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India's first PPP airport bets on a future-ready plan

V. Sajeev Kumar

Cochin International Airport Limited (CIAL), the first Indian airport set up under a public-private partnership model, is embarking on a major expansion drive focused on green energy, smart tech and integrated growth.

The plans include a dedicated IT park, a green hydrogen production facility and airport-wide digital upgrades, all of which are expected to usher CIAL into a new era of sustainable and tech-driven growth.

More than 150 projects have been envisaged. According to S. Suhas, Managing Director of CIAL, the exercise goes beyond mere expansion of the airport's infrastructure.

"We are redefining the role of an airport in today's world. From green hydrogen production to advanced digital systems and the creation of a vibrant commercial ecosystem, each step is part of a larger vision: to integrate sustainability, technology and regional development into the core of airport operations. Our aim is to ensure that CIAL remains future-ready, efficient and deeply aligned with the evolving needs of passengers and partners alike," he said.

Going green: Cochin International Airport is collaborating with BPCL to build a green hydrogen plant. THULASI KAKKAT

The ₹200-crore digital infrastructure programme will harness smart technology to create a safer and seamless airport experience, he said. Moreover, CIAL is now part of an exclusive group of seven Indian airports that offer the Fast Track Immigration – Trusted Traveller Programme (FTI-TTP).

CIAL is collaborating with BPCL to build a green hydrogen plant. Slated to be inaugurated by August, it will be the first ever hydrogen production facility at an airport globally. With an installed capacity of 1 MW and production capacity of 220 kg per day, the project is primarily targeted for green mobility solutions within and around the airport.

The initiative complements CIAL's legacy as a solar-powered airport and aligns with global carbon neutrality goals by promoting cleaner alternatives to conventional fuels, Suhas said. To position Kochi as a leading destination for maintenance, repair and overhaul (MRO) services in South Asia, catering to both domestic and foreign airlines, Cochin International Aviation Services, a subsidiary of CIAL, is constructing its third MRO hangar at an investment of ₹50 crore.

The expansion at Kochi aims to offer a competitive, high-quality alternative for MRO services within India, Suhas said.

This initiative supports the broader goals of the 'Make in India' and 'Atmanirbhar Bharat' programmes by enhancing domestic capabilities, reducing dependence on overseas service providers and attracting overseas business to Indian soil, he added.

On the infrastructure front, CIAL is executing a diverse array of projects to strengthen aviation and allied sectors. The projects are designed to enhance capacity, improve efficiency, and generate long-term revenue.

The key works include an import cargo terminal (1 lakh sq. ft.), airport emergency services modernisation with the induction of the latest safety systems, perimeter intrusion detection system (PIDS), India's largest aero lounge – 0484 Aero Lounge, golf resorts, and the ongoing phase one of the international terminal (T3) expansion project. CIAL aims to follow an aerotropolis model by integrating commercial and lifestyle zones around the airport.

(The writer is with The Hindu businessline)

ILLUSTRATION: SAINATH B.

India's emerging shield against the climate crisis

As extreme events become more frequent and harder to predict, conventional insurance models need a fundamentally different approach ; parametric insurance offers an alternative

CLIMATE OF SAFETY

Tarun Mathur

In the span of a few days, Himachal Pradesh was battered by over 20 flash floods, series of landslides, and cloudbursts, events that upended daily life and damaged critical infrastructure in the State. Events like these are now part of an unsettling pattern. The return period for such catastrophic weather events is shortening, making them more frequent, and far less predictable.

India recorded 764 major natural disasters since 1900 with almost half of them occurring after 2000. A clear pattern is emerging: climate volatility and global warming are accelerating and with them, scale and complexity of economic disruption.

Between 2019 and 2023 alone, India suffered over $56 billion in losses from weather-related disasters. That's nearly a quarter of all climate losses in the Asia-Pacific during the same period and the highest in South Asia by far.

As extreme events become both more frequent and harder to predict, conventional insurance models need a fundamentally different approach

Parametric insurance offers an alternative built for speed and clarity. It pays out the moment a predefined threshold is breached – rainfall crossing a certain mark, seismic activity above a set magnitude or wind speed crossing destructive limits. Payouts are triggered automatically, based on independently-verified data, and given within hours.

> Parametric cover is finding applications across transportation, manufacturing and even livestock farming where claim delays can lead to financial stress

How it works

At its core, parametric insurance is a simple proposition: it pays out when a pre-agreed index threshold is breached.

These thresholds, such as rainfall below a certain level or temperatures above a critical mark, are based on verified data from sources like the India Meteorological Department, NASA MERRA or other accredited global satellite systems. Everything, from trigger to payout, is defined upfront.

This is finding application across transportation, manufacturing and even livestock farming where claim delays can hugely compound financial stress.

A microfinance institution in Jharkhand, for instance, could structure a parametric policy that automatically covers loan repayments for small farmers if rainfall during the sowing season falls below 300 mm or temperatures cross 40°C.

This would help protect income during weather extremes, without requiring damage inspections.

> Globally, countries in Africa, the Pacific Islands, and even U.K. have used parametric products to cover everything from droughts and floods to cyclone winds

Even in emerging sectors like renewable energy, such insurance has a role to play. A solar power firm operating in Rajasthan can link its policy to solar irradiance data. If sunlight hours drop significantly below expected levels for a given month, payouts will compensate for lost output. When climate-linked disruptions strike, liquidity is needed immediately– to buy seeds, cover interest costs, and quickly restore working capital. Parametric models remove subjectivity and replace it with automation.

Where it's working

Parametric insurance is already being deployed across India and beyond. In parts of Rajasthan and U.P, a pilot protected thousands of women small-holder farmers from drought. It used a water balance index and delivered payouts automatically when water availability dropped below a defined threshold. When sowing conditions fail on rainfall deficits or extreme temperatures, the policy triggers loan support – aiding borrowers avoid defaults and maintain livelihoods. Globally, countries in Africa, the Pacific Islands, and even the U.K. have used parametric products to cover everything from droughts and floods to cyclone winds and flood depths. The examples prove such insurance works across contexts.

What India needs next

Parametric insurance has demonstrated its ability to deliver fast, transparent relief when climate volatility strikes. The building blocks are already in place–robust climate data, digital delivery platforms, and early success stories across agriculture, energy, and disaster-prone geographies. What's needed now is scale – and a clear framework to finance it.

In 2024, Nagaland became the first Indian state to purchase multi-year parametric cover for landslides and extreme rainfall, using disaster mitigation funds. Other States now have the green light to act pre-emptively.

India must treat parametric insurance as essential climate infrastructure, much like UPI did for payments. That means expanding data networks, encouraging State-level adoption, and embedding smart cover into public disaster response. In a future shaped by climate uncertainty, it offers something rare viz. speed, trust and financial resilience when it matters most.

(The writer is co-founder & CBO, Policybazaar for Business)

How is India preparing against GLOF events?

How many Glacial Lake Outburst Flood events has Nepal witnessed in recent times? What are the two most prominent types of glacial lakes found in the Indian Himalayan Region? How is the National Disaster Management Authority mitigating risks associated with GLOF events?

EXPLAINER

Safi Ahsan Rizvi

The story so far:

On July 8, Nepal experienced a catastrophic Glacial Lake Outburst Floods (GLOF) event which caused a flash flood along the Lende river, flowing from Tibet to Nepal, and washed away a China-built friendship bridge. The bridge had serviced the 10-year old inland container port at Rasuwagadhi in Rasuwa (north of Kathmandu). The catastrophe is also reported to have made four Nepalese hydro-power plants along the Bhote Koshi river unusable, obliterating 8% of the country's power supply. With rising temperatures and subsequent glacial melt, the increased risk of GLOFs is threatening life and property in the higher Himalayas.

Do trans-boundary watersheds diminish possibilities of early warning?

While Chinese authorities have as yet refrained from confirming the cause, most Nepalese scientists and officials confirmed a GLOF event in Tibet, where a supra-glacial lake had burst, diminishing its surface area to 43 hectares from 63 hectares a day before. Nepalese officials were quoted lamenting in local media that neither did the Chinese authorities provide an early warning, nor was there an established system of doing so, despite a recent increase in supra-glacial lakes on the Tibetan side.

Hours later, on the same day, another GLOF event occurred at a moraine-dammed lake in the northern part of the Mustang district in Nepal (north-west of Kathmandu). Two months before, two glacial lakes in the Humla district (far-north corner of Nepal) had witnessed significant GLOF events, while in 2024, a GLOF in the Solukhumbu district had destroyed the Thame village in Nepal, the base camp for Mount Everest climbers. The need for trans-boundary collaborations in setting up early warning protocols seems paramount, given that Nepal has lost many lives and much infrastructure in successive GLOF events.

Similar events have impacted Nepal regularly, including the GLOF in Cirenma Co, a glacial lake, in Tibet in 1981, which released 20 mcm of water raising the Bhote Koshi river by 30 metres. Several decades later the same lake was reported to have rejuvenated and was rated high-risk. Other significant events include the Dig Tsho GLOF event in 1985, and the Tama Pokhari GLOF event in 1998. In response, Nepal has conducted risk mitigation works on the Imja Tsho and Tsho Rolpa lakes by drawing down water levels through artificial channels, a challenging task at heights above 5,000 m, and has further plans to target half a dozen more at-risk glacial lakes.

What is the nature of GLOF risk for India?

As per India's National Remote Sensing Centre, the Indian Himalayan Region (IHR) is home to 11 river basins and 28,000 glacial lakes. There are two prominent types of glacial lakes found in the IHR. The first are supraglacial lakes, formed in depressions on glaciers from meltwater, highly prone to melting in the summer months. The second are moraine-dammed lakes, formed by meltwater at the toe/snout of a glacier, dammed by loose debris or ice-cores, making them prone to sudden failure.

Definite risk: The south-end of the Shako Cho lake (5,200 m) in north Sikkim. The south-end shows the weak debris that forms its moraine-dam. NDMA

Almost two-thirds of GLOF events are triggered by ice avalanches or landslides, and the remaining due to excessive meltwater pressure on weak moraine dams and earthquakes.

With 2023 and 2024 being the hottest years on Earth, extreme temperatures in smaller geographies have been higher, thereby causing more glacial melt in certain pockets, making some glacial lakes highly risky.

In addition to rising heat, is the problem of scale. 7,500 glacial lakes are situated in India, with most above 4,500 metres in height, hence approachable for surveys only during a short window in the summer season. There are almost no weather and water monitoring stations in these regions due to inaccessibility, lack of sustainability and cost, leaving this growing risk largely unmapped.

The only credible means is measuring growth in surface area via remote sensing over periods of time, a measure which is post-facto and provides little by way of risk assessment or early warning of any sort.

Additionally, vulnerability of the immediate geography is critical to determining the exact nature of risk. This includes damage to homesteads, livelihoods, biodiversity, bridges and hydro-power projects along rivers that relay GLOFs downstream. The South Lhonak GLOF in 2023 in Sikkim wiped out the $2 billion and 1200 MW generating Chungthang dam and also intensified the flash flood causing massive silting downstream. Since then, the Central Water Commission has found that the Teesta riverbed has risen several metres, significantly reducing its carrying capacity and increasing the chances of its banks overflowing.

Besides the Sikkim GLOF, one of the most damaging events in recent times was the Chorabari GLOF in 2013, which turned into a cascading disaster accompanied by cloudbursts and landslides, known as the Kedarnath catastrophe – causing hundreds of casualties and billions in infrastructure damage.

How can India reduce GLOF risk?

The National Disaster Management Authority (NDMA) has markedly accelerated its efforts to manage these increasing risks. With respect to mitigation, it has initiated a proactive shift from mere post-disaster response to risk reduction through its Committee on Disaster Risk Reduction (CoDRR). This national coordination effort brought together related central scientific agencies, academic and research institutions, and States/UTs to study, monitor, warn, and mitigate GLOF risk in India. As a result, the central government finalised its first national programme of $20 million, prioritising 56 at-risk glacial lakes. The list has now been expanded to 195, categorised into four risk levels. Following the expected award of the 16th Finance Commission for the period FY2027 to FY2031, there are plans to scale up this programme, significantly.

Objectives of this programme are five-fold – hazard assessment of each at-risk lake; installing Automated Weather and Water Stations (AWWS); establishing Early Warning Systems (EWS) downstream; mitigating risk by drawing down water levels or building flow through retention structures; and community engagement, an essential element of risk reduction. Under the programme, States where glacial lakes are resident were encouraged to take the lead in sending scientific expeditions to 40 of the highest at-risk lakes in the summer of 2024.

One of the critical parameters in the exercise was to encourage Indian technology, systems and scientific expertise, one of which is the science of SAR interferometry – the art of analysing micro-changes in slope stability (upto a centimetre) using remote sensing satellite imagery as high as 10-metre resolution. The near-absence of usage of this scientific method to predict GLOFs and landslides is an identified gap that needs to be plugged through this programme. Another significant gap is the absence of well-resourced Indian foundations and innovative technology providers in the business of risk reduction in the Himalayan cryosphere.

What is status of mitigation efforts?

Several multi-institutional expeditions returned with success stories, across J&K, Ladakh, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh with a couple of light-hearted tales for their archives. One such expedition lost its way in bad weather, and another had to leave behind an expedition member in the village as security so that the rest of the expedition did not pollute the sacred lake by entering its holy waters. These episodes were evidence of the critical need for community engagement, to integrate the local community in expeditions and the need to convince residents of the credibility and sincerity of the exercise.

The successful expeditions conducted bathymetry to assess the volume of water in the lakes; used Electrical Resistivity Tomography (ERT) to understand the existence of ice-cores under moraine-dams, a key reason for dam breaks; and performed UAV and slope surveys of surrounding land/ice forms. Monitoring stations were installed at two lakes in Sikkim, which relay weather and water data every 10 minutes, with a daily dose of pictures of both ends of the lake and its shoreline. In subsequent summers, States will be installing more such systems, thereby overcoming an oft-repeated data-gap in the IHR cryosphere. In the absence of automated early warning mechanisms, Indo Tibetan Border Police (ITBP) deployments in high reaches have been oriented towards the role of manual early warning. After the monsoon this year, States/UTs are gearing up for another round of expeditions.

Safi Ahsan Rizvi is an IPS officer and adviser to the NDMA.

THE GIST

- As per India's National Remote Sensing Centre, the Indian Himalayan Region (IHR) is home to 11 river basins and 28,000 glacial lakes.
- The National Disaster Management Authority (NDMA) has markedly accelerated its efforts to manage these increasing risks. With respect to mitigation, it has initiated a proactive shift from mere post-disaster response to risk reduction through its Committee on Disaster Risk Reduction (CoDRR).
- One of the critical parameters in the exercise was to encourage Indian technology, systems and scientific expertise, one of which is the science of SAR interferometry.

The need for doctor-led innovation

Dr Abdul Ghafur

Consultant in Infectious Diseases, Apollo Hospital, Chennai, and Lead Strategist, QuorumVeda Consulting Services

Y.K.Gupta

National Scientific Co-ordinator, Pharmacovigilance Programme of India

The world of medicine is evolving at an unprecedented pace, fuelled by advancements in artificial intelligence, digital health, and personalised medicine. However, despite the transformative changes, medical professionals often find themselves on the periphery of innovation. Engineers and entrepreneurs increasingly shape the future of healthcare, while doctors are largely confined to their roles as service providers, rather than creators of new medical solutions. This paradigm needs to change if we are to foster the next generation of medical breakthroughs and solve the pressing challenges of our time.

Why doctors must innovate

Medical professionals, with their deep understanding of patient care, clinical workflows, and treatment protocols, are ideally positioned to drive innovation. Healthcare systems worldwide are under increasing pressure to meet the demands of rising patient populations, chronic diseases, and limited resources. By leveraging their insights, doctors can create solutions that address these systemic issues. Doctor-led innovation would ensure that new technologies are not only groundbreaking but also clinically applicable.

However, medical professionals face several obstacles in becoming entrepreneurs. The demanding nature of medical practice, combined with patient care and administrative responsibilities, leaves little time for innovation. Medicine is also inherently risk-averse, to ensure the safest possible care. This cautious mindset contrasts sharply with the risk-taking required in innovation. The discomfort with uncertainty and failure can deter doctors from pursuing entrepreneurship.

Moreover, a lack of exposure to financial management and product development further hinders doctors' transition into entrepreneurship. Medical education is primarily clinical, leaving professionals unprepared for the complexities of creating healthcare solutions. Many doctors also perceive innovation as the domain of engineers. Despite these challenges, successful examples of doctors who have become deep-tech entrepreneurs show that combining both areas is possible.

While starting a clinic or hospital is a form of entrepreneurship, the primarily focus is on conventional service delivery rather than disruptive innovation. While clinics and hospitals enhance healthcare access, they do not fundamentally transform medical practice. True innovation involves developing new treatment methods, medical devices, or digital health solutions that redefine patient care.

This means medical colleges must introduce courses in entrepreneurship, bio-design, and digital health. The curriculum should encourage entrepreneurial thinking alongside clinical practice. Interdisciplinary collaborations between medical and engineering students would enable doctors to understand product development while allowing engineers to gain clinical insights. Innovation hubs and incubators should support problem-solving in healthcare.

Internships in biotech incubators should be integrated into medical education, exposing doctors to startup environments and the commercialisation of healthcare innovations. Hospitals should establish innovation hubs to help doctors test new ideas. Mentorship programmes must connect medical professionals with engineers and funding sources to help them navigate regulatory pathways. Government incentives and streamlined regulatory processes should support med-tech startups to ensure financial and bureaucratic barriers do not stifle innovation.

In India, MedTech entrepreneurs benefit from a wide array of supportive systems aimed at fostering innovation and growth. Government initiatives such as the Biotechnology Industry Research Assistance Council, Startup India, and Atal Innovation Mission offer funding, grants, and infrastructure support, while incubators such as the Centre for Cellular and Molecular Platforms, Venture Center, and the Bangalore Bioinnovation Centre, provide mentorship, research and development facilities, and financial assistance. The Make in India initiative supports MedTech entrepreneurs by promoting local manufacturing, reducing reliance on imports, and offering incentives such as tax benefits and easier regulatory approvals for domestic production of medical devices. Academic collaborations with institutions such as the Indian Institutes of Technology and the Indian Institute of Science drive innovation through research partnerships. The India Health Fund, supported by Tata Trusts, finances innovations in healthcare, particularly in infectious diseases.

The path forward

Innovation in healthcare is no longer optional; it is essential. Doctors must take charge, not just as caregivers but as entrepreneurs and problem-solvers. To facilitate this shift, medical professionals should enrol in short-term courses on product development. Hospitals and medical associations should foster an environment that is innovation-friendly by establishing dedicated funds and organising events where doctors can present ideas to investors. De-stigmatising failure in medical entrepreneurship is crucial. Just as failed experiments contribute to scientific progress, unsuccessful startups provide lessons for future success. The medical community must embrace calculated risk-taking and take ownership of healthcare's future. The white coat should not only represent clinical expertise but also leadership in healthcare innovation.

Engineers and entrepreneurs increasingly shape the future of healthcare, while doctors are largely confined to their roles as service providers, rather than creators of new medical solutions. This paradigm needs to change

WHAT IS IT?

Deep-brain stimulation: nudging neurons

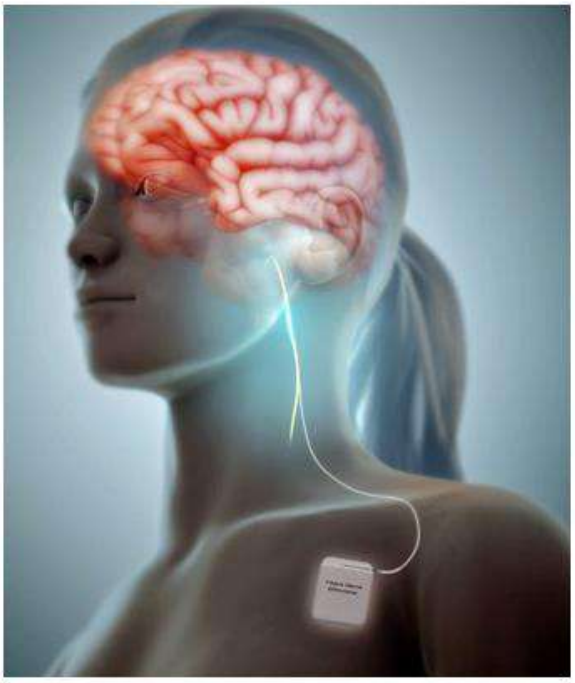
Vasudevan Mukunth

Deep-brain stimulation (DBS) is a medical technique where doctors implant electrodes deep inside specific areas of the brain to treat certain disorders. These electrodes are connected by wires to a small device, similar to a heart's pacemaker, which is usually placed under the skin in the upper chest. The device sends controlled, mild electrical impulses to targeted brain regions, helping adjust abnormal brain activity or chemical imbalances.

DBS is most commonly used for movement disorders, especially in people with Parkinson's disease, essential tremor, and dystonia, whose symptoms no longer respond well to medication. It has also been approved for some psychiatric conditions like obsessive-compulsive disorder, and is being studied for severe depression and epilepsy.

Technically, DBS works by modifying how groups of neurons talk to each other. Many of these disorders involve faulty electrical signals in the brain. Delivering electrical pulses through DBS can interrupt these erratic signals, helping reduce symptoms such as tremors or muscle stiffness. The amount and pattern of stimulation can be precisely adjusted by doctors or, to some extent, by patients themselves using external programmers.

One advantage of DBS is that, unlike brain surgery that destroys tissue, its effects are reversible: if you turn off the device, the stimulation stops. While the exact ways DBS works are still not fully understood, it is believed to help normalise disrupted brain circuits at both the cellular and network levels. More than 1.6 lakh people worldwide have received DBS.



The vagus nerve can be stimulated to manage epilepsy. MANU5 (CC BY-SA)

For feedback and suggestions for 'Science', please write to **science@thehindu.co.in** with the subject 'Daily page'

New microscope reveals molecular jostling faster than ever before

Conventional microscopes are invasive and have limited fields of view. Other microscopes still can't distinguish individual molecules, which are around tens of angstroms in size. A team from Caltech has now found a way to indirectly detect molecules by observing their interactions with light and tapping into Brownian motion

Unnati Ashar

More than a century ago, a 26-year-old Albert Einstein explained Brownian motion in one of four papers he published in his *annus mirabilis*, the miraculous year, called because these papers shot him to fame. Brownian motion is the random jittering of small particles in a fluid, caused because they're constantly colliding with molecules around them.

Now, scientists at the California Institute of Technology (Caltech) have developed a breakthrough imaging technique that enables real-time filming of these molecular motions. Their findings were published in *Nature Communications*.

'Surreal experience'

Conventional microscopes are invasive and have limited fields of view. Other microscopes still can't distinguish individual molecules, which are around tens of angstroms in size (1 angstrom = 0.0000000001 m). To compare, one human hair is about a million angstrom thick. The Caltech team has now found a way to indirectly detect molecules by observing their interactions with light. Their technique also taps into the Brownian motion of particles.

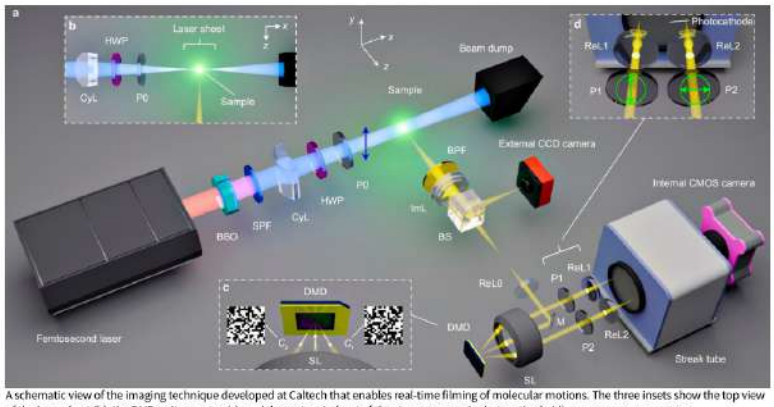
Using the device they have reported that they can see down to tens of angstroms. "It was a surreal experience to visualise molecular sizes in real-time at the angstrom scale," Yogeshwar Nath Mishra, who co-led the study when at Caltech's Jet Propulsion Laboratory and who is now an assistant professor at IIT Jodhpur, said.

"Even more remarkable was the realisation that no existing technique can achieve this level of detail."

Need for speed

The more massive a particle, the slower its Brownian motion. "[It] is like watching how much a spinning object twists after being nudged by light. Small molecules spin fast and scramble the light more. Big molecules spin slowly and keep it aligned," Lihong Wang, director of the Caltech Optical Imaging Laboratory and who supervised the study, said. So by measuring how fast a molecule changes the properties of light, they could determine its size.

The Egyptian-American chemist Ahmed Zewail from Caltech was the first to measure particle motion at super-short time scales. This work allowed his team to observe chemical reactions as they happened for the first time. He was awarded the Nobel Prize for chemistry in 1999.



A schematic view of the imaging technique developed at Caltech that enables real-time filming of molecular motions. The three insets show the top view of the laser sheet (b), the DMD as it operates (c), and the system in front of the stream camera's photocathode (d). NAT COMMUN 16, 5019 (2025)

"While traditional techniques often rely on time-consuming point-by-point scanning, our approach captures the scene in a single shot," Wang said. "We also achieved imaging speeds of hundreds of billions of frames per second, making it possible to observe molecular interactions in unprecedented slow motion."The device is thus the world's fastest single-shot microscope.

"Finally, unlike [traditional methods] which require extensive sample preparation and often damage the specimen, our method is non-intrusive, enabling direct, *in-situ* measurements," Wang added.

"Some of the most exciting features of this microscope include its wide-field imaging capability, offering an image area of a few square centimetres, an order of magnitude larger than conventional microscopes," per Mishra. "To the best of our knowledge, our work is the first ever to achieve the feat of single-shot 2D molecular sizing."

Playing jigsaw

They tested their microscope using a molecule called fluorescein-dextran. Fluorescein is a food colouring dye. Fluorescein-dextran is used to monitor blood flow, drug delivery, and tissue and cell labelling. These fluorescent molecules come in the form of powders. The scientists blended them with water and used clean pipettes to pour drops of these samples into cuvettes (clear, short, rectangular tubes for holding liquid samples).\Then they turned to ultrashort pulses from a laser. These lasers aren't unlike those used in LASIK and cataract surgeries. The laser sheet slices through the sample in the cuvette. As it does, the sample emits light that falls on an array of small square mirrors making up a digital micromirror device (DMD).

> The key is the use of the streak camera to detect dynamics in nanoseconds. This is within the actual lifetimes of the molecules and wouldn't be possible with slow detectors or photodetectors
>
> **BASUDEV ROY**
> ASSOCIATE PROFESSOR AT IIT MADRAS

The DMD's job is to shape the light beam. Researchers use software code to tilt each individual mirror in this light-crafter depending on the corresponding pixel in the input image.

"Imagine you're trying to solve a jigsaw puzzle, but instead of having all the pieces, you only have a few of them – and surprisingly, you can still figure out what the full picture looks like," Wang said.

This idea underpins the team's technique, which can reconstruct the full picture from very few measurements provided the structure is repetitive.

The DMD converts the transient scene into a random jigsaw pattern from which researchers can extract information about the full picture.

The light finally passes through a streak tube that converts the photons in light to electrons.

A phosphor screen collects these electrons as they sweep across it and creates a pattern of streaks. The streak pattern reveals the pulse duration from which scientists can infer the sizes of the molecules.

Ensemble of molecules

"It is an interesting piece of work. The key in this work is the use of the streak camera to detect dynamics in nanoseconds. This is within the actual lifetimes of the molecules and wouldn't be possible with slow detectors or photodetectors," Basudev Roy, an associate professor at IIT Madras who works on super-resolution microscopy and wasn't involved in the recent study, said.

The size of molecules measured using their technique concurred with previous estimates.

"It still sees an ensemble of molecules inside a detection region – it still doesn't see a single molecule yet. But the dynamics indicate chemical compositions and also chemical reactions," Roy said.

"Surprisingly, we found out that the technique also works in gas phases. ... Initially, we assumed it would be challenging to apply [it] in turbulent environments, such as within a flame," said study co-lead Peng Wang of Caltech.

The team observed black carbon nanoparticles in flames through the microscope. "Our data in the gas phase turned out to work excellently and the molecule size matches ... experimental observation well," Peng said.

This new imaging technique could help better visualise processes and transform biomedical research, disease detection, drug design, and nanomaterial fabrication, among others.

(Unnati Ashar is a freelance science journalist. unnati_a@ymail.com)

THE GIST

The more massive a particle, the slower its Brownian motion. Small molecules spin fast and scramble the light more. Big molecules spin slowly and keep it aligned. So by measuring how fast a molecule changes the properties of light, researchers could determine its size

The new approach captures the scene in a single shot. Researchers achieved speeds of hundreds of billions of frames per second, making it possible to observe molecular interactions in slow motion. The device is thus the world's fastest single-shot microscope

This new imaging technique could help better visualise processes and transform biomedical research, disease detection, drug design, and nanomaterial fabrication

‘We have to acknowledge that Mughal period saw violence’

The head of the Curricular Area Group for social science textbooks, which works with NCERT, says previous attempts at writing textbooks have whitewashed such aspects unnecessarily; he says Britain has not recognised sufficiently the tremendous amount of suffering it inflicted not only on India but also on most of its colonies; textbook development team experienced zero political pressure, he says

INTERVIEW

Michel Danino

Maitri Porecha
NEW DELHI

Michel Danino, guest professor (archaeological sciences) at the Indian Institute of Technology, Gandhinagar, and head of the Curricular Area Group for social science textbooks, which works in collaboration with the National Council of Educational Research and Training (NCERT), speaks about the process of designing new social science textbooks for middle school and the controversies surrounding the portrayal of the Mughals and the colonial era in the new Class 8 textbook. Edited excerpts:

A debate has arisen about the portrayal of Mughals in the new Class 8 NCERT textbook with their rule being called ‘a blend of both brutality and tolerance’. Elaborate on an attempt to reframe portrayal of Delhi Sultanate and Mughals in the new textbook.

We did speak of brutality and tolerance, though we did not highlight these two words. They were caught by the media. It is a fact that this is a period which sees a lot of violence, and we have been pretty mild about it. If you look at Muslim texts like *Baburnama* or *Akbarnama*, there is no doubt that these conquests were very violent. In the initial stages, this violence was not limited to India. The Turkic, Mughal, and Afghan powers warred against each other, in the Indian subcontinent as well as in Central Asia, sometimes in Persia and beyond. This has to be acknowledged as a fact of history. We feel that preceding attempts (at writing textbooks) often have been whitewashing some of these aspects unnecessarily. We have tried to show the complexity of their personality (the Mughals).

What was the thought behind putting the note on ‘History’s Darker Periods’ at the beginning of the history section. Also, there was an example of the Second World War and Nazi atrocities. Please explain.

It is more of a preparatory note for the student who suddenly would be exposed to unpleasant events of the past. This phase is in the so-called medieval period and the colonial era where there are famines, millions of deaths. The Second World War is the most striking example you can take where there were untold atrocities. And yet we find that a few years after the Second World War, Germany is on good terms with most of the European powers, including those that Nazi Germany had mistreated. It is possible because the facts were faced and accepted, because there was no attempt to deny them. We are not trying to parallel this with anything in the Indian past, but it’s only by looking honestly at history that you can find the key to healing, you know, the suffering. Because there is a government in place, in the U.K. too. And it is not unknown that there had been trillions of dollars of drain of wealth that has also been very well documented, from British rule to Britain. I feel that Britain has not recognised sufficiently the tremendous amount of suffering that it inflicted not only on India but also on most of its colonies. I will not discuss the question of reparation, which is a separate question, but at least an honest admission of guilt, of the abuse, atrocities and economic plunder that took place during the colonial period, is something that we have not seen to a desired extent.

The new Class 8 social science textbook, unlike older versions, has no mention of Tipu Sultan or Haider Ali. On the other hand, there is an entire chapter dedicated to the rise of Marathas and Shivaji’s exploits. What was the thought behind introducing a new chapter on Marathas?

For events like the Anglo-Mysore Wars you have to give the student enough context for that event to become meaningful. You can’t just drop names like Tipu Sultan and Haider Ali. However, there are four more years after Class 8 where the working groups can take certain themes (which were missed out), and the gaps will be somewhat filled in the later years, hopefully.

It is very well known among historians that the division between Hindu, Muslim, and then the British period is absolutely not valid. We wanted to show that this was not a straightforward story and there was a lot of resistance. We could only very briefly mention the case of the Ahoms in Assam and the Sikh Empire.

We selected the Marathas for bigger treatment because it is a fact that they were the ones who ultimately managed to build, though briefly, an empire which spread over a very large portion of India, since their influence extended to Delhi and even beyond to what is today’s Pakistan.

They stymied multiple attempts by Mughals to conquer South India. Aurangzeb spent more than 25 years stuck in the Deccan. He was able to return to Delhi mostly because he was blocked by the Maratha campaigns.

I am just explaining the statement which we made in the textbook that was deliberately a little bit provocative – maybe the British conquered India more from the Marathas than from the Mughals.

There are rumours that there could be interference of the right wing in directing the trajectory of the new textbooks. Does the development of new textbooks mean that there is a reshaping of political ideology?

So the media loves these stories, and finding a political axe to grind is always very tempting. Our textbook development team has experienced zero political pressure from the government or from any right wing channel or personality whatsoever. We have been left free to work the way we thought we should work under the National Education Policy, 2020 and the National Curriculum Framework mandate.

Full interview is available at newsth.live/micheldanino

Heritage conservationist Tara Murali, 75, passes away

The Hindu Bureau
CHENNAI

Tara Murali, 75, architect and wife of N. Murali, Director of The Hindu Group of Publications and president of The Music Academy, passed away at their home in Chennai late in the evening of Saturday. She had been ailing for some time.

She is survived by her husband, their son Krishna Murali, their daughter Kanta Murali, three grand-children, and her elder brother, Ramesh Pattabhiraman.

Tara Murali was schooled at Sacred Heart Matriculation Higher Secondary School at Churchpark in Chennai, did her pre-university course at Stella Maris College, and took her Bachelor of Architecture (B.Arch.) degree at the School of Architecture and Planning, University of Madras. She had an active architectural practice over four decades and pursued public causes related to town planning, and environmental and consumer protection. Among the causes she has taken up were the conservation of Palani Hills, protection of heritage buildings including the Director General of Police's office, and Queen Mary's College.

Tara Murali

Thoroughly secular and modern in outlook, she had varied interests: music, literature, environment, heritage and consumer action. She served for several years as a Trustee of the Citizen Consumer and Civic Action Group (CAG), was a member of the Broadcast Complaints Council and INTACH governing council, and was active in book groups. She was President of the Tamil Nadu Table Tennis Association and also of the Table Tennis Players Welfare Association. She translated Ma. Po. Sivagnanam's Tamil book on Veerapandiya Kattabomman into English.

The cremation will be at the Besant Nagar crematorium on Monday.

She was known for pursuing public causes, promoting civic rights, heritage conservation, and environmentalism

Legacy of Chola dynasty provides road map for modern India: PM Modi

Prime Minister announces statues for Rajaraja Chola and Rajendra Chola I; like Cholas, India too accords high priority to national security, gave firm response during Operation Sindoor, he says

The Hindu Bureau
GANGAIKONDA CHOLAPURAM

Paying glowing tributes to the military might and administrative acumen of Chola dynasty emperors Rajendra Chola I and his father Rajaraja Chola, Prime Minister Narendra Modi on Sunday said the heights reached by the emperors were a source of inspiration, providing an ancient road map for India to become a developed nation.

"The economic and strategic advancements during the Chola era remain a source of inspiration to modern India. To become a developed nation, we must prioritise unity, strengthen our navy and defence forces, and look for new opportunities, while safeguarding our core values," Mr. Modi said at the valediction of the Aadi Thiruvathirai festival marking the birth anniversary of Rajendra Chola I at Gangaikonda Cholapuram in Tamil Nadu.

Mr. Modi also released a commemorative coin in honour of Rajendra Chola I. The king had built Gangaikonda Cholapuram, the ancient capital of the Imperial Cholas, along with the Brihadisvara Temple and the Cholagangam, a massive lake, after his victorious expedition to the Gangetic plains about 1,000 years ago.

Steeped in history: Prime Minister Narendra Modi at Brihadisvara Temple in Gangaikonda Cholapuram in Ariyalur on Sunday. SPECIAL ARRANGEMENT

The Prime Minister said the Centre would install grand statues of the two emperors in Tamil Nadu to serve as pillars of the country's historical consciousness. "The legacy of Rajaraja Chola and Rajendra Chola is synonymous with India's identity and pride. The history and heritage of the Chola Empire proclaim the true potential of India," he said.

Cholas' democracy

Rajaraja Chola built a powerful navy; his son Rajendra Chola I strengthened it. The Cholas strengthened local administration and established extensive trade and cultural links. The Chola rulers extended their diplomatic and trade relations to Sri Lanka, the Maldives, and Southeast Asia, he said.

India, too, accorded the highest priority to national security, Mr. Modi said, adding that during Operation Sindoor, the world witnessed the firm and decisive response of the country to any threat to its sovereignty.

Mr. Modi said the dynasty was not only known for its military strength but also for being the mother of democracy by introducing the *kudavolai* system of electing local representatives. The global discourse at present revolved around water management and ecology preservation, but our ancestors understood the importance of these issues long ago, he said, citing the water management systems created by the Cholas.

"The Chola rulers had woven a thread of cultural unity. Our government is carrying forward their ideals," he said, referring to the conduct of the Kashi Tamil Sangamam and the Saurashtra Tamil Sangamam to reinforce the centuries-old bonds of unity. Over the past decade, the nation had worked in mission mode to preserve its cultural legacy. About 600 ancient statues and artefacts, which were stolen and sold abroad, had been brought back to India since 2014. Of them, 36 belonged to Tamil Nadu.

Tamil Nadu Governor R.N. Ravi, Union Minister of State for Information and Broadcasting L. Murugan, State Ministers Thangam Thennarasu and S.S. Sivasankar, and Chidambaram Lok Sabha Member Thol. Thirumavalavan were present.

SIR has become a process to rule on citizenship: INDIA

I humbly urge the Election Commission... it is not a matter of political obstinacy or institutional arrogance. Please reconsider it... everyone is urging you

A.M. SINGHVI
Congress leader

They [EC] are making all kinds of self-congratulatory and misleading claims... basically corroborating our apprehension

DIPANKAR BHATTACHARYA
CPI (ML) Liberation leader

The Hindu Bureau
NEW DELHI

The Indian National Developmental, Inclusive Alliance (INDIA) on Sunday urged the Election Commission (EC) to refrain from "institutional arrogance", and stop the special intensive revision (SIR) of the electoral roll in Bihar, saying it has effectively become a process of establishing citizenship.

Speaking at a joint press conference, along with Communist Party of India (Marxist-Leninist) Liberation general secretary Dipankar Bhattacharya, Rashtriya Janata Dal MP Manoj Jha, and Communist Party of India (Marxist) leader Nilotpal Basu, Congress Rajya Sabha member A.M. Singhvi said it was not an issue of "political obstinacy" or "institutional arrogance". "I humbly urge the Election Commission... Please reconsider it," Mr. Singhvi said.

Stating that the SIR had become a process of establishing citizenship, he asked if the EC was authorised to do so. The Congress leader cited a 1995 Supreme Court judgment to say that detailed legal provisions should be followed to take away anyone's citizenship.

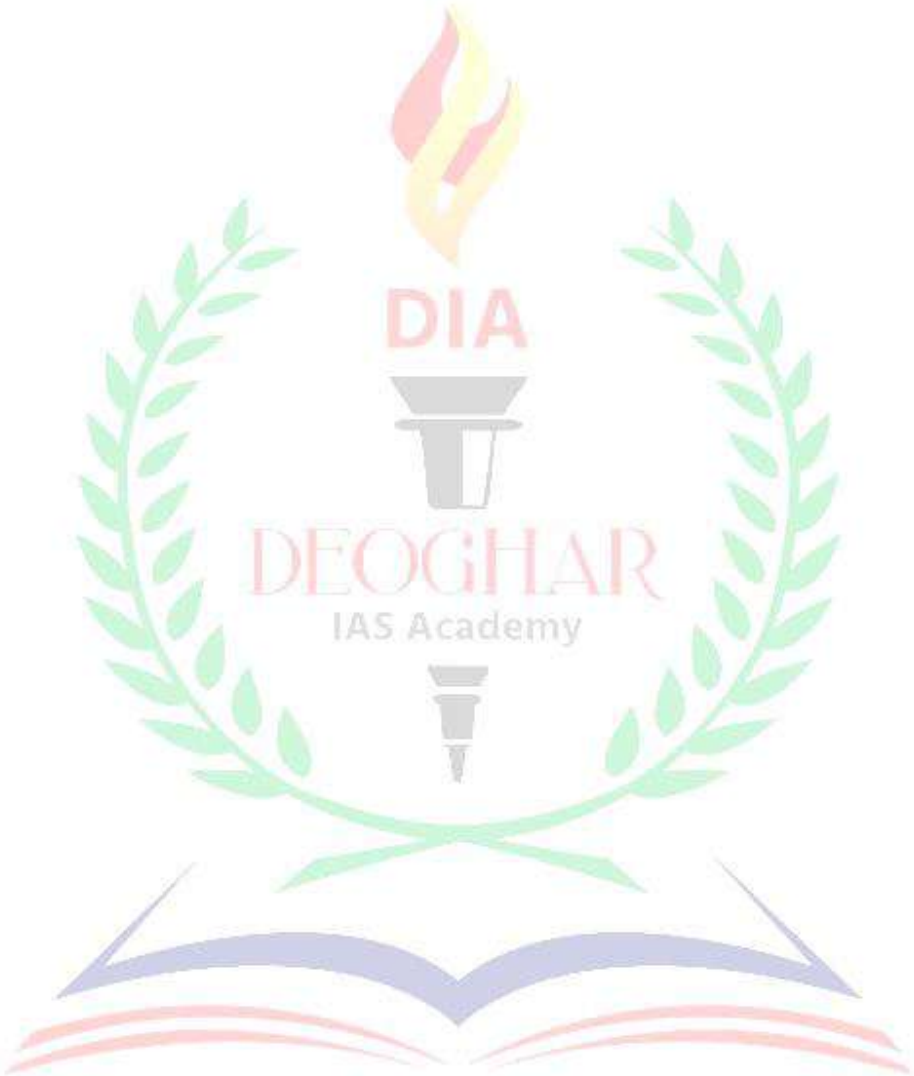
About 10 elections had been held after 2003 and till then, all the ID cards had been valid throughout. "In that case, what was the urgency in initiating the process in June-July, link it to an election," he said, adding that the exercise could have been undertaken after yet another election (Bihar). The attempt to squeeze the entire process within two-three months was resulting in several errors, Mr. Singhvi said.

Mr. Bhattacharya said the EC's "self-congratulatory" statements were confirming the INDIA bloc party's apprehensions. After the process started, the number of possible deletions from the voters' list kept increasing, he said. The Opposition parties had flagged concerns over about two crore alleged deletions.

"The EC has made one very misleading and false claim that it has shared this with the political parties. We have received block-level data about pending enumeration forms, which were not submitted... had the details been shared with us, we could have cross-checked them before the draft was prepared...," Mr. Bhattacharya said, stating that no door-to-door visits had been made during the EC's exercise.

Describing it as the biggest exercise of "disenfranchisement since Independence", Mr. Jha said the EC had not consulted political parties on the SIR.

'91.96% SUBMITTED FORMS'
» **PAGE 4**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