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School of Electrical Engineering

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VISION AND MISSION OF THE SCHOOL

ABOUT SCHOOL

The **School of Electrical Engineering** at VIT University, Chennai was established in the year 2010. Since the inception of the institute, the department has developed a state-of-the-art infrastructure for teaching and research. The Smart Grid lab, for instance, is one of a kind in the country. The school has also signed an MoU with MSME, Govt. of India for collaborative works. SELECT has highly qualified and experienced faculty. The school offers Bachelor's program in Electrical and Electronics Engineering, and a PhD program. There are four major research groups: Power Systems, Power Electronics, Controls and Instrumentation and Electrical Machines and Drives. The research findings of these groups are published in several peer-reviewed International Journals every year. SELECT has always endeavored to contribute significantly to the growth of technical education. There have been several workshops, seminars and guest lectures for faculties, students and research scholars of educational institutions from all over the country and abroad. Eminent professors from reputed Indian and Foreign Universities share their expertise with student and faculty here.

VISION

- To offer an education in electrical engineering that provides strong fundamental knowledge, skills for employability, cross-disciplinary research and creates leaders who provide technological solutions to societal and industry problems.

MISSION

- Provide personalized experiential learning in industry sponsored laboratories to prepare students in electrical engineering with strong critical thinking and employability skills.
- Foster design thinking, creativity and cross-disciplinary research with highly qualified faculty to create innovators and entrepreneurs in the broad area of electrical engineering.
- Collaborate with national and international partners to provide innovative solutions to societal and industry challenges.

Green Hydrogen for Sustainability: A Path Toward a Clean Energy Future

By Divyank Roy (22BEE1049)

Green hydrogen is emerging as one of the most promising solutions to accelerate the transition to a sustainable energy future. Unlike traditional hydrogen, which is produced using fossil fuels (grey hydrogen), green hydrogen is produced through the electrolysis of water using renewable energy sources such as wind, solar, or hydroelectric power. This method of production is environmentally friendly, with no carbon emissions, making green hydrogen a key player in the global effort to combat climate change.

What is Green Hydrogen?

Green hydrogen is hydrogen that is produced using renewable electricity from sources like wind, solar, or hydropower. The process of producing green hydrogen is known as water electrolysis, which involves passing an electric current through water (H_2O) to split it into hydrogen (H_2) and oxygen (O_2). When the electricity used in this process comes from renewable sources, the entire process is considered green or sustainable.

This contrasts with grey hydrogen, which is produced from natural gas (through a process called steam methane reforming) and blue hydrogen, which is also produced from natural gas but with carbon capture and storage (CCS) to reduce emissions.



The Role of Green Hydrogen in Sustainability

1. **Decarbonizing Hard-to-Abate Sectors** One of the key advantages of green hydrogen is its potential to decarbonize sectors that are difficult to electrify, such as heavy industry, transport, and shipping. These sectors typically rely on fossil fuels for their energy needs, and electrification alone may not be sufficient to replace these fuels. Green hydrogen can serve as a clean alternative in these industries:
 - **Heavy Industry:** Green hydrogen can be used as a feedstock in the production of steel, cement, and chemicals, replacing carbon-intensive processes that rely on coal and natural gas.
 - **Transport:** Hydrogen-powered fuel cells can be used to power heavy-duty trucks, buses, trains, and even ships, providing a zero-emissions alternative to traditional fossil fuel-based transport.
 - **Shipping:** The maritime industry is a significant source of global CO₂ emissions, and green hydrogen can help reduce this impact when used in hydrogen-powered ships.
2. **Energy Storage and Grid Balancing** Green hydrogen can act as an energy storage solution. Renewable energy sources like solar and wind are intermittent, meaning they don't always produce energy when it's needed. By using surplus renewable energy to produce green hydrogen, it can be stored and later converted back into electricity when demand is high or when renewable generation is low. This ability to store and manage energy makes green hydrogen a valuable asset for balancing grids that rely heavily on renewable energy sources.
3. **Reduction of Greenhouse Gas Emissions** The main appeal of green hydrogen is its ability to significantly reduce greenhouse gas (GHG) emissions. When hydrogen is burned or used in fuel cells, the only byproduct is water, making it a clean alternative to fossil fuels. This makes green hydrogen an essential component of efforts to reduce emissions across sectors and meet global climate goals, particularly those outlined in the Paris Agreement.
4. **Supporting Renewable Energy Integration** Green hydrogen can facilitate the integration of more renewable energy into the grid. As renewable energy sources like wind and solar become more widespread, green hydrogen can act as a buffer, storing excess energy during periods of high production and releasing it during periods of low production. This flexibility helps reduce grid instability and allows for greater penetration of renewable energy.
5. **Energy Independence and Security** Green hydrogen offers an opportunity for countries to reduce their reliance on imported fossil fuels and enhance energy security. Since renewable energy sources like wind and solar are widely available, countries can produce their own hydrogen, which could be used domestically or exported. This decentralization of energy production can create more resilient and sustainable energy systems.

Challenges to the Widespread Adoption of Green Hydrogen

While green hydrogen holds tremendous promise for sustainability, there are several challenges that need to be addressed for its widespread adoption:

1. **Cost of Production** Currently, the production of green hydrogen is more expensive than grey hydrogen, primarily due to the high cost of renewable energy infrastructure and electrolysis technology. However, as renewable energy prices continue to fall and electrolysis technology improves, the cost of green hydrogen is expected to decrease over time.

2. **Infrastructure Development** To realize the full potential of green hydrogen, a significant investment in infrastructure is required. This includes building hydrogen production facilities, storage systems, pipelines, and fuelling stations. The lack of existing infrastructure in many regions poses a challenge to the deployment of green hydrogen on a large scale.
3. **Scaling Electrolysis Technology** Electrolysis is the primary method for producing green hydrogen, but current electrolyzers are not yet capable of producing hydrogen at the scale required to meet global demand. Scaling up this technology to commercial levels will require significant investment and innovation.
4. **Energy Efficiency** The process of converting electricity to hydrogen and then back to electricity (via fuel cells or combustion) involves energy losses. Green hydrogen is currently less efficient than direct electricity use, which can be a disadvantage in certain applications. Research into improving electrolysis efficiency and hydrogen fuel cell technologies is essential to overcome this limitation.
5. **Regulatory and Policy Framework** Governments play a crucial role in creating policies and regulations that support the development and deployment of green hydrogen. This includes incentivizing renewable energy production, providing financial support for hydrogen infrastructure, and establishing standards for hydrogen safety and use. Clear policy frameworks and international collaboration are necessary to drive the hydrogen economy forward.

The Future of Green Hydrogen

The future of green hydrogen looks promising, with governments, industries, and researchers increasingly recognizing its potential to drive the transition to a sustainable energy future. Several countries, including Germany, Japan, and Australia, have already established national hydrogen strategies, and large-scale projects are underway worldwide.

In the coming decades, green hydrogen could play a central role in:

- Decarbonizing global energy systems
- Supporting the growth of renewable energy
- Reducing the carbon footprint of various industries
- Enabling new, clean modes of transportation

As the technology matures, costs decrease, and infrastructure expands, green hydrogen has the potential to be a game-changer in the global energy landscape.

Conclusion

Green hydrogen represents a key opportunity in the pursuit of sustainability. Its potential to decarbonize hard-to-abate sectors, store renewable energy, and contribute to global emission reduction goals makes it an essential element of the clean energy transition. However, addressing challenges such as cost, infrastructure, and scaling of technology is crucial for realizing its full potential. With the right investments and policy support, green hydrogen can help pave the way toward a cleaner, more sustainable energy future.

FPGA-BASED FAULT TOLERANCE AND REDUNDANCY TECHNIQUES

By Jheyanth C S(22BEE1055)

In the rapidly evolving landscape of digital design and electronic systems, the demand for reliability and resilience has become paramount. As electronic devices find their way into critical applications such as aerospace, healthcare, and automotive systems, the need to mitigate the impact of faults and enhance system robustness has led to the exploration of advanced fault tolerance techniques. Amidst these strategies, the utilization of Field-Programmable Gate Arrays (FPGAs) offers unparalleled flexibility in digital design, allowing engineers to tailor hardware configurations to specific applications. However, FPGAs are susceptible to transient faults arising from factors such as radiation, electrical noise, and environmental conditions – commonly known as soft errors. Nowadays, these are the biggest challenges in the design, development, and evaluation of the reliability of digital circuits. Owing to these errors, the digital circuits may operate incorrectly and can fail, necessitating the implementation of fault tolerance mechanisms to safeguard against potential disruptions.

Factors Contributing Semiconductor Boom in India

One of the cornerstone techniques employed in FPGA-based fault tolerance is Triple Modular Redundancy (TMR). TMR is a widely used technique that involves triplicating the critical components of a system, such as logic circuits or memory. Three identical modules perform the same computation, and a voting mechanism is used to determine the correct result. In FPGA designs, TMR can be applied by triplicating the relevant logic or registers and using voter circuits to compare the outputs. If one module produces an incorrect result due to a fault, the other two can outvote the faulty one.

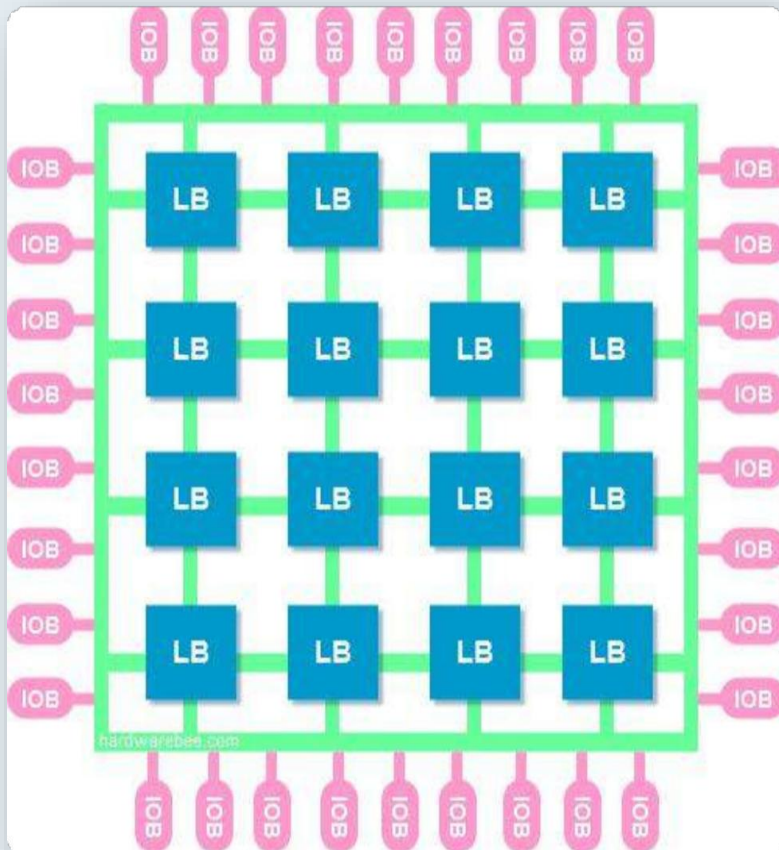
Partial Reconfiguration is another key technique, allowing for the dynamic modification of a portion of the FPGA while the rest of the system continues to operate. This approach is particularly valuable for bypassing faulty components and maintaining system functionality without requiring a full system reset, as in the case of conventional programming. Next comes the Error Detection and Correction mechanisms, such as parity and Error-



Correcting Code (ECC), which play a crucial role in identifying and rectifying errors in data stored within FPGAs.

ECC, in particular, provides the ability to detect and correct single or multiple-bit errors, ensuring the integrity of critical data and enhancing the robustness of the system. Various

techniques are used to locate the changed bit, as each bit in the configuration memory represents a specific point in the circuit. Watchdog Timers, integrated into FPGA designs, continuously monitor system operation. Many modern FPGAs boast built-in watchdog timers with configurable settings like timeout periods and reset options. If the system fails to provide a periodic "heartbeat" signal indicative of normal operation, the watchdog timer can trigger a system reset to recover from a fault. If the logic fails to reset the timer before it reaches zero, the watchdog triggers a predefined action. This proactive approach to fault recovery contributes to the overall resilience of FPGA-based systems.



hardware-based testing method where a circuit is equipped with its own testing capabilities, allowing it to independently generate and evaluate test patterns to detect faults or defects without external test equipment. These mechanisms allow the FPGA to identify and isolate faulty components, contributing to the early detection and rectification of faults, thereby enhancing the overall reliability of the system.

A Glimpse into Redundancy Technique

There are also FPGA-based redundancy techniques for ensuring the reliability of electronic systems. Hot redundancy employs standby components ready to take over immediately upon the failure of a primary component, suitable for applications where minimizing downtime is critical. On the other hand, Cold redundancy switches to backup components only after a failure, offering power efficiency but potentially resulting in a longer recovery time. Spatial redundancy involves duplicating critical modules on the FPGA, ensuring a redundant copy can seamlessly take over if a module fails. Temporal redundancy, specifically time redundancy, executes tasks multiple times, allowing the system to rely on correct results

from redundant executions in the event of a fault. These techniques collectively contribute to fault tolerance and uninterrupted functionality in FPGA-based systems.

Summary

In conclusion, the increasing integration of electronic devices into critical applications demands a heightened focus on reliability and resilience. The exploration of advanced fault tolerance techniques, particularly within the context of FPGAs, has become pivotal in ensuring the sustained and reliable operation of digital systems. FPGAs, while offering unparalleled flexibility in digital design, face challenges such as transient faults or soft errors originating from factors like radiation and environmental conditions. These challenges underline the importance of implementing fault tolerance mechanisms to mitigate potential disruptions.

These FPGA-based fault tolerance and redundancy techniques collectively contribute to uninterrupted functionality and enhanced reliability in electronic systems, addressing the challenges posed by soft errors and ensuring the robust operation of digital circuits. As technology continues to advance, these strategies will play a pivotal role in shaping the future of fault-tolerant and resilient electronic systems across various critical applications.

HYPERLOOP: THE FUTURE TRANSPORTATION

By Karan Sandeep Durugkar (21BEE1138)

In the ever-evolving landscape of transportation, one concept is causing ripples that may soon turn into waves – the Hyperloop. Conceived as a radical solution to modern transit challenges, this brainchild of entrepreneur Elon Musk has captivated the world's imagination with its promise of high-speed, efficient, and sustainable travel.

What is a hyperloop?

At its core, the Hyperloop is a visionary transportation system that involves passenger or cargo pods hurtling through low-pressure tubes at speeds rivalling commercial aeroplanes. The underlying principles include magnetic levitation to eliminate friction, reduced air pressure within the tubes to minimise resistance, and an innovative propulsion system for swift acceleration.



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The Essence of Hyperloop Technology

a. Magnetic Levitation and Propulsion: At the heart of the Hyperloop lies magnetic levitation, a technology that eliminates the friction between the pod and the tube. The pod hovers above the track using powerful magnets, minimising energy loss. Propulsion is achieved through electromagnetic forces, propelling the pod at astonishing speeds.

b. Reduced Air Pressure: To conquer air resistance, the Hyperloop tube is

designed to maintain low pressure. This near-vacuum environment significantly decreases air drag, enabling the pod to reach high velocities with minimal energy consumption.

Race to Reality: Leading Players in Hyperloop

Development Several frontrunners have emerged in the quest to transform the Hyperloop from a concept on paper to a tangible mode of transportation. Companies such as Virgin Hyperloop, SpaceX, and Hyperloop Transportation Technologies have taken the lead, investing heavily in research, development, and ambitious testing programs. Virgin Hyperloop, for example, recently celebrated a breakthrough with its successful full-scale system test, achieving record speeds while showcasing the safety and feasibility of its magnetic levitation technology.

Overcoming Challenges: The Journey to Implementation

While the allure of travelling at near-supersonic speeds captures the public's imagination, the Hyperloop faces many challenges: regulatory frameworks, safety considerations, and the vast infrastructure required present formidable obstacles. Industry experts and policymakers are collaboratively navigating these challenges, emphasising the need for rigorous testing and comprehensive safety measures.



The Hyperloop Promise: Revolutionising Transportation

Proponents of the Hyperloop extol its potential to revolutionise transportation. Imagine commuting between cities at speeds exceeding 700 miles per hour, drastically reducing travel times and congestion. The system's minimal environmental footprint and energy efficiency contribute to its appeal as a sustainable alternative to traditional transit modes.

In conclusion, the Hyperloop represents a paradigm shift in transportation, challenging the boundaries of speed and efficiency. As engineers and innovators continue to refine and advance the technology, the Hyperloop promises to transform how we perceive and experience long-distance travel.

EMERGING TRENDS IN ELECTRICAL AND ELECTRONICS ENGINEERING

By Mezaib Boti Anibal Hadriano Akhiles(21BEE1339)

Electrical and Electronics Engineering (EEE) has evolved rapidly over the years, with numerous advancements shaping the field and influencing modern technology. As we move further into the 21st century, several emerging trends in EEE are making a significant impact across industries such as automation, energy, telecommunications, and consumer electronics. This article explores some of the most exciting trends within this field.

1. Artificial Intelligence and Machine Learning Integration

Artificial Intelligence (AI) and Machine Learning (ML) are transforming many fields, and Electrical and Electronics Engineering is no exception. Engineers are increasingly using AI and ML to enhance the functionality of various systems, such as automation processes, predictive maintenance of electrical equipment, and energy management systems. For instance, smart grids use AI algorithms to predict power demand and adjust supply efficiently. Similarly, electronics like smartphones and wearables are utilizing AI to improve user experience and battery management.

2. IoT (Internet of Things) and Smart Devices

The Internet of Things (IoT) continues to grow, with more devices and systems being connected to the internet. This trend is paving the way for the creation of smart homes, cities, and industrial environments. IoT devices use sensors, microcontrollers, and wireless communication technologies, all of which are rooted in EEE. Smart meters, wearable health devices, and even autonomous vehicles rely heavily on innovations within electrical and electronics engineering.

3. 5G Technology

5G technology is revolutionizing the way communication systems function. With its ultra-low latency, faster speeds, and higher capacity, 5G is enabling advancements in everything from autonomous vehicles to virtual and augmented reality (VR/AR). EEE engineers play a vital role in designing and optimizing the infrastructure needed for 5G networks, including new antennas, transmitters, and receivers. This technology is also driving innovations in smart manufacturing, healthcare, and entertainment.

4. Renewable Energy and Sustainable Power Solutions

The shift towards sustainable energy sources is one of the most significant trends in EEE. Engineers are focusing on improving the efficiency and scalability of renewable energy technologies such as solar, wind, and hydroelectric power. Moreover, the development of smart grids and energy management systems ensures that these renewable sources can be integrated efficiently into the global power grid.

5. Advanced Power Electronics

Power electronics have seen remarkable advancements in recent years. Engineers are designing more efficient and compact power converters, batteries, and electric drives to meet the increasing demand for electric vehicles (EVs) and renewable energy systems. Power semiconductor devices, such as wide bandgap semiconductors (e.g., silicon carbide (SiC) and gallium nitride (GaN)), are enabling higher efficiency, faster switching, and better thermal performance in power systems. These

developments are crucial for improving energy efficiency in various sectors, including electric transportation, industrial automation, and consumer electronics.

6. Quantum Computing

Though still in its early stages, quantum computing holds immense potential to revolutionize the field of Electrical and Electronics Engineering. Quantum computers have the ability to solve problems that classical computers cannot, such as simulating complex quantum systems, optimizing large-scale systems, and enhancing cryptography.

7. Autonomous Systems and Robotics

The field of robotics is advancing quickly, with autonomous systems becoming more sophisticated. In EEE, this means designing and implementing control systems, sensors, and



communication interfaces that allow robots and drones to perform tasks autonomously. These systems are already being used in manufacturing, healthcare, agriculture, and logistics. The next big leap is integrating advanced AI and machine learning algorithms to make these systems more adaptable and smarter in real-world environments.

8. Flexible Electronics and Wearables

Flexible electronics, which can be bent, stretched, or twisted without losing

functionality, are gaining traction in the field of EEE. This technology is being used to develop lightweight, flexible displays, sensors, and wearable devices. Flexible circuits could revolutionize consumer electronics, medical devices, and even clothing by allowing for the seamless integration of electronic components into everyday life.

9. Cybersecurity in Electronics and IoT

As more devices become interconnected through the IoT, cybersecurity has become a critical concern. EEE professionals are tasked with designing secure communication protocols and encryption methods to protect sensitive data. With the increasing sophistication of cyberattacks, the demand for secure, tamper-proof electronic systems is higher than ever, especially in critical sectors such as healthcare, finance, and transportation.

10. Edge Computing

Edge computing is becoming more important as the number of connected devices grows. Rather than sending all data to centralized cloud servers, edge computing processes data closer to where it is generated (e.g., at the device level). This reduces latency, improves speed, and enhances privacy by keeping sensitive data local. In the context of EEE, engineers are developing low-power edge devices that can handle computing tasks autonomously, reducing the strain on networks and cloud infrastructure.

Conclusion

The emerging trends in Electrical and Electronics Engineering are shaping the future of technology across various domains. From AI-driven automation and renewable energy solutions to quantum computing and edge computing, EEE professionals are at the forefront of innovation. These advancements are not only making existing technologies more efficient but also enabling entirely new systems and capabilities that will transform how we live, work, and interact with the world.

As the field continues to evolve, engineers in EEE must stay ahead of these trends to ensure that they can harness the power of new technologies while addressing the challenges of the digital and sustainable future.

THE FUTURE OF CLOUD-BASED OPERATING SYSTEMS

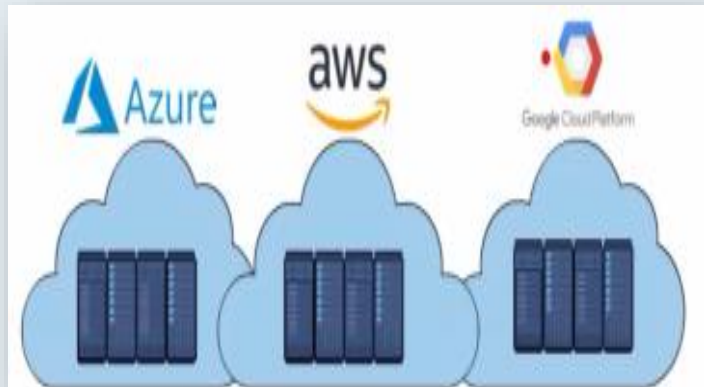
By Sayanth K(23BEL1005)

A cloud operating system (Cloud OS) is an OS that manages computing resources across a network of remote servers rather than a single physical machine. Unlike standard operating systems, which are installed on individual devices, a Cloud OS allows users to access programs, storage, and computing power via cloud infrastructure. With the increasing demand for scalability, virtualization, and remote access, cloud operating systems have transformed computing, providing solutions for organizations, developers, and common consumers. As cloud technology progresses, operating systems evolve to completely integrate with cloud settings, allowing for easy access and control.

Evolution of Cloud-Based Operating Systems

Several technological developments fuelled the transition from traditional operating systems to cloud-based ones.

- **Virtualization:** Enabled numerous VMs to run on a single physical computer.
- **Distributed computing** allows computer power to be shared among numerous servers.
- **Cloud Infrastructure Growth:** Platforms such as AWS, Google Cloud, and Microsoft Azure have simplified the transition to cloud operations.
- **Web-Based Applications:** Cloud-hosted apps are becoming more popular as local storage becomes less important.



Key Features of Cloud OS

A Cloud OS provides several key features that make it an attractive choice for businesses and individual users:

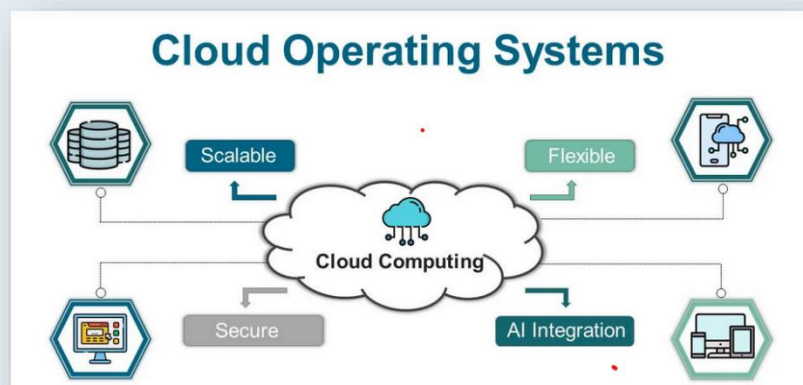
- a. **Scalability** – Dynamically allocates computing resources based on demand.
- b. **Accessibility** – Allows users to access applications and files from anywhere with an internet connection.

- c. **Virtualization Support** – Efficiently runs multiple applications and services using virtual machines.
- d. **Automation** – Automates system updates, backups, and resource allocation.
- e. **Resource Optimization** – Ensures that processing power, memory, and storage are used efficiently.

Types of Cloud Operating Systems

Cloud OSs can be categorized into three main types:

- ✓ **Public Cloud OS** – Managed by third-party providers, offering scalability and cost-effectiveness. Example: **Microsoft Azure, AWS EC2.**
- ✓ **Private Cloud OS** – Dedicated to a single organization, ensuring enhanced security and control.
- ✓ **Hybrid Cloud OS** : Combines public and private cloud features, balancing security and scalability. Example: **Red Hat OpenShift.**



Applications of Cloud OS

Cloud OSs are widely used in different industries due to their flexibility and efficiency. Here are some key applications:

- **Software Development** – Provides cloud-based development environments and deployment tools.
- **Education** – Enables online learning platforms and remote collaboration.
- **Healthcare** – Stores and secures patient data while supporting telemedicine applications.
- **E-commerce** – Handles transactions and customer data while ensuring high availability.

Future Trends in Cloud OS

The future of cloud-based operating systems looks promising, with emerging innovations such as:

- **AI-driven Cloud Management** – Uses AI to optimize resource allocation and enhance security.

- **Edge Computing Integration** – Reduces latency by processing data closer to the user.
- **Quantum Computing Compatibility** – Cloud OSs will likely integrate quantum computing for advanced problem-solving.
- **Stronger Cybersecurity Measures** – Advanced encryption and threat detection for enhanced cloud security.

Conclusion

Cloud-based operating systems have transformed how we manage computing resources, offering scalable and flexible solutions for various industries. Despite challenges like internet dependency and security risks, advancements in AI, edge computing, and cybersecurity will continue to drive innovation in Cloud OS development. As cloud adoption grows, Cloud OSs will play an increasingly crucial role in shaping the future of computing.

LEUKAEMIA CANCER CELL DETECTION USING YOLOV8: A BREAKTHROUGH IN MEDICAL IMAGING

By Suryanarayanan D(21BEE1238)

Leukaemia, a type of blood cancer, remains a major global health concern, requiring early and accurate diagnosis for effective treatment. Traditionally, pathologists examine blood smear images manually, which can be time-consuming and prone to human error. However, advancements in artificial intelligence (AI) and deep learning are revolutionizing medical diagnostics. Researchers are now employing YOLOv8 (You Only Look Once version 8), a state-of-the-art object detection model, to automate leukaemia detection, significantly improving accuracy and efficiency. YOLOv8 enables rapid and precise identification of leukaemia cells in microscopic images, making the diagnostic process faster and more reliable.

Detailed Description:

YOLOv8, a powerful object detection model, has proven to be highly effective in medical image analysis. Unlike traditional Convolutional Neural Networks (CNNs), YOLOv8 performs real-time detection and classification of leukaemia cells in blood smear images with remarkable accuracy.

By training YOLOv8 on a dataset of microscopic blood smear images, the model can distinguish between healthy and cancerous cells efficiently.

- a. **Data Collection:** Large datasets of blood smear images are collected from various medical sources, labelled as normal or leukemic cells.
- b. **Preprocessing:** Image enhancement techniques such as normalization, noise reduction, and augmentation are applied to improve the model's accuracy.
- c. **Model Training:** YOLOv8 is trained on labelled datasets to learn patterns and features associated with leukaemia cells.
- d. **Classification and Detection:** Once trained, the model classifies new blood smear images into different categories (normal, leukaemia, or specific subtypes of leukaemia) in real-time.
- e. **Validation and Testing:** The model is tested against unseen datasets to evaluate its accuracy, sensitivity, and specificity.
- f. **Deployment and Integration:** The trained model can be integrated into hospital diagnostic systems for automated leukaemia detection, assisting medical professionals in making timely decisions.

Studies comparing YOLOv8 with other models, such as ResNet, VGG16, and earlier YOLO versions, have shown that YOLOv8 offers superior performance in terms of speed and accuracy while maintaining a lightweight architecture suitable for deployment in clinical settings. YOLOv8 offers several advantages in leukaemia detection. It achieves high accuracy in identifying leukaemia cells, reducing diagnostic errors and enabling more reliable results.

Real-time detection allows for immediate analysis, leading to quicker medical decisions that can significantly impact patient outcomes. The implementation of YOLOv8 also reduces dependency on expensive and time-consuming manual evaluations, making it a cost-effective solution. Additionally, the system is highly scalable, capable of analysing large volumes of data, making it ideal for hospitals and research laboratories. Automation further eases the workload on medical professionals by eliminating the need for tedious manual blood smear analysis, allowing pathologists to focus on complex cases and improving overall healthcare efficiency.

Summary:

Despite its advantages, YOLOv8-based leukaemia detection faces some challenges. High-quality labelled datasets are essential for model training, but obtaining them is difficult due to privacy concerns. Additionally, model interpretability remains an issue, as understanding how AI makes decisions is crucial for gaining trust in clinical settings. AI-based medical tools must also meet strict regulations and gain approval before widespread adoption, posing a significant barrier to integration into healthcare systems. Ensuring that the model performs well across diverse patient populations and different types of microscopic imaging devices is another challenge that researchers are working to address. Future research will likely focus on integrating YOLOv8 with other diagnostic techniques, such as genetic analysis and multi-modal imaging, to enhance accuracy further. Additionally, incorporating explainable AI (XAI) techniques will make the decision-making process of AI models more transparent and interpretable for medical professionals.

BATTERY HEALTH MONITORING

By Eeshant Singh(21BEE1256)

Battery health monitoring is a hot topic, especially with the rise of EVs, renewable energy systems, and portable electronics. It's all about ensuring safe, reliable, and efficient use of batteries, typically lithium-ion.

It's the process of evaluating and tracking a battery's State of Health (SoH) and predicting its Remaining Useful Life (RUL) using real-time measurements.

Key Parameters to Monitor

- State of Charge (SoC) – how much energy is left (%).
- State of Health (SoH) – current battery condition vs. original.
- Internal Resistance – increases as battery degrades.
- Capacity Fade – loss of charge capacity over time.
- Temperature – overheating can indicate faults.
- Voltage and Current – abnormal patterns can suggest aging or faults.

Techniques Used in Battery Health Monitoring

1. Model-Based Methods

- ✓ Use equivalent circuit models (ECM), electrochemical models .
- ✓ Kalman Filters (EKF, UKF) often used to estimate SoC/SoH.

2. Data-Driven Approaches (Emerging Technique)

- Machine Learning / Deep Learning models trained on sensor data.
- Popular algorithms:
 - LSTM (Long Short-Term Memory)(for time series prediction)
 - CNN (for patterns in thermal/electrical maps)
 - Random Forests, SVM
 - WNN (Wavelet Neural Networks) – great for transient or frequency-rich data.
- Require lots of labelled data but adapt well to complex patterns.

3. Hybrid Methods

- Combine model-based + data-driven for better robustness.

Comparing WNN, LSTM, and Kalman Filters for battery health monitoring

Criteria	WNN	LSTM	Kalman Filters (KF/EKF/UKF)
Type	Data-driven + frequency-aware	Deep learning, time-series focused	Model-based (mathematical estimation)
Good For	Transient detection, multi-scale patterns	Sequential data, long-term dependencies	Real-time estimation of SoC/SoH
Input Requirement	Pre-processed (wavelet-transformed) signals	Raw time-series (voltage, current, temp)	Accurate model of battery dynamics
SoH Estimation Accuracy	High (especially for hybrid faults)	Very high with enough data	Medium (depends on model accuracy)
RUL Prediction	Moderate-High (needs proper tuning)	High (trained on full life cycles)	Limited (not predictive by nature)
Real-Time Capability	Moderate (can be optimized)	Low-Medium (computationally heavy)	High (designed for real-time tracking)
Noise Robustness	Good due to wavelet preprocessing	Good (especially with dropout/reg techniques)	Excellent (built to handle noise)
Data Requirements	Moderate (needs labelled fault data)	High (needs large time-series datasets)	Low-Moderate (needs model parameters)
Training Time	Moderate	High	None (tuning, not training)
Complexity	Moderate	High	Low-Moderate

Observation:

Scenario	Recommended Method
Real-time SoC/SoH tracking with limited compute	Kalman Filter (EKF/UKF)
Accurate RUL prediction with lots of historical data	LSTM
Early fault detection with transient anomalies or noise	WNN
Hybrid approach (physics + ML)	Combine KF + LSTM or ECM + WNN

Summary

- WNN: Best for transient analysis and fault diagnosis when time-frequency features matter. Great for early-stage fault detection in noisy environments.
- LSTM: Best for long-term degradation modelling and RUL prediction. Needs a lot of data but gives high accuracy.
- Kalman Filters: Best for real-time tracking of SoC/SoH, especially in embedded systems. Easy to implement with battery models but less predictive.



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