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KMEA ENGINEERING COLLEGE
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KRCC
KMEA
RESEARCH AND CONSULTANCY COUNCIL

"Science may set limits to knowledge, but should not set limits to imagination"
- Bertrand Russell

TECHNO-VIBES: THE TECHNICAL ARTICLES

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Message from Director

It is a matter of great pride and utmost satisfaction for our college to bring out the online technical magazine: Techno-vibes under KMEA Research and Consultancy Council (KRCC). The college has crossed many milestones, targeting to become a centre of excellence in the field of technical education. Very recently, the college has been accredited by the National Assessment and Accreditation Council (NAAC).

I am confident that this technical magazine will provide a platform for both the staff and students of the college to showcase their academic and research activities and help them to develop and enrich the writing skills of students in particular and teaching faculty in general.

I express my sincere gratitude to Dr Sangeetha C P, Coordinator-KRCC for her sincere effort to take the lead role and accomplish the task of releasing the first issue of this biannual technical magazine within the stipulated time. I appreciate the efforts put in by the editorial board to bring out this technical magazine in record time. Also, I render my heartfelt congratulations to the faculty members for their contribution to the first issue of the magazine.

Best wishes!

Dr Amar Nishad T M
Principal & Director

Message from Vice Principal

It is a pleasure for me to see the initiative taken by KRCC to present the first issue of the online technical magazine, "Techno-vibes". This magazine will definitely provide a platform for staff to share their technical knowledge, thereby creating a technically trained community. The college has been simply unstoppable in its progress as it has been actively involved in providing quality education.

My appreciation to the team who took the responsibility for the arduous task most effectively. Reading this magazine would definitely be an inspiration and motivation for all students and staff to contribute even more to the forthcoming issues. I hope that everyone will continue to work hard to keep the momentum going and to raise the magazine's standards.

Dr. Rekha Lakshmanan
Vice Principal

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Evolution of 6G

Melbin Antony P M
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The generation of mobile networks refers to the evolution and advancements in wireless communication technology that have occurred over the years. Each generation represents a significant leap forward in terms of the speed, capacity, and capabilities of mobile networks. From the first generation (1G) to the current fifth-generation (5G), and also the upcoming sixth generation (6G), mobile networks have undergone remarkable changes, giving faster data transfer, improving connectivity, and also enhanced user experiences.

The first handheld cellular mobile phone was demonstrated by John F. Mitchell and martin cooper of Motorola in 1973. Martin Cooper is widely regarded as the father of the cellular phone.

1G: The first generation of mobile networks, was launched in the 1980s, which has only basic voice calls. Limited coverage and low data transfer rates were their disadvantages.

2G: The second generation introduced digital technology to mobile networks in the early 1990s. It improved voice quality, and bring basic data services like email, internet browsing, and text messaging (SMS). It also introduced SIM cards for user identification.

3G: The third generation, launched in the early 2000s, made a big mobile network evolution. It has higher data transfer speeds, multimedia services like video calling, mobile TV, and faster internet browsing. It also supported GPS and location-based services.

4G: The fourth generation, introduced in the late 2000s, brought about significant improvements in data speeds and capacity. 4G networks provide high-quality video streaming, online gaming, and advanced mobile applications. It provided a more seamless and reliable user experience compared to previous generations.

5G: The fifth generation of mobile networks is the latest and most advanced technology currently being deployed worldwide. 5G promises significantly faster speeds, lower latency, and increased capacity. It enables futuristic applications such as autonomous vehicles, smart cities, virtual reality, and Internet of Things (IoT) devices. It has millimetre waves, and network slicing to achieve these improvements.

6G: The sixth generation of mobile networks that operates in untapped radio frequencies and uses cognitive technologies like AI to enable high-speed, low-latency communication at a pace multiple times faster than fifth-generation (5G) networks. 6G is currently under research and development, yet to be released.

The evolution of mobile networks has revolutionized communication and connectivity. Each generation, from 1G to 5G, has pushed boundaries and improved our lives. It has opened up new opportunities for industries and society as a whole, looking further we can expect even greater connectivity and enhanced digital experiences.

Portable Air Purifiers

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Portable air purifiers are devices designed to clean the air by removing pollutants such as dust, pollen, smoke, and other airborne particles. They are typically small and can be moved from room to room, making them a popular choice for people who want to improve the air quality in their homes or offices.

There are several types of portable air purifiers available on the market, including:

1. HEPA air purifiers: These use high-efficiency particulate air (HEPA) filters to trap particles as small as 0.3 microns in size.
2. Activated carbon air purifiers: These use activated carbon to absorb odors, gases, and volatile organic compounds (VOCs).
3. UV-C air purifiers: These use ultraviolet-C (UV-C) light to kill bacteria, viruses, and other microorganisms.
4. Ionic air purifiers: These use negatively charged ions to attract and remove particles from the air.

HEPA air purifiers are devices that are designed to remove various pollutants from the air, including dust, pollen, pet dander, and other airborne particles. HEPA stands for High-Efficiency Particulate Air, which refers to the filter inside the purifier that is able to trap particles as small as 0.3 microns. HEPA filters use a dense mesh of fibers to trap particles as they pass through the filter. The filter can capture up to 99.97% of particles that are 0.3 microns or larger in size. Some HEPA air purifiers may also have additional filters or technologies to remove other pollutants, such as activated carbon filters to remove odors and volatile organic compounds (VOCs). HEPA air purifiers are commonly used in homes, offices, and other indoor spaces to improve air quality and reduce the risk of respiratory problems caused by airborne pollutants. They are particularly useful for people with allergies, asthma, or other respiratory conditions, as well as for those who live in areas with high levels of pollution or wildfire smoke. However, it's important to note that HEPA air purifiers are not a complete solution to indoor air quality and should be used in conjunction with other measures such as proper ventilation and regular cleaning.

Activated carbon purifiers are air purification systems that use activated carbon as the primary filtration material to remove impurities, odors, and harmful chemicals from the air. Activated carbon is a form of carbon that has been treated with oxygen to create millions of tiny pores between the carbon atoms. These pores give activated carbon a very large surface area, which allows it to absorb a wide variety of gases, liquids, and solids. When air passes through an activated carbon purifier, the activated carbon adsorbs and traps impurities and odors, leaving the purified air to be circulated back into the room. Activated carbon purifiers are effective at removing common pollutants such as smoke, cooking odors, and volatile organic compounds (VOCs) from the air. However, activated carbon purifiers may not be as effective at removing particles like pollen, dust, and pet dander, which require a different type of filtration technology. For this reason, some air purifiers combine activated carbon with other types of filters, such as HEPA filters, to provide comprehensive air purification.
UV-C air purifiers are devices that use ultraviolet (UV) light to kill or inactivate airborne pathogens such as viruses, bacteria, and mold spores. They work by emitting short-wave UV-C light, which damages the genetic material of these microorganisms and prevents them from reproducing. UV-C air purifiers are commonly used in healthcare facilities and other high-risk environments where air quality is critical, but they are also becoming more popular in

homes and offices as people become more concerned about indoor air quality. UV-C air purifiers can be standalone units or can be integrated into HVAC systems. Some models also include additional air purification technologies such as HEPA filters or activated carbon filters to remove other types of pollutants from the air. While UV-C air purifiers can be effective at killing microorganisms, they may not be effective at removing other types of pollutants such as dust and allergens. Additionally, prolonged exposure to UV-C light can be harmful to humans, so it's important to follow safety guidelines when using these devices.

Ionic air purifiers, also known as ionizers or negative ion generators, are air purifiers that work by releasing negatively charged ions into the air. These ions attach themselves to airborne particles, such as dust, pollen, and smoke, and give them a negative charge. This causes the particles to stick to positively charged surfaces, such as walls or furniture, and reduces the amount of particles in the air. While ionic air purifiers can be effective at removing some airborne particles, they may not be as effective as other types of air purifiers, such as HEPA filters. This is because ionic air purifiers may not be able to capture all types of particles, such as bacteria and viruses. It is also important to note that some ionic air purifiers can produce ozone as a byproduct, which can be harmful to human health, particularly for those with respiratory issues. It is recommended to choose an ionic air purifier that does not produce ozone, or to use one in a well-ventilated area.

When choosing a portable air purifier, consider the size of the room you want to purify and the type of pollutants you want to remove. Look for models with a high CADR (clean air delivery rate) and a low noise level. You should also check the filter replacement schedule and the cost of replacement filters, as this can add up over time.

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Foam Materials and Its Applications

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Foam is a substance that is made up of a collection of gas bubbles trapped within a liquid or a solid. The bubbles in foam are typically small and evenly distributed throughout the material, giving it a spongy or fluffy texture. Foam is used in a variety of applications, from insulation and cushioning to food packaging and firefighting. Some common types of foam include:

1. Polyurethane foam: a popular type of foam used in furniture cushions, mattresses, and insulation.
2. Polystyrene foam: also known as Styrofoam, this type of foam is often used in packaging and disposable food containers.
3. Memory foam: a type of polyurethane foam that molds to the shape of the body, making it popular for use in pillows and mattresses.
4. Silicone foam: a type of foam that is resistant to extreme temperatures and is often used in aerospace and automotive applications.

Foams have many structural applications due to their unique properties, such as low density, high strength-to-weight ratio, and good energy absorption. Here are some examples of structural applications of foams:

1. Insulation: Foams are commonly used as insulation materials in buildings, refrigerators, and other appliances. They provide thermal insulation and can help reduce energy consumption.
2. Packaging: Foams are often used as cushioning materials for packaging fragile items such as electronics, glassware, and artwork. They absorb shock and protect the items from damage during transportation.
3. Automotive industry: Foams are used in various automotive applications such as seats, headrests, dashboards, and door panels. They provide comfort, reduce noise and vibration, and improve crash safety.
4. Aerospace industry: Foams are used in aircraft interiors for insulation, soundproofing, and fire retardancy. They are also used in composite materials to reduce weight and increase strength.
5. Sports equipment: Foams are used in sports equipment such as helmets, padding, and shoes. They provide cushioning and absorb impact energy, reducing the risk of injury.
6. Medical devices: Foams are used in medical devices such as prosthetics, orthotics, and cushions. They provide comfort and support and can help reduce pressure ulcers and other injuries.

Overall, foam is a versatile material that can be tailored to meet specific needs and applications, making it an important part of many industries.

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These articles cover a range of topics related to foams, including their properties, applications, and methods of production.

Nanotechnology in Tissue Engineering

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Nanotechnology in tissue engineering entails manipulating materials at the nanoscale to develop structures and devices that interact with biological systems. The goal is to design and develop breakthroughs in regenerative medicine and tissue repair. solutions that use nanomaterials to improve cell interactions, drug transport, and tissue regeneration processes. Current tissue engineering approaches confront challenges such as a lack of adequate bio-materials, poor cell growth, a lack of tools for capturing optimal physiological structures, and unstable and insufficient growth factor synthesis to encourage cell communication and proper response. Stem cell Development is one of the best uses of nanotechnology. Pluripotent stem cells must often be grown before being transplanted into the human body. Two-dimensional Nanostructures have been shown to be advantageous for the production of scaffolds suited for the growth of pluripotent stem cells due to their enormous surface area and bio-compatibility at low concentrations.

Quantum Computing

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Quantum computing is a multi-disciplinary field, with the elements of computer science, Physics and Mathematics. We can simply solve complicated problems much faster than on classical computers. Classical computers used bits to represent either 0 or 1, but quantum computing use qubits, which can exist in several states simultaneously due to a phenomenon called superposition. As a result, we can enable them to perform complex calculations or tasks like simulating Quantum systems, Optimisation, and cryptography easily.

Applications

Quantum computing's potential uses can be found in different sectors, in a worldwide range of industries and fields. • Cryptography: it is one of the important fields, where it's possible for quantum computers to decrypt data using conventional encrypting methods. • Practical physics or high energy physics: it is useful for this field, models for particle physics are very intricate. Consequently, numerical simulations demand extensive computing time and all amounts of resources. • Quantum computing in AI: planning and scheduling is one example of quantum computing. Quantum computers can be used to construct AI architectures more quickly on a bigger scale.

New Projects

• Platform for quantum encryption: it makes use of the special features of quantum physics to establish incredibly secure communication Pathways. The project might concentrate on putting into practice a secure communication system that uses quantum key distribution (QKD) to Shield data from potential cover dropping, giving a preview of the promise of quantum-secure communication.

• Quantum Machine Learning Algorithms: these techniques by developing new algorithms of quantum machine learning. We can harness the strength of both machine learning and Quantum computing. Examine how patterns recognized, data clustering and optimization issues can be sped up using quantum computing. The creation and testing of quantum iterations of well-known machine-learning algorithms.

• Quantum simulations for the discovery of new drugs: create a Framework for Quantum simulations that is especially suited for drug discovery. Examine how condom computers can more accurately simulate molecular interaction, protein folding, and drug binding than can classical computers. Quantum computers are computing platforms that are the future of the latest innovations and Technologies. It is an exciting and Revolutionary voyage into the world of advanced computation that researchers and businesses from all around the world are actively engaged in

Ages of Autonomous Drones

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Past years, Drones were controlled by humans. Which was a difficult task, However, a new era has come with the emergence of autonomous drones Unmanned aerial vehicles which can make decisions without human intervention.

UAVs worked with the help of Lidar sensors that uses lasers and reflected light. These futuristic marvels are transforming industries across the world, this article shows the world of UAVS exploring challenges, applications, and technology.

Designing and manufacturing was a bit challenging. UAVs are usually expensive. When it comes to its size, drones are usually in small sizes and parts. Propulsion is another task, the propeller should have the ability to lift this weight barrier However there are 5 main components as a propeller, light controller, battery, frames, motors, and sensors in the automated drone. Usually, UAVs are used for health care, photography, wildlife monitoring, disaster response, asset protection, agriculture, etc. These are mainly used in places where humans can't practically reach them. Nowadays the military is using the Us drastically to locate and track enemies. Autonomous drones should improve the ability to identify and obstacles in the environment require the best sensory systems. Autonomous drones have a scientific role in science friction.

Solar Photovoltaic Energy Optimization Methods

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The unsustainable global energy consumption has seriously increased the pressure on the fossil fuel resources resulting in a rise in the global warming effects and climate change issues. Consequently, it is expected that the global ambient temperature will increase by approximately 2 C by 2050 due to the pollutant emissions caused by non-renewable energy resources (Bastida et al., 2019) (Al-Shetwi et al., 2020).To address these concerns, effective actions need to be initiated immediately to decrease the negative environmental impacts as well as explore efficient and economical renewable energy sources (RESs). Numerous research works have been carried out on RESs technologies for the last few decades to improve the overall system efficiency. According to the International Renewable Energy Agency (IRENA) report (IRENA,2018), the electricity cost from renewable power generation has reduced gradually in the last few years. This cost decrement has encouraged many countries of the world to adopt RESs in their national power systems. The power generation by RESs has become prevalent since the energy demand is rising continuously because of the growth in the world industry and urbanization. The cost of electricity from solar photovoltaic (PV) cells dropped by almost three-quarters in the period between 2010 and 2017 (Hannan et al., 2019a).
The PV cells produced for outside operation and its production of electricity are affected by the surrounding weather condition like temperature, direct sunlight, and dust (Kalogirou, 2004). A PV panel may contain as many numbers of PV modules and the individual PV cells are typically only a few inches in diameter. To generate more power, multiple cells are interconnected into a module, and multiple modules are connected in the form of arrays. As such, a large system is constructed. The optimizations in operational parameters to enhance the efficiency of the solar PV systems are based on both traditional and intelligent approaches.

Overview of solar energy optimization methods

The presence of solar radiation is important and essential factor for the proper functioning of the solar energy system. The energy generated by solar PV varies with the change in solar irradiation during the day. The reliability of the solar energy system is substantially affected by the weather parameters (Bhandari et al.2015). Therefore, optimization methods play an imperative role in enhancing the reliability and effectiveness of the solar system. To achieve this, it is crucial to develop methods to resolve complex optimization problems for a PV system. (Al-Shahri, Omar A., et al. (2021)

The adaptability, robustness, and strong computational intelligence of optimization methods have allowed to solve complex problems in PV based hybrid system. For instance, an optimization model for hybrid systems was used to achieve an optimal configuration of

hybrid RESs based on various generating system combinations. The computer software HOMER has been extensively used in the last decade to define optimum RESs size, configuration, and operational approach (Bahramara et al., 2016). 2016). It was shown that the optimal configuration of a hybrid renewable energy system (HRES) is a combination of solar PV, wind turbine, diesel generator, and battery storage. The appropriate structure of HRES can bring several benefits such as continuous power supply, high efficiency, low maintenance cost and efficient load management. However, HRES has some limitations such as complex layout, high installation cost and complicated control operation (Uche et al., 2019). The authors in (Ming et al., 2017) introduced an optimization technique to enhance the design of PV-wind hybrid system based on the multi-objective genetic algorithm. Reliable energy supply with the minimum investment was achieved by this proposed analysis. The results obtained in this work demonstrated that influential parameters of the system had the potential to optimize the system performance.

The RES optimization, especially the PV system, is strongly linked to weather factors such as solar radiation, ambient temperature, and wind speed. In addition, mathematical models are mostly employed in several previous studies (Sathishkumar et al.2016). Therefore, various intelligence techniques have been employed recently to improve the overall performance of PV systems. The PSO algorithm has been proven to become one of the most efficient and reliable techniques that can be implemented for maximizing PV systems performance, and thus greater output power can be attained, as shown by MATLAB simulation results in (Sawant and Bhattar, 2016).

Renewable energy output power will soon be cheaper than fossil-fuel power. Overall, with the advancement of RESs, many optimization challenges have been taken into consideration with respect to energy cost reduction, net present cost reduction, other cost-related optimization includes life cycle cost (LCC). The optimum size and capacity of RESs depend on the fulfilment of the desired levels of reliability in terms of reduction of power supply, operational cost, overall system efficiency and carbon emissions.

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Power Quality Issues in Electric Vehicles

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The increasing adoption of electric vehicles (EVs) has led to a need to address the potential power quality issues that may arise in the charging infrastructure. Power quality refers to the electrical characteristics of the power supply, including voltage levels, current waveform, and frequency, and their impact on the performance and reliability of electrical devices. Power quality issues in EVs can arise from various factors, including the design and operation of the charging infrastructure, the electrical grid that supplies power to the charging stations, and the characteristics of the EVs themselves. Due to the presence of power electronic converters in electric vehicle battery chargers, the electrical power drawn from the distribution system has severe distortions which pose many problems to the power quality. Herein, the impact of chargers in terms of indicators, e.g., penetration level, battery state of charge, type of charging stations, the time of connection of chargers to the network, and the location of charging stations was comprehensively studied on a sample distribution network (M Shadnam et.al., 2022). This article will discuss some of the common power quality issues that can affect EVs and potential solutions to mitigate these issues.

Voltage sags and swells:

One of the most common power quality issues that can impact EVs is voltage sags and swells. These are temporary reductions or increases in voltage levels that can occur when there is a sudden change in the electrical load on the grid. Voltage sags can cause charging times to slow down and reduce the life of the battery. Voltage swells can result in overvoltage conditions that can damage the EV's electrical components (M.Sabarimuthu et.al.,2021)

To mitigate voltage sags and swells, voltage regulation equipment can be installed in the charging infrastructure to stabilize voltage levels and reduce the impact of sudden changes in load. This can include voltage stabilizers and uninterruptible power supplies (UPSs) that can provide backup power in the event of a power outage.

Fig 1 common power quality problems

Harmonic distortion:

Another power quality issue that can affect EVs is harmonic distortion. This occurs when the waveform of the electrical current is distorted, resulting in additional frequencies that are not part of the original power supply. Harmonic distortion can cause overheating of electrical components and reduce the efficiency of the charging infrastructure.

As electric vehicles are marging in the current market, it has gained a widespread popularity. But there is still a problem which are faced by electric vehicles owner. There is no sufficient electric vehicles charging point. Although initiatives are taken by government to set up electric vehicles charging stations but the maximum charging activities are done at private which might be illegal as they might not have proper permit. This kind of activities puts an enormous amount of stress on the grid. These problems results in degrading the power profile of the grid. Due to this kind of activity the power demand increases which leads to a lot of problems (D Selvabharathi et.al., 2020)

To mitigate harmonic distortion, harmonic filters can be installed in the charging infrastructure to filter out unwanted harmonic frequencies. These filters can be passive or active, and they can be designed to target specific frequencies that are causing the distortion.

Transient voltage spikes:

Transient voltage spikes are rapid changes in voltage levels that can cause electrical components in the charging infrastructure to fail prematurely, reducing the reliability of the system. These spikes can be caused by lightning strikes, switching operations, or other electrical disturbances.

To protect against transient voltage spikes, transient voltage surge suppressors can be installed in the charging infrastructure. These devices can suppress voltage spikes and protect against damage to electrical components.

Unbalanced loads:

Unbalanced loads can occur when there is an unequal distribution of current across the three phases of an AC charging system (Christoph et.al.,2017). This can cause voltage unbalance, which can result in damage to electrical components.

- Voltage sags and swells: EVs rely on high-quality, stable voltage levels to charge their batteries. Voltage sags and swells can result in slower charging times and reduced battery life.
- Harmonic distortion: Nonlinear loads in EV charging systems can cause harmonic distortion, which can result in power quality issues such as overheating of electrical

components.

- Transient voltage spikes: Rapid changes in voltage levels can cause electrical components in EV charging systems to fail prematurely, reducing the reliability of the system.
- Unbalanced loads: Unequal distribution of current across the three phases of an AC charging system can cause voltage unbalance, which can result in damage to electrical components. To mitigate these power quality issues, various measures can be taken such as:
- Installing voltage regulation equipment to stabilize voltage levels and reduce sags and swells.
- Using harmonic filters to mitigate harmonic distortion.
- Implementing transient voltage surge suppressors to protect against transient voltage spikes.
- Ensuring proper load balancing to reduce voltage unbalance.
- Designing EV charging systems with sufficient capacity to meet demand.

Overall, addressing power quality issues in EVs is important to ensure their reliability and optimal performance. Effective design, installation, and operation of EV charging systems, along with appropriate power quality monitoring and mitigation techniques, can help to ensure that EVs provide reliable and efficient transportation.

To mitigate unbalanced loads, proper load balancing techniques can be employed in the charging infrastructure. This can include the use of three-phase AC power supplies and the distribution of loads across all three phases.

Impact on the electrical grid:

In addition to power quality issues in the charging infrastructure, EVs can also impact the electrical grid itself. EV charging stations can create additional load on the grid, which can result in power quality issues such as voltage drops and blackouts.

To mitigate the impact of EVs on the electrical grid, charging stations can be designed with sufficient capacity to meet demand, and the electrical grid can be upgraded to accommodate the additional load. This can include the installation of energy storage systems and the use of smart grid technologies that can dynamically adjust the load on the grid to minimize the impact of EV charging (Basalaru et.al.,2022).

Conclusion:

Power quality issues are an important consideration when designing and operating EV charging infrastructure. Voltage sags and swells, harmonic distortion, transient voltage

spikes, and unbalanced loads can all impact the performance and reliability of the charging infrastructure and the EVs themselves. Mitigating these issues can involve the use of voltage regulation equipment, harmonic filters, transient voltage surge suppressors, proper load balancing techniques, and the use of smart grid technologies

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AI-Driven VLSI Design: A Technical Perspective

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Artificial intelligence (AI) is revolutionizing the field of very large-scale integration (VLSI) design. With AI-driven VLSI design, engineers can create more efficient and powerful chips in less time than ever before. After decades of steady progress, the field of Very Large-Scale Integration (VLSI) design is now rapidly evolving, thanks to advances in Artificial Intelligence (AI). AI-driven VLSI design has the potential to revolutionize the microelectronics industry by enabling faster and more efficient chip design. The Very Large-Scale Integration (VLSI) industry has started adapting the Artificial Intelligence (AI) techniques in design automation as it provides the opportunity to transform the whole chip design methodology.

In the nanometre regime, it will be important for the integrated circuit (IC) industry to research and develop ways to reduce the design complexity caused by increasing process variations and shorten the time it takes to make chips. Usually, these kinds of tasks are done by hand, which takes a lot of time and uses a lot of resources. In contrast, the unique learning strategies of artificial intelligence (AI) offer many exciting automated ways to handle complex and data-intensive tasks in very-large-scale integration (VLSI) design and testing. Using AI and machine learning (ML) algorithms in VLSI design and manufacturing makes it easier and takes less time to understand and process data within and between different abstraction levels. It improves the yield of ICs and shortens the time it takes to make them.

Artificial Intelligence, Machine Learning, and Genomics: Revolutionizing Healthcare and Research

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In the merger of genomics, where the complexity of data seems limitless, the integration of Artificial Intelligence (AI) and Machine Learning (ML) has emerged as a game-changer. Researchers are increasingly relying on these technologies to uncover the complex patterns hidden within enormous genomic datasets, heralding a new era of possibilities for healthcare and scientific exploration.

The Big Picture

Genomics has witnessed a relentless expansion in the use of computational methods, particularly AI and ML. These technologies are at the forefront of unraveling the mysteries within large and intricate genomic datasets, sourced from diverse research projects encompassing both fundamental and clinical domains. The potential applications of ML in disease research and genomic tools such as CRISPR are particularly promising, holding the key to groundbreaking discoveries.

The National Human Genome Research Institute (NHGRI) has recognized the significance of the convergence between genomics and machine learning research and is actively shaping its unique role in this pivotal intersection.

What is Artificial Intelligence?

Artificial Intelligence is a multifaceted field, encompassing various computational technologies that draw inspiration from, but often operate differently than, human nervous systems and cognitive processes. AI systems can be developed as software or tools that replicate and, in some cases, surpass human intelligence in specific contexts.

To construct AI systems, scientists require extensive, well-explained datasets to understand the techniques and processes involved in human-like analysis and interpretation. The field of AI is dynamic, with researchers continuously innovating and creating new techniques and tools.

Machine Learning and Deep Learning

Machine Learning and deep learning are subfields of AI that play a central role in genomics research. Machine learning involves enabling machines to learn from datasets without explicit programming. This learning can be supervised, where machines are trained on categorized data to make predictions, or unsupervised, where machines identify patterns independently in large datasets.

Deep learning, a more recent addition to the field, employs artificial neural networks to mimic how human brains process and weigh information. These algorithms excel at handling complex data, detecting patterns, and addressing bias.

The Need for AI/ML in Genomics

A significant accomplishment that produced a vast amount of genomic data was the completion of the draft human genome sequence. Within the next decade, genomics research is expected to produce data in the range of 2 to 40 exabytes. These data sets will continue to grow in size and complexity as DNA sequencing and other scientific techniques continue to progress. In this situation, artificial intelligence (AI) and machine learning (ML) are useful because they provide computational tools that can handle, extract, and understand the important information concealed within this vast collection of data.

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