MINISTRY OF EXTERNAL AFFAIRS

NEW, EMERGING & STRATEGIC TECHNOLOGIES (NEST) DIVISION

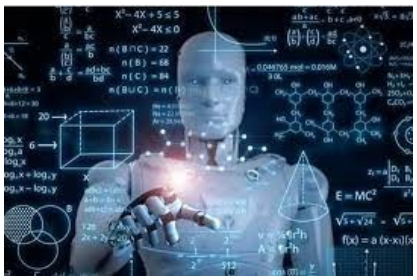
NEWSLETTER

MARCH 2024

IMPORTANT EMERGING TECHNOLOGY NEWS

ARTIFICIAL INTELLIGENCE

1. Artificial Intelligence Act: MEPs adopt landmark law:



European Parliament approved the Artificial Intelligence Act that ensures safety and compliance with fundamental rights, while boosting innovation. The regulation, agreed in negotiations with member states in December 2023, was endorsed by MEPs with 523 votes in favour. The new rules ban certain AI applications that threaten citizens' rights, including biometric categorization systems based on sensitive characteristics and untargeted scraping of facial images from the internet or CCTV footage to create facial recognition databases. The use of biometric identification systems ("Real-time" RBI) by law enforcement is prohibited in principle, except in exhaustively listed and narrowly defined situations. Clear obligations on high-risk AI systems including critical infrastructure, education and vocational training, employment, essential private and public services (e.g. healthcare, banking), certain systems in law enforcement, migration and border management, justice and democratic processes (e.g. influencing elections). Artificial or manipulated images, audio or video content ("deep-fakes") need to be clearly labelled as such. Regulatory sandboxes and real-world testing will have to be established at the national level, and made accessible to SMEs and start-ups, to develop and train innovative AI before its placement on the market.

https://www.europarl.europa.eu/news/en/press-room/20240308IPR19015/artificial-intelligence-act-meps-adopt-landmark-law

2. Rural development ministry collaborates with IIT Delhi for geospatial tech, AI applications in BhuPRAHARI:

In a significant stride a MoU was signed between MoRD and IIT Delhi to formalize their partnership in applications of geospatial technology and artificial intelligence. 'BhuPRAHARI,' an ambitious initiative aimed at leveraging ground and space-based geospatial technologies along with Artificial Intelligence to monitor and manage assets under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA). The project is to be executed by the Hydro Sense lab and this collaboration is a commitment to harnessing the power of technology for the betterment of rural development processes. The integration of cutting-edge technologies is expected to modernize the way rural development projects are planned, monitored, and executed, ensuring accountability, and optimizing resource allocation.
https://government.economictimes.indiatimes.com/news/technology/rural-dev-ministry-collaborates-with-iit-delhi-for-geospatial-tech-ai-applications-in-bhuprahari/108449740

3. United Nations General Assembly Adopts by Consensus U.S.-Led Resolution on Seizing the Opportunities of Safe, Secure and Trustworthy Artificial Intelligence Systems for Sustainable Development:

On March 21, 2024, The United State's leadership encourages principles for Member States to promote safe, secure, and trustworthy AI systems by:
Cooperating with and providing capacity building and technical and financial assistance to developing countries;

- Closing the AI divides and other digital divides that exist between and within countries;
- Promoting equitable access to the benefits of AI systems;
- Respecting, protecting, and promoting human rights and fundamental freedoms throughout the life cycle of AI systems;
- Protecting individuals from all forms of discrimination, bias, misuse, or other harm from AI systems;
- Developing regulatory and governance approaches and frameworks related to AI systems;
- Testing AI systems prior to deployment and use;

- Raising public awareness of the appropriate civil use of AI systems;
- Encouraging the development of tools that identify AI-generated digital content and their origin;
- Safeguarding privacy and the protection of personal data;
- Respecting intellectual property rights;
- Mitigating the potential negative consequences for workforces; and
- Encouraging the private sector to adhere to applicable international and domestic laws.

https://www.state.gov/united-nations-general-assembly-adopts-by-consensus-u-s-led-resolution-on-seizing-the-opportunities-of-safe-secure-and-trustworthy-artificial-intelligence-systems-for-sustainable-development/

4. AI Predicts Genetic Editing Efficiency with Quantum Precision:

CRISPR-Cas technology has proved to be a transformative force in molecular biology; however, its efficacy has been hampered by the unpredictable nature of genomic landscapes across different organisms. In a bid to overcome this obstacle, researchers from Oak Ridge National Laboratory and the University of Tennessee, Knoxville, turned to artificial intelligence, specifically a novel application known as explainable artificial intelligence (XAI). By leveraging publicly available datasets, the team trained an XAI model, termed iterative Random Forest, to discern patterns governing the efficiency of CRISPR-Cas9-mediated genome editing. A novel set of quantum chemical properties, which apply the rules of quantum mechanics to molecules to better understand the interactions between molecules, to refine predictions of CRISPR-Cas genome editing locations.
https://www.synbiobeta.com/read/ai-predicts-genetic-editing-efficiency-with-quantum-precision?utm_source=substack&utm_medium=email

SEMICONDUCTOR

1. Micron and IIT Roorkee join forces to drive semiconductor innovation in India:

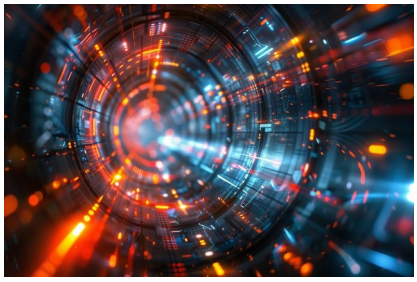
Micron, the US-based technology company, and the Indian Institute of Technology (IIT) Roorkee have formalized a partnership through a MoU which aims to foster innovation and cultivate a highly skilled local workforce, aligning with India's objective of achieving self-reliance in the semiconductor sector and strengthening the overall electronics ecosystem. Under this partnership, the focus includes research in technology fields, experiential learning opportunities for students, recruitment activities for students, and industry-relevant training. This initiative falls under Micron's University Research Alliance (URAM) outreach and aligns with the India Semiconductor Mission (ISM) thrust areas.
https://www.manufacturingtodayindia.com/micron-and-iit-roorkee-join-forces-to-drive-semiconductor-innovation-in-india/

2. Union Minister Rajeev Chandrasekhar Inaugurates India's 1st FutureLABS center at C-DAC Thiruvananthapuram:

This center, namely, "Centre for Semiconductor Chips & Systems for Strategic Electronics", will be playing a crucial role in catalyzing an ecosystem for next generation chip design, manufacturing, and research. A collaboration announced between C-DAC(T) and the Ministry of Railways for the development of electric locomotive technologies. An MoU was signed between C-DAC(T) and Tata Power for the development and deployment of microgrid technologies. There was also the announcement for the transfer of technology of the electric vehicle wireless charger, developed by C-DAC(T) and VNIT Nagpur, to BelRise Industries Limited. The vision is very clear in the government and in the industry, that the world's digitization and the digital economies of the world are expanding today at an unprecedented pace. Three areas have great potential for Indian startups and students — AI, Semiconductors, and the future of electronics. CDAC will be a willing and facilitating partner to create these labs within colleges and universities. This initiative will make Thiruvananthapuram India's next innovation hub.
https://pib.gov.in/PressReleasePage.aspx?PRID=2013900

QUANTUM

1. Quantum Computing Takes a Giant Leap With Light-Based Processors:

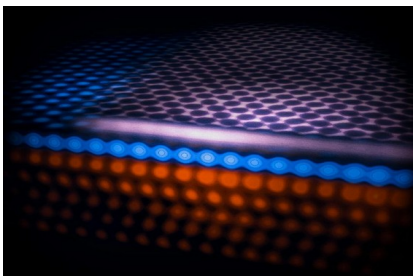


Researchers from RMIT University have developed a groundbreaking light-based processor that enhances the efficiency and scalability of quantum computing and communication. By minimizing light losses, the processor promises significant advancements in secure data transmission and sensing applications. The innovative photonic device, using a crystal called lithium niobate has a unique optical and electro-optic properties, making it ideal for various applications in optics and photonics. The newly-developed approach showed significant improvement over the traditional methods of modelling and control, and could be applied to other quantum devices beyond photonic processors.
https://scitechdaily.com/quantum-computing-takes-a-giant-leap-with-light-based-processors/

2. Quantum Resurrection: High-Performance Niobium Superconducting Qubits:

Stanford University's research team has made a significant breakthrough in quantum technology by improving niobium-based qubits to match leading alternatives. This advancement highlights niobium's potential to operate at higher temperatures and wider ranges. It can operate across an eight-times-greater frequency range and a massive 18,000-times-wider magnetic field range compared to aluminum-based qubits, expanding the menu of uses for the superconducting-qubit family. By harnessing niobium's standout features, scientists will be able to expand the capabilities of quantum computers, networks, and sensors. These quantum technologies draw on quantum physics to process information in ways that outclass their traditional counterparts and are expected to improve areas as varied as medicine, finance, and communication.
https://scitechdaily.com/quantum-resurrection-high-performance-niobium-superconducting-qubits/

3. Quantum Leap in Ultrafast Electronics Secured by Graphene's Atomic Armor:



Researchers from University of Wurzburg have developed a groundbreaking protective coating for indenene, a quantum material promising for ultra-fast electronics, enabling its use in air without oxidation. The team experimented with heating silicon carbide (SiC) as a substrate for indenene, exploring the conditions needed to form graphene from it. Silicon carbide consists of silicon and carbon atoms and heating it causes the carbon atoms to detach from the surface and form graphene. Then the vapor-deposited indium atoms, which are immersed between the protective graphene layer and the silicon carbide substrate. This is how the protective layer for two-dimensional quantum material indenene was formed. This breakthrough paves the way for applications involving highly sensitive semiconductor atomic layers.
https://scitechdaily.com/quantum-leap-in-ultrafast-electronics-secured-by-graphenes-atomic-armor/

4. How scientists are using quantum squeezing to push the limits of their sensors:

Long period, scientists have been observing the so-called gravitational waves to help them study fundamental questions about the cosmos, including the origin of heavy elements, but detecting gravitational waves isn't easy. By the time they reach Earth and the twin detectors of the Laser Interferometer Gravitational-Wave Observatory (LIGO), the ripples have dissipated into near silence. LIGO has confirmed 90 gravitational wave detections. Physicists from MIT is creating a device that will allow LIGO's detectors to detect far more black hole mergers and neutron star collisions. The device belongs to a growing class of instruments that use quantum squeezing that increasingly using it to exert more control over the act of measurement, dramatically improving the precision of quantum sensors. In precision sensing applications where you want to detect super-small signals, quantum squeezing can be a pretty big win.
https://www.technologyreview.com/2024/02/29/1089092/how-scientists-are-using-quantum-squeezing-to-push-the-limits-of-their-sensors/?utm_source=substack&utm_medium=email

SPACE

1. NASA's UVEX: New Mission Will Unlock the Ultraviolet Mysteries of the Universe:

As NASA explores the unknown in air and space, a new mission to survey ultraviolet light across the entire sky will provide the agency with more insight into how galaxies and stars evolve. The space telescope, called UVEX (UltraViolet EXplorer), is targeted to launch in 2030 as NASA's next Astrophysics Medium-Class Explorer mission. In addition to conducting a highly sensitive all-sky survey, UVEX will be able to quickly point toward sources of ultraviolet light in the universe. This will enable it to capture the explosions that follow bursts of gravitational waves caused by merging neutron stars. The telescope also will carry an ultraviolet spectrograph to study stellar explosions and massive stars. The telescope's ultraviolet survey will complement data from other missions conducting wide surveys in this decade, including the Euclid mission led by ESA (European Space Agency) with NASA contributions, and NASA's Nancy Grace Roman Space Telescope, set to launch by May 2027. Together, these missions will help create a modern, multi-wavelength map of our universe.
https://scitechdaily.com/nasas-uvex-new-mission-will-unlock-the-ultraviolet-mysteries-of-the-universe/

2. Astroscale Successfully Launches World's First Debris Inspection Spacecraft, ADRAS-J:

Astroscale Japan Inc. ("Astroscale Japan"), a subsidiary of Astroscale Holdings Inc. ("Astroscale"), the market leader in satellite servicing and long-term orbital sustainability across all orbits, confirmed the successful launch of its commercial debris inspection demonstration satellite, Active Debris Removal by Astroscale-Japan (ADRAS-J), from Rocket Lab's Launch Complex 1 in Mahia, New Zealand. The ADRAS-J

spacecraft was selected by the Japan Aerospace Exploration Agency (“JAXA”) for Phase I of its Commercial Removal of Debris Demonstration Program. Astroscale Japan is responsible for the design, manufacture, test, launch and operations of ADRAS-J. The mission will demonstrate the most challenging RPO capabilities necessary for on-orbit services.
https://astroscale.com/astroscale-successfully-launches-worlds-first-debris-inspection-spacecraft-adras-j/

3. Isro successfully lands 'Pushpak', India’s first Reusable Launch Vehicle:

The Indian Space Research Organisation (Isro) successfully carried out the landing mission of its Reusable Launch Vehicle (RLV) named 'Pushpak' from the Aeronautical Test Range (ATR) in Challakere near Karnataka's Chitradurga. The rocket draws its name from the 'Pushpak Viman' mentioned in the Ramayana, known to be the vehicle of the Lord of Wealth. The making of the space shuttle by a dedicated team of engineers and scientists began 10 years ago. The 6.5-meter aeroplane-like craft weighs 1.75 tons. During its descent, small thrusters help the vehicle navigate to the exact spot where it is supposed to land. The government has invested over ₹ 100 crore in the project.
https://www.ndtv.com/science/isro-successfully-lands-pushpak-indias-first-reusable-launch-vehicle-5287362

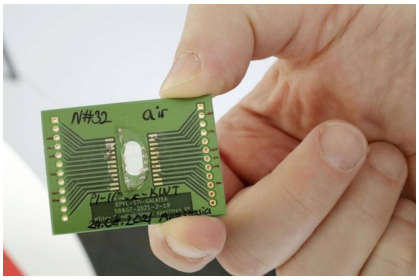
4. Tamil Nadu creates history with India’s second privately developed rocket:

Agnikul Cosmos Private Limited, prepares to launch its first rocket, Agnibaan Sub Orbital Technology Demonstrator (SOrTeD), from the Satish Dhawan Space Centre in Sriharikota, Andhra Pradesh. This launch marks several significant milestones in India’s space exploration journey. This launch will also be India’s first semi-cryogenic

engine-powered rocket launch, showcasing advancements in propulsion technology. Agnikul Cosmos achieves another feat with the world's first single piece 3D printed engine, demonstrating indigenous innovation and engineering prowess. India's journey into privately-developed rockets commenced with the launch of Vikram-S in 2022, developed by Skyroot Aerospace Private Limited.
https://www.thehindu.com/sci-tech/science/tamil-nadu-creates-history-with-indias-second-privately-developed-rocket/article67969511.ece

GREEN ENERGY & CRITICAL MINERAL

1. Japanese and Swiss scientists create glass that generates electric current:



Researchers from the Tokyo Institute of Technology and the Swiss Federal Institute of Technology Lausanne successfully confirmed current generation on the glass surface after employing a femtosecond laser, which emits ultrashort light pulses, to etch a circuit into it. During the research, a semiconductor crystal on the glass being created, which, when coupled with a laser-inscribed circuit, resulted in the tellurite glass producing an electric current in response to ultraviolet and visible light. This may may potentially pave the way for clean energy production in the future.
https://www.japantimes.co.jp/news/2024/03/07/japan/science-health/japan-switzerland-glass-electricity/?utm_source=substack&utm_medium=email

2. Africa: African leaders call for the sustainable and equitable extraction and management of transitional minerals:

Africa holds substantial reserves of the critical minerals. More than a half of the world's cobalt and manganese, and 92% of its platinum, are found on the continent.

DRC produces two-thirds of the world's cobalt, a mineral used to build electric-vehicle batteries. The demand presents an opportunity for mineral-rich African countries that remains untapped. Many of the region's countries have limited capacity to process these critical transitional materials domestically. The minerals are often exported in their raw state and refined often in China, which does the bulk of global minerals processing and production. The region exports roughly 75% of its crude oil, which is refined elsewhere and re-imported as petroleum products. It exports 45% of its natural gas, which contributes only minimally to regional energy needs, even as 600 million Africans remain without access to electricity. In this context a resolution for structural change that will promote equitable benefit-sharing from extraction in African countries, including Senegal, Burkina Faso, Cameroon, and Chad, was presented at the UN environmental assembly in Nairobi and called for the sustainable use of transitional minerals. This resolution is crucial for African countries, the environment and the future of our population.
https://www.business-humanrights.org/en/latest-news/africa-african-leaders-call-for-the-sustainable-and-equitable-extraction-and-management-of-transitional-minerals/

BIOTECHNOLOGY and HEALTH

1. Digital Twins to Advance Biomanufacturing:

The rapid development of synthetic biology expanded the array of products microbes can produce and also gave rise to a new challenge: scaling up needs to become faster, cheaper, more efficient, and accommodate more varied bioprocesses. The transition to fully digitized biomanufacturing processes is not just an aspiration but a necessity for the future of sustainable and efficient bioproduction. Using bioreactor datasets, researchers worldwide create digital twins to understand the fermentation process better and generate in silico models of bio-productions. Digital twins are digital representations of a system or a process and are in heavy use in the majority of engineering disciplines. Model-driven approach provides a faster and more cost-efficient means to evaluate many different conditions in silico, reducing the need for expensive and time-consuming experiments. The ultimate goal of fully digital

bioprocess, able to predict strain behavior and production outcomes with minimal experimental data input, may be difficult, but not impossible.
https://www.synbiobeta.com/read/digital-twins-to-advance-biomanufacturing?utm_source=substack&utm_medium=email

2. Scientists Develop New Very Different Approach to Producing Artificial Tissue:

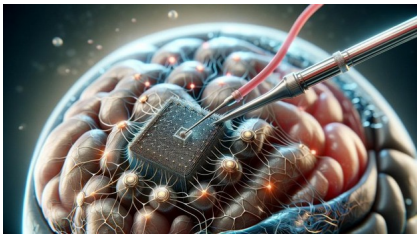
Researchers from Vienna University of Technology have developed a novel method to grow replacement tissue, such as cartilage, in the lab using a unique high-resolution 3D printing process that creates porous spheres for cell colonization. This technique allows for the assembly of these spheres into any shape, with cells combining to form a uniform, living tissue, overcoming previous challenges in controlling tissue shape and integration. Cultivating cartilage cells from stem cells is not the biggest challenge. The main problem is that you usually have little control over the shape of the resulting tissue. The team created tiny cage-like structures that look like mini footballs and have a diameter of just a third of a millimeter which serve as a support structure and form compact building blocks that can then be assembled into any shape.
https://scitechdaily.com/scientists-develop-new-very-different-approach-to-producing-artificial-tissue/

3. IIT-M partners with Vellon space to advance extra-terrestrial manufacturing R&D:

This collaboration marks a significant milestone in orbital ‘Microgravity Research.’ Vellon Space will receive a Technology Development Fund from IIT-M to demonstrate its miniature space laboratory called ‘AsteriX Lab’, in orbit. The AsteriX Lab, during its demonstration, will undergo space qualification to conduct biological experiments, particularly in long-duration cell culture under Lower Earth Microgravity. This

demonstration in space is expected to take place by 2025.This demonstration sows the seed for biomanufacturing in space which can revolutionize cell culture and drug development processes in space, ultimately leading to enhanced pharmaceuticals and better human health outcomes.
https://www.dtnext.in/news/city/iit-m-partners-with-vellon-space-to-advance-extra-terrestrial-manufacturing-rd-773284?infinitescroll=1

4. Revolutionary Graphene Interfaces Set to Transform Neuroscience:



Researchers from Catalan Institute of Nanoscience and Nanotechnology (ICN2) together with the Universitat Autonoma de Barcelona (UAB) and other national and international partners developed a innovative graphene-based neurotechnology with the potential for a transformative impact in neuroscience and medical applications. ICN2 spearheaded in collaboration with the University of Manchester the development of EGNITE (Engineered Graphene for Neural Interfaces), a novel class of flexible, high-resolution, high-precision graphene-based implantable neurotechnology. This innovative technology based on nonporous graphene integrates fabrication processes standard in the semiconductor industry to assemble graphene micro electrodes of a mere 25 µm in diameter. The graphene micro electrodes exhibit low impedance and high charge injection, essential attributes for flexible and efficient neural interfaces. INBRAIN Neuroelectronics is gearing up for the first-in-human clinical trials of this innovative graphene technology.
https://scitechdaily.com/revolutionary-graphene-interfaces-set-to-transform-neuroscience/

TELECOMMUNICATION

1. DoT unveils spectrum regulatory sandbox to promote R&D in telecom:

The Minister for Telecom and IT, GoI unveiled the policy on 'Spectrum Regulatory Sandbox' that will enable a hassle-free regulatory environment for research and development in the telecom sector. The policy also holds the potential of advancing India's telecommunications landscape and fostering global collaboration in the field. Minister also announced a complete abolition of Wireless Operating License (WOL) that further simplifies the licensing processes in telecom. An MoU was also signed between the Department of Telecommunications and Ericsson for offering accredited courses on 5G for students of DoT's 100 5G use case labs. The project aims to strengthen capacity building and skill development in the 100 5G use case labs, enabling institutes to mentor students and faculties in creating innovative 5G products and use cases.
https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2013602

2. S. Korea joins 10-nation statement on endorsing 6G principles:

South Korea has participated in a 10-nation joint statement outlining principles for the research and development of the sixth-generation (6G) wireless communications systems. The statement was jointly issued by South Korea, the United States, Australia, Japan and six other countries on the sidelines of the Mobile World Congress Barcelona 2024, calling for the creation of a safe and interoperable 6G network. Under the declaration, the 10 countries have agreed to work together to support a trusted technology that is protective of national security, and secure, resilient and protective of privacy. The 6G system should also be built on global industry-led and inclusive standards, and support open and interoperable innovation as part of efforts to foster international collaborations. The statement also called for affordability, sustainability and global connectivity, as well as secure and resilient supply chains in the system to promote healthy competition in the global market.
https://en.yna.co.kr/view/AEN20240227005400320

DEFENSE

1. Mission Divyastra: first test of Agni-5 with multiple warhead technology:

India successfully tested a new-age Agni-5 ballistic missile equipped to carry multiple warheads, each of which is capable of hitting a separate target. The test marks a long-awaited upgrade of India's missile system and significantly enhances its strike capability, including the nuclear option. This ability to carry multiple warheads on a single missile, called MIRV or Multiple Independently Targetable Re-entry Vehicle, is a technology that originated five decades ago, but is in possession of only a handful of countries i.e., the United States, Russia, China, United Kingdom and France. MIRV technology can aim multiple targets that can be located hundreds of kilometres apart and Agni-5, which can carry nuclear warheads and hit targets more than 5,000 km away. The next upgrade of Agni missile, Agni-6, is expected to be a full-fledged intercontinental ballistic missile with a range well over 7,000 km.
https://indianexpress.com/article/india/pm-modi-agni-missile-drdo-agni5-weapons-system-9208122/

2. Scientists Develop Groundbreaking Sensor That Can Wirelessly Detect Chemical Warfare Agents (CWA):

Researchers from Aerospace Information Research Institute, Chinese Academy of Sciences have developed a wireless sensor system using surface acoustic wave (SAW) technology, set to revolutionize chemical warfare agent detection by specifically targeting dimethyl methylphosphonate (DMMP), a simulant for nerve agents. This sensor operates at 433 MHz, using a unique coating of fluoroalcohol polysiloxane (SXFA) on a lithium niobate substrate, enhancing its sensitivity and stability under various environmental conditions. This technology has immense potential in military

and civilian defense, offering a reliable, efficient means of early CWA detection. Its ability to operate wirelessly and in challenging environments makes it a valuable tool for ensuring public safety and preparedness against chemical threats.
https://scitechdaily.com/scientists-develop-groundbreaking-sensor-that-can-wirelessly-detect-chemical-warfare-agents/

OTHERS

1. NPCI joins hands with IISc for joint research on blockchain, AI tech:

The collaboration will also propel further innovation through the establishment of the 'NPCI-IISc Centre of Excellence (CoE) for Deep Tech Research & Development. The partnership will focus on scalable blockchain platforms and multi-modal analytics over fintech data. NPCI's collaboration with the reputed institute is aimed at solving complex technological and engineering problem statements in the areas of scalability, privacy preserving designs, neural networks, Graph AI, Large Language Models (LLM), etc. Faculty members from five departments at IISc will work with NPCI researchers on practical challenges related to these areas.
https://cio.economictimes.indiatimes.com/news/artificial-intelligence/npci-joins-hands-with-iisc-for-joint-research-on-blockchain-ai-tech/108286817

2. Israel Aerospace Industries, IIT Delhi Sign CSR agreement to collaborate on Applied Research:

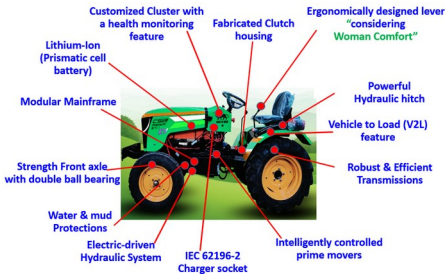
In the spirit of India's self-reliance, the Israel Aerospace Industries (IAI) and Indian Institute of Technology Delhi (IIT Delhi) has signed its first IAI-IIT CSR agreement which demonstrates IAI's commitment to its corporate social responsibility in India. The cooperation includes collaborative projects, training, and research consultancy. This

alliance between IAI and IIT Delhi demonstrates a shared vision leveraging cutting-edge research to drive progress and technological excellence, shaping together the future of technology in India. IAI works closely with the international innovation business environment including Government R&D Officials, cutting-edge start-ups, research centers and academia to efficiently enable the transition of ideas into viable products and systems.
https://government.economictimes.indiatimes.com/news/technology/israel-aerospace-industries-iit-delhi-sign-csr-agreement-to-collaborate-on-applied-research/108457222

INNOVATIONS AND ACHIEVEMENTS BY INDIAN INSTITUITIONS

1) CSIR:

a) CSIR-CMERI Developed Compact Electric Tractor CSIR PRIMA ET11:



In India, agriculture is the primary source of livelihood for nearly 55% of Indian population, feeding 1.3 billion people and contributing significantly to the country GDP. Tractors play a crucial role in increasing agricultural productivity by mechanization. Traditionally tractors use diesel, thus contributing significantly to the environmental pollution. Global carbon foot print reduction strategy necessitates rapid transition of this sector towards electrification. Considering this, CSIR-CMERI has indigenously designed and developed (Technology Readiness Level-6) compact Electric Tractor named CSIR PRIMA ET11 mainly to cater small and marginal farmers of India. Compact electric tractors offer several benefits, contributing to increased efficiency, sustainability, and convenience in agricultural operations.

https://youtu.be/mSsCwK5lx3E

2) IIT Jodhpur:

a) Experimental Investigation and Performance Evaluation of HARQ Technique for Free-Space Optical (FSO) Communication Systems:

The performance of FSO systems is significantly deteriorated due to the presence of

atmospheric turbulence induced fading, weather conditions and foresight pointing errors. In this project, research team from iit jodhpur improved the performance of FSO communication systems using hybrid automatic repeat request technique which is a link layer technique that combines ARQ and channel coding. Physical layer security analysis for FSO systems is also performed in the presence of eavesdroppers and a novel artificial noise injection scheme is proposed for FSO systems to improve physical layer security. The developed FSO experimental setup lays the foundation towards development of all optical high speed FSO communication system for 5G and beyond applications. The developed FSO experimental set-up has a huge potential of FSO-fiber converged systems for improving the data rates and coverage. The derived BER, outage probability and asymptotic expressions reveal useful design insights into the FSO system performance and can be used by the industry for FSO system design.

b) Thermoelectric Performance Study Using First-Principles Calculations Based Methods:

Thermoelectric materials are used to convert waste heat into electrical energy and help us effectively utilize fuel sources. The conversion efficiency depends on the figure of merit zT of the modules used in the thermoelectric devices. The zT, in turn, depends on the electronic transport (seebeck coefficient, electrical conductivity, electronic part of thermal conductivity) and phonon transport (lattice thermal conductivity). In this project, research team have studied electronic and phonon transport in skutterudites, and zinc antimonides using first-principles calculations to provide insights for improving zT. The fundamental understanding from these guides experiments is to realize efficient thermoelectric materials.

c) Quantum Attacks on Block Ciphers and Its Counter-Measures:

Block ciphers are widely used as primitives of symmetric key cryptography in real-world applications. The development of quantum computers can pose a real threat to the security of block ciphers. In this project the main focus is to study the existing quantum attacks on classical block ciphers and the design criteria of block ciphers that are thought to be secure against a cryptanalytic attack by a quantum computer. The research work have important applications in both commercial and defence organizations where two parties want to protect the hidden meaning of their exchanged information.

d) Self-Healing Bacterial Concrete for Resilient Wastewater Infrastructure:

This project aims to understand the (i) Attack mechanisms of different biogenic loads on concrete in a biological environment, (ii) Evaluate bacterial concrete efficiency in

resistance to the different biogenic loads of waste-water, (iii) Evaluate the crack healing mechanism of self-healing bacteria in different waste-waters. The applications is to develop buildings with self-healing ability and higher lifespan and a building material which can resist chemical and biological attacks.

3) IIT Kanpur:

a) Handled & Portable Smart Diagnosis Device for Early detection of Oral Cancer:

The novel and patented technology is handheld and portable diagnosis device. The device is based on IoT and visual imaging technology. It captures images of intra oral mucosa of subjects using developed device in presence of mounted light source and through their ML/AI model it analyze the captured images and categorize the subjects in Normal, pre-malignant, and malignant. Device has built-in power supply which can provide backup for mass screening of subjects and can connect to smartphone, tablet, iPad, etc. wirelessly. It can store subject health history for tracking of health status, no harmful radiation or residual associated with the device and no need of any chemicals or additional process. The technology is at TRL-7 stage and developed by the research team from the Department of Chemical Engineering.

4) IIT Delhi:

a) Fibre-based Quantum Key Distribution:

Brief Description:

- Method for secure key exchange : quantum key distribution (QKD)
- Technology utilizing principles of quantum Physics
- First 100km intercity QKD between Prayagraj and Vindhyanchal
- Secure quantum communication for >200km fibre globally
- Highest secure key rate and lowest error reported for this protocol

Societal or Economical Impact:

- Safe communication for strategical services using quantum means
- Making online transactions and digital communication un-hackable
- Securing data centers, classified information and national secrets

****

Compiled by:
NEST Division
Email Id: nestsection@mea.gov.in