of the set, the group is called Permutation or Symmetric Group. Its importance arises from the fact that any finite discrete group of order \(n\) will be isomorphic to one of the subgroups of the Permutation group \(S_n\). An example of a permutation \(\pi_1\) on the set \(\{1,2,3,4\}\) is \([3 \ 4 \ 1 \ 2]\) which relates to the images of the set under \(\pi_1\).

XI. MOLECULAR APPLICATIONS OF GROUP THEORY

Point Groups are the group of symmetry transformations, these transformations are physical e.g. rotation, reflection etc. which leaves the molecule invariant under such transformations. Some symmetry operations associated with the permutation group is reflection, rotation, inversion, and improper rotation helps in study of molecular bond of an atom.

Groups relates to the mathematical structure of the world around and helps in study of nature. The symmetry in the environment can be studied and related with the permutation group. The most popular puzzle Rubik’s Cube is an illustration of permutation group.

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