After second de-boost, Chandrayaan-3 on glide path to moon

Hemanth C.S.
BENGALURU

The lander module of Chandrayaan-3, the third lunar mission of India, is expected to touch down on the surface of the moon around 6.04 p.m. on Wednesday, the Indian Space Research Organisation (ISRO) said on Sunday.

The powered descent of the lander module with the rover in its belly is expected to commence at 5.45 p.m., it said.

The space agency completed the second and final de-boosting (slowing down) of the module in the early hours of Sunday.

"Chandrayaan-3 Mission: The second and final deboosting operation has successfully reduced the LM [lander module] orbit to 25 km x 134 km," ISRO posted on X (formerly Twitter).

It added that the module would now undergo internal checks and await sunrise at the designated landing site.

Live streaming

Announcing the time of the moon landing, the space agency said the event would be broadcast live from 5.27 p.m. on Wednesday.

The live coverage would be available on multiple platforms, including the ISRO website, YouTube, ISRO's Facebook page, and DD National TV channel.

CONTINUED ON
» PAGE 14

'Chandrayaan to touch down on August 23'

"The soft landing of Chandrayaan-3 is a monumental moment that not only fuels curiosity but also sparks a passion for exploration within the minds of our youth. It generates a profound sense of pride and unity as we collectively celebrate the prowess of Indian science and technology. It will contribute to fostering an environment of scientific inquiry and innovation. All schools and educational institutions across the nation are invited to play an active role in this historic event. The institutions are invited to actively publicise this event among your students and faculty and organise the Live streaming of the Chandrayaan-3 soft landing within the premises," ISRO said.

In July, while announcing the date of the launch of the Chandrayaan-3 mission, ISRO Chairman S. Somanath said, "If the launch takes place on that day, then we will be ready for landing on the moon possibly by the last week of August. The date is decided when there is sunrise on the Moon. When we are landing, sunlight must be there. So, the landing will be on August 23," he said. Mr. Somanath said that if the landing does not take place on August 23, then ISRO will wait for another month to make a landing attempt.

DRDO drone crashes in Karnataka

The Hindu Bureau
SHIVAMOGGA

An unmanned testing aircraft of the Defence Research and Development Organisation (DRDO) crashed on a farmland in Chitradurga district of Karnataka on Sunday. No one was injured.

The incident happened around 8.15 a.m. While a wing of the aircraft fell on the farmland that belongs to Thippeswamy, another portion was found a few metres away on the land that belongs to Siddappa. The local people informed the police about the crash.

Crash landing: A DRDO UAV crashed on a farmland in Chitradurga district of Karnataka on Sunday. SPECIAL ARRANGEMENT

Chitradurga Superintendent of Police K. Parashuram told *The Hindu* that the unmanned aircraft was being operated by the DRDO facility at Kudapura near Challakere.

The police and the DRDO team, including project director S. Rajagopal, reached the spot. DRDO India, in a post on X, said "TAPAS UAV was undergoing an experimental flight trial today morning from ATR Challakere, Karnataka. During the flight, a technical snag was encountered, and the UAV crashed in nearby farmland. The technical reason is being investigated, and there is no collateral damage".

A similar incident happened at Jodi Chikkenahalli near Challakere in 2019. The incidents have left residents of villages around the Aeronautical Test Range, established by the DRDO, anxious.

Luna 25, Russia's first lunar mission in 47 years, crashes into the moon

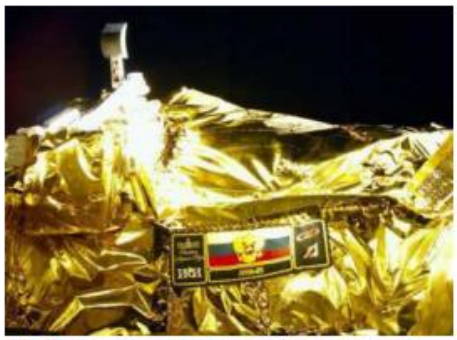
The pilotless spacecraft was aiming to land in the south pole area of the moon where scientists believe there could be important reserves of frozen water and precious elements; Roscosmos had lost contact with the spacecraft on August 19

The Hindu Bureau

Russia's Luna 25 spacecraft crashed into the moon after it spun into an uncontrolled orbit, the country's Roscosmos space agency said on August 20.

The pilotless spacecraft was aiming to land in the south pole area of the moon, an area where scientists believe there could be important reserves of frozen water and precious elements. It had been expected to land on August 21.

However, Roscosmos said it lost contact with Luna 25 on August 19 after the spacecraft ran into difficulties and reported an "abnormal situation".



Failed bid: A picture taken from Luna-25 showing the mission emblem and the bucket of the lunar manipulator complex. REUTERS

"The apparatus moved into an unpredictable orbit and ceased to exist as a result of a collision with the surface of the moon," read a statement from the agency. It said a special commission was looking into why the moonshot failed.

India's Chandrayaan 3 mission, launched on July 14, is also hoping to land in the moon's south pole area.

Its lander's powered descent is expected to begin on August 23 evening.

Implications of failure

The lunar mission was Russia's first since 1976, when it was part of the Soviet Union. Only three governments have managed successful moon landings: the Soviet Union, the U.S., and China.

The lunar south pole is of particular interest to scientists, who believe the permanently shadowed polar craters may contain frozen water in the rocks that future explorers could transform into air and rocket fuel.

The failure of Luna 25 - Russia's first moon mission since 1976 - underscores the decline of Russia's space power status, from a time when it was the first country to launch an artificial satellite and launched the first human, both to earth orbit.

Multiple plans

In the past three decades, Russia has considered various moon missions that were delayed or shelved amid the chaos of the 1991 fall of the Soviet Union and, later, by the ill-fated Fobos-Grunt mission, to a Mars moon, in 2011.

Eventually, in the early 2010s, Russia settled on Luna 25 for the lunar south pole.

(with agency inputs)

The vagaries and dangers of space that Chandrayaan-3 is built to brave

A journey through space – even as short as the one from earth to the moon – is an adventure in which the spacecraft's own needs need to be balanced against the harsh demands of spaceflight; vacuum, extreme temperatures, and radiation make space a brutal workplace which requires minute planning

Awanish Pandey

On July 14, the Indian Space Research Organisation (ISRO) launched its Chandrayaan 3 mission. In roughly a month, the mission spacecraft built up its momentum around earth, slingshot itself to the moon, and there, is currently preparing to descend over the lunar surface on August 23.

While Chandrayaan 3 has a complicated mission, a lot has gone into increasing the chances of its success, including how its instruments were built and tested. A journey through space – even as short as the one from earth to the moon - is an adventure in which the spacecraft's own needs need to be balanced against the harsh demands of spaceflight.

The solar wind

A particularly frustrating problem is due to the sun. The scorching hot surface of the star, a very busy place, emits a stream of energetic charged particles, such as protons and electrons, moving extremely fast, called the solar wind. Since they are charged and earth has a magnetic field, these particles are deflected and guided towards earth's magnetic poles.

When they cross over into the planet's upper atmosphere, the electrons and protons collide violently with atoms there, especially oxygen and nitrogen, which are its chief constituents. When the oxygen and nitrogen atoms absorb an electron, they acquire 'excess' energy that they release as photons, or light, of some frequencies. Oxygen is responsible for the shades of green and orange, whereas nitrogen contributes to the blues.

These interactions produce the radiant display known as the northern lights, spanning a spectrum of hues and intensities.

Earth's magnetic field renders such beautiful skies as well as protects the life and objects it hosts from the wrath of the solar wind. But earth also has its own van Allen radiation belts - particles from the solar wind that are now trapped along the planet's magnetic field.

Particles that sway polls

This said, unlike instruments on the ground, satellites, space stations, and moon-bound spacecraft like Chandrayaan 3 have no 'natural' protection, leaving them vulnerable to a variety of issues.

The equipment onboard these spacefaring vessels have to withstand the impact of the particles of the solar wind or face catastrophic failure. The potential problems range from laptops crashing to a complete malfunction of critical systems, as was the case with Canada's Anik E2 satellite in 1982.

The Chandrayaan 3 propulsion module (top) attached to the lander (bottom) containing the rover, while undergoing a test. ISRO

Generally, these effects are categorised as displacement damage and single-event transients. Displacement damage results when the impact of a charged particle in the solar wind is so strong that it displaces an atom in an electronic chip. Such damage, due to which the chip's performance decays over time, is usually permanent.

Single-event transients cause signals being transmitted by the spacecraft to momentarily fluctuate, corrupting the intended message encoded in the transmission. In a famous example of such signal corruption, votes ended up being miscounted in an election in Belgium in 2003. A single-event transient flipped a bit in a voting machine from '0' to '1', resulting in one candidate receiving 4,096 votes more in the poll.

Multiple protections

With all possible outcomes in mind, scientists and engineers use advanced engineering techniques to design and manufacture the corresponding electronics, and these are commonly called radiation-hardened electronics.

> Chandrayaan 3 represents an important collective achievement, on the part of ISRO and people who acquired the knowledge, engineered materials, planned for eventualities and launched it to the moon

During chip design, manufacturing, and packaging, experts meticulously consider radiation levels and possible damage mechanisms, and incorporate multiple layers of protective measures in both software and hardware components. For instance, three copies of the same signal can be transmitted (triple modular redundancy). In the unwelcome event of bit corruption, the other two bits can 'outvote' the corrupted bit.

These safeguards also need to be mindful of those required to protect the instruments against other problems.

For example, just before they get to space, they need to be launched. On the launchpad, the rocket's contents - including the spacecraft it is launching - will be subject to severe vibrations. So the instruments have to be built and tested to make sure they survive this experience.

A hairy environ

In space, the spacecraft could experience enormous temperature fluctuations. Chandrayaan-3 itself may have to work through both -200 degrees to 200 degrees Celsius, depending on the satellite's position relative to the moon and the sun. Wires could break, solder could fail, and chips could crack. Support materials on the solar panel (required to power the spacecraft) made of copper could become more 'active' - like water at its boiling point - and seep through the solar cell, rendering it inefficient.

When some materials are placed in a vacuum, they release air molecules trapped in them. This outgassing can be a nuisance, particularly with temperature fluctuations. For example, outgassed air molecules can deposit themselves on a camera lens, and there's no one on the moon to wipe the lens. The result: bad photos. Outgassed molecules lodged between electrical contacts can even burn the contacts and electrical switches.

Sometimes there are problems that experts don't fully understand, but nonetheless need to deal with. For example, one explanation for why some metal coatings form whiskers - electrically conductive protrusions - is that they are expressions of built-up stress in the metal. Some metals 'grow' whiskers when in a vacuum, and the whiskers can short some circuit or other. Several satellites have failed completely as a result. In response, experts need to carefully select the metal coating and optimise the way it is applied - an exercise both knowledge- and resource-intensive.

So far, so good

These are just a few of the profound challenges that any space mission must contend with. Vacuum, extreme temperatures, and radiation make for a brutal workplace in which to perform one's job, so only the most resilient, sophisticated, and smart solutions survive.Chandrayaan 3 has survived so far - and this is why, even before it attempts to land on the moon, it represents an important collective achievement, on the part of ISRO as much as the wider national community of people who acquired and synthesised the requisite knowledge, engineered and assembled the materials, planned for a host of eventualities and eventually launched it to the moon.

(Awanish Pandey is a senior fellow at CERN.)

The Katchatheevu controversy

Why is the uninhabited 285 acre islet important to Tamil Nadu and Sri Lanka? What was agreed upon in the 1974 pact between India and the island nation? What has been the stand of the Tamil Nadu government over the years? Can Sri Lanka claim sovereignty?

EXPLAINER

T. Ramakrishnan

The story so far:

On August 18, Tamil Nadu Chief Minister M. K. Stalin revived the debate over Katchatheevu, an uninhabited and barren 285 acre islet about 14 nautical miles off Rameswaram. He reiterated the demand for retrieval of the islet from Sri Lanka, which will, according to him, put a permanent end to the problems of fishermen of the State. Addressing a fishermen's conference in Mandapam of Ramanathapuram district, he pointed out that following his letters to Prime Minister Narendra Modi, fishermen arrested by the Sri Lankan authorities, were released but the boats and fish nets, essential to the livelihoods of the fishermen, had not been returned. Last month, ahead of the visit of Sri Lanka's President to New Delhi, the Chief Minister urged Mr. Modi to raise the issue with the dignitary.

When did Katchatheevu become a part of Sri Lanka?

During June 26-28, 1974, the then Prime Ministers of India and Sri Lanka, Indira Gandhi and Sirimavo R.D. Bandaranaike, signed an agreement to demarcate the boundary between the two countries in the historic waters from Palk Strait to Adam's Bridge. A joint statement issued on June 28, 1974, stated that a boundary had been defined "in conformity with the historical evidence, legal international principles and precedents." It also pointed out that "this boundary falls one mile off the west coast of the uninhabited" Katchatheevu.

How important is Kachatheevu?

Fisherfolk of the two countries have been traditionally using the islet for fishing. Though this feature was acknowledged in the 1974 agreement, the supplemental pact in March 1976 made it clear that fishermen of the two countries "shall not engage" in fishing in the historic waters, territorial sea and exclusive zone or exclusive economic zone of either of the countries "without the express permission of Sri Lanka or India."

While certain sections of political parties and fisherfolk in Tamil Nadu believe that the retrieval of Katchatheevu would resolve the problem of fishermen having to illegally cross the International Maritime Boundary Line, fishermen of the Northern Province in Sri Lanka say that this would only add to their suffering from the adverse impact of T.N. fishermen using the fishing method of bottom trawling on their territorial waters.

Conflicting claims: A view from Katchatheevu. BALACHANDAR. L

What triggered the negotiations between India and Sri Lanka?

Sri Lanka claimed sovereignty over Kachatheevu on the ground that the Portuguese who had occupied the island during 1505-1658 CE had exercised jurisdiction over the islet. India's contention was that the erstwhile Raja of Ramnad [Ramanathapuram] had possession of it as part of his zamin. According to an article published by *The Hindu* on March 6, 1968 which was based on an interview of the erstwhile Raja Ramanatha Sethupathi, Kachatheevu was under the jurisdiction of the zamin "from time immemorial". However, during a debate on the matter in Lok Sabha in July 1974, the then External Affairs Minister Swaran Singh said that the decision had been taken after "exhaustive research of historical and other records" on the islet.

How was the 1974 pact received?

The present demand for the Katchatheevu retrieval traces its origin to the opposition that the pact generated in 1974. During the debates in both Houses of Parliament in July 1974, most of the Opposition including the Dravida Munnetra Kazhagam (DMK), All India Anna Dravida Munnetra Kazhagam (AIADMK), Jan Sangh, Swatantara and the Socialist Party, staged walk outs in the two Houses. Former Prime Minister Atal Bihari Vajpayee, who was the Jan Sangh's leader, had contended that the decision to transfer the islet had been taken "behind the back" of the people and Parliament. The then Chief Minister M. Karunanidhi, in 1973 when the talk of the islet transfer had been doing rounds, had urged Indira Gandhi that the popular feeling was in favour of retaining Katchatheevu which "belonged to India and not to Tamil Nadu alone," according to a report published by *The Hindu* on October 17, 1973. Three months later, he wrote a letter reiterating the stand, a copy of which was released a day after the 1974 agreement was signed. M. G. Ramachandran, founder of the AIADMK, had criticised Karunanidhi for "his failure to guide the Centre properly" on the issue and sought his resignation.

When did the issue emerge again?

The Katchatheevu issue was revived in August 1991 with the then Chief Minister Jayalalithaa demanding retrieval during her Independence Day address. She later modified her demand to one of getting the islet back through "a lease in perpetuity." In the last 15 years, both Jayalalithaa and Karunanidhi had approached the apex Court on the matter.

What has the Centre said?

In August 2013, the Union government told the Supreme Court that the question of retrieval of Kachchatheevu from Sri Lanka did not arise as no territory belonging to India was ceded to Sri Lanka. It contended that the islet was a matter of dispute between British India and Ceylon (now Sri Lanka) and there was no agreed boundary, a matter of which was settled through 1974 and 1976 agreements. In December 2022, the Centre, pointed out in its reply in the Rajya Sabha that Katchatheevu "lies on the Sri Lankan side of the India-Sri Lanka International Maritime Boundary Line." It added that the matter was sub-judice in the Supreme Court.

THE GIST

- On August 18, Tamil Nadu Chief Minister M. K. Stalin revived the debate over Katchatheevu, an uninhabited and barren 285 acre islet about 14 nautical miles off Rameswaram.
- Fisherfolk of the two countries have been traditionally using the islet for fishing. Though this feature was acknowledged in the 1974 agreement, the supplemental pact in March 1976 made it clear that fishing vessels and fishermen of the two countries "shall not engage" in fishing in the historic waters.
- Sri Lanka claims sovereignty over Kachatheevu on the ground that the Portuguese who had occupied the island during 1505-1658 CE had exercised jurisdiction over the islet. India's contention was that the erstwhile Raja of Ramnad had possession of it as part of his zamin.

How AI is used to increase the frequency of Acoustic Side Channel Attacks

In such attacks, the sound of clicks generated by a keyboard is used to analyse keystrokes and interpret what is being typed to leak sensitive information. These attacks are particularly dangerous as they are often underestimated by users

Nabeel Ahmed

The story so far:

In August, a research paper titled "A Practical Deep Learning-Based Acoustic Side Channel Attack on Keyboards", published and supported by the ethics committee of Durham University, U.K., revealed that Artificial Intelligence (AI) can be used to decode passwords by analysing the sound produced by keystrokes. The study highlighted the accuracy of Acoustic Side Channel Attacks (ASCA) when state-of-the-art deep learning models were used to classify laptop keystrokes and their mitigation. While ASCA is not new, the development of AI and deep learning has increased the risks posed by side channel attacks.

What are ASCA?

To understand Acoustic Side Channel Attacks, one should know Side Channel Attacks (SCAs). SCAs are a method of hacking a cryptographic algorithm based on the analysis of auxiliary systems used in the encryption method. These can be performed using a collection of signals emitted by devices, including electromagnetic waves, power consumption, mobile sensors as well as sound from keyboards and printers to target devices. Once collected, these signals are used to interpret signals that can be then used to compromise the security of a device.

In an ASCA, the sound of clicks generated by a keyboard is used to analyse keystrokes and interpret what is being typed to leak sensitive information. These attacks are particularly dangerous as the acoustic sounds from a keyboard are not only readily available but also because their misuse is underestimated by users. While most users hide their screens when typing sensitive information, no precautionary steps are taken to hide the sound of the keystrokes. And though over time, the sound of keyboard clicks has become less profound with devices making use of non-mechanical keyboards, the technology with which the acoustics can be accessed and processed has also improved drastically.

Additionally, the use of laptops has increased the scope of ASCAs as laptop models have the same keyboard making it easier for AI-enabled deep learning models to pick up and interpret the acoustics.

How accurate are Acoustic Side Channel Attacks?

The research conducted by a group of scientists from Cornell University, Durham University, University of Surrey, and the Royal Holloway University of London investigated the use of audio recordings taken from Zoom video conferencing calls, smartphone microphones, and off-the-shelf equipment and algorithms to launch ASCA attacks. The study found that when trained on keystrokes by a nearby phone, the classifier achieved an accuracy of 95%, the highest accuracy seen without the use of a language model.

When a deep learning model was trained on the data with default values, the model was able to acquire a meaningful interpretation of the data. On a MacBook Pro, which features a keyboard identical in switch design to Apple's models from the last two years, the model was able to achieve state-of-the-art accuracy with minimal training data.

Additionally, when the AI model was made to recognise keystrokes using audio captured through a smartphone microphone, it was able to achieve 95% accuracy. However, accuracy dropped to 93% when Zoom calls were used.

Are such attacks new?

ASCA attacks are not new and have been around since 1950 when acoustic emanations of encryption devices were used to crack their security. Additionally, the United States National Security Agency (NSA) declassified documents listed acoustic emanations as a source of compromise in 1982. Over the past decades, researchers have published papers talking about the threats from ASCA attacks with the advent of modern technology that brought more microphones in close proximity to keyboards, making it easier to collect and interpret acoustic data.

However, with the increasing use of AI and the accuracy with which deep learning models can recognise and analyse keystrokes, the threat from ASCA has resurfaced. Especially since users may not take ample precautions while typing in sensitive information including banking data and password on their laptops in public spaces like coffee shops, airports, and cafes.

How can users protect against ASCAs?

While there is no explicit means of defence against ASCAs, simple changes to typing could reduce the chances of attacks. Using touch-based typing can also reduce the chances of successful keystroke recognition from 64% to 40%, making it more difficult for threat actors to leak sensitive information.

Additionally, changes in typing style and creating stronger passwords that use a combination of upper- and lower-case alphabets can make it more difficult for criminals to launch successful ASCA attacks; the study found that even deep learning models had a difficult time recognising the use of shift key to change the case of alphabets when typing. Users should also avoid the use of easily recognisable phrases which can make it easier for AI models to predict the text.