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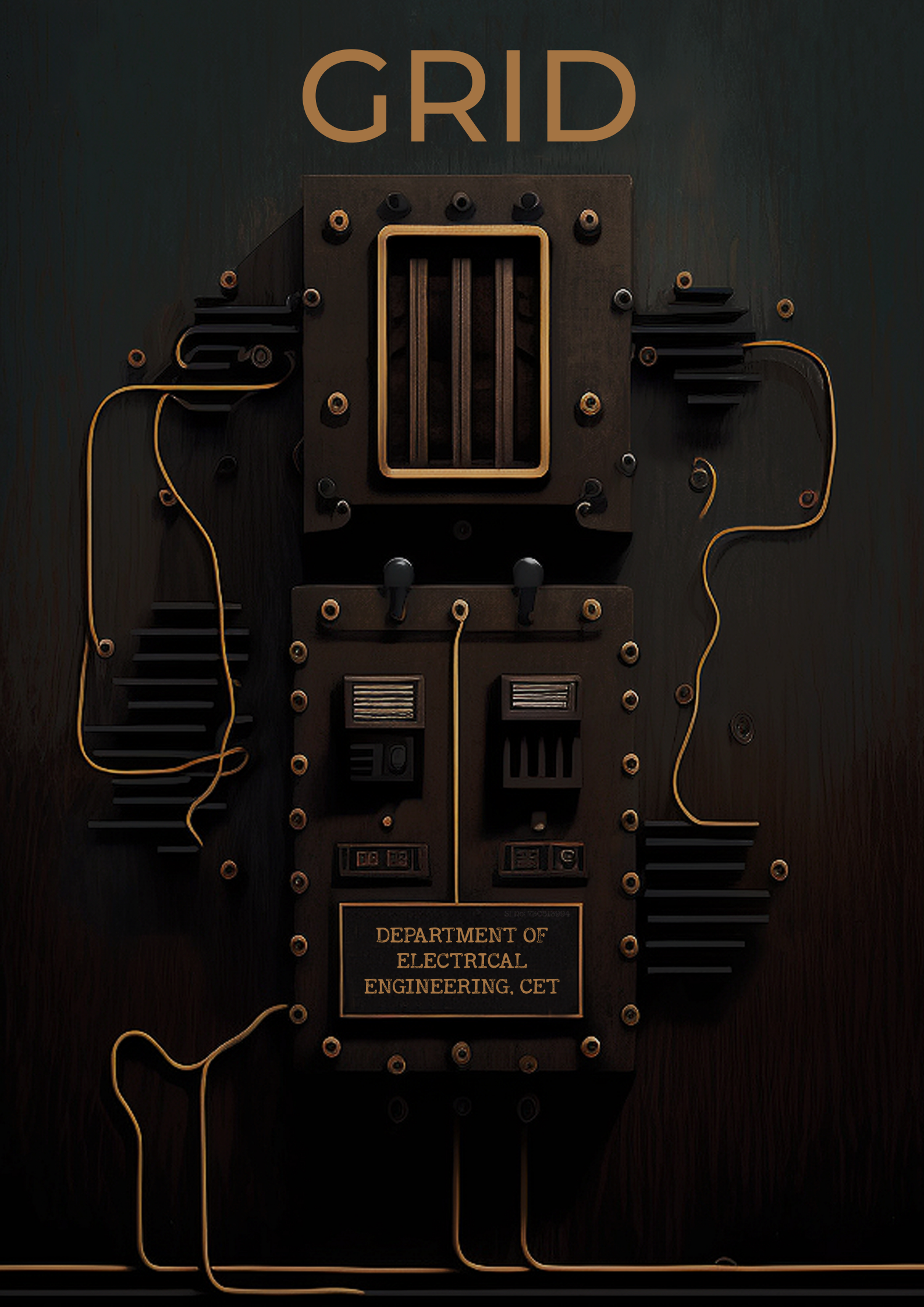

GRID

Issue 3 Volume 1

2021-22

Department of Electrical Engineering

College of Engineering Trivandrum

GRID 3.0
Technical Magazine 2021-22
Department of Electrical Engineering
College of Engineering Trivandrum

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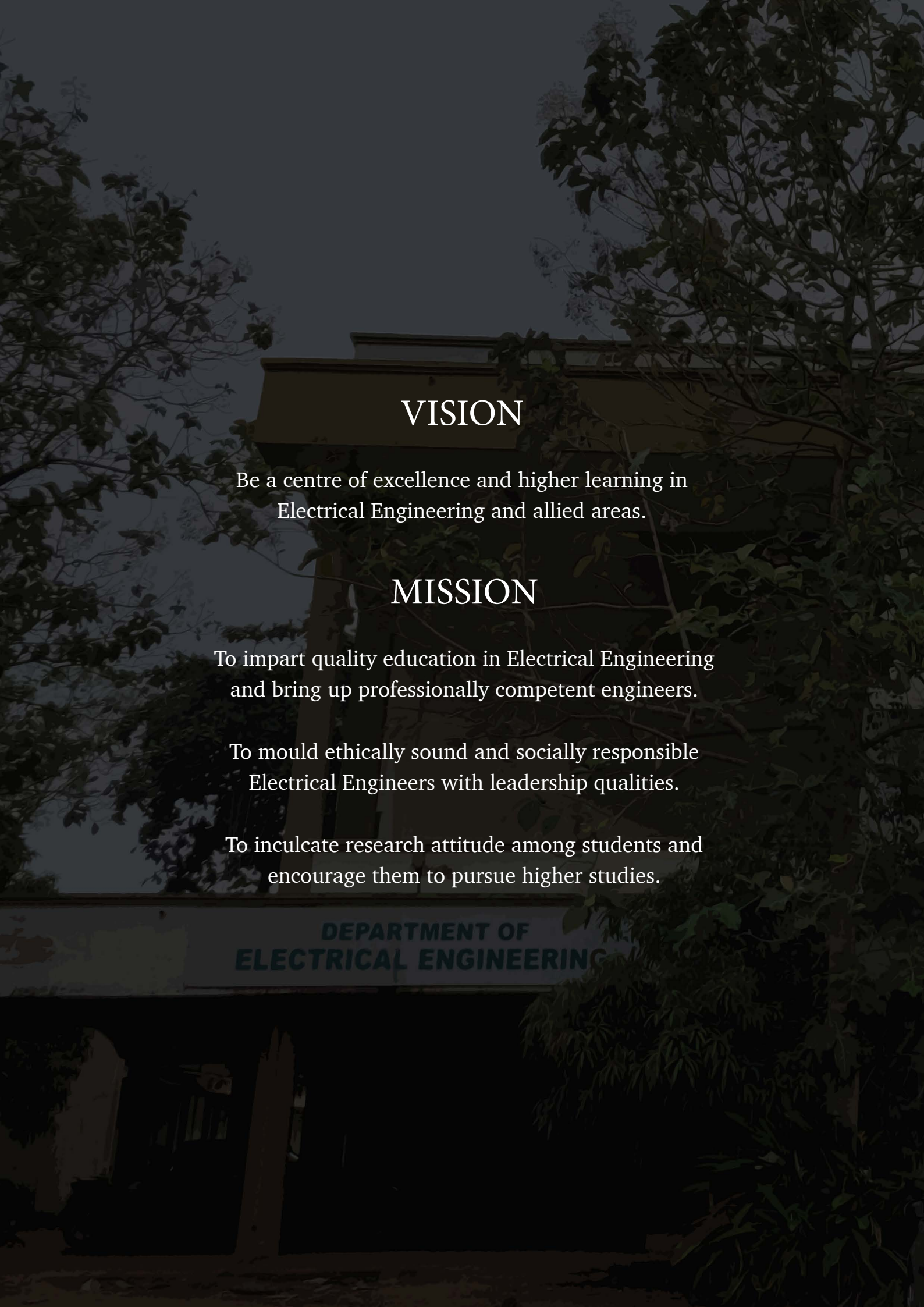
“In loving memory of Prof. Jaijith M B”



VISION

Be a centre of excellence and higher learning in Electrical Engineering and allied areas.

MISSION

To impart quality education in Electrical Engineering and bring up professionally competent engineers.

To mould ethically sound and socially responsible Electrical Engineers with leadership qualities.

To inculcate research attitude among students and encourage them to pursue higher studies.

About the Department

The Electrical Engineering Department at College of Engineering Trivandrum is one of the founding departments and began operations in 1939. Right from its inception, the department has been highly regarded in academic circles for delivering superior technical education to young individuals with a passion for advancing human knowledge and progress. The department is dedicated to furthering human knowledge and progress through the efforts of its students, staff, and faculty. Currently, the department offers undergraduate, graduate, and doctoral programs that have been approved by the All India Council for Technical Education (AICTE). It is also an approved QIP center. Graduates typically secure employment in leading industries or organizations and continue their education at reputable institutions in India and abroad. The department offers a B.Tech program, four M.Tech programs, and a Ph.D. program, all affiliated with APJ Abdul Kalam Technological University.

Message from Principal

I am delighted to hear that the third edition of the technical magazine GRID, produced by the Department of Electrical Engineering, is set to be released this academic year. I appreciate the efforts taken by the students and faculty to bring about pioneering ideas in the realm of technology. The magazine provides a platform for the students and faculty to share their knowledge and insights with a wider audience, thereby contributing to the advancement of the field. I offer my warmest congratulations and best wishes to the team for their continued success in producing future editions of the magazine.

-Dr. Suresh Babu V
Principal
College of Engineering Trivandrum

Message from HOD

It gives me great pleasure to introduce you to the third edition of the Grid, our technical magazine dedicated to the electrical department. Our goal is to keep you informed and updated on the latest advancements, innovations, and breakthroughs in the field of electrical engineering.

As the demand for energy continues to grow, the significance of electrical engineering has never been more apparent. Whether it's power generation and transmission, renewable energy, or smart grid technology, electrical engineering plays a crucial role in addressing some of the most pressing challenges in the world.

Each issue of Grid features comprehensive articles and analysis, interviews with top experts, and the most recent research and developments from across the globe. Our team of writers and editors is dedicated to providing you with the most relevant, accurate, and informative content possible.

Grid also invites contributions from our readers. If you have an intriguing research paper, case study, or project that you would like to share with our audience, please do not hesitate to reach out. Thank you for your continued support, and we hope you enjoy reading Grid.

-Dr. Savier J. S.
Head of Department
Department of Electrical Engineering

Staff Editor's Note

I am delighted in giving this message for the third issue of our technical magazine- GRID for the academic year 2021-2022. Indeed, it was a privilege to be a part of this journey. Magazines are the stress buster for contributors and readers. It is a perfect platform for students and teachers to showcase their co-curricular talents. This magazine is intended to inform students and teachers about the recent advancements in the Electrical and Electronics Engineering domain. Students and teachers with dedication and talent have filled the pages of this issue.

"All of us do not have equal talent. But, all of us have an equal opportunity to develop our talents" -A. P. J. Abdul Kalam

I take this opportunity to congratulate all my team members for their relentless effort in releasing this magazine. We are also grateful to our Principal and Head of the Department for their invaluable suggestions, guidance and encouragement. Finally, we are thankful to our reviewers for their honest feedback and constructive suggestions.

-Staff Editor
Prof. Anu A. G.
Associate Professor

Student Editor's Note

The GRID has been a long journey that came on to us as a surprise. As the editor of the third edition of the GRID, it is my pleasure to bring you the latest information and insights on the advancements in technology. A bunch of dedicated individuals has worked tirelessly to provide you with in-depth articles on the most current and relevant topics in the industry. From cutting-edge research to practical applications, we strive to deliver content that is both informative and engaging. We understand that technology is constantly evolving, and we are committed to staying at the forefront of these developments. It is our goal to provide you with the knowledge and resources you need to stay ahead of the curve.

I am incredibly grateful to our Head of the Department, Dr. Savier J. S. and our staff editor, Prof. Anu A. G., for their invaluable guidance and motivation throughout the process of creating this magazine. My heartfelt thanks also go out to all those who were directly or indirectly involved in the publication. I want to acknowledge the hard work and dedication of every member of the GRID team, without which this magazine would not have been possible.

We hope that you enjoy reading this issue and we welcome your feedback and suggestions for future topics. As always, thank you for your continued support of our magazine.

-Sreelakshmi S
Student Editor

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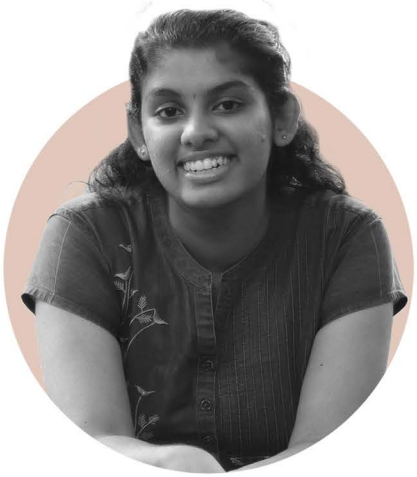

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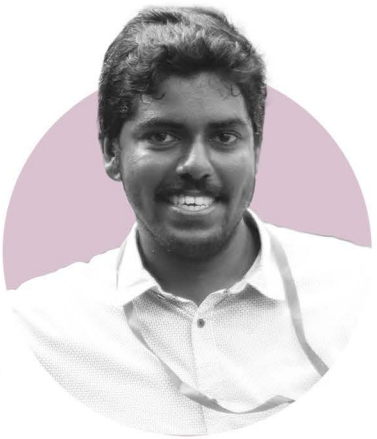

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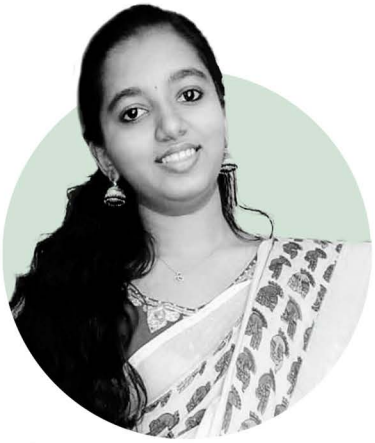

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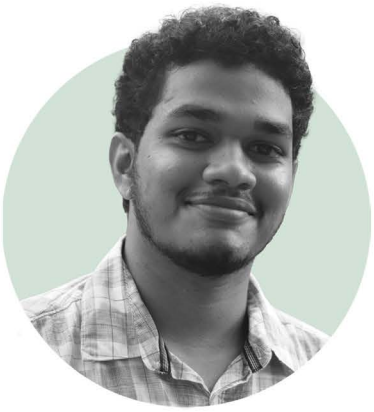

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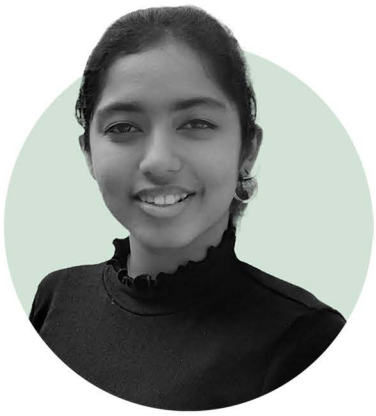

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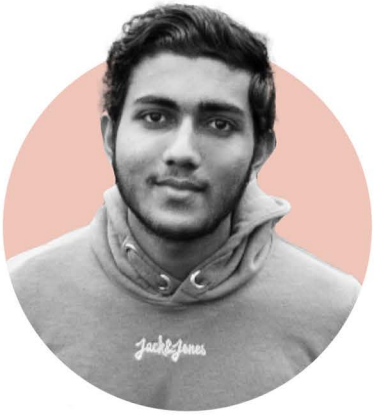

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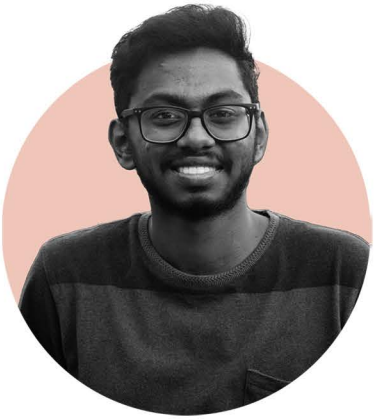

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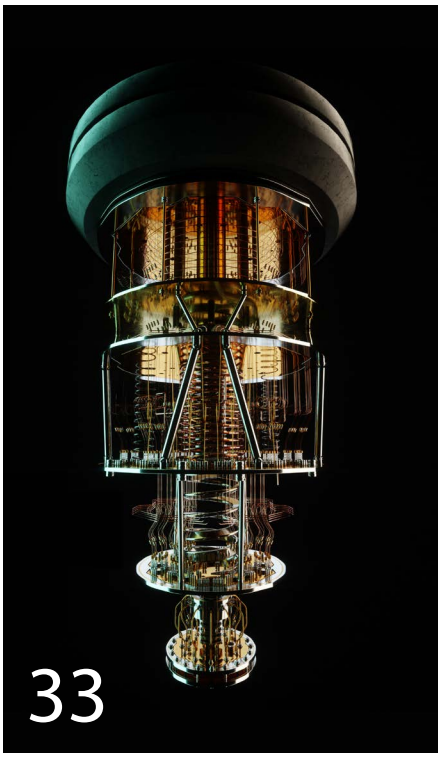
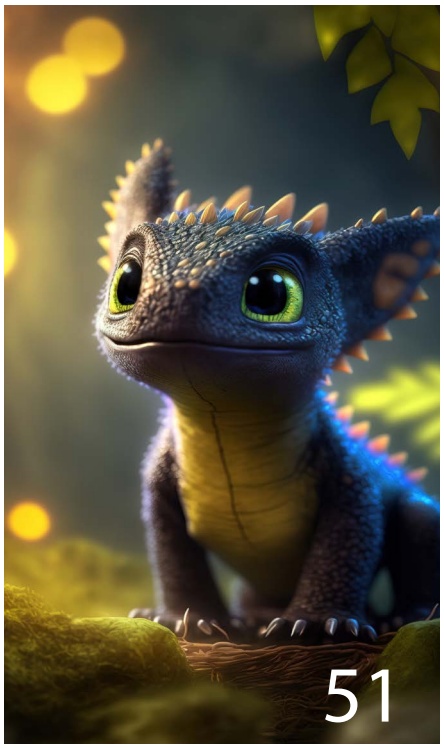
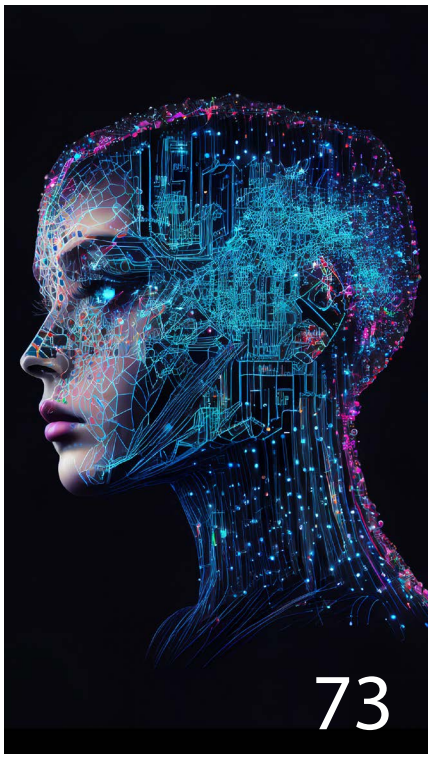
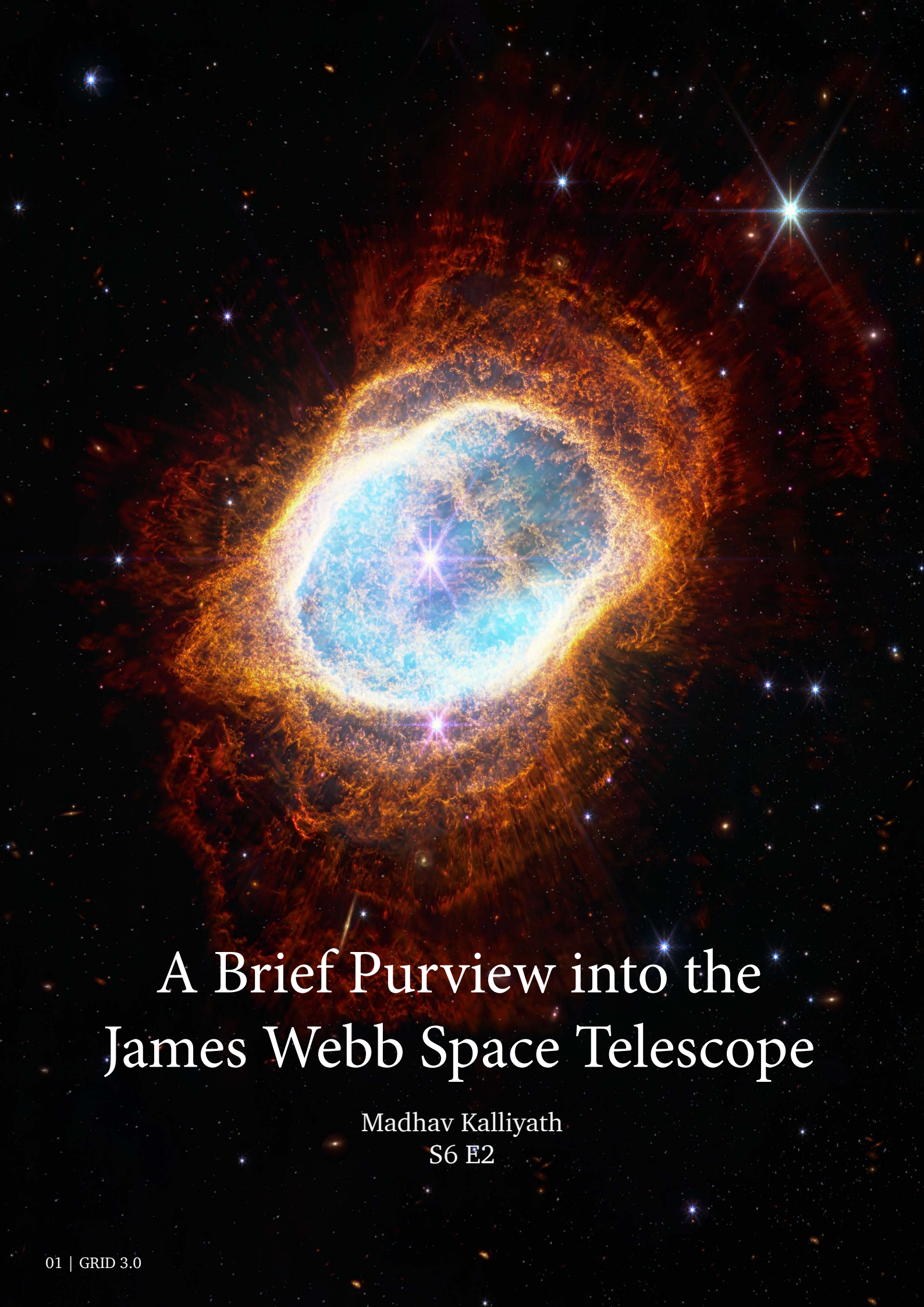








A Brief Purview into the James Webb Space Telescope

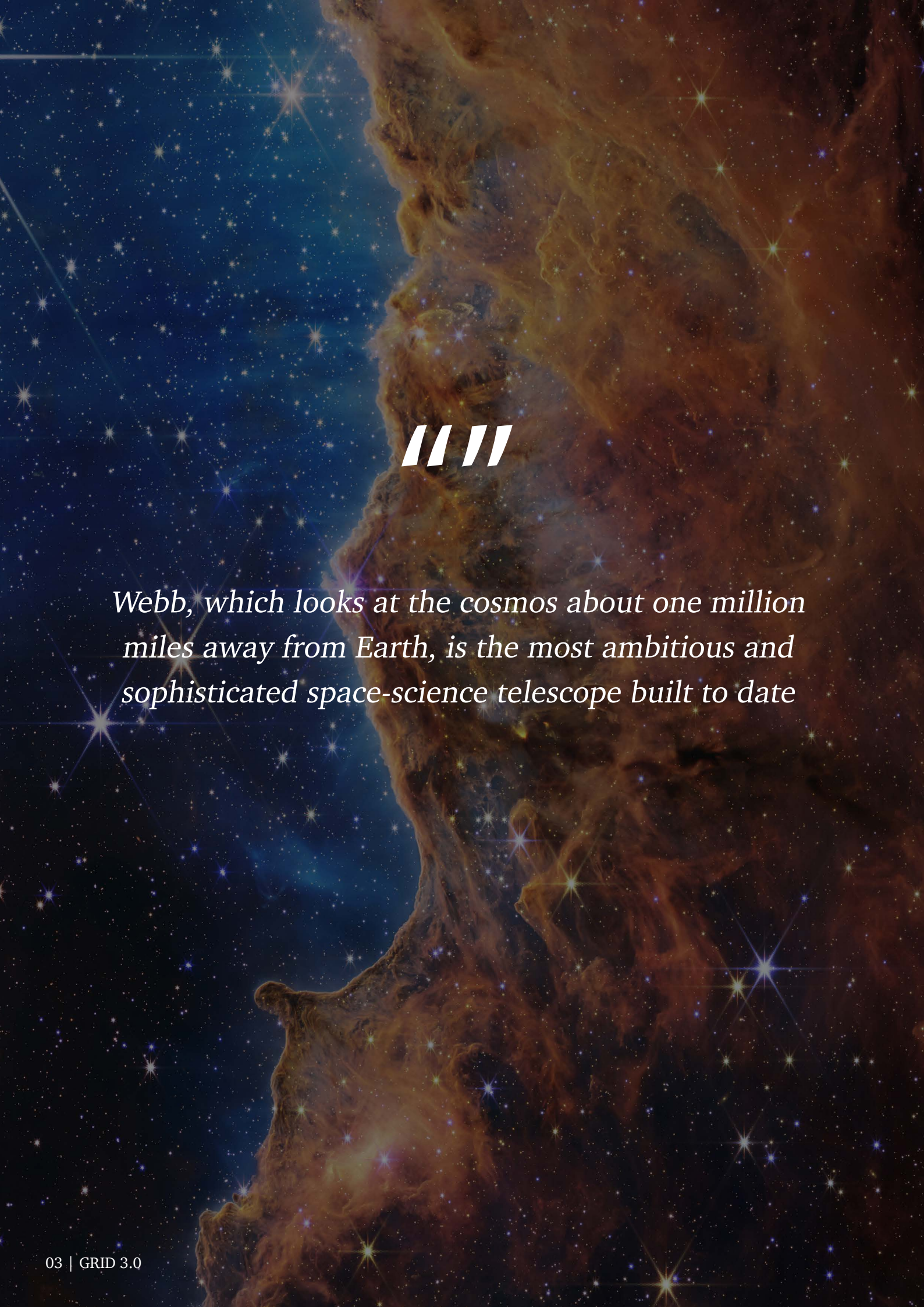
Madhav Kalliyath
S6 E2

The James Webb Space Telescope or the JWST is the largest and most powerful telescope created by humankind costing around $10 billion around the time of its launch, spanning over 25m^2 with its golden hexagonal multitude of sensors. Ensuing its launch the JSWT has released many new and exciting photos from the vast unknown expanses of space. Knowing the image at hand is from the JSWT is in itself a neat trick, due to the odd choice of hexagonal mirrors on the telescope, all glare coming from stars will have 6 specific spikes due to the 6 corners of the individual mirrors. It is located at a point called Lagrange 2 in orbit around the Sun, nearly 1.6 million kilometres from the Earth. With about 45 grams of gold spread across all the mirrors to form a uniform layer of 100nm the mirror setup of the eye in the sky is possibly humanity's best bet on finding new and exciting galaxies and stars. With a time horizon of 5-10 years, the JSWT has locked its vision on an in-depth look into the outer planets of our solar system and beyond.

Building the Webb Telescope was an ambitious effort, and it has now been proven to work and its technology will be implemented into future telescopes. The James Webb Telescope, commonly just called The Webb telescope or JWST, is an orbiting infrared observatory launched under the International Program propelled by NASA, European Space Agency (ESA), and the Canadian Space Agency (CSA) to augment and expand upon the discoveries made by the Hubble Space Telescope. The telescope is named after James E. Webb, the administrator under whose tenure the world witnessed its first moon landing. He also oversaw critical missions like the Gemini and Mercury projects.

The Webb Telescope views the world in infrared wavelengths, which allows for deeper views into space, to see early stars and galaxies in the Universe formed after the Big Bang. NASA's Hubble was capable of looking into the universe in optical and ultraviolet wavelengths whereas the JSWT scouts space through infrared. NASAs James Webb Space Telescope has a mirror that is far larger than Hubbles, a 2.4 meter wide mirror setup compared to a 6.5m wide reflecting surface, giving it more surface area to gather light, and the ability to peer back farther into the past. Billed as the successor to the Hubbles, James Webb's telescope is optimised to see infrared near- and medium-infrared light that is not visible to the human eye, which allows us the opportunity to see through the dust that could blur stars and other objects in Hubble's images. Hubble and JSWT differ in the basic sense, Hubble captures light that comes to it, while the JSWT does not work on the same principle.

The Hubble telescope cameras are currently equipped with better sensitivity and resolution sensors than they were when they were launched, made possible by continued upgrades during several NASA space shuttle servicing missions between 1993 and 2009. The James Webb Space Telescope filled in the gaps with an infrared instrument, data that could combine with earlier visual and UV spectrum images, providing the first full-spectrum images of planets and galaxies. The acquisitions are also accompanied by data from other observatories, including the NASA/ESA Hubble Space Telescope, and will help lay the groundwork for future observations of galactic systems using Webb. Hubble and Webbs NIRCAM images reveal distorted spiral arms in the galaxy, and the MIRI shows a faint, ghostly glare from interstellar dust. The Hubble space telescope and Gemini-North telescope have shown earlier possibilities for transitional galaxies, but they certainly did not suggest the kind of flocking



Webb, which looks at the cosmos about one million miles away from Earth, is the most ambitious and sophisticated space-science telescope built to date

we might be seeing thanks to the fantastic infrared instrumentation of NASA's James Webb Space Telescope.

Webb, which looks at the cosmos about one million miles away from Earth, is the most ambitious and sophisticated space-science telescope built to date, featuring an enormous, 6.5-meter-wide primary mirror, which will be capable of picking up faint lights of distant stars and galaxies. The mirror consists of 18 hexagonal gold-plated beryllium mirrors that can be individually moved for precision and accuracy and high levels of focus. Webb was launched aboard the Ariane 5, which has a nose cone that is 5.4 metres wide, one of the largest in the world. Three segments on either side of the mirror were folded for launch to accommodate Webb. The Webb telescope will not reside in Earth's orbit, nor will it currently be accessible to astronauts should something go wrong. NASAs Goddard Space Flight Center managed the development effort, while the Space Telescope Science Institute is currently managing the JWST's science missions.

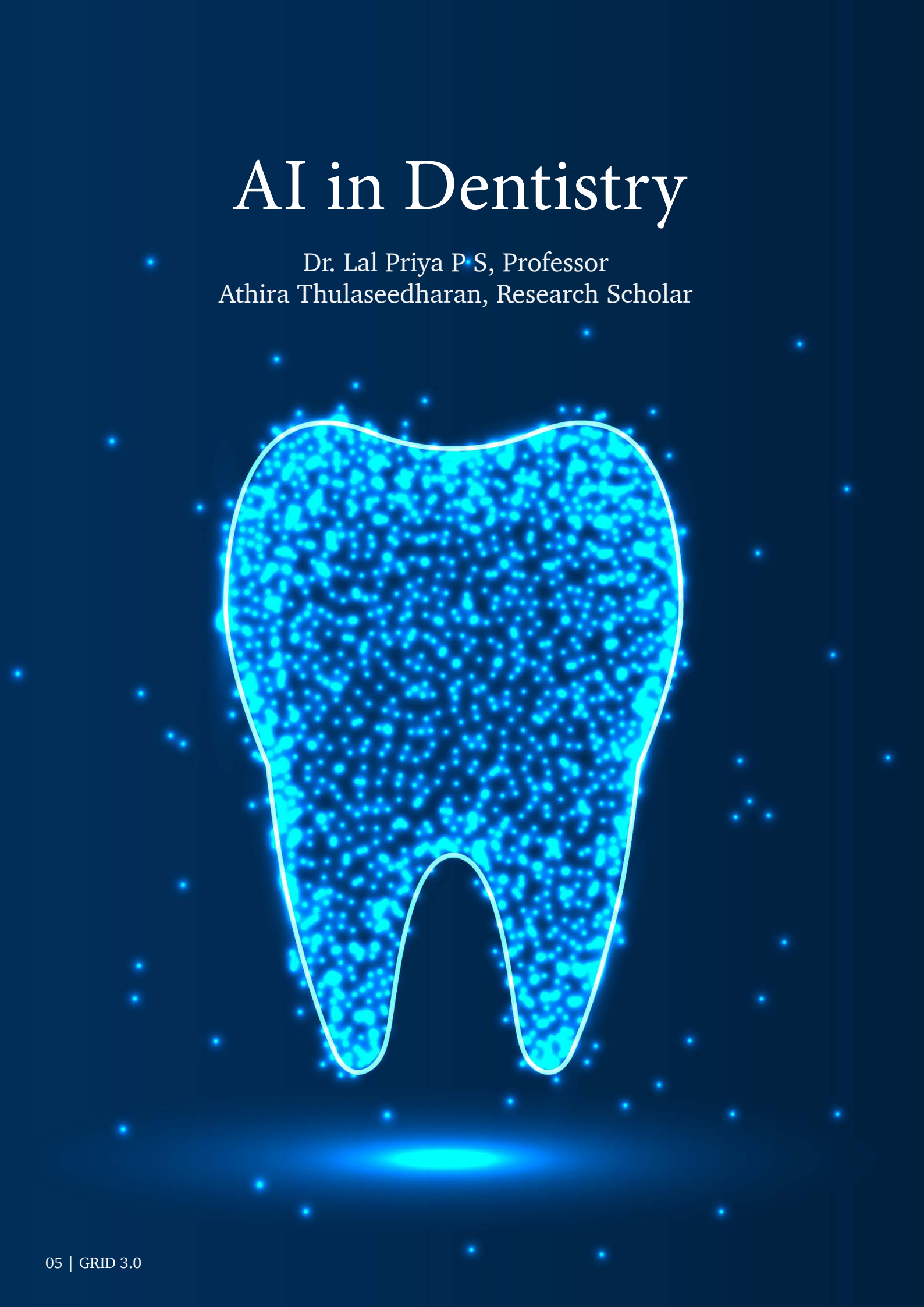
Slated for launch later this year, JWST will peer further into the Universe than any optical or infrared telescope ever made and will show us galaxies at their infant stages, survey potentially habitable worlds, and explore the mysteries of dark energy. JWST is the official successor to Hubble, and because it is focused on infrared astronomy, it is also a successor to the Spitzer space telescope. Unlike Hubble, JWST will observe at lower frequencies, from longer-wavelength visible light to the middle infrared (0.6 to 28.3 millimetres), allowing the JWST to observe objects with higher redshifts(wavelength stretching), too old and too far away to have been observed by Hubble. Because of this, the JWST instrument will not measure visible or UV light as well as Hubble, but it will have much greater capability for performing infrared astronomy.

Observing far-flung objects, like the earliest galaxies formed in the universe, requires infrared telescopes. Light from objects at that remote region of the universe -- like early galaxies -- is strongly redshifted, meaning that we need an infrared telescope to observe them. Long-wavelength light from objects formed closer to the Big Bang is redshifted, deeper in the infrared; in some cases, it is outside of the reach of Webb.

The telescopes pioneering infrared-sensitivity technologies--the Mid-Infrared Instrument (MIRI), Near-Infrared Spectrograph (NIRISpec), and Near-Infrared Camera (NIRCam)--were used by a team to acquire an impressive pair of spiralling galaxies with remarkable resolution at meaningful wavelengths. With Webb's infrared capabilities, launched into space less than a year ago, we were able to peer past the opacity of iconic Pillars of Creation, uncovering the shapes of new stars.

AI in Dentistry

Dr. Lal Priya P S, Professor
Athira Thulaseedharan, Research Scholar



When speaking to dentists, whether they work in solo or group practices, they typically are unaware of the profound influence that AI will have on their lives. It would be absurd to insist that only dentists are capable of diagnosing, planning treatments, and providing dental care. Dentists need to realize that dentistry and dental practices will be significantly changed by AI as a result of AI's improved ability to diagnose and plan treatments, discover best practices, control risk, and better manage patient scheduling and finances. Successful treatment of any disease depends on an accurate diagnosis. Artificial Neural Networks(ANN)are effective for this, particularly when the etiology of the disease is complicated. When the diagnosis provided by a dental surgeon and the one produced by ANN are compared in various trials, results suggest excellent specificity and sensitivity of ANN. This highlights the value of AI in the identification of even complex oral diseases while lowering the likelihood of human mistakes.

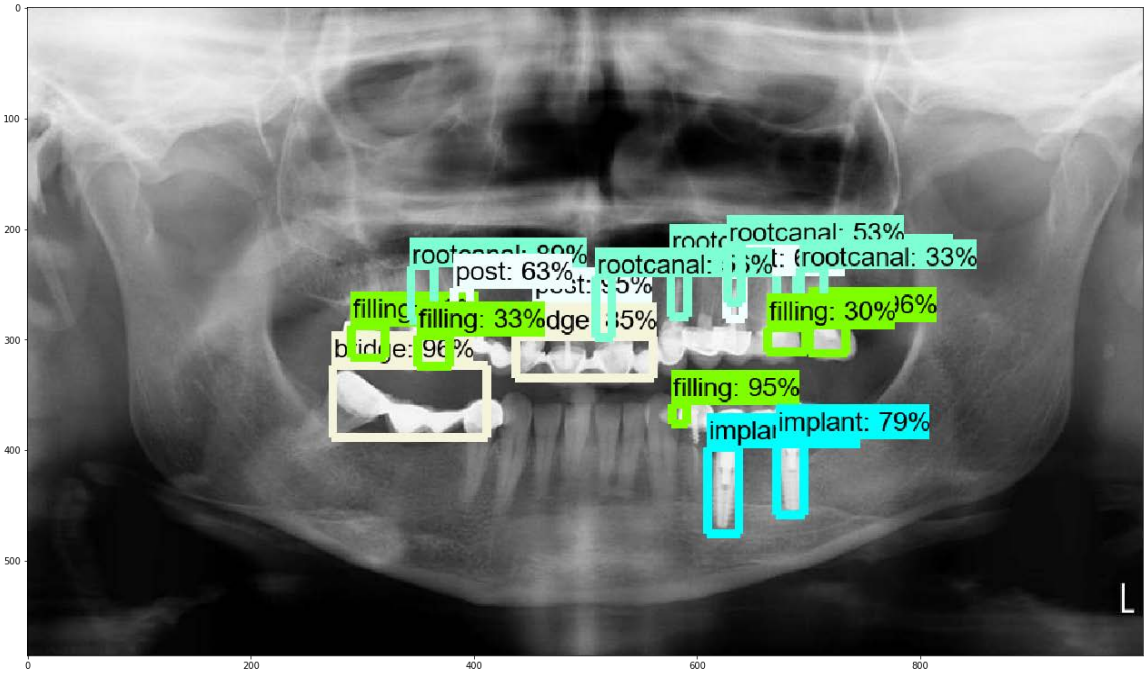
Artificial intelligence-based virtual dental assistants can carry out a variety of duties in dental clinics with more accuracy and fewer error. Booking a patient's appointment at the clinic, gathering the patient's complete medical and dental history, handling insurance, and aiding the dental surgeon with a suitable diagnosis and treatment plan may all be needed. Additionally, it works by warning the dental expert about the patient's medical history and routine habits, such as their usage of alcohol or cigarettes. In this manner, a digital record of each patient is produced, aiding the dentist in disease diagnosis and treatment. Additionally, it will help with patient follow-up and online emergency health consultation.

Object detection model

A collection of panoramic X-ray images that have been labeled may be used to train a deep convolutional neural network (CNN), and the object identification model was used to detect various classes of dental diseases and differential treatments. The provided figure shows the object detection model output, where various dental diseases and differential treatments are detected along with their confidence score. In this way, we see our platform contributing to transform the way dental practices are administered and how software empowers staff members to do more while working more effectively and efficiently. In addition to data analysis, the platform will provide us with second opinions on what treatments should be carried out and in what order, ensuring that the patient's care is constantly on target. The dental chair will be a true virtual assistant to the healthcare professional rather than merely a chair with a computer connected to the Internet or a local database. It will serve as a central point for creating and obtaining new, useful data from patients as well as instantly assessing the outcomes as soon as a customer requires therapy.

The future of dentistry will move to the extent that once the patient is seated in the dental chair, a complete 3D scan is taken, and any necessary operations are then immediately offered. The doctor may then put on smart glasses to observe the real-time bone

structure of the patient's teeth and skull so they are fully informed about the intricacies of the extraction. Additionally, there are technologies that automatically determine where braces should be put and how much pressure should be used to get the greatest outcomes based on the patient's age and bone density. You could complete all of this without ever using a mouse or keyboard.



Source: Dx Vision(Dentem)/Medium.com

Benefits of AI in dentistry

1. Executes tasks in nearly no time.
2. Decisions are reasonable and practical and lead to an appropriate diagnosis.
3. Standardized processes are possible.

Shortcomings of AI in dentistry

1. System/mechanism complexity.
2. Expensive setup.
3. Suitable training is necessary.
4. Data reuse leads to "data snooping bias"

In conclusion, Artificial Intelligence is not a myth; but the future of dentistry. Its applications are expanding- ing daily in all fields. Although it can- not in any way take up the role of a dentist because the practice of dentistry is not about disease diagnosis, it does include correlation with various clinical findings and patient treatment. However, having a thorough knowledge of AI's methods and ideas will undoubtedly be helpful in the future. Soon, we want to see AI fully in- integrated into endodontics, restorative dentistry, and orthodontics (reconstructive surgeries). The availability of incomplete and erroneous data is now the only constraint on the usage of AI. Therefore, it is the responsibility of dentists and clinicians to concentrate on gathering and inputting the real data in their database, which will soon be completely employed for AI in dentistry.

Lithium-Air Battery

Battery technology to meet all the energy demands of the future

Sandyagu R
S6 E2

What are batteries and why they are important?

Batteries are charge-storing devices. They are made by connecting cells together either in series or in parallel mode. Batteries are classified into two depending on their ability to recharge. They are primary batteries and secondary batteries. Primary batteries cannot be recharged while secondary batteries can be charged again. Battery technologies and battery manufacturers are facing huge demand due to upcoming innovations like electric vehicles and smart grids. In this article, we will investigate a new field in battery technology, Lithium-air battery cells. We will also investigate whether the available abundance of Li is capable to meet the future battery demand.

How are conventional batteries constructed?

In a cell, there are 3 main components - anode, cathode, and electrolyte. Anode is known as Negative terminal, where the oxidation takes place. Cathode, which is known as Positive terminal is where the reduction takes place. The third main component of a cell is known as Electrolyte. Electrolyte has many important functions providing a passageway for the movement of ions from the cathode to the anode in charging and in reverse on discharging. There are many other components like separators, positive charge carriers, negative charge carriers, etc. But cathode, anode, and electrolyte are the main parts. The electrochemical redox reaction happening between anode and cathode gives rise to a potential difference between the terminals, which is known as nominal voltage. Nominal voltage depends on the type of materials used as anode and cathode. When these cells with specific nominal voltage are connected either in series or parallel, a battery is created. When batteries are connected in series, the total voltage increases and the capacity of the battery remains the same. When batteries are connected in parallel, total voltage remains the same but the total capacity of the battery increases. In large-scale applications like automobile battery systems, batteries for storing solar energy in large generation plants, batteries for grid applications, we require bigger batteries. e.g.: 400-800V in electric-only vehicles and 100-200V in plugin hybrid vehicles.

What are Lithium-Air batteries?

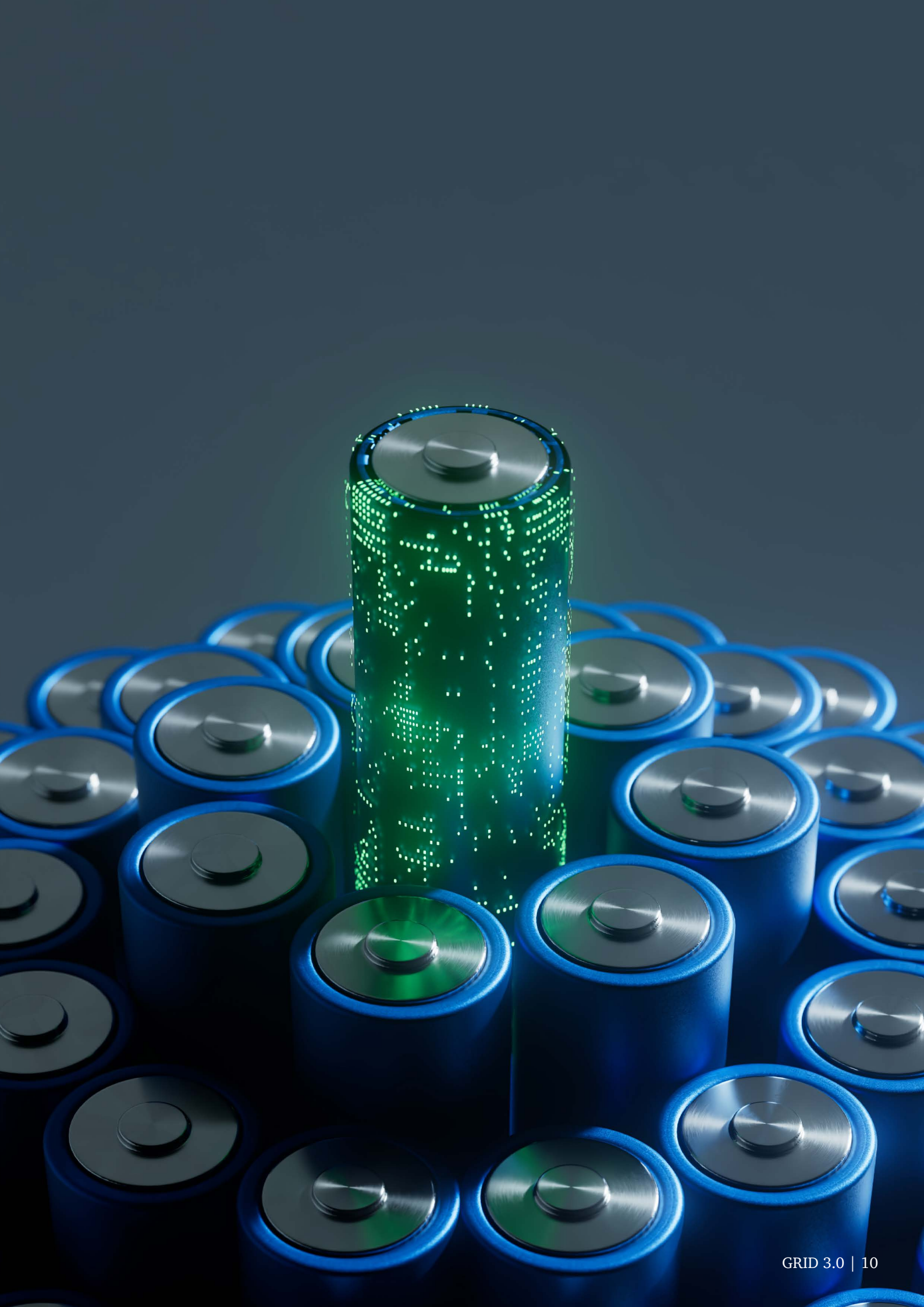
Today, almost all the battery power demand of the world is fulfilled by Lithium-ion batteries which work slightly differently from standard electrochemical cells. Li-ion batteries follow a mechanism called intercalation. In Li-ion batteries, the positive terminal is made out of intercalated Lithium compounds like Lithium Cobalt Oxide and the negative terminal is mainly made out of graphite. These cells have higher energy density compared to similar batteries like Nickel Cadmium(NiCd) batteries and Nickel Metal Hydride (NiMH) batteries and also have higher nominal voltage.

Battery Type	Nominal Voltage	Energy Density
NiCd	1.2 V	50-150 Wh/L
NiMH	1.2 V	140-300 Wh/L
Li-ion	3.7 V	250-693 Wh/L
Lead acid	2.1 V	80-90 Wh/L

From the above table, it is evident that to get the total voltage that one Li-ion battery offers, it is required to connect at least 3 NiCd or NiMH batteries in series. Also, they are having the highest energy density among them. But there are many limitations to Li-ion batteries. Some of them are listed below

1) They are more complex to manufacture.
2) A poor or a faulty battery management system or failure of the system may result in explosions.
3) Li-ion batteries are manufactured only in fewer quantities than other batteries in the list.
4) They are costly
5) They are sensitive towards over-discharge or overcharge

Though these are some of the major challenges faced by the industry today, studies show that in near future, it is expected to have low-cost Li-ion batteries than today. But is the available abundance of lithium on the Earth enough to meet the battery needs of the future? We will look into that at the end of the article. Now, what are Lithium-Air (Li-air) batteries? They are a little bit more sophisticated than Li-ion batteries. In Li-Air batteries, oxygen acts as the cathode. A Lithium-air battery combines oxygen from the air with Lithium present in the anode. The mix produces Lithium peroxide during the discharging phase – and a breakdown of Lithium and Oxygen components in the charging phase. A similar technology is also under research in which Lithium is replaced with Zinc making a Zinc-Air battery. In near future, we may see lots of new batteries in the market using the above two technologies.

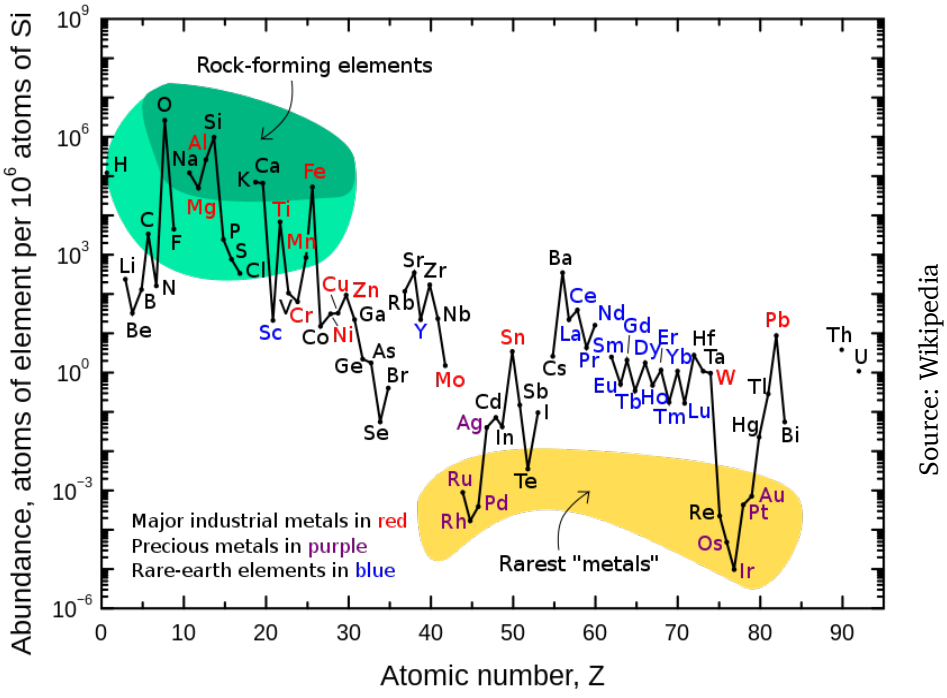


Differences between Li-ion and Li-air battery

Since the cathode of the Li-air battery is made out of oxygen and the weight of oxygen is less compared to metals, Li-air batteries are lighter than Li-ion batteries which results in higher energy density. Lithium-Air batteries are believed to have the capacity to store 5 times the energy stored in a similar Lithium-ion battery. However, many challenges are being faced by researchers. In the experimental setup of a Li-air battery in the laboratory, carbon enters the electrolyte through a carbon-based spongy lattice structure. Li-air batteries are having a nominal cell voltage of 2.91V which is 3.7 for Li-ion batteries. As we know changes in geographic parameters like altitude would result in a change in the pressure of oxygen and result in less efficiency or sometimes explosion of the batteries.

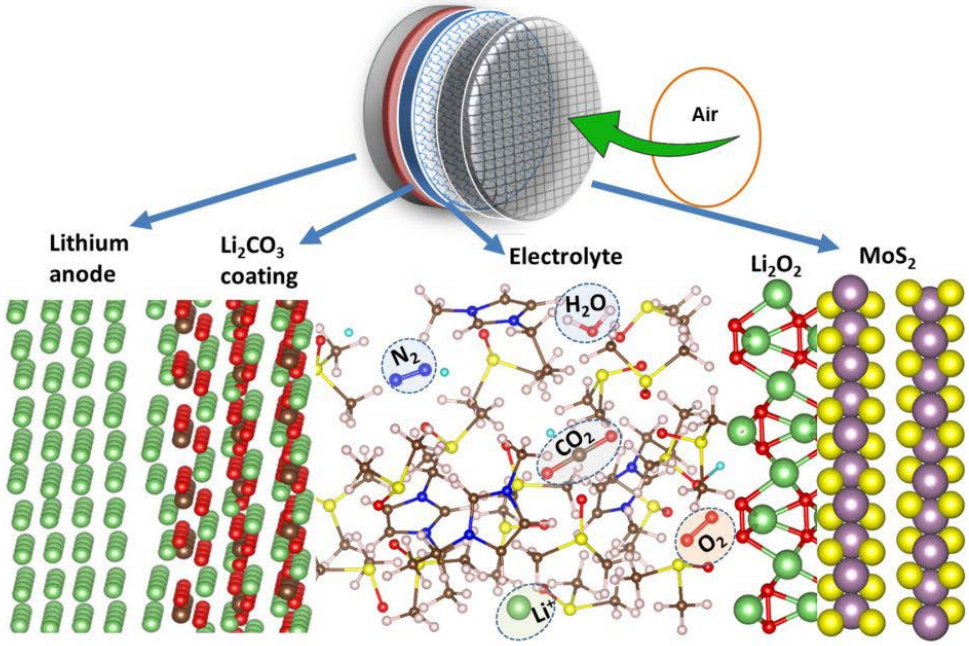
Is available Lithium enough to meet future demand?

Let's take the scenario of electric vehicles. They are expected to replace all IC engine-based automobiles by 2050, making zero emission of greenhouse gases and making the atmosphere cleaner. Oil rigs make emissions of many gases that harm the environment. Also, the availability of crude oil is decreasing and it is proved that we can't completely rely upon these non-renewable sources of energy. But will the raw materials used for making Li-ion batteries face this crisis in the future or in short will the future face a Lithium crisis?



When we examine the graph given above we can see that abundance of lithium is greater than cadmium, lead and nickel which are used to make batteries in large numbers than Li-ion. But it is still challenging to find it in nature in free state because Lithium is very reactive. If we also consider the sea, the known available supply of lithium is 200 billion tons. Studies have shown

that Lithium contributes to a maximum of 3% of the total weight of the battery. Considering the above condition as a general case, let us calculate the amount of Lithium in larger batteries. In electric vehicles, as a general condition, we need 7 kg kW/h which means .2kg kW/h of Lithium is needed. In a 200-mile range electric vehicle, a 60kWh battery is required which means approximately 12kg of Lithium is required for that battery. Let's assume 2 million cars are manufactured, it would consume 24000 tonnes of Lithium. Considering the total supply of Lithium and the above calculations, each human being alive could own not less than 1000 electric vehicles. So it is more likely that in the future we may not face the Lithium crisis. But we have considered only the requirement of batteries in electric cars. There are many other needs for the batteries like electric trucks, electric buses, etc. which require much larger battery packs. So Lithium is not the real problem of the future, it is the other raw materials used like Cobalt in Lithium cobalt oxide; cobalt which is toxic, rare, and costly. So there must be an alternative to that. In many battery technologies, some of the cobalt is replaced with nickel and manganese making NMC batteries.



A schematic drawing of the lithium-air battery
(Credit: IC and Argonne National Laboratories)

Conclusion

The battery technology field is having a lot of research and is progressing these days to cope with the demand. This article discussed only one among them. Most of the research is being held around lithium-based cells. Some of the other battery technologies that may emerge in the future are Lithium-Sulphur(Li-S), Lithium-ion batteries with silicon anode, Zinc-air batteries, Gold nanowire batteries, and Solid state lithium-ion batteries. Since this is an emerging field there is a requirement for many engineers to develop battery management algorithms, and charging and discharging drivers.

The Clash of the Titans:

The Kurukshetra war in Electrical Engineering

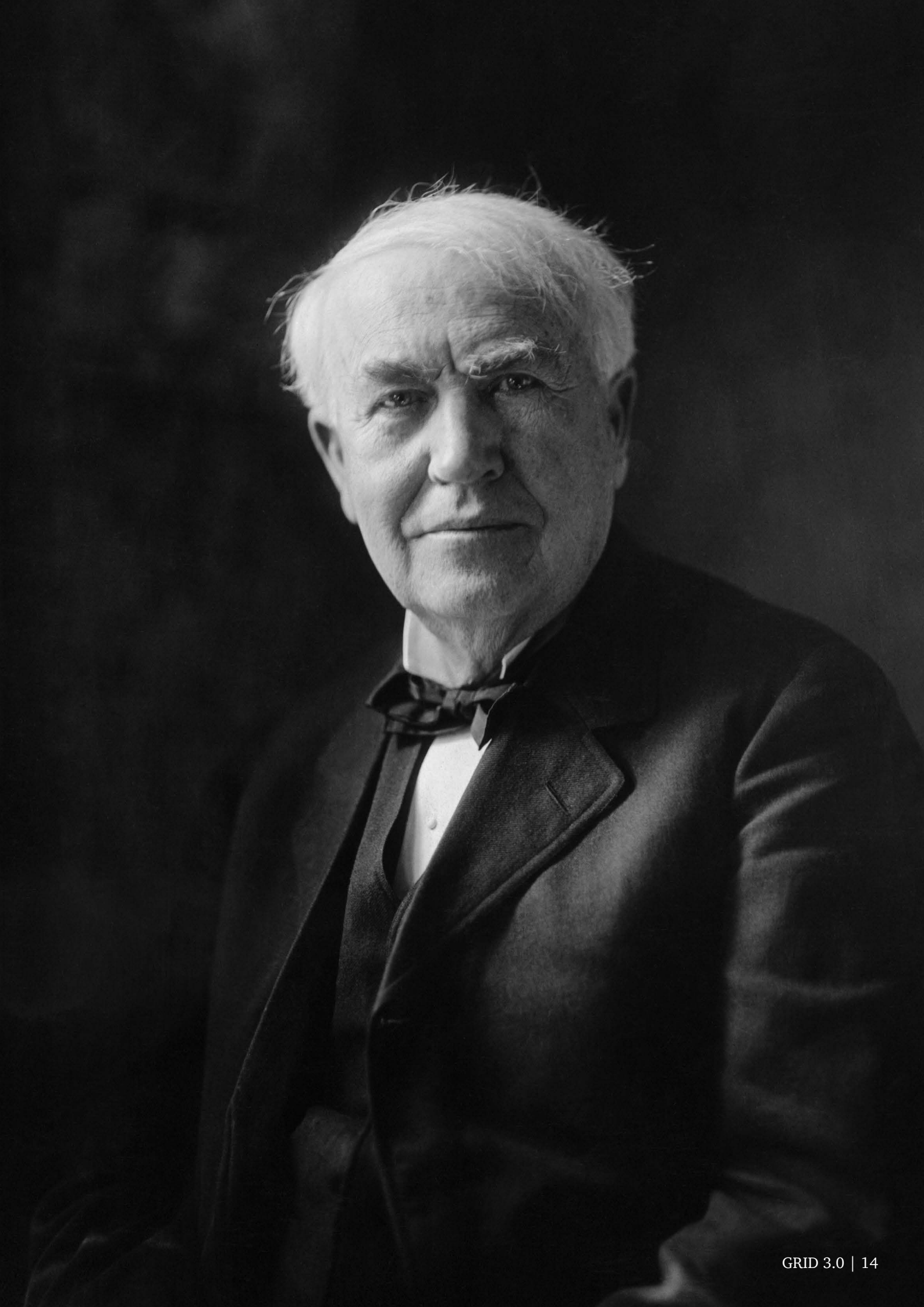
Dr. Bindu G R
Dean(International Affairs)

Nikola Tesla and Thomas Alva Edison are two scientific geniuses whose inventions revolutionized Electrical Engineering. In the 1880s, a fierce disagreement erupted between Direct Current (DC) and Alternating Current (AC) which was later referred to as the War of the Currents. As with any other conflict in human history, this war had competing ideas on the most effective way to distribute electricity globally. This article is a brief explanation of this war: like how Sanjayan, with his magical eyes, described the Kurukshetra battle to Dhritarast. It was up to history to determine whether Thomas Edison and his Direct Current forces could maintain their stance or if Nikola Tesla, George Westinghouse, and their Alternating Current army would emerge victorious. This was a struggle for the future of humankind, not Dharma: but as in the Kurukshetra war, plenty of foul play was involved.

1. Let there be artificial light!

Who invented the lightbulb? Was your answer Edison? In our school, we have all learned that Thomas Alva Edison was the ultimate inventor with over 1000 patents, including the incandescent light bulb. Edison was not only a talented inventor but also a savvy entrepreneur who successfully marketed nearly all of his inventions. He once said, “Anything that won’t sell, I don’t want to invent. Its sale is the proof of utility and utility is success”.

After the perfection of the newly invented light bulb, Edison’s next step was to plan a distribution system. However, to commercialize it, one must also lay down plans for a wider Electrical system. He proposed a DC distribution system – safe, simple, and easy to install with connection to different towers. Before then, electricity was mainly generated by individuals. But Edison changed this by building a network of cables beneath New York’s streets, supplying homes and businesses with electricity from a distant generator. This idea, which is now considered basic, was groundbreaking at the time. Edison transformed the way people used electricity when he opened the first central



power plant on Pearl Street in Manhattan in 1882. However, sending electricity over distances exceeding a mile caused voltage losses in Edison's network.

The drawbacks of DC transmission are:

• Difficulties with commutation prevent high DC voltage power generation.

• DC switchgear has limitations and is more costly than AC switchgear.

• DC voltage cannot be easily transformed for high voltage transmission or low voltage distribution.

• Requires additional equipment (rectifier, inverter) adding to transmission cost.

These factors make it challenging to implement DC power stations at frequent, close intervals.

2. Enter TESLA

Nikola Tesla recognized the inadequacy of Edison's DC powerhouses along the Atlantic coast and believed the key was in using AC due to its cyclic nature. Born on July 10, 1856, in the Austrian Empire (now Croatia), Tesla had a sporadic academic background before immigrating to the US in 1884 to work for Thomas Edison. He became a US citizen in 1891 and the same year invented the Tesla coil. Nikola Tesla created a system of AC generators, motors, and transformers and had 40 patents for it in the US. George Westinghouse acquired these patents and aimed to implement Tesla's system across the country. In 1888, Tesla presented his electrical systems and motors in a seminal paper titled "A New System of Alternating Current Motors and Transformers" to the American Institute of Electrical Engineers.

Industrialist and inventor George Westinghouse was particularly noteworthy. During a visit to Tesla's lab, he was astounded by what he saw. Tesla had built a model polyphase system with an AC dynamo, step-up and step-down transformers, and an AC motor. This marked the start of a successful partnership between Tesla and Westinghouse for the widespread use of electricity in America. While Edison's rivals, Westinghouse and Tesla, capitalized on DC's limitations and promoted AC, Edison fought to preserve his DC empire, leading to a fierce "war of the currents" between AC and DC.

3. THE WAR!

The validation of Westinghouse's success with AC was demonstrated at the 1893 Chicago World Fair and later through his hydroelectric power at Niagara Falls. General Electric proposed to electrify the fair using Edison's DC for $554,000 but was outbid by Westinghouse, who offered to power the fair with Tesla's AC for $399,000. In the same year, the Niagara Falls Power Company chose Westinghouse, who held the license for Tesla's polyphase AC induction motor patent, to generate power from Niagara Falls. Despite skepticism that the falls could power Buffalo, NY, Tesla was confident it could power not just Buffalo but also the entire Eastern US. On November 16, 1896, Buffalo was powered by AC from Niagara Falls.

3.1 The foul play

Many scientists and business people began to recognize the benefits of using AC over DC, causing frustration for Edison. He then launched a campaign to discredit AC and swayed state legislatures. In his rivalry with Tesla and Westinghouse, Edison aimed to link AC with danger and death. Sadly, a severe storm in New York in 1888 led to a broken AC wire that carried up to 6000 volts and electrocuted a child. However, this was less a result of AC and more due to poorly insulated and poorly maintained power lines. To

protect his royalty income from DC patents, Edison intensified his efforts to discredit AC.

3.1.1 Topsy- The Aswadhama

Edison spread false information claiming that AC was more dangerous, even going so far as to demonstrate it by publicly electrocuting animals with AC. One such demonstration was the electrocution of Topsy the elephant at Luna Park Zoo in 1903, which was captured on film by Edison himself as part of his efforts to discredit AC. An innocent elephant was thus sacrificed to gain victory as was done with the poor elephant named Aswadhama in the Kurukshetra war!

3.1.2 Electric chair- The sara-shyayya

Edison secretly funded Harold Brown's project to create the electric chair, ensuring that it would use alternating current, in an attempt to discredit it. The first execution by the electric chair, of William Kemmler, was a disaster due to multiple malfunctions and resulted in a gruesome outcome. Despite Edison's assurance that 1000 volts of AC would result in death, the first charge delivered only 700 volts for 17 seconds, causing Kemmler to be merely unconscious. This led to the crowd wrongly thinking the execution was a success. The situation worsened as someone in the audience cried out, "Great God, he is alive!" and was confirmed by the attending physician. The scene turned even more terrible as Kemmler, who was still fighting, was shocked with a higher charge of 1,030 volts for over a minute. He was burned alive, with sparks and smoke coming from his face, and bloody sweat. Many witnesses were overwhelmed by the sight and the smell and had to quickly leave due to the overpowering stench of death. Thus the electric chair proved to be Kemmler's sara-shyayya because he was subjected to an excruciating and slow death!

4. The Aftermath

Tesla's alternating current soon became the dominant power system after the Chicago World's Fair, and the whole country switched to it. Tesla proudly stated, "The future, for which I have really worked, is mine." Throughout his career, Tesla made hundreds of inventions that permanently changed the course of human civilization and ushered in the modern era of electronics. Tesla's unmatched engineering abilities, which allowed him to harness electricity in new and innovative ways, transformed the world and cemented his status as a visionary engineer far ahead of his time. Though Edison and Tesla were highly public figures during their lifetimes, while Edison enjoyed increasing fame and popularity after his death, Tesla on the other hand sadly spent his last years as a recluse drifting into relative obscurity.

5. Finally, who comes out victorious?

The competition between AC and DC technologies has been a well-known and much-discussed topic in the electrical engineering world. In the late 19th century, both AC and DC were vying to become the dominant form of electrical power transmission. At the time, DC was being used primarily for lighting and small motors, while AC was seen as more suitable for long-distance power transmission.

After intense battles, AC emerged as the winner due to its ability to be easily transformed to higher and lower voltages, making it suitable for widespread use in both residential and industrial applications.

However, with the advent of new technologies and advancements in power electronics, DC has made a comeback in recent years and is now widely used in various applications such as computer power supplies, electric vehicles, and renewable energy systems. The process of converting AC power to DC power and back results in energy loss, which has led to increased interest in utilizing DC systems in a variety of applications. This has given rise to the concept of microgrids, similar to Edison's original concept of local power plants for sustainable power sources. With an already established alternating current distribution system in place, this situation calls for a hybrid AC/DC system with minimum conversion stages that can accommodate both AC and DC loads, generators, and storage systems. This hybrid system will allow for the efficient integration of both AC and DC technologies and provide a more flexible and efficient power system that can better meet the demands of the modern world.

The coexistence of AC and DC technologies is a testament to the dynamic and evolving nature of technology. The outcome of their competition is a demonstration of how different approaches can coexist and be applied effectively in different areas of electrical power systems. The development of a hybrid AC/DC system will provide a more flexible and efficient power system that can better meet the demands of the modern world. The peaceful coexistence of AC and DC technologies is a prime example of how technology continues to evolve and adapt to changing needs and circumstances.

Smart Grid

Varsha Sharma
S4 E1

The global power crisis, the unreliability of rapidly depleting fossil fuel reserves and climate concerns surrounding it, signal the need to shift to a more sustainable and energy-efficient grid technology. The conventional power grid consists of various power system elements such as power transformers, synchronous machines, transmission substation, transmission and distribution lines and loads connected together. However, it is limited to a one-way interaction,i.e from the generator to the substation and finally to the consumer. The existing infrastructure, built around 60 years ago, is not efficient enough to meet the current energy demand. There are several other challenges in locating grid failure and facilitating spontaneous rerouting of electricity, as well as the possible overheating of power lines resulting in energy loss. There is also a pressing need to shift to a low-carbon and clean energy system to combat the global climate crisis.

The Smart Grid, an intelligent, digitized energy network, offers solutions to these issues as a more adaptive and reliable power grid. It involves a two-way communication or bi-directional power flow between the utility and consumer. The smart grid is capable to monitor activities of the grid-connected system, consumer preferences of using electricity, and provides real-time information on all the events. The key components of a smart grid include smart appliances, smart substations, smart meters, and advanced synchrophasor technologies. Electricity transmission is possible with low power lines, as smart grids incorporate small-scale power generating stations.

Power electronics play an important role in the implementation of smart grids, especially in controlling the power flow and conversion of power from AC/DC or DC/AC. In the case of renewable sources like wind turbines and photovoltaic systems, power electronics-based Flexible AC Transmission (FACTS) technologies and automation technologies are crucial for their integration with the main grid.

In the current scenario, there is high dependence on a few large power plants, mainly thermal or hydroelectric, for electricity production. Smart grids will ensure a space in the economy for a larger number of small producers who utilize energy sources like solar, wind, biogas, etc. which are environmentally more sustainable as well. It also opens up the opportunity to decentralise the infrastructure for electricity generation, overcoming even national boundaries. Smart grids make it possible for consumers to actively participate, producing power in their own homes and selling it to the grid. It is a marked shift from the previous narrative where the role of consumers was quite passive.

Currently, under the National Smart Grid Mission, several pilot projects are under implementation in Mysore, Naroda, Siliguri, Agartala, Puducherry, etc. TMR study on the transmission & distribution market forecast immense revenue possibilities in the next few years, the valuation is projected to surpass US $300 Bn by 2031. Smart grids are the way forward for achieving the goals of self-sufficiency and reliability of electricity infrastructure, a requisite to accelerate the pace of development and economic progress of our country.

Future of Grid Storage System through Sustainability

Akhil Hayash
S4 E2

As of now, we are running behind sustainability in everywhere we could, it is very fundamental for us to bring sustainability to electrical technology. Electrical technology is considered as the easiest and simplest way to implement sustainability in the real-world problem scenario. Nowadays, we are running behind low carbon emission methods and so far, to bring a carbon neutral mission which is the hardest problem to tackle and that's what the world organizations are working on. We are investing millions of dollars and pounds in it so as to ensure sustainable development and thereby to make this earth a better place for living instead of finding a new planet for our new base just like mars or some other terrestrial planet as we name which sounds strange. As a path to the sustainable low carbon emission method, we are using electric vehicles and we are using electric traction for all of our traction purposes just like in road, rail, air, water, etc.

When we look into power generation, transmission and distribution, sustainable development is not so motored. As we know we are using solar, wind, and tidal which is the non-conventional sources of energy, it is very important to note that, all of these renewable energy resources (not avail 24x7). If it is solar, we could only harvest nearly half a day, if it is wind, harvesting may depend upon the wind conditions, and if it is the case of tidal, which is still in its first stage of development and not widely commercialized yet. So, it is very important to store it whenever it is available. As of today, we are using big capacitive banks or battery banks to store the energy and release it as needed. As per the industry standard, we are using the Li-ion battery which is not so good. Even though we have the most advanced Li-ion batteries which will work for more than 1000 charging cycles and have a much higher energy density, it has their limitations that they may catch fire, the materials used in the Li-ion batteries are rare earth metals which are very costly and their mining is not eco-friendly. Most electric vehicles are running on Li-ion Batteries, even though we are saying that electric vehicles are eco-friendly, the truth is that they are not actually eco-friendly when we are looking from these aspects. So, it is very vital to replace the Li-ion batteries from the industry and to find an alternative for it. In now on days, we are having some research on some new battery technologies such as Li-S, and Iron Air batteries, they are not so sufficient to replace Li-ion from the market and there comes the new idea.

1.1 THERMAL STORAGE SYSTEM

In Li-ion batteries, we are storing electrical energy in the form of chemical energy. But the new proposed system will store the electricity in the form of thermal. The proposed system is consisting of a shipping container like box that will contain the graphite and aluminum, during the off-peak hours, the excess energy thus generated is sent to these blocks so as to convert it into the molten state by using some heaters, once it is melted, then the melted aluminum is then stored inside the graphite box which is already embedded within the block like ship container. During peak hours when the demand is more and supply is less, this stored electricity is retrieved. The container block is fitted with as many copper ducts which will pass a working fluid just like the water which will absorb the heat from the molten aluminum and which will turn into steam. This steam could drive the turbine and thereby the electric generator and thereby we could generate the electric power. The water thus used is cooled down and sent back to the container block. The main advantage is that there is no more pollution, we are recycling the aluminum, cheap and abundant nature of

aluminum and graphite, and this method could bring job opportunities for the workers from the coal power plant because all the power plants are shutting down and their workers are not getting new jobs.

1.2 GRAVITRICITY

"Madness is just like gravity, all you need is a little push", this is a famous movie dialogue made by one of the most iconic villain characters in the world. So why don't we use this madness of gravity in sustainability and that is what is done by some scientists. They just tested successfully an entirely new prototype to store electric energy by using gravity. They just elevated some weight to a height and then dropped it slowly by using some pulleys and couplings. The downward stream will rotate the turbine or the generator and there we could generate power from it. They tested this concept by dropping 50-liter water can from a height to the ground slowly by using some pulleys and coupling and they were able to play a musical system for about half an hour. They just proposed a new commercial model by having some concrete blocks which will get aligned vertically. During the off-peak hours, all the concrete blocks are raised to some height and during peak hours when the supply is less and the demand is more, these concrete blocks are retrieved and thus energy is generated.

1.3 CGSS

CGSS (Compressed Air storage system) is a kind of storage system that will use compressed gas most likely liquid nitrogen so as to hold the energy in the form of temperature. But instead of heating the element, we are using cooling technology. The nitrogen gas is sucked from the atmosphere and filtered out for any particles, the filtered nitrogen is compressed and cooled down to liquid form by using some refrigerators like an adiabatic magnetic cooling refrigerator so as to attain lower temperatures like nearly -200 centigrade. During the off-peak hours, we are compressing the nitrogen and storing it in the huge vessels and during the on-peak hours, we are releasing the nitrogen from the storage tanks and allow them to expand in an expansion chamber which will rotate the turbine and thereby we could generate electric power since we are using the adiabatic magnetic cooling technology, we are free from the greenhouse gas which is also an advantage and we don't need any new or external technology to implement this idea because we already have this idea.

As we know sustainable development is very vital and its importance is increasing day by day. Here that I have mentioned is only a few of the methods and there are more of such interesting ideas in the sustainable grid energy storage system and lets hope there will be more and more improved sustainable ideas in every sector so as to protect our health and make this planet a good heavenly place for living.

Virtual Reality

Abhiram Prakash
S4 E1

Virtual reality (VR), by definition, is a fully immersive computer-simulated environment that provides the user the perception of being in the said environment instead of the one in which they are existing. The term virtual means 'being something in effect or essence though not formally recognized or admitted' and reality means 'state of things actually existing'. The sense of reality is not altered as the user is just a spectator viewing the events that are happening in a computer-generated world.

VR APPLICATIONS

The world of VR is expanding every day and is most commonly used in the fields of entertainment, education, military training, medicine, and business. VR technology has ushered in a whole new era of gaming. Starting with virtual reality headsets, first released in the mid-1990s by video game companies for 3D cinema and video gaming, the industry now boasts of next-generation VR headsets like Oculus(Rift), HTC(Vive), and Sony(PS VR), commercial tethered and used for gaming and virtual cinema experience. It is also used productively for the rehabilitation process of people diagnosed with diseases like Alzheimer's and Parkinson's.

VR can generate virtual workspaces for different purposes-education, training, and health to name a few. In the field of engineering, it has proven its utility for educators and students alike. Students are able to interact with live 3D models of the project, and these simulated models can be programmed to react and respond to several real-world possibilities. Military, especially the air force has incorporated VR in their training exercises. Simulations of an airplane landing, crashing, and taking off are used by trainees to learn the real-world outcomes of these situations without actually spending a lot of money on crafting such situations. Such training simulations are also being used by medical students.

VR SOFTWARE AND HARDWARE

Virtual Reality Modelling Language(VRML) is used for representing 3D interactive vector graphics and was first introduced in 1994. Nowadays, multiple software is used for VR development which includes Unity, OpenVR SDK, CRYENGINE, Blender, etc. Modern-day VR headsets have different sensors like gyroscopes and motion sensors for tracking body and hand movements. They are also provided with a small HD screen for stereoscopic displays. Such sensors are used because certain VR experiences also include sensory stimulation such as sound and even tactile feedback for simulating touch.

VIRTUAL IMMERSIVITY

Virtual Immersivity and interactivity are the two features of the latest VR technology. True interactivity allows for a certain degree of user-controlled navigation. Only when we are able to move freely within that environment and interact with things in it, can our brains truly perceive the virtual world as real, hence the name- Virtual Reality. To provide such an immersive overall VR experience, special input devices like 3D mouse, wired gloves, motion controllers, optical tracking sensors, etc are incorporated into VR

The world of VR is expanding every day and is most commonly used in the fields of entertainment, education, military training, medicine and business

wired gloves, motion controllers, optical tracking sensors, etc are incorporated into VR technologies. Infrared cameras are typically used in optical tracking systems for navigation and location to ensure free movement without the interference of wires. Nowadays, VR cameras are gaining popularity, as they can take 360-degree camera shots which when accompanied by special effects amalgamate virtual elements and reality.

HEALTH AND SAFETY RISKS

The prolonged use of virtual reality technologies has been associated with numerous health concerns. Such findings were among the major reasons for the slowing down of progress in this domain. Several adverse health effects include twitches, seizures, discomfort, and stress injuries.

Most importantly, children are not instructed to use VR headsets because it has the potential to cause developmental issues. Among other risks, eye fatigue is the most commonly experienced one. During a VR experience, people tend to blink less which causes their eyes to dry out. Studies have shown that long-term usage of them can cause myopia and other such eye ailments. Virtual reality sickness or cybersickness arises when a person experiences symptoms similar to motion sickness while being inside the virtual environment. VR sickness has symptoms like nausea, headache, and vomiting. It is estimated that 20-40% of people experience some kind of cybersickness while using VR machines.

AUGMENTED REALITY VS VIRTUAL REALITY

Augmented Reality (AR) is a technology that uses an AR device, such as a smartphone or a head-mounted display, to overlay 3D virtual objects onto the real world. These virtual objects can then interact with real-world things, such as surfaces, objects, and people, to produce the desired meanings. For example, an AR application could be used to display a virtual 3D model of a car on a dealership showroom floor. The user can walk around the car, look inside, and open the door, just as if it were a real car. But the virtual car can also provide additional information, such as the car's performance statistics and price.

AR is different from Virtual Reality (VR) in that VR replaces reality by creating a new environment that is completely different from the real world. VR is typically used to simulate immersive experiences, such as video games or simulations. While AR adds to reality by projecting information and supplementing real-world information, thus allowing users to see the real world while also interacting with virtual objects and information. Both AR and VR are technologies that simulate a virtual environment but the key difference between them is that AR enhances the real world, whereas VR replaces it.

Nuclear Energy and Climate Change

Meera R Pai
S4 E2

The United Nations regards climate change as the most crucial problem of our era and the main objective of the Paris Agreement of 2015 is to limit the increase in global temperatures to less than 2°C. Almost 81 percent of the world's primary energy sources are still fossil fuels, underlining the immediate need to shift to greener alternatives.

However, humanity's fixation on fossil fuels will keep on growing, despite all the hype for solar and wind farms, LED bulbs, and hybrid cars because our energy consumption rises every year. The average energy consumption per person in China is 3 kW, which is 6 times higher than the average African consumption of 0.5 kW. However, it is still lower than the average American consumption of 9.2 kW (equivalent to running 9 toasters all day). Despite international efforts to increase renewable energy sources like wind and solar, fossil fuels still dominate the energy mix. Modern society is becoming highly dependent on electricity owing to the increased electrification of transport, domestic heating, and industrial processes. Though electricity is relatively clean at the point of use, its generation produces over 40% of all energy-related carbon emissions. It goes without saying that the increased consumption of fossil fuels is largely contributing to global warming and other climate issues. This makes it clear that it would neither be possible to avoid trashing the atmosphere nor will future generations be able to meet the rising demand for energy without finding alternative resources to run the world.

Nuclear energy, nuclear power, nuclear reactors-what first comes to your mind when you hear these words? You might think of infamous nuclear accidents like the Chernobyl accident of 1986 or maybe the unsettling politics involving nuclear weapons. Will it help achieve nobler goals like alleviating climate change or boosting the economy? Let us look into it! Nuclear power is said to be relatively clean. Nuclear power plants are free of greenhouse gas emissions both during operation and over their lifespan. They produce roughly the same amount of CO2-equivalent emissions per unit of electricity as wind and one-third the amount compared to solar. To meet the goal of deep decarbonization and combat climate change, it is crucial to prioritize nuclear energy as it is reliable and scalable,

Nuclear technology is a crucial area of research, as there is much more potential in providing clean energy compared to other sources

enabling it to directly replace fossil fuel plants. Nuclear energy currently in use reduces emissions equivalent to removing 1/3 of all cars from roads and has the potential for sustainable energy transitions. It is crucial to accelerate innovation and research in nuclear power. However nuclear reactors are not waste-free. Nuclear waste is radioactive, a potential carcinogen that we need to protect ourselves from. But what if we put highly developed nuclear computing in the hands of the world's best nuclear physicists and give them a high bar to clear in terms of safety, quality, efficiency, and sustainability? What if they invent a nuclear power plant that is capable of generating less waste or even burning the existing waste? Many companies and organizations have thrived in this domain and are on their way toward building such futuristic reactors. TerraPower is one among those companies which work on advanced nuclear projects and explore futuristic kinds of reactors-huge ones, tiny ones, ones that float, and ones that operate underground. Many of these innovative designs are equipped with the technology of burning nuclear waste along with the by-products of Uranium enrichment.

Nuclear technology is a crucial area of research, as there is much more potential in providing clean energy compared to other sources. Furthermore, a full-scale nuclear plant can produce enough energy needed to power up an entire city! However, as stated earlier, this form of technology is very fragile, with dire consequences if misused. In the wrong hands, nuclear technology is beyond destructive. Let's look forward to more explorations in the field of nuclear technology, and tap into its full potential as tackling climate change is of utmost importance in our path to development!

Hybrid Resources

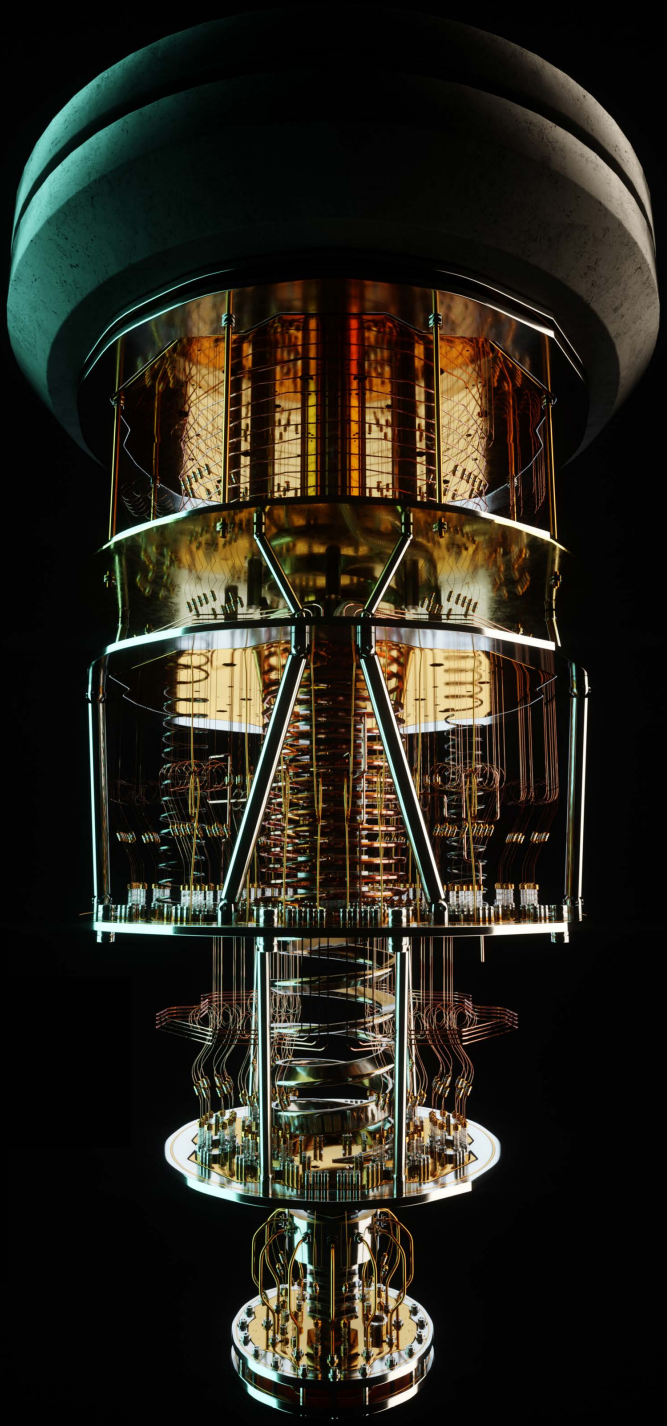
Gopika R H

S6 E1

The conventional electric power system was established with the goal of providing consistent energy to customers through a limited number of conventional generators that were well-understood and easily manageable. The load, generation, and transmission aspects of the system were separate and clearly defined, with the majority of the planning and operational duties, such as constructing a robust network from less reliable components, being handled by the system manager such as a utility company or regional market operator. The rapid increase in the popularity of hybrid resources, which incorporate various technologies into one system, caught many industry experts off guard. In the traditional power system, the system operator had control over each individual technology. However, hybrid resources have a more hands-on approach, actively optimizing and coordinating their functions. This change in responsibility represents a significant departure from the conventional method of managing the electric power system.

The shift towards hybrid resources is a result of the many benefits they offer. By combining multiple technologies, they can provide a more flexible and efficient solution to meet energy demands. Furthermore, hybrid resources can also mitigate risks associated with relying on a single technology, increasing overall system reliability. This change in the way the electrical power system is managed represents a major shift in the industry, and the growing interest in hybrid resources, as indicated by the increasing interconnection queues in various regions, is a clear indication of the potential they hold. Developers and investors see the advantages of hybrid resources and are investing in them, leading to a rise in their popularity. The increasing interest in hybrid resources, reflected by the growing number of interconnection queues in different regions, suggests that developers and investors believe these resources offer advantages over traditional electrical power systems. This increased demand for hybrid resources points to a possible change in the way the electrical power system is managed in the future.

The advantages of hybrid resources include their ability to provide a more flexible and efficient solution to meet energy demands, as well as their ability to mitigate the risks associated with relying on a single technology, thereby increasing the overall reliability of the system. By combining multiple technologies, hybrid resources can provide a balanced and versatile energy solution, which can adapt to changing energy needs and requirements. The integration of advanced technologies, such as renewable energy sources, into hybrid resources, allows for a more sustainable and environmentally friendly energy solution. This is becoming increasingly important as society moves towards a more eco-friendly future, and renewable energy sources become more prevalent. The growing interest in hybrid resources reflects a change in the way the electrical power system is viewed and managed and highlights the potential for a more sustainable and efficient energy future.



Quantum Computing

Tom Johnson V
S8 E1

Quite recently a team of researchers from Google, NASA, and the Oak Ridge National Laboratory claimed to have achieved "Quantum supremacy". They've shown that a quantum computer processing qubits can accomplish tasks significantly faster than conventional computers. The Sycamore quantum processor carried out a specific calculation that would take almost 10000 years to complete on the most advanced supercomputers of present times in around 200 seconds.

While this was great news for all the quantum physicists out there, it was quite frightening for cyber security experts. The reason for this is that the difficulty in building a decryption algorithm is the heart of any efficient encryption system. Almost all encryption techniques are essentially math problems that are quite hard to solve. Some of the encryption techniques produce keys that are quite complex, which makes it take a very long time to crack with classical computing techniques. The good thing about these keys is that by the time it's cracked the possibility of humans existing would be quite slim. An example is the RSA algorithm, which is quite extensively used by modern computers to encrypt and decrypt messages. It's used in various applications from Bluetooth, MasterCard, VISA, e-banking, e-commerce, etc. In the RSA cryptosystem, the encryption key is different from the decryption key. This means that the shared key (encryption key) can be shared with anyone, so the 2nd party can send encrypted messages. But the private key (decryption key) is needed for decrypting the message. In RSA, this asymmetry is based on the practical difficulty of factoring the product of two large prime numbers. There are no efficient classical computing algorithms for carrying out this task. Because this is a problem of exponential growth, that is the possibilities of the solution grow exponentially as the number becomes bigger.

This is where quantum computing comes in. Quantum computers use qubits instead of normal binary bits. The states of qubits remain uncertain until the final calculation. This enables a quantum computer to try out effectively many different keys in parallel. By employing a quantum method called Shor's Algorithm the problem of integer factorization can be solved quite efficiently and even a 4096-bit key pair could be cracked in just a few hours.

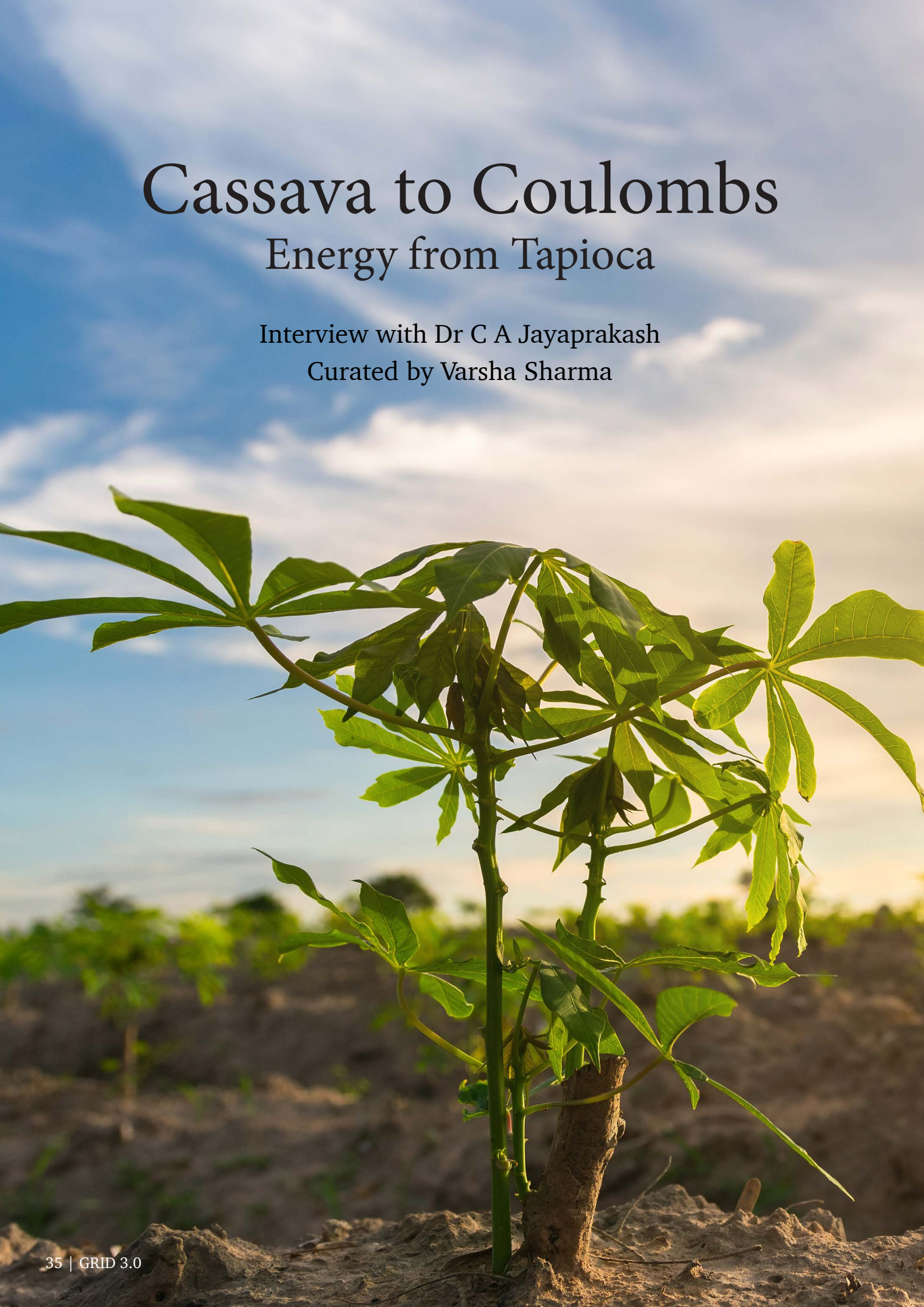
Even for the more traditional brute force attack method, quantum computers are much superior to today's supercomputers. A quantum computing method called Grover's algorithm speeds up the process, turning a 128-bit key into the quantum-computational equivalent of a 64-bit key. The defense is straightforward, though they make the keys longer. A 256-bit key, for example, has the same security against a quantum attack as a 128-bit key against a conventional attack.

But today's quantum computers are quite far away from achieving these feats due to the constraints in processing power and error rates. Future code-breaking quantum computers would need 100,000 times more processing power and an error rate 100 times better than what today's best quantum computers have achieved. But when we look at the rate at which the quantum computing industry is growing, those numbers look achievable. Also, the fact that more and more hackers can get access to quantum computers as they are being made available on the cloud as an IaaS is needed to be noted as well. Fortunately, researchers are working on developing public key algorithms that could resist attacks from quantum computers. Projects like CiViQ and the steps taken by organizations like the US National Institute of Standards and Technology are aimed toward techniques for post-quantum cryptography.

Cassava to Coulombs

Energy from Tapioca

Interview with Dr C A Jayaprakash
Curated by Varsha Sharma



Dr. C A Jayaprakash is the head and principal scientist of Central Tuber Crops Research Institute under the Indian Council of Agricultural Research. Working as a scientist for 35 years, he has contributed greatly towards agricultural research in the country. He spearheaded the tapioca power project, funded by the Department of Atomic Energy. This project had garnered worldwide attention owing to its huge generation efficiency, waste to wealth approach, especially in this era of climate crisis, where sustainable energy has acquired prime importance.

On 6th October 2022, the magazine team of GRID arrived at the Central Tuber Crop Research institute in Sreekaryam. Dr. JayaPrakash along with his research protege Sreejith met with us outside the building that housed his famous discovery, the technology behind Cassa Dipah.

Electricity from tapioca- How did you stumble upon this unlikely yet brilliant combination?

I would have to say, it is a journey spanning throughout the 35 years of my career. Initially, my research was aimed only at manufacturing organic pesticides from the biowaste of tapioca leaves. The technology for this was patented earlier, and the pesticides branded as Nanma, Menma and Shreya were distributed to Krishi Vigyan Kendra. These pesticides are highly effective, and even if it falls on our skin, it produces no effect, because it is organic.

The slurry left as waste after manufacturing the pesticide was collected, and it came to my attention that a high amount of methane gas was being freely released from it. Upon discussing with my colleagues, I decided to find out more about the amount being released. For comparison, cow dung has up to 40% efficiency and in our case even if the tapioca leaves gave just 10% efficiency, it would still be a gain, considering that our primary aim was biopesticide. To our utmost surprise, the efficiency was a whopping 60%. From then on, the rest is history.

Dr. Jayaprakash gives us a tour of the plant, the machine used for pesticide manufacture, the gas being collected from the slurry, filtered and stored in cylinders. Using this cylinder, we light a cooking stove. Afterward, we saw the gas being used as fuel to run a generator that takes care of the entire lighting of the laboratory. Cassava, the scientific name of tapioca was borrowed while christening as Cassa Gas and Cassa Dipah respectively.

What is the feasibility of using this electricity on a commercial level?

In Mahindra World City, a Bio-CNG plant was set up after investing several crores, wherein eight tons of food and kitchen waste generated daily in the city was converted into 1000 cubic metres of raw biogas. With just 3ha. of tapioca farming, we can generate more power than this. India has 0.21 million hectares of tapioca farming and 4.48 lakh tonnes of tapioca leaves are thrown away as waste after each harvest. Added to this, tapioca is highly climate resilient, requires less water and hence used for many wasteland development initiatives. The breakdown of complex cellulose molecules, which is considered a costly and uneconomical procedure, is automatically achieved in our pesticide manufacturing unit. This helps us bypass so many extra costs, and the production of biopesticides increases the profit margin by a large degree. Therefore, it can be concluded that this discovery effectively overcomes the economic barriers to large-scale biofuel production using tapioca leaves.

Let us take the example of your college itself. Consider all the waste generated- food waste, dry leaves, etc. Extracting methane from this biomass would require a pretreatment process which is much more difficult, costly and has lesser efficiency compared to using tapioca as the energy source and employing the technology we have in place here. The same logic can be applied even in the large-scale implementation of this technology. Isn't it much better to buy a unit of electricity at a lower price than the current rate? Our claim for improved efficiency and reduced costs are backed by numbers, feasibility studies, etc. undertaken with data collected from both national and state-level sources. To be specific, 1-tonne cassava leaves can produce 51 kg of methane, which translates into 57.14 units of electricity. While a mere 4000 hectares can yield up to 1 lakh units in a month, in a country like India, with 0.2 million hectares of tapioca cultivation, it goes up to 5 million units. The profit from one tonne of cassava leaves per month lies between Rs.338- Rs.508 lakhs per month.

What is your take on improving this technology, say, incorporating new technical features?

I am always looking to upgrade the existing technology, to make it more efficient or cost-effective. Recently, I met with my old friend and colleague, who is a professor at IIT Delhi, to learn more about how to make the nano molecule of biopesticide. He took me to the Centre for Rural Development and Technology, a university department, wherein I came upon this purification technique using water. In simple words, the impure gas that we obtain initially can be passed through water, which would dissolve the impurities -carbon dioxide and hydrogen sulphide, while the clean gas gets collected above. Right now, we're doing a more expensive purification process using molecular sieves. This is a major finding when it comes to the scope for expansion.

Since all of you are electrical engineers, I encourage you to explore more about expanding the scope of this technology when it comes to the electricity generation part.

You mentioned in previous interviews about the anti-cancer properties of cassava leaves. How did you discover that through this study?

Linamarin, a cyanogenic glucoside found in cassava leaves, is proven to the inhibit growth of cancer cells. CTCRI has received collaboration requests from many international universities regarding this prospect. Research experts in many countries are still searching for the technology that we developed here. During the pandemic times, I received a WhatsApp forward about some country medicine expert prescribing a spoonful of tapioca leaves for COVID patients. This being my field of interest, some people approached me to confirm this. I shook off the claims as absolutely baseless. There was very less chance of dissolving the spike protein in coronavirus. However, my curiosity wouldn't cease, which is why I did some digging into it.

We know that there are different varieties of any crop species, around 1500 varieties for Cassava itself, both indigenous and exotic. The Cassava Mosaic virus is a crop disease affecting tapioca plants, causing wrinkling or curling of its leaves. I along with my chemist Dr. Rajeshwari, decided to screen the varieties, which revealed that there are some varieties of cassava that are resistant to the Cassava Mosaic virus. Where we usually used to get around 800ppm of the virus suppressing compound, these varieties had as much as double the amount. This was the first evidence of the presence of

Going green is no longer an option but a necessity for our survival

strong antiviral properties in tapioca leaves. To put it simply, the antiviral properties we observed in plants could be translated to humans as well, giving proof that the local expert's claims were not so baseless after all.

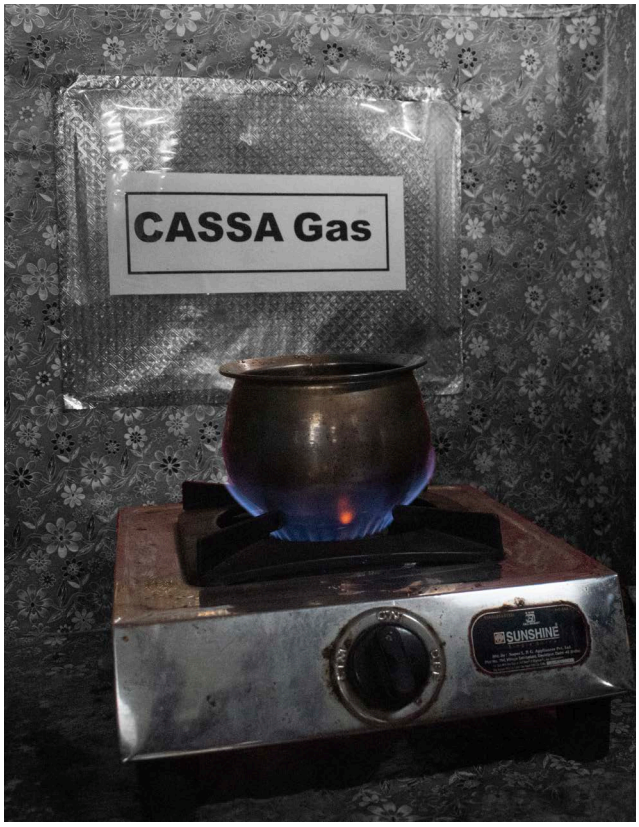
I have sent some samples to Rajiv Gandhi Central for Biotechnology, where there is a pseudo coronavirus culture, and currently waiting for their reply. On my official visits outside India, to attend academic conferences and conclaves, leading researchers from Germany, Australia, Israel, and Nigeria are working on the many applications of cassava, especially the anti-cancer properties of linamarin, which is generally exported from the Philippines, but found to be plenty in the cassava leaves that we throw away as waste. I believe that this application of cassava should be explored further, and more research should be undertaken in this domain.

Why tapioca of all plants? Any special reason that got you hooked on it?

During my childhood, back in the 60s, poverty was very commonplace. Rice was not as affordable, and tapioca fed our hungry stomachs many a day. There are some things that deeply strike our beings, mostly things we saw growing up and intentionally or unintentionally they act as a major driving force throughout our careers. It might even be after 20-30 years, that we translate this into a ground-breaking discovery or idea. As I love to put it, the same tapioca that once sustained my life now sustains my fame.

What is your advice to upcoming researchers and scientists?

Observing the natural world around us is essential for gaining knowledge and understanding the intricacies of our environment.

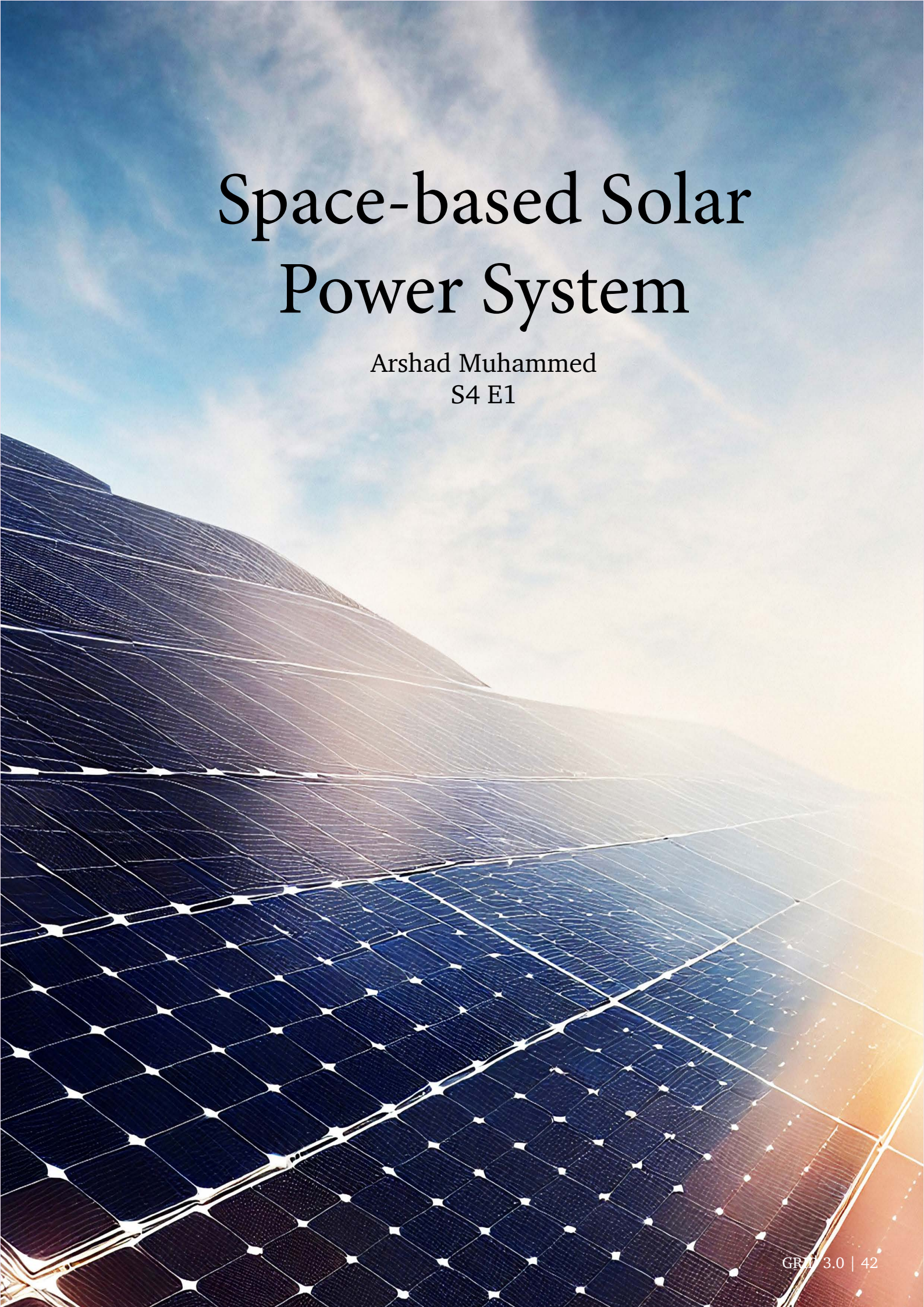


From the behavior of animals to the patterns of weather, there is so much to learn and discover. Learning throughout our lives is equally important as it allows us to continually grow and develop as individuals. By remaining curious and open-minded, we can expand our knowledge base and gain a deeper understanding of the world around us. However, observation and learning alone are not enough. Success requires a sense of perseverance and dedication. When we encounter obstacles or challenges, we must be willing to persist and work towards our goals.

The government has been promoting Make In India and self-reliance, so creating technologies that are affordable and feasible will definitely receive due recognition. Added to that, I sincerely hope for more research in the domain of renewable energy, such as mine, considering the grave situation faced by our planet with regard to the climate crisis and pollution. The need for sustainable living has become more critical than ever before. Our planet is facing various environmental challenges such as climate change, pollution, and resource depletion. Going green is no longer an option but a necessity for our survival. It is imperative that we adopt environmentally conscious practices and technologies to reduce our carbon footprint and preserve our planet's resources for future generations.

Space-based Solar Power System

Arshad Muhammed
S4 E1



With the rapid increase in population and growth of human civilization, the insistence for power is expeditiously increasing. This ratchet increase of exigencies has led to pressure build-up among various energy generation industries. The staple energy sources are fossil fuels, which is a non-renewable resource, and in addition to their exhaustibility, they also detrimentally affect the environment. The sheer rudimentary prerequisite for energy independence is energy conservation. Aside from the conservation of energy, there is another aspect called sustainability which should also be taken into rumination for successful and efficient energy engendering. The majority share of the energy market is possessed by conventional energy sources such as natural gas, oil, coal, and nuclear. Such sources offer many disadvantages- they pollute the environment, destroy natural systems, etc. Apart from the environmental damage it also has high setup costs and the extraction of energy is a time-consuming process. Such drawbacks catalyzed the pursuit of a much finer and more efficacious energy source.

The usage of such nonrenewable sources still generates more than 80% of the total global energy of which solar energy accounts for less than 1%. Between 2004 and 2015, investments in renewable energy increased marginally from US$46.7 billion to US$284.8 billion. Current predictions indicate that the world population will reach 9.7 billion by 2050. With the increase in population, world energy consumption is also predicted to grow by 50% by 2050. So the demand for a more viable renewable energy source is increasing day by day. Non-Conventional sources of energy like solar, wind, hydrothermal energy, etc. came into view. They offer a wide spectrum of advantages which include renewability, little or no pollution as compared to traditional energy sources, less maintenance, and more pronounced long-term cost-effectiveness. The most extensive and imperative source among them is solar energy.

Space-based solar power (SBSP) is a technology that entails the efficient collection of solar energy and wirelessly transmitting it to Earth. The basic collection process is facilitated by using solar panels and reflectors. These huge reflectors (essentially inflatable mirrors) are installed in space and they reflect solar radiation onto the solar panels. Solar is a device used to convert imminent solar radiation into electric current. These solar panels absorb the incident radiations which are then beamed onto the earth using either microwave or laser radiation at a variety of frequencies. The subsequent step is to receive the incoming solar power via a rectenna- a microwave antenna. Essentially it involves the collection of solar energy in space efficiently and then beaming it to earth to satisfy our energy demand.

According to the National Space Society, space-based solar power has the potential to dwarf all the other sources of energy combined. Solar energy in space is available throughout the year in contrast to the regular solar panels installed at households that can deliver power only during day time. This is a considerable trump card in our energy efficiency game because in SBSP systems the power is available during almost 99% of the year. A regular household solar panel can generate around 2850KWh of energy, this energy figure is calibrated for ideal conditions only, but household solar energy is not always continuous. On the contrary, SBSP systems can generate around 2000 gigawatts of power constantly which is more than 40 times the energy generated by the household

solar system annually. Along with such elevated energy outputs, this form of harnessing solar energy is accompanied by increased efficiency. Space-based solar power would generate 0% greenhouse gases, unlike other alternatives like coal, nuclear, oil, etc. The amount of waste generated is also substantially less as compared to conventional sources.

While the SBSP system is an avant-garde design, we are unable to build a proper working setup for such designs. There are certain limitations associated with this issue. Firstly, launching such a system comprising of panels, reflectors, etc. is onerous. Launching an SBSP system is extortionate-the total cost is estimated to be about 100 times too high to compete with current utility costs. Another quandary that arises is in the case of launching solar panels. With our current technologies, the solar panels developed have a high mass per watt generated ratios, or to put it this way it is too ponderous per watt generated to make it expedient.

This idea is becoming increasingly popular as a potential solution for the world's growing energy needs, due to the abundance of sunlight in space and the lack of atmospheric interference that can reduce the efficiency of ground-based solar panels. However, there are significant challenges associated with space-based solar power, such as the high cost of launching and maintaining solar panels in space, as well as the technical challenges of designing and building solar panels that can withstand the harsh conditions of space. Despite these challenges, a lot of research and engineering is ongoing to find the most feasible way to build space-based solar panels and launch systems, at a lower cost. With the primary source of energy coming from fossil fuels at the risk of dying down in a few thousand years, and increased investment and research in the renewable sector, there is a high possibility that space-based solar power can grow to become the viable future of solar power.

Privatisation of Power Sector in India

Ardra S S
S4 E1

The architecture of the power sector dates from a time when India was a smaller and simpler economy. The electricity system was built around public sector ownership of generation, transmission, and distribution and the problems of this public sector system remained internal to it. Risk assessment and mitigation were not required. Delayed payments, unbalanced contracts, or poor fiscal performance had implications only for the owner of this public system, the government. The reforms brought about by the Electricity Act, 2003 essentially took this public system and grafted independent power production onto it. Various other reforms have been brought in over the past 20 years, involving sometimes creative but ultimately always incremental thinking, remaining trapped in the context of a government-owned, centrally-planned power sector. These reforms did not prevent the need for a series of financial bailouts that the Electricity Act 2003 was originally brought in to prevent. More incremental reform will not prevent the need for further bailouts in the future. Strategic thinking and deep change are required for the sector to not make demands on the taxpayer as it has done for the incremental thinking two decades. The first step is fixing the distribution sector

Discom Dysfunction(discom -distribution company)

India's discoms impede the path to the large-scale investments needed to fuel India's energy transition. There are problems with them beyond the fact that most of them are broke and do not present as financially credible contractual counterparties. Discoms are ultimately controlled by politicians and used as tools for redistribution and political patronage. Discoms, and the state more generally, have low capacity in contracting, as a result of which power purchase agreements are unbalanced and allocate risk inadequately. These unbalanced power purchase agreements are not negotiable, and no producer wishes to antagonize a state discom that it has to live with through a 20-year contract. The only sustainable way to avoid these problems is large-scale discom privatisation. This will enable us to build an electricity sector organised around the price system, as opposed to the current centrally planned, government-owned sector, with a few private vendors brought in as service providers. The route to effective privatisation is therefore to address the issue state-by-state.

This will require us to develop a deep understanding of the political economy of the power sector in each state, which will identify the potential losers from the privatisation. Then, detailed state-specific bargains can be designed through which these losers can be compensated. Here, key constituencies are those groups that do not currently pay the true cost of power. Schemes such as the solarisation of water pumps and direct benefit transfers from the government (instead of subsidies paid for by the discoms) are being launched, these and similar measures must be broadened. At the same time, those who steal electricity will also have to be compensated, for example by giving them formal electricity connections and vouchers for a certain amount of free power. This is not dissimilar to the way that slum dwellers in Mumbai were compensated by rehousing them as part of the slum redevelopment. The climate of opinion on privatisation more generally has shifted. Air India has been sold, talk of privatising banks is no longer taboo, there is a National Asset Monetisation Pipeline and the union government has started work on privatising union territory discoms. If close and sensitive attention can be paid to the political economy, there is now a good opportunity to free the electricity sector from the shackles of government ownership and enable a more effective energy transition.

Mission Mars

D Nandana Kurup

S4 E1

Mars is one of the closest planets to Earth, yet far away for us to set foot on its surface. Even before spaceflight was possible, the planet Mars has always been an object which fascinated humans. Mars has great significance in religions, myths, epics, etc. Human missions to Mars have always been depicted in fiction, movies and novels. All these being passed through many generations made humans curious about this red dot in the night sky. With the sighting of the presence of water, Mars possibly having the potential to support life on it has driven Scientists to explore our neighbour. Mars missions have been launching from Earth with regularity since the 1960s. NASA's Mariner 4 flew by the planet Mars in 1965 and sent 21 photos of Mars back to Earth, becoming the first craft to reach Mars after several attempts. Later, the former Soviet Union space program, the European Space Agency (ESA) and the Indian Space Research Organization(ISRO) made their success in reaching Mars. The Mars Orbiter Mission or Mangalyaan launched by ISRO has been orbiting Mars since 24 September 2014. In February 2021, NASA made another landmark by landing the Perseverance rover on Mars and the Ingenuity helicopter, the first helicopter to fly outside Earth.

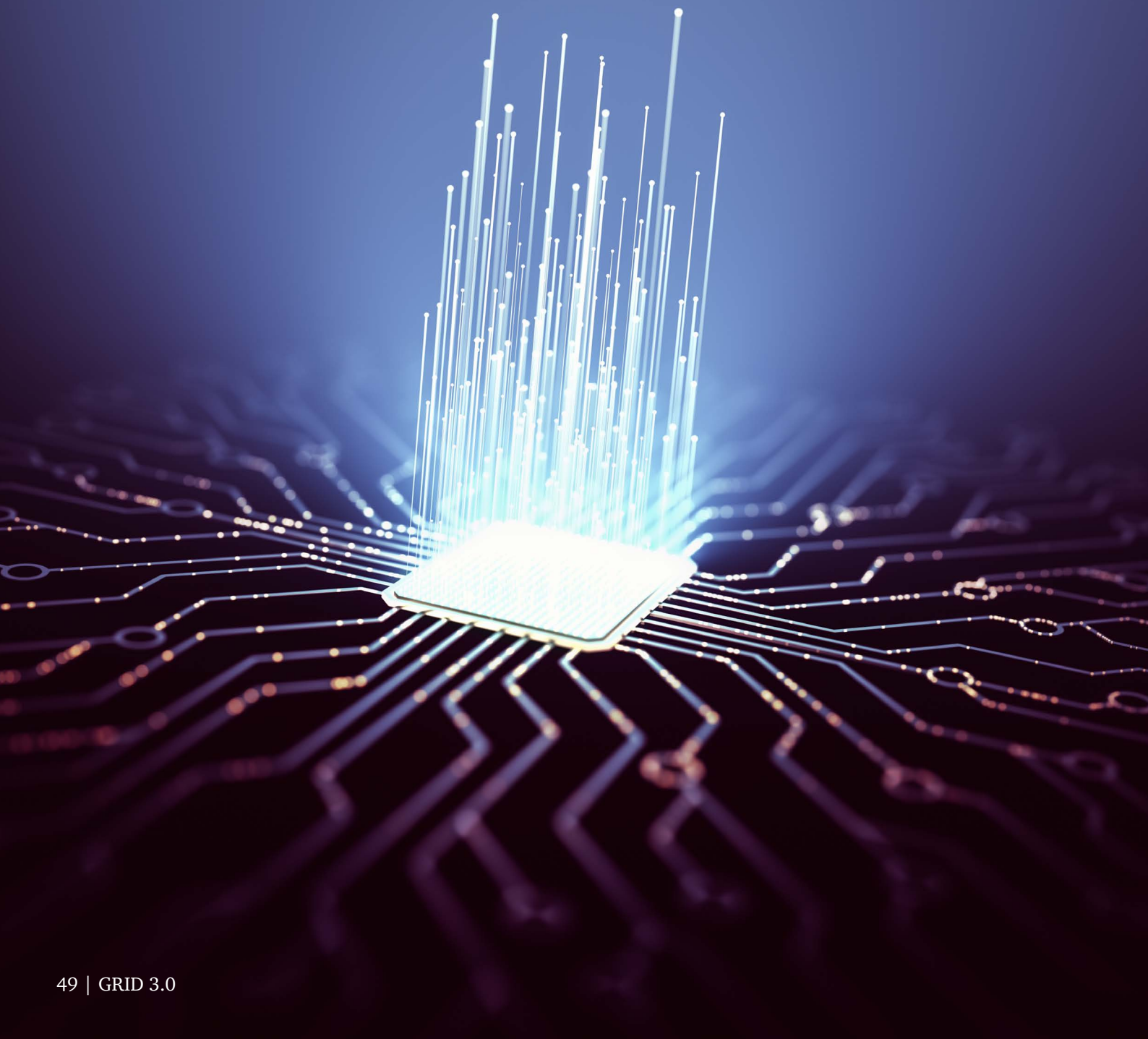
As of 2022, only rovers have been on Mars' surface. For the broader exploration of Mars, sending humans to Mars has been a subject of research by scientists and aerospace engineers. Conceptual proposals for missions that would involve human explorers started in the early 1950s and are expected to take place between 10 and 30 years from the time they are drafted. Mars is considered the most habitable planet after Earth and evidence shows that it might have supported life once. With the existing technology and logistics, it is very challenging to send astronauts to Mars, mostly due to distance and other factors. Based on the analysis, multiple challenges were identified to be limiting the success of manned missions with current technology. Some of them include the flight trajectory for Mars and corrective maneuvers, spacecraft and fuel management, radiation, microgravity, and astronaut health, isolation and psychological issues, communications (in transit and on Mars) and finally the Mars approach and orbital insertion.

A major issue when it comes to planning missions to Mars is the distance involved. Launch windows between Earth and Mars only occur every two years when the two planets are at the closest in their orbits to each other. Waiting for such a long period to launch holds many risks. During these windows, a spacecraft can make the journey from Earth to Mars in five to ten months. This makes re-supply of food, fuel, power and other essentials to astronauts impossible and the next launch is possible only during the next launch window. The distance also poses a threat to safety and power generation. Power production gets limited as solar flux from the Sun gets reduced with distance. Besides, concerns also arise regarding the health of astronauts and exposure to harmful radiation.

All these challenges need to be faced with innovations and development in space technology. A Mars subsurface habitat is under development which can address health-related issues. Technologies like nuclear thermal and electric propulsion can cut short the journey to Mars to just 100 days. On Mars, with a day and night cycle similar to that of Earth and periodic dust storms, it is easier to rely on nuclear fission power than solar power. Using laser communication techniques, the time needed to send back a map of Mars can be reduced. Hightech Martian spacesuits and inflatable heatshields are other innovations, currently under test, which can aid astronauts to land on Mars and make the journey smoother.

XAI for Power System Emergency Control

Amin Fathima Sadique
S6 E2



Artificial Intelligence (AI) has had a significant impact on various research domains in the past decade. This is due to the growing understanding of the importance of interdisciplinary studies in solving complex problems. The past decade has seen a growing understanding of the importance of interdisciplinary studies in solving complex problems and this has led to the rapid development and widespread adoption of AI-based solutions across various research domains. Every day, novel and creative ways to use data are being developed. In the modern scenario, the amount of data being generated far outpaces the humans' capability to absorb, interpret, and make complex decisions based on that data. It can be said that AI attains the vast characteristics of human experts to perform complex tasks in seconds. Power systems engineers are expected to perform necessary computations to ensure the proper working of the system and verify that the system can withstand expected stress and be protected in case of failures. In recent years, most efforts in the analysis have been successfully reduced by AI techniques.

Machine Learning is generally a black box - data in and prediction out. The algorithms are complex and the users are unclear about the decision-making process. In critical systems like Healthcare, autonomous driving, and power systems, we require an understanding of the particular alternative that is computed to be the optimum solution. Generally, a tradeoff between understandability and accuracy exists. Interpretable ML and eXplainable AI is an important aspect of ML and AI, as it helps to increase the transparency and accountability of the model's decision-making process while maintaining high accuracy. Existing emergency control schemes are designed offline based on conceived worst cases and a few typical operating scenarios. Modern-era electrical grids are large-scale systems and are more complex and uncertain. Therefore, to overcome the issues of adaptiveness and robustness, a DRL model in grid control is implemented on the modified IEEE 39 bus system. Assuming the faults to be caused due to stalling or tripping, a deep Q-network (DQN) algorithm was applied for developing a coordinated Undervoltage load-shedding scheme. The action decided on by the DRL algorithm is mapped so as to get the marginal contributions, both positive and negative of each cause. The obtained Shapley values are transformed into the form of probability to better grasp its meaning by passing through the Softmax function

The Deep SHAP method is a technique used to interpret the output of a deep reinforcement learning (DRL) model. This method is used to analyze the performance of the DRL model in order to understand how it is making its decisions. The method computes the influence of all input features on the model's output and provides an overview of which features are most important in the model's decision-making. This information can be used to improve the performance of the DRL model by identifying and addressing any issues with the input data or the model itself. Additionally, it allows us to understand which output actions are more relevant to the model's decisions. This method can be reliably and accurately used to assist operators in the control strategy of a power system.

The Art of CGI

How to Bring Your Imagination to Life

Dhanya P
S2 GNC

Computer-Generated Imagery is a type of computer graphics used to create 2D or 3D art and media for print, screen, film, TV, games, simulations, or VR. It can be used for animation or combined with live-action in movies for special effects. CGI has the ability to create simple or intricate shapes, 3D models with various lighting, reflections, particle effects, and physics. It is produced through software, often with the aid of 3D capturing, and computing power to render the final frames.

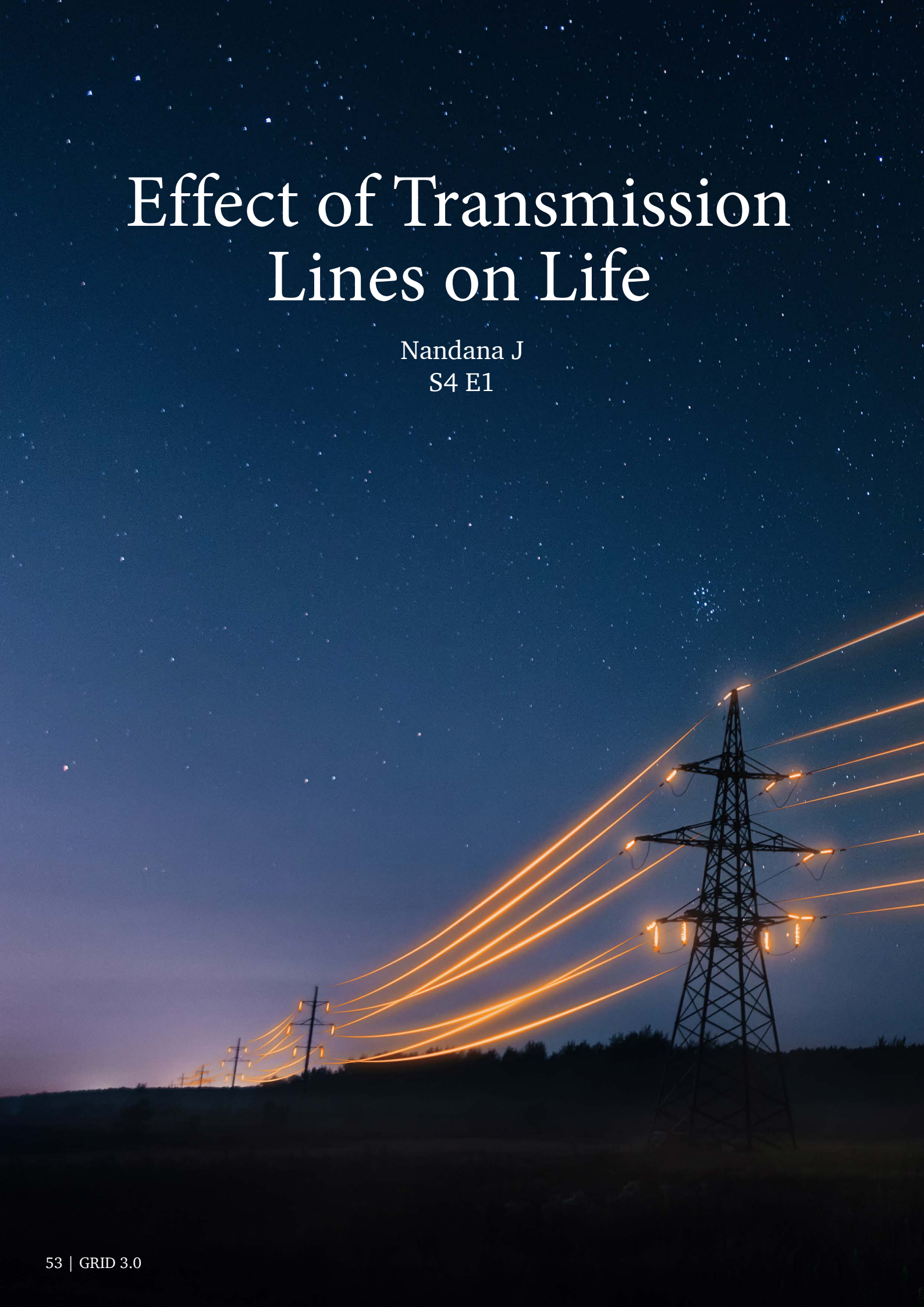
CGI has revolutionized the film industry, providing filmmakers with new tools to tell stories and create worlds that were previously impossible to achieve. CGI can be used in a variety of ways in film, from creating entire virtual environments and creatures to adding visual effects to live-action scenes. The technology is used to create realistic and seamless transitions between live-action footage and computer-generated elements. CGI has enabled filmmakers to create believable and detailed special effects that are integral to the story and enhance the viewing experience. For example, in the movie "Avatar," CGI was used to create the alien world of Pandora and its diverse inhabitants, including the Na'vi race. CGI also provides filmmakers with the ability to create scenes and scenarios that would be dangerous or impossible to achieve in real life. For instance, in the movie "Inception," CGI was used to create a dream world where the laws of physics can be bent and manipulated.

The technology behind CGI has advanced rapidly in recent years, with filmmakers using a variety of software, hardware, and techniques to produce stunning visual effects. Some of the key technologies used in CGI include 3D modeling software, animation software, rendering software, and motion capture technology. 3D modeling software is used to create detailed virtual objects, environments, and characters. This software allows artists to create 3D models from scratch or modify existing models and includes features such as texture mapping, lighting, and shading. Some of the most popular 3D modeling software used in the film industry include Autodesk Maya, Blender, and 3ds Max. Animation software is used to create movement and behavior in 3D models and characters. This software allows animators to control the movement of objects and characters, as well as add physics simulations, such as gravity and friction. Some of the most popular animation software used in the film industry include Autodesk Maya, Blender, and Houdini.

Rendering software is used to convert 3D models and animations into images and video sequences. This software uses complex algorithms and powerful computing hardware to produce photorealistic images, taking into account the lighting, shading, and material properties of the 3D models. Some of the most popular rendering software used in the film industry include Arnold, Redshift, and V-Ray. CGI has transformed the film industry, allowing filmmakers to create stunning visual effects and bring their stories to life in new and exciting ways. The use of 3D modeling, animation, rendering, and motion capture technology has enabled filmmakers to create believable and detailed virtual environments, characters, and special effects that are seamlessly integrated into the live-action footage. As technology continues to advance, we can expect to see even more incredible and breathtaking CGI effects in the future of filmmaking.

Effect of Transmission Lines on Life

Nandana J
S4 E1



Electricity, one of the greatest inventions made by men which transformed human lives, is worthy of appreciation. In the early 1900s, before electric current came into place, all the daily chores starting from fetching water to adjusting to the weather were done by man-power. But now, every task is done by a machine, which needs an electric current for its work. Keeping in mind the activities happening in a day, can you imagine a life without it!? Nowadays its acceptance is rising due to the fact of zero emissions in vehicles that could aid in eliminating the pollution from earth. Many of us have noticed how the current from generating stations is transmitted to our homes. But do you know that these transmissions create an adverse effect on the living beings on earth!? It's a fact that the high voltage transmission lines which we see bound to large towers are those that help electricity to reach our homes that enhance our comforts and at the same time there are certain harmful effects for it.

Electromagnetic fields and their effects

Electromagnetic fields occur naturally as a result of power generation, transmission, or even usage. The strength of the electric field could be reduced by the objects around us like trees, plants, buildings, etc. The electric field is produced by charged bodies ie. positive or negative charges. The higher the potential difference between two points greater will be the strength of the electric field. Magnetic fields arise with moving charges ie. current. These are also directly proportional to the strength of the current flowing through a conductor. The strength of EMF decreases considerably as we move away from the source producing it. EMF can produce charging of bodies, discharge currents, biological effects, and sparks. Similarly, magnetic fields induce current inside object bodies, causing health effects and a multitude of interference problems. Both these fields are invisible and people living near areas with high-voltage transmission lines are surrounded by some kind of artificial EMF.

The human body consists of a large number of ions rich body fluids such as blood lymph that respond to the forces exerted by these electric and magnetic fields which are referred to as electric and magnetic field induction. Also the power frequency electric fields induce eddy currents(current loops produced by varying magnetic fields on the surface of a body) as well as charges on the surface of a body which decreases in strength as we move deeper into it. This induced voltage affects the tissues in the human body and could turn out to be a boon or bane depending upon its nature. The magnitude of surface charge and internal body currents depends on various factors like distance from the source, body posture, presence of other objects, etc. For example, if an ungrounded individual approaches a nearby overhead transmission line, an electrostatic field will be created within the body. When that person touches a grounded object, the charge will discharge through their body, resulting in a substantial flow of discharge current. Hence while designing a transmission line these things are to be taken care of and proper clearance is to be provided between the earth and transmission lines in order to avoid dangerous situations.

Health issues in Human Beings

According to the research and publications put forward by the World Health Organization, EMF results in long-term health issues as well as short-term health issues for human beings. The strong artificial EMFs like those produced by the high voltage transmission lines can

scramble and interfere with the natural Body EMF, causing harm to your sleep cycle and stress levels. Studies show that it could even harm your immune system and DNA! The short-term health issues caused by these EMFs include headaches, fatigue, anxiety, insomnia, rashes, muscle pains, etc. sometimes these can be irritating and affect our mental balance as well. There exist long-term health issues like the risk of damaged DNA, cancers, leukemia, miss carriage, neurodegenerative disorders, etc. Hundreds of studies from across the world confirm that people, especially children living under power lines are at greater risk of occurring these diseases as compared to others living far away from power lines. Maintenance workers are the most affected. The emf generated could harm them or even cause death.

Effects of EMF on plant and animal life

Many researchers are studying the effect of emf on plants and animals by keeping their cages under high electrostatic fields(about 30kV/m). When this is done, it has been observed that their body acquires a charge and a spark jumps from their nose when they try to drink water. It was shocking to notice that hens when kept under such high electrostatic fields were unable to pick up grains due to the chattering of their beaks. The emf produced from high-voltage power transmission systems also affects the growth of plants. A number of transmission lines pass through agricultural fields and forests which we feel least affected, but it is not so. Many practical studies show that the response of crops to emf produced by power lines is worthy of discussion. Various growth characteristics like root length, shoot length, leaf area, total biomass contents, etc. were reduced significantly over those plants that were under the influence of power lines.

Effects on other objects

An electrostatic field is generated in a parked vehicle under a high-voltage transmission line, and discharge current flows through a person who touches the car. To prevent this, it is recommended that parking areas located near these transmission lines maintain a safe distance from the lines. Additionally, objects such as fences, irrigation pipes, pipelines, and electrical distribution lines can form a conductive path when connected to the ground at both ends. If a person touches an end of an open fence then he completes the loop making a possibility that he could get a shock. Thus proper care must be taken while such constructions are made.

Contradictions and Mitigation

Human health is not endangered by the electromagnetic fields generated by power systems for two main reasons. Firstly, the emf produced by power lines and appliances has very low energy and frequency. Secondly, the electric fields across the outer membranes of body cells are much stronger than those generated by transmission lines. There are also various ways through which we could reduce its severity on human health. Proper care like line shielding, line configuration and compaction, grounding, maintaining clearance, providing R.O.W, etc. has to be followed so as to reduce risks and harm. Hence by doing so our transmission is also not affected.

Conclusion

Electromagnetic fields (EMFs) are all around us and have become an integral part of our daily lives. They are produced by a wide range of sources, including power lines, electrical appliances, and electronic devices. Despite numerous studies and research projects, there is no concrete evidence that exposure to extremely low-frequency EMFs is linked to increased health problems in humans. Despite this lack of evidence, concerns about the potential negative effects of EMFs persist. Some studies have indicated that exposure to high levels of EMFs can result in various health issues, including headaches, fatigue, sleep disturbances, and even an increased risk of certain types of cancer. However, these claims are often based on limited data and are not supported by conclusive evidence.

High-voltage transmission lines are particularly concerning to many people due to their proximity to residential areas and their ability to generate strong EMFs. However, despite some studies indicating a potential risk, there is still no clear scientific proof that these transmission lines are hazardous or pose a significant threat to human health. Proper safety measures can greatly reduce the potential risks associated with high-voltage transmission lines. This can include the implementation of effective insulation and grounding systems, regular maintenance and inspections, and careful planning when constructing new transmission lines to minimize their proximity to residential areas.

The transmission of electricity is an essential component of modern life and cannot be discontinued. While some concerns about the potential negative effects of EMFs persist, there is still no clear scientific evidence linking exposure to high-voltage transmission lines to increased health problems in humans. However, by implementing proper safety measures, we can ensure that the transmission of electricity is as safe as possible for both the people and the environment.

Autonomous Drones

Abhishek Jayachandran

S8 E2

All of us have witnessed technology revolutionizing our world - gently seeping into our lives and redefining the way we see and do things. Every task that we face today has either been simplified, automated or is being done so. The traditional methods of doing the same may seem obsolete in the near future. As ambiguous as this statement may seem, it is fundamentally the reason why our living standards have increased over the past decades. As more and more machines automate the industry, we are moving towards a world that is driven extensively by Artificial Intelligence. Self-driving cars and swarms of drones filling the sky will no longer be just Sci-Fi movie visuals. In fact, autonomous cars and drones are now very much capable of mass deployment, although the credibility over their human-controlled counterparts may not be yet justified.

Drones are UAVs(Unmanned Aerial Vehicles) often controlled by remote controllers and used for many applications like videography and crowd management. Autonomous drones have realized the dreams of many engineers and pilots, and taken over the modern film and photography industry by storm. These drones are much like your average drone, but capable of flying autonomously - as the name suggests. This means that it satisfies its purpose of flying, sensing, and everything in between, without the need for human intervention.

The autonomous nature of drones is accomplished by giving them sensors to study their environment, and a processor to crunch this data and make informed decisions. The entire computation can either be done onboard, or the drone can function as a node with a host system doing the processing. At any rate, the drone still requires an autopilot to give it the control to remain in flight.

One of the major challenges faced by autonomous drones is the problem of navigation in the absence of a world coordinate system ie. access to GPS data. This means that the drone has to rely on its sensors to map its environment, and also simultaneously plot its instantaneous position with respect to that frame. The sensor data may be noisy, and odometry data may not be easily available, but this will have to be compromised. A famous class of algorithms that have been developed to map and navigate in these environments is SLAM (Simultaneous Localisation and Mapping).

SLAM can vary according to your requirements of the map and the type of sensors used in the drone and is grouped into many sub-classes like LSD SLAM and ORB SLAM. Implementing these algorithms requires fundamental computer vision knowledge and some optimization algorithms. It, therefore, still remains an open-ended problem with newer and better algorithms making their way into the industry. Some of the autonomous commercial drones are Parrot Ar Drones, Asctec Pelican, and Hummingbird drones.

Besides videography and filmmaking, autonomous drones are also taking off in the courier and delivery industries, with many major names in the market focussing on shifting to aerial delivery. They are also being used extensively to aid in the fight against the global COVID-19 pandemic. Applications range from thermal vision to large-scale disinfection of infected areas. Despite the cost and effort of making a drone, it still remains one of the most popular engineering projects. Adding autonomy to such a familiar project makes for a very interesting area of research for both students and hobbyists alike. To envision a future with robots and drones, traveling and communicating among themselves and with humans - an integration of man and machine. Now that is a dream!

Let's go fly a kite

Smriti Pillai
S8 E1

Kites!

Still, associating with your childhood? The world is currently heavily dependent on fossil fuels such as coal, oil, and natural gas for energy production. However, fossil fuels are non-renewable resources, meaning that they cannot be replenished once they are used. As the world runs out of fossil fuels, it is important to find and develop alternative energy sources to ensure a sustainable energy supply and as it seeks, several companies have come up with the 'promising option' of self-flying energy kites that may be the answer to tapping the increasing need for power around the globe.

Why kites?

Wind turbines have traditionally been limited in their ability to capture strong winds due to the height of their turbine masts. However, kites can reach much higher altitudes, up to 260 meters, making them a promising option for capturing stronger winds. These energy kites come in different designs, such as the Skysails kite which is a parachute-like structure attached to an 800m long tether, and the Makani kite, which is an airplane-like structure tethered to a base installed on a floating platform in the water. Kites are being used as an alternative form of energy generation by companies like Skysails and Makani. Skysails' kite is a parachute-like structure attached to an 800m long tether, while Makani's is an airplane-like design tethered to a base on a floating platform in the water.

As the kite is pulled by the wind, the tether uncoils and spins a drum. The drum is connected to a generator, which converts the mechanical energy from the spinning drum into electrical energy. The process of using a kite to generate power is efficient because reeling in the kite only requires a small amount of energy. Specifically, it is said that reeling in the kite only takes 4% of the power generated. This means that 96% of the power generated by the kite is available for use. This is a much more efficient process than traditional wind turbines, which require a significant amount of energy to start and stop the turbine blades. The concept of altitude wind generation is intriguing, and it remains to be seen if these self-flying energy kites can live up to the promise of being a viable alternative energy source in the coming years.

Hologram

Susan Ann Roy

S2 E2

What are holograms?

From a very early age of scientific innovations and discoveries, people have been developing better and more efficient technologies each day to produce an exact illusionary existence of reality. Their quest to do so has grown over the ages. Ranging from photographs and videos to virtual and augmented reality, the creativity of mankind is finding space not just in the field of research but also in various interlinked fields of education, career, military, healthcare, communication, and many as such.

The hologram is one such technology that aims to produce a three-dimensional record of reality based on the simple phenomenon called interference of light waves. It has been the dream of many tech and entertainment companies but was believed to be impossible and was confined to its existence in movies as fiction. Dennis Gabor, the inventor of holography, first proposed the idea in 1948 and created his first hologram using a mercury arc lamp with a green filter as a light source. Now, researchers are utilizing laser technology, digital processors, and motion sensing to develop various types of holograms that could revolutionize media consumption and interaction in the near future.

The Holographic theory of universe

Proposed by Juan Maldacena, in 1997, the principle of the holographic universe is yet an unsolved puzzle and aims to break the black hole information paradox, and the entropy problem as well as gives impetus to the String theory. According to this theory, the three-dimensional real world as we perceive is in fact just a profound illusion of alternatively viewing what is stored on a two-dimensional surface, i.e., The universe itself is a hologram.

The Blackhole Information Paradox

The contradictions regarding the storage of information in a black hole were whether the existence of Hawking's radiation was true or not. The universe when viewed as an isolated system, no matter what happens to fundamental particles that exist in it, the quantum information of the objects as well as the particles should never get destroyed. This created confusion among scientists as no one understood what happened to all the bulk matter that went into a black hole and how it was stored just in a hole of the spacetime curvature. Also, Stephen Hawking proposed that black holes themselves had a sufficient amount of temperature and would gradually evaporate back into the universe or in a clear sense radiated back as H into the universe. But still, scientists were struggling a lot to clearly explain the phenomena underlying reality with true logic, especially regarding the storage of multidimensional information of matter and energy on the boundary of an isolated system, such as the black holes.

However, the theory of holographic universe, though not proven completely true, was able to temporarily solve this paradox by stating that: When an object falls into the gravity well

of a black hole, it leaves a two-dimensional imprint of its information to be encoded on the event horizon and when the radiation leaves the black hole, it picks up the imprint of this data from the surface and thus the information is not destroyed.

Science Behind

A hologram is created by splitting a laser beam into two parts. The light waves in these two beams travel in the same way. When they are recombined on a photographic plate, the light waves in one of the beams (the object beam) have been disturbed because they have reflected off the surface of an object. Since the two beams were originally in perfect alignment, the recombination of the beams shows how the light waves in the object beam have been altered in comparison to the reference beam. In other words, by joining the two beams back together and comparing them, you can see how the object changes light rays falling onto it—and that's simply another way of saying "what the object looks like." This information is burned permanently into the photographic plate by the laser beams. So a hologram is effectively a permanent record of what something looks like seen from any angle. In simpler terms, a hologram is a permanent record of the way an object appears, as captured by a laser beam. This is achieved by recombining two beams and comparing them to see how the object has altered the light waves. This information is then recorded permanently on a photographic plate. The hologram can be viewed from any angle to see the object.

Holograms are produced by the superimposition of coherent light waves when the reference beam is reflected from a real object.

The Entropy Problem

The entropy problem had become a topic of active debate among scientists, since for ordinary matter, the entropy or the randomness of particles within an isolated system is proportional to the volume of the three-dimensional system but for black holes, there was no volume and instead, the entropy was proportional to the area of the two-dimensional surface of the black hole's event horizon. The holographic principle solved this problem also by viewing the three-dimensional existence of matter as an illusion of a two-dimensional imprint and concluded that the volume of higher dimensional space was encoded on a lower dimensional boundary and that the maximal entropy of an isolated system scaled with its radius squared and not cubed.

The ADS-CFT Correspondence

The anti-de-Sitter-space-conformal field theory correspondence, also known as the holographic duality or the gauge-gravity duality, posits that a gravity theory, such as string theory, defined in a d-dimensional anti-de-Sitter (ADS) space-time is mathematically equivalent to a gauge theory, such as a conformal field theory (CFT), defined on the d-1 dimensional boundary space-time of the ADS space-time. This equivalence means that the strong coupling regime of one theory, where problems are difficult to solve using perturbative methods, can be translated into the weak coupling regime of the other theory, where problems are easier to solve. Furthermore, the weak coupling regime of the first theory can be translated into the strong coupling regime of the other. This duality allows for a deeper understanding of the behavior of the systems in question and opens up new avenues for solving problems that were previously intractable. Additionally, the strong-weak coupling duality also means that one theory can be used to shed light on the behavior of the other in regimes where it is not well understood.

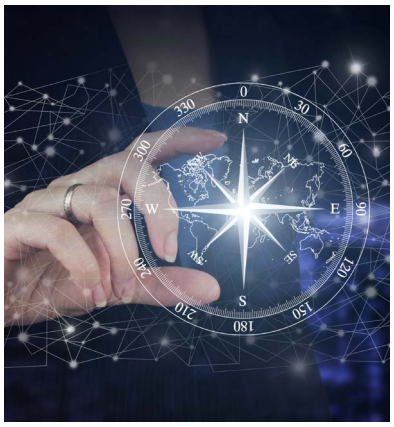
This correspondence was first proposed by Juan Maldacena in 1997 and is considered one of the most significant developments in string theory in the past two decades. The theory promised to resolve many intractable problems in various field theories through simplified calculations in lower dimensions as both had the same quantum information.

Simple Hologram

A simple and good holographic image can be produced by anyone much more easily with a transparent material like glass/plastic film and an electronic screen like that of a mobile/ computer. Just make a prism out of the transparent material with a square-shaped hole cut at the vertex portion. Browse for holographic visuals on youtube and then place the prism invertedly on the screen in a dark room. The setup produces a holographic moving three-dimensional visual in the air.

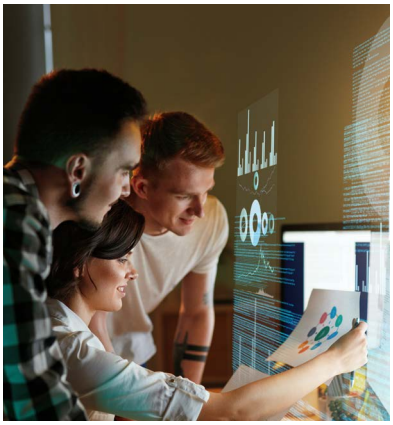
Fraud and Security

Due to their complexity and difficulty in replication, holograms are considered to be highly advantageous in the field of commercial security. Their use as a security feature on credit and debit cards helps to reduce the risk of counterfeiting. The reflective color-changing holographic strips on bank notes that produce floating images were introduced with the same purpose of detecting illegal monetary activities.



Military Mapping and Navigation

The development of 3D holographic maps of battle spaces allowed soldiers to view three-dimensional terrain and explore all nooks and corners to improve mission planning and training. Airplane pilots use Holographic Optical Elements (HOEs) for navigation by displaying a holographic image of the cockpit instruments that appears to be floating in front of the windshield. This allows the pilot to keep his eyes on the runway or the sky while still being able to read the instruments.

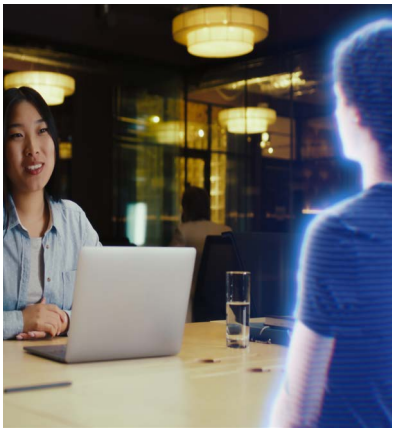


Hologram and Education

The use of holograms in education provides enhanced learning platforms for students by producing graphical three-dimensional virtual displays of diagrams and demonstrations that can be seen with the naked eye also, thereby strengthening their knowledge of core subjects. Students can also attend live or recorded video lectures with or without the tutor's actual presence by producing the holographic projections

Medical Imaging

Holography could also revolutionize medicine, as a tool for visualizing patient data while training students and surgeons and also for producing computer-generated three-dimensional projections of electronic information from MRI and ultrasound scans. Holographic interferometry is used by researchers and industrial designers to test and design prosthetic limbs and artificial bones and joints. Now, scientists are also developing technologies to artificially create and edit brain activity, stimulate various regions of the brain with much precision and develop neural prosthetics to control the senses related to it.



Communication Devices

Holographic mobile phones, computers, smartwatches, and smart rings are the future innovations that will gain much demand and popularity over ordinary smartphones and electronic communication devices. They can also be used to produce three-dimensional visuals of various kinds of maps produced by satellites and radars.

Architecture and Design

The growing marvelous innovations of mankind have been a driving force for the creation of a hyper-technologized future and to reshape the way we experience and conceptualize architecture through the concept of pseudo-holographic projections rather than physical or material qualities of constructions. The 1 of creative visual images and architectural illustrations for enhanced measurement and planning of constructions was made possible through the discovery of holograms.

History behind the discovery

In 1947, Dennis Gabor, a Hungarian-British electrical engineer and physicist, developed the concept of wavefront reconstruction as a means to enhance the capabilities of the electron microscope. This idea laid the foundation for optical holography, which allows for three-dimensional imaging. However, the practical application of optical holography required the use of coherent light sources, which were not available until the invention of the laser a few years later.

Hologram was actually discovered by chance as a part of Gabor's efforts to correct the spherical aberrations of magnetic lenses for improving his electron microscope and on the identification of the supporting theories, his further research works began to deflect towards the making of holograms. During the initial stage of recording, an interference pattern is captured on a photographic plate by using a coherent electron beam (referred to as the object wave) and a coherent background (referred to as the reference wave). This pattern, referred to as a "hologram" by Gabor, contains all the information about the object wave, including the amplitude and phase, and the name "hologram" is derived from the Greek word "holos" meaning "whole".

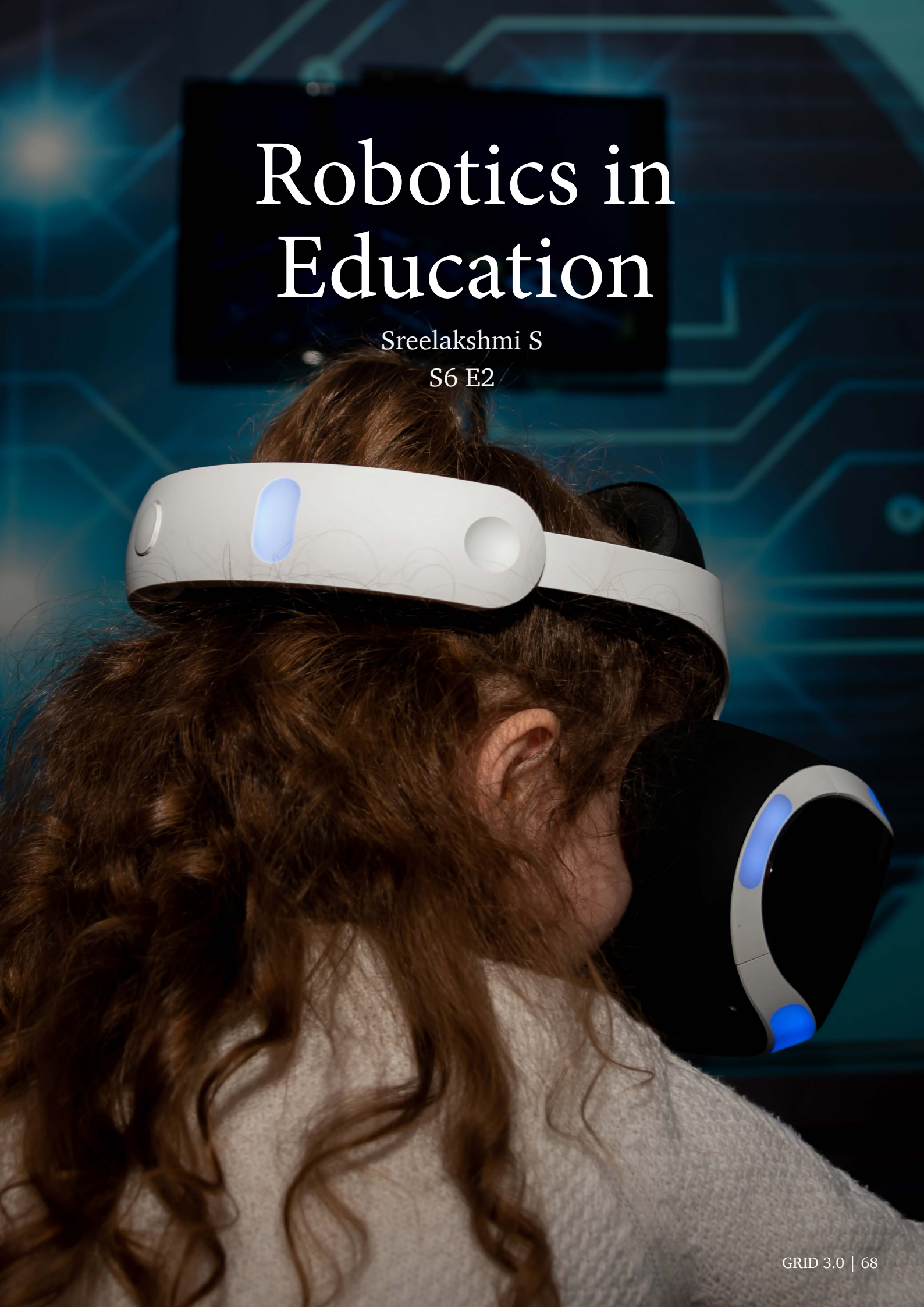
The second stage, known as reconstruction, involves illuminating the hologram with visible light, which allows the original wavefront to be reconstructed. This enables corrections to be made to the aberrations of the electron optics using optical methods. Gabor's invention of holography was recognized with the Nobel Prize in 1971, as well as the IEEE Medal of Honor, with the citation "For his ingenious and exciting discovery and verification of the principles of holography." The invention of laser technology in 1962 led to the creation of practical optical holograms that could capture 3D objects. This was achieved by Yuri Denisyuk in the Soviet Union and by Emmett Leith and Juris Upatnieks at the University of Michigan in the United States.

Conclusion

From their introduction as fiction in high-rated films, holograms have now eclipsed the film industry and are on their way to becoming an integral part of our daily lives with their endless applications. The 3d hologram displays are an inevitable part of a more human-compatible digital world and therefore the development of affordable holograms technologies and their availability to a large population is yet a growing challenge of the digital world. The partial theories of cosmology related to holograms, though not completely proven, seem to provide temporary solutions to many paradoxes in the field of research. In future years, let's hope to replace all the present displays in small devices with large projections of virtual nature that are easy to access and utilize such that it benefits all different fields of the world for accelerated safe technological development.

Robotics in Education

Sreelakshmi S
S6 E2



In recent years, education has undergone significant changes, particularly in terms of technology integration in classrooms. With the advent of new technologies such as laptops, tablets, and interactive whiteboards, students are now able to access a wide range of information and resources in a more engaging and interactive way. This has led to an increase in student engagement and a shift towards more student-centered learning. Additionally, the widespread adoption of remote learning due to the ongoing COVID-19 pandemic has forced educators to adapt to new teaching methods and has required students to become more independent learners. As a result of these changes, the way in which kids learn and are educated has shifted significantly.

Educational robotics is a rapidly growing field that is being used in many colleges and universities to teach STEM (Science, Technology, Engineering, and Math) skills to students. The use of educational robots allows students to learn about robotics and technology in a hands-on, interactive way. This helps students to gain a deeper understanding of the concepts and principles that are involved in robotics and also provides them with the opportunity to develop problem-solving, critical thinking, and creativity skills. One of the main advantages of using educational robots in primary education is that they provide students with their first exposure to robotics at a young age. This allows students to learn and develop the skills that are becoming increasingly important in a world where technology is developing quickly. Additionally, educational robots can be used to teach a wide range of STEM subjects, including science, technology, engineering, and math. For example, students can learn how to construct and program a robot to perform a variety of tasks, such as moving, sensing, and responding to its environment. The use of educational robots in primary education can be an effective tool for teaching STEM skills and providing students with their first exposure to robotics. It helps students to learn in a more engaging way and provides them with a valuable foundation for future studies in the field of robotics and technology.

As children progress through their education, more sophisticated robots can be introduced in the classroom to challenge and engage them further. These robots are typically more complex and difficult to program and are capable of performing more advanced tasks. For example, older students can learn about advanced programming languages such as Python, and use them to program robots to perform tasks such as object recognition, navigation and voice commands.

Educational robotics offers many benefits, including:

- Providing teachers with a helpful tool and serving as an alternative for students who are learning remotely.
- Enhancing cognitive abilities and mathematical reasoning for young children, as well as providing transferable skills that can be applied to other subject areas.
- Preparing children for potential future careers in technology and engineering.
- Making it possible for students who live far away to access their school remotely via avatars.
- Making programming more accessible for children by simplifying complex concepts.
- Supporting special needs students by providing visual and interactive ways of learning.

Robotics in the classroom can also be used in a variety of ways that can be tailored to meet the needs of students of different ages and abilities. For example, younger students can be introduced to basic robotics concepts using simple, pre-built robots that are easy to program and control. As they progress to higher grades, they can learn more advanced programming languages and use them to program robots to perform more complex tasks. Additionally, robotics can be used in the classroom to teach other subjects such as physics, mathematics, and engineering. Robotics can be used to demonstrate the application of physics principles such as forces, motion, and energy. Robotics can also be used to teach mathematical concepts like geometry and trigonometry, as well as engineering concepts like design and prototyping. Robotics in the classroom can be used in a variety of ways that can be customized to meet the needs of students of various ages and abilities. It can help to engage and motivate students, while also providing them with valuable STEM skills that will be useful in their future studies and careers.

Currently, several educational robots are being used in classrooms. One such robot is NAO, a humanoid robot that has been widely adopted in classrooms across different educational levels. Its ability to communicate with students and participate in debates makes it an engaging tool for teaching various subjects. Another popular educational robot is Robo Wunderkind, which consists of modular building blocks that can be assembled to create a complete robot. This robot is designed to introduce children to robotics, engineering, and problem-solving. By using the building blocks to construct a robot, students can develop their creativity, critical thinking, and problem-solving skills while learning the basics of robotics and engineering. Finally, there is the Makeblock mBot, a beginner-friendly robot that is designed to introduce kids to the world of robotics, programming, and electronics. With its user-friendly interface, students can quickly learn the basics of robotics and technology, including programming and electronics. This robot is an ideal tool for schools looking to introduce students to the exciting world of technology and robotics, and lay the foundation for future careers in these fields.

The Future Grid

Manu Moncy

S6 E2

The Smart Grid has significantly updated the power grid system with the introduction of intelligent features like bidirectional distribution and communication, autonomous monitoring and healing, and also the integration of distributed generation systems. The advancement of the grid system from the classical electromechanical meters to the Smart Grid has eliminated many a problem in the global energy market. However, they are bounded by the limited technology it leverages. The integration of sophisticated tools and technology can further supplement the interrelation of the generation, distribution, and transmission networks.

The Next-generation smart grid is a modernized version of the traditional electrical grid that utilizes advanced technologies such as artificial intelligence (AI), the Internet of Things (IoT), and 5G networks. These technologies enable the grid to become more interactive, with multi-way communication and multi-directional power flow. This means that the grid will be able to handle power flow in multiple directions, allowing for a more efficient distribution of energy. Additionally, the use of distributed intelligence, including control, stability, and optimization, will enable the grid to self-monitor and self-correct, resulting in a more reliable and efficient system. Overall, the Next-generation smart grid (or "Future Grid") is designed to be more adaptable and resilient, making it better equipped to handle the challenges of the 21st century, such as increasing renewable energy generation and electric vehicle integration. The transition from the existing Smart Grid to the Future Grid is a process that aims to improve the efficiency, reliability, and security of the power grid.

One key component of this transition is the inclusion of the Virtual Power Plant concept. Virtual Power Plants (VPPs) are a network of distributed energy resources (DERs) such as solar panels, wind turbines, and energy storage systems that can be controlled and managed remotely. VPPs allow for better management of energy supply and demand, which can improve grid reliability and reduce costs. Another important aspect of the Future Grid is the implementation of smart transmission lines and automated substations. Smart transmission lines use advanced sensors and communication technologies to monitor and control the flow of electricity, while automated substations use programmable logic controllers (PLCs) and other technologies to improve the efficiency and reliability of the grid.

An essential element of the Future Grid is the inclusion of an AI-powered Network Management Center. This center uses multiple AI and ML techniques to improve the monitoring and control of the grid. These techniques can be used for efficient fault monitoring and detection, accurate load forecasting, and systematic grid stability assessment. With the help of AI, the system can also predict potential issues and take preventive measures to avoid them. The integration of these technologies also improves the security of the grid by eliminating vulnerabilities and increasing the resilience of the system. The use of AI can detect and respond to cyber threats and other security concerns. The progress of the Future Grid is dependent on the capabilities of the 5G network and the rapid growth of Artificial Intelligence as they provide the necessary infrastructure and tools to support the deployment and operation of advanced technologies.

Neuralink

A Fitbit in your Skull

Nanditha S
S6 E2

Neuralink is a neurotechnology company founded by Elon Musk and a team of seven other scientists and engineers in 2016. The company focuses on developing implantable brain-computer interfaces. This device is described as "a Fitbit in your skull with tiny wires" which will revolutionize the future. What makes Neuralink unique is that it is wireless and works using Bluetooth technology. These devices can be implanted in the brain and help humans interact with machines using their brains. These devices can be used to treat brain diseases and can be extended to human enhancement.

History of brain implants

The functioning of the brain has always been a curiosity to scientists all over the world. The beginning of brain implants can be traced back to the 17th century. In 1870, Eduard Hitzig and Gustav Fritsch demonstrated that movements can be produced by electrical stimulation of the brains of dogs. The ability to produce movements through electrical stimulation of the brain was first demonstrated in 1870 by Eduard Hitzig and Gustav Fritsch on dogs. Robert Bartholow later confirmed this to be true for humans in 1874. In the early 20th century, Fedor Krause began mapping human brain areas using patients who had undergone brain surgery. In 2002, scientists were able to control a cursor in real-time using brain stimulation on monkeys. In 2008, a monkey was able to feed itself using a robotic arm controlled by brain signals. In 2012, a study led by Leigh Hochberg showed that people with tetraplegia were able to control robotic arms through thought. By 2017, humans were able to control a cursor to type out words and sentences, and in 2018, a person used brain signals to control a tablet to browse the web and send emails.

The science behind Neuralink

Neuralink is based on neuro-electrophysiological recording. Electrophysiology is a branch of neuroscience that explores the electrical activity of living neurons. This branch of science delves into the molecular and cellular processes that govern the signaling of these living neurons. When we perform a certain activity, say moving a leg to the left, certain neurons are activated in a pattern. We can predict the direction of movement by listening to the set of neurons that are wired to our muscles. This is the basic principle behind Neuralink. The major application of brain implants by Neuralink is for paralysis and other severe brain diseases. In the case of a paralyzed patient, the neurons for a particular function are activated in the brain. But the pathway for the neurons to the muscles is damaged and they cannot get down to the muscles. This can be solved with the help of an artificial chip in the brain that listens to the neurons.

The Neuralink chip can be implanted by neurosurgery. This required cutting the skin and getting down to the skull. Then a hole is drilled in the skull to expose the protective layer of tissue that surrounds the brain called the dura. The dura is cut and folded back to expose the brain. Then the electrodes are implanted on the surface of the brain. Infection, bleeding and tissue damage are the biggest issues with these types of techniques. Neuralink and implantable brain interfaces are revolutionary technologies. This can help change the lives of many people suffering from various neurological conditions. This technology has the potential to change the way of treatments for all brain diseases including strokes, paralysis, Parkinson's, epilepsy, dementia, Alzheimer's and other degenerative diseases. Neurotechnology is a promising research area with much to offer the world.

The Internet Amid a Global Pandemic

Harisankar Arun
S8 E2

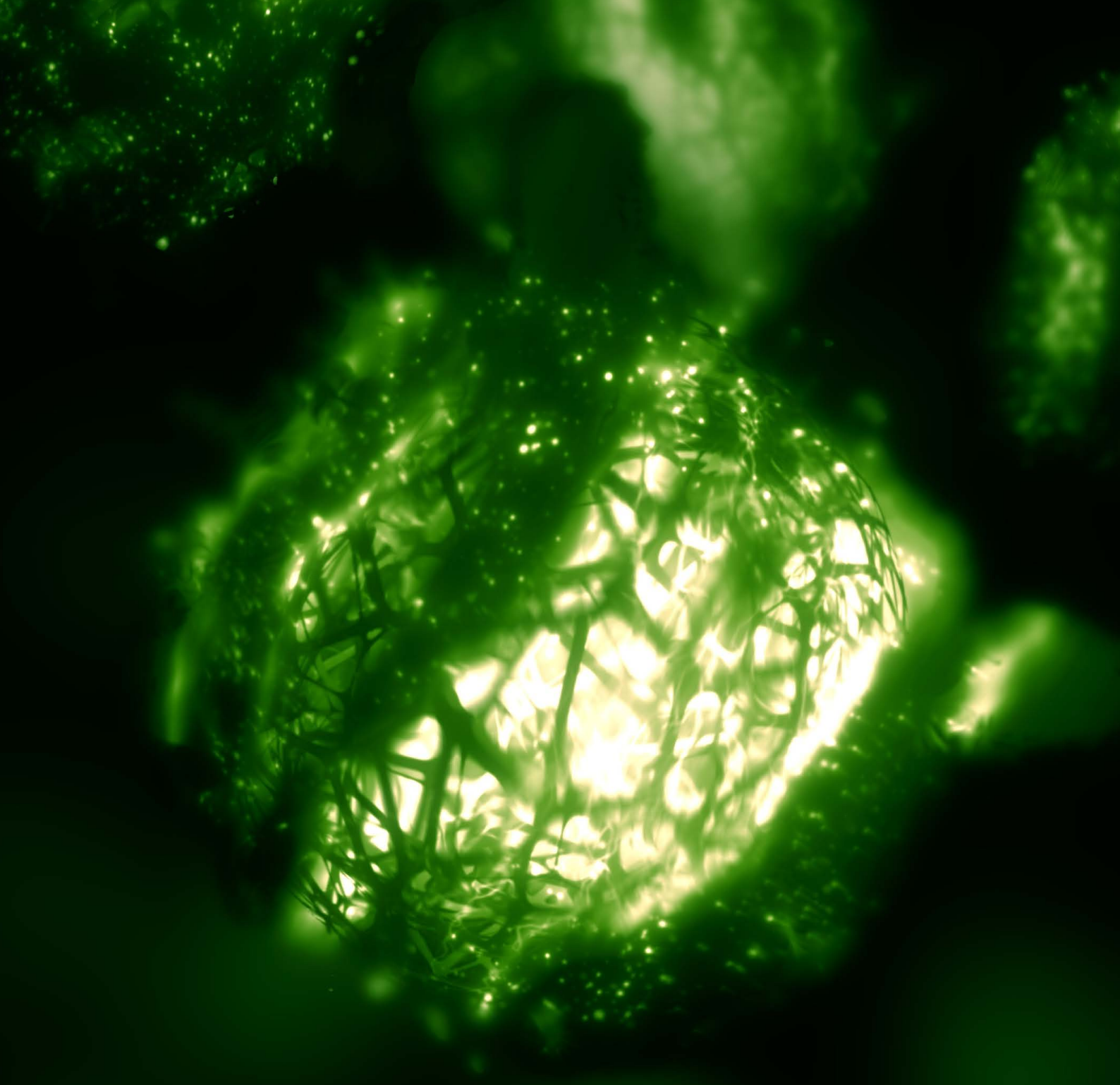
The Internet has become a vital technology in the current era, just as the electrical engine was in the past. It allows people to stay connected with loved ones remotely and complete work projects during the pandemic-induced social distancing. However, the increased reliance on the internet also presents an opportunity for hackers. The importance of the internet has become even more apparent during the pandemic, as it is crucial for people to stay connected and for the continuity of essential services. With more people turning to digital tools for communication and education, secure methods of communication need to be in place.

The worldwide pandemic has resulted in a tremendous increase in the usage of streaming services and online video platforms. For example, Netflix experienced a significant boost in global subscribers during Q1, with many signing up in March as lockdowns were implemented. However, this spike in traffic has presented challenges for internet service providers and other companies. To manage the high demand for bandwidth, some companies, such as Netflix and Google, have reduced the quality of their streaming videos. Similarly, Facebook has also adjusted the quality of its live videos, which have seen a significant rise in usage.

The social network stated in a blog post that the usage of its platform has grown significantly due to the impact of Covid-19 and that they are seeing new records in usage almost daily. The cloud infrastructure, which supports many online websites and apps, has been able to handle the increased traffic efficiently. Amazon Web Services (AWS), the largest cloud computing company, is designed to adjust and grow capacity as needed, similar to how the internet itself functions. Its servers can be operated remotely and can automatically scale up or down to handle surges in traffic. This allows AWS to accommodate the increased demand by spinning up extra servers as needed.

Despite some services adapting well to the increased demand due to the COVID-19 pandemic, others have struggled to keep up. Zoom, a popular video conferencing app, has seen a sudden surge in usage in the past month, due to the need for people to communicate through voice and video calls while staying at home. However, this sudden growth has also brought to light several privacy and security concerns with the platform. Reports have surfaced that over 500,000 Zoom accounts have been hacked and are being sold or given away for free on the dark web.

The ongoing COVID-19 pandemic has led to a rise in online scams, with people receiving emails and texts that appear to be official alerts about the response to the pandemic but are malware. It is important to learn how to identify these malicious links and pop-ups. The increased usage and reliance on the internet due to the pandemic have put a significant strain on networks, making it more important than ever to be vigilant in protecting ourselves online.



Green Spark for Indian Farmers

Sradha M
S6 E1

Imagine trees giving out free Wi-Fi! Most of us will be out on a tree-planting frenzy. Pity that they only give us life-sustaining oxygen we so casually breathe. Now, imagine a garden on your very own rooftop that could power your entire house. Or a wetland or green field producing thousands of watts? Plant-e, a Dutch start-up has devised a way to draw electrical power from plants and utilize it for powering Wi-Fi, chargers, cell phones, and even their headquarters in the Netherlands. This establishment was founded in 2009 as a division of the Sub-Department of Environmental Technology at Wageningen University, their founding mission is to provide renewable energy to 1.4B people around the world.

The Plant Microbial Fuel Cell from Plant-e generates electricity from natural reactions between plant roots and soil bacteria. To understand this better, let us rewind certain basic facts we have already learned in school-level biology classes. When plants synthesize food by photosynthesis, a large chunk of organic matter generated is passed back into the soil by the roots. The organic matter is then consumed by soil microbes, and electrons are released as a result of this consumption. An electrode placed near the roots aids this fuel cell in gathering this energy and turning it into electrical power.

Upon understanding this process, one might wonder if it will alter the natural mechanisms of a plant or affect it in a detrimental manner. The answer to it is, not at all. Several tests have been conducted and it is scientifically proven that the plants remain unharmed by the presence of electrodes. Moreover, this technology does not require any complex infrastructure as well. The ideal locations to install these systems are wetlands or watery fields (for instance, paddy fields). In a country like India, where agriculture is the primary source of livelihood for more than half of the population, this invention can trigger massive economic change. During the pandemic and the economic depression that followed, farmers suffered greatly and the widespread application of this technology will help alleviate their dire financial situation.

The first project under Plant-e was a modular system consisting of a 100 sq.m installation, tested and used to power outdoor lighting. In 2014, the first commercial system consisting of 50x50cm plant trays(generating 5V each) was launched. The main challenge for this technology is the extent to which we can scale up the modular system and generate enough energy to commercialise it. Currently, it has been possible to generate one watt of electric power with the possibility of going up to 3 watts with further research and development. Upon achieving that landmark, it would be possible to power an average home with an area of 125 sq.m. In our quest for achieving the twin goals of environmental sustainability and economic development, green technologies such as these would serve as ideal instruments of global progress.

Understanding Neural Language Processing

Navneeth S
S4 E1

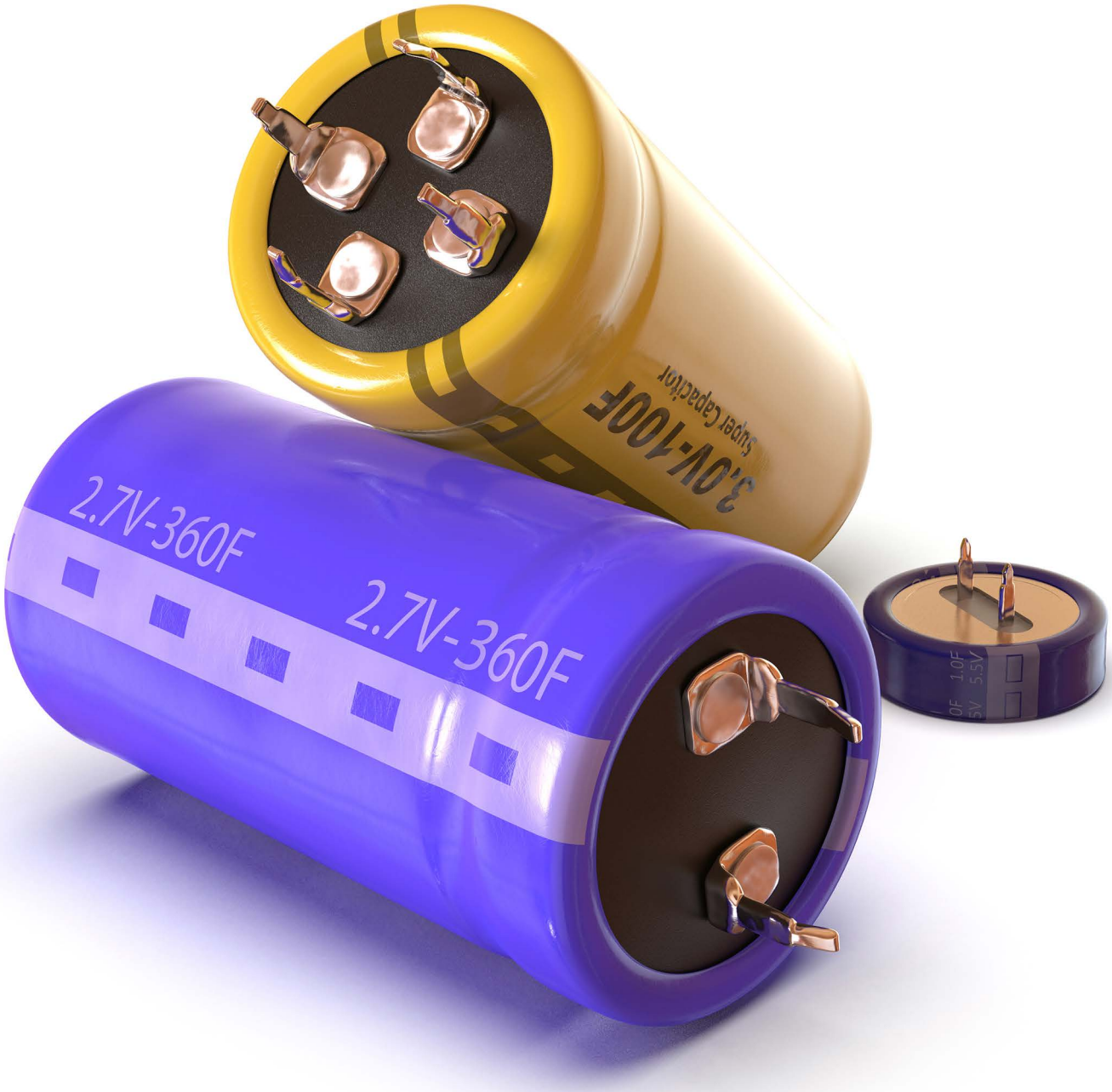
Artificial Intelligence(AI) is the latest buzzword we hear every day. The importance of AI has grown tremendously over the past decade. There are many forms in which we use AI whether it be solving complex problems like making self-driving algorithms, for navigation, or even predicting a cuisine you would like to eat by identifying your current emotion. We all have used the Google Search Engine but have you ever thought about how the search engine works? This is exactly where we use Natural Language Processing or NLP. The analysis of the text at various linguistic levels is a crucial aspect of Natural Language Processing (NLP) systems. This is because it mimics the way humans break down and understand language. This human-like approach to processing language is considered a fundamental part of Artificial Intelligence (AI). Natural Language Processing (NLP) has a wide range of applications and is currently being studied and applied in fields such as military science, security systems, virtual reality, medicine, and computer science. Businesses, in particular, benefit from NLP as it allows them to effectively analyze and process large amounts of unstructured, text-heavy data, which is often in the form of natural human language. This was a challenge for businesses in the past but NLP has made it possible to analyze this data.

NLP is a deep learning problem in which we use various forms of Neural Networks especially Recurrent Neural Networks (RNN). RNN is a class of artificial neural networks where the connections of different layers of the neural networks form a cycle. The inputs and outputs can be connected which helps it to exhibit dynamic behaviour. They have a special capability of storing information for a very short term. Let me explain this with an example.

“My mother is a teacher and she teaches science subjects”

In machine learning problems we only deal with numbers. So when we are solving NLP problems the first thing we do is convert this sentence into a numerical form. To do this, we use a tokenization layer as well as an embedding layer. The tokenization layer assigns a numerical value to each sub-word of the sentence. After this process, it is passed on to an embedding layer. An embedding is a representation of natural language which can be learned by the machine. Representation comes in the form of a feature vector. For example, the word “teach” could be represented by the 5-dimensional vector. When the feature vectors are learned or trained the context of the sentence should not be changed. This is by default handled by the pre-trained tokenisation layer and embedding layer like BERT, RoBertA, etc.

In conclusion, NLP is a field of computer science and Artificial Intelligence that mainly focuses on the interaction between the machine and humans. Some of the existing examples and applications of NLP are Google’s voice assistant, Amazon’s Voice assistant - Alexa, etc. The field of natural language processing is very promising in the future because it will help us to automate many of the tedious linguistic tasks. It even helps in marketing and ad sense software to target the right audience, at the right moment. Natural Language Processing (NLP) is crucial for understanding the language and communication of users and customers, making it essential for any application where language is used. It enables more seamless interaction across various platforms.



Supercapacitor-based Surge Absorbers

S Sandeep
S6 E2

A capacitor is a passive energy storage element that can store electrical energy. It has dielectric material present between two electrodes. Both batteries and capacitors have the capability to store electrical energy, but what makes batteries a better energy storage element is their ability to store energy for a very long period compared to capacitors. The major issue with batteries in applications like use in Electric Vehicles (EVs) is their size and weight which increases with the ampere-hour (Ah) capacity. This problem to some extent was solved by the development of supercapacitors.

Supercapacitors, also known as ultracapacitors are energy storage elements with a high value of capacitance. Unlike capacitors, supercapacitors have high power density, and long life cycles and can charge and discharge at very quick rates. Construction-wise, supercapacitors have an electrolyte between the electrodes rather than dielectric material which is seen in the case of supercapacitors. Supercapacitors can mainly be classified into two types, symmetrical electrical double-layered capacitors (EDLC) which store charge electrostatically, and pseudocapacitors in which storage happens through the transfer of charge between the electrode and electrolyte. Hybrid supercapacitors have also been developed by combining the properties of both EDLC and pseudocapacitors. Supercapacitors are being used in the electric vehicle industry to store the power regenerated during the deceleration of the vehicle and in the power grid as auxiliary energy storage systems.

One of the recently developed applications of supercapacitors is in the field of surge protection. Power surges are sudden and brief voltage over spikes, higher than the designated level on the power waveform. This can damage the electrical and electronic components present in a facility. Surges can be produced due to internal factors like switching of loads, electrostatic discharges, and external factors like lightning. Surge protective devices (SPDs) are used to protect devices against power surges. SPDs based on metal oxide varistors (MOV) which vary their resistance according to the variation in input voltage are mainly used.

The ability of supercapacitors to absorb transient charges has led to the development of a supercapacitor-based surge absorber (SCASA). Consider a circuit with a DC input source, a supercapacitor, and a resistance. Due to the high value of capacitance, the time constant of the RC circuit has a high value. If a surge or voltage spike happens, the supercapacitor charges up to its rated voltage only and thus energy stored by it Rest of the energy will be dissipated across the energy. This is the basic principle of SCASA. SCASA-based surge protection techniques use symmetrical EDLCs having capacitance values between 1 to 100F. SCASA can be used along with MOV and other semiconductor-based SPDs to successfully dissipate surge energy and provide protection to the loads connected to the power line during a surge.

TESLA ‘22

Technical Fest of Department of Electrical Engineering,
College of Engineering Trivandrum

Tesla is the annual technical fest of the Department of Electrical Engineering, CET. With a handful of workshops and project presentations, the fourth edition of Tesla was conducted on May 7, 2022. One of the proudest events of our college, Tesla, has invariably been a platform of scientific and technological innovation. TESLA'22 was conducted in a full-fledged offline mode, along with a few online pre-Tesla workshops being introduced for the first time to this fest. Tesla night and the series of all technical and non-technical events were conducted successfully with the active and agile participation of students of CET and other colleges. Tesla'22 was officially inaugurated by Mr. Rajkumar S, Director KSEB Ltd. on May 7th, 2022. It was a day that brought together all different ways of learning new things about electrical engineering and related domains. Tesla, this year, was inclusive of workshops, competitions, talks, project exhibitions and public exhibitions. The major highlights included exhibitions of projects done by students and the public exhibition of electric vehicles.

TESLA EXHIBITIONS

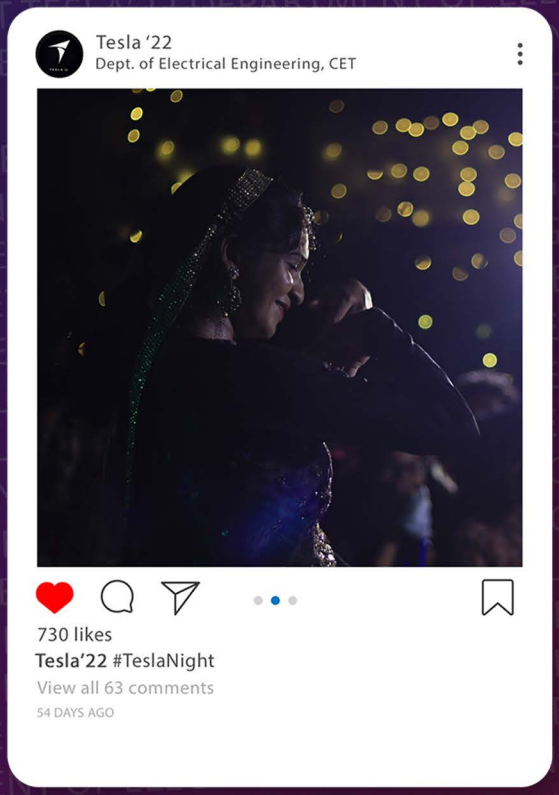
Engineering is one such area of study that demands practical knowledge of concepts and theories learned from textbooks and therefore, exhibitions of related projects will not only encourage students to explore more by giving them opportunities to understand real-life models but also motivate them to come up with new and innovative ideas for a better and sustainable model. With this aim in mind, we had exhibitions of interesting models on the day of Tesla. The major highlight was the display of electric vehicles by Tata Private Ltd. and Ampere vehicles. C-DAC Instruments also joined us on the day to exhibit their latest innovative project models such as smart meters, medical safety analyzer units, active gate drivers and more. Along with them, Ammini solar exhibited devices that work efficiently with solar energy. It was a boost to students and teachers alike to understand and learn such models through these exhibitions as it also gave a platform to have discussions about the economical feasibility of such products which should be considered when we design new engineering models.

PROJECT EXHIBITIONS

Projects were done by students as a part of Tesla'22 and they were exhibited on the same day. There were a total of 25 projects. This was one of the highlights of the exhibition part since the work was solely done by students of all four years of B.Tech Electrical Engineering. The project works were the efforts of more than 100 students who worked together day-night to get their project successfully completed. The projects were done by giving importance to industry-standard techniques like laser cutting and precision soldering. The public was also given the opportunity to see these projects and have discussions about various details related to the projects with the students who have done them.

TALKS

Discussions and talk sessions will always help students and enthusiasts to learn more about the topics they're interested in before getting into the practical side. A series of talks were conducted as a part of Tesla'22 to give opportunities to listen to experts in a particular field. A talk on the topic of 'Dexterous Robotic Manipulation and its challenges' was taken by one


Tesla '22
Dept. of Electrical Engineering, CET
730 likes
Tesla'22 #TeslaNight
View all 63 comments
54 DAYS AGO


Tesla '22
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994 likes
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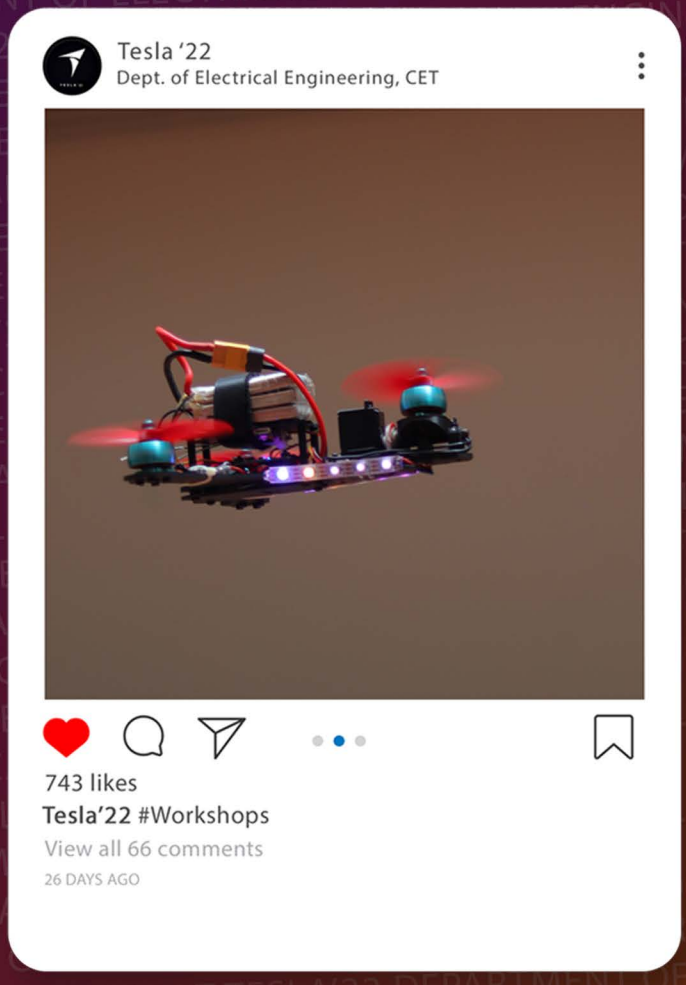
26 DAYS AGO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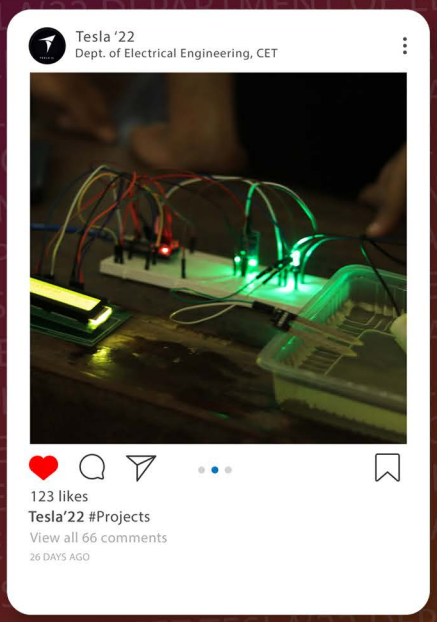
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Dept. of Electrical Engineering, CET
123 likes
Tesla'22 #Projects
View all 66 comments
26 DAYS AGO

of our alumni Michael J Mathew (2011 AE) on the 25th of April 2022. He is a Robotics and Research Engineer at Ocado Technologies, UK. A talk on Embedded systems by Jyotis Indirabhai, NETRASEMI CEO, TREST Park was conducted to enrich students' knowledge base. TESLA '22 in collaboration with IEEE SB CET provided an offline awareness session on First Aid for Electric Shock as a part of this year's technical fest.

WORKSHOPS

A technical fest would be incomplete without workshops that provide quality sessions on various engineering systems. The main objective of organizing workshops was to provide ample opportunities to students who look forward to hands-on sessions and to improve practical knowledge in areas they're interested in. Students in our department handled most of the workshops we organized. But there were also workshops handled by experts in the field. The prominent workshops of TESLA'22 were Introduction to Quantum Computing, Pick & Place Bot - Workshop using Arduino and NFT Workshops.

COMPETITIONS

A number of competitions both technical and non-technical were conducted on behalf of TESLA'22 which provided a platform for students and enthusiasts to participate and sharpen their skills. Abscissa 3.0, CrossWire competition, Mr/Ms. Tesla and Simaestro were some of the technical competitions. Non-technical competitions like Valorant were also conducted.

TESLA NIGHT

The grand technical fest of the Electrical Engineering Department of our college winded up with a fabulous night that witnessed students talented in various domains of music, art and dance. All students and faculty of the EEE department gathered together and had some light moments which celebrated happiness and harmony. Tesla night provided a platform for faculties and students to rejuvenate their talents.

SPONSORS

The Title sponsors were Ozone Overseas Education who supported us immensely in our work, our Associate sponsors were SEL of Sankar Group and Agency for New and Renewable Energy Research and Technology (ANERT), they helped a lot by providing the required technical knowledge and support. Energy Management Center (EMC), Coding Ninjas, Ammini Solar, Ones App, and Fortune IAS academy have been our co-sponsors and have been immensely supportive to the students who are aspiring to learn more about new and renewable energy sources which can be different engineering systems and firms. The electrical batch of 2002 also helped with an amount that paved the way for the base fund. Leo travelers, Shaw sir(alumni of CET), and Comorin Solar were our event sponsors.

Special Thanks

Dr Mayadevi N

Dr Lekshmi Mohan

Jithin K

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Anusree Sunil

Amal P Santhosh

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