NARAYANA
ENGINEERING COLLEGE :: GUDUR
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Department of Electronics and Communication Engineering

TECHCOM

Volume -15

Contents

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FacultyCo-Ordinators

Mrs. G.Kalyani
Asst. Professor

Mrs. M. Divyavani
Asst. Professor

Student Co-Ordinators

SK.SAFIYA(22F11A0470)
K.MAHATHI(23F11A04B4)
I.CHANDANA(23F11A4116)
A.ADIKA(23F11A0402)

Vision of the Institute

To be one among the premier institutions of the country for professional Education in producing technocrats with Competent skills, Innovative ideas and Ethics strong to serve the nation.

Mission of the Institute

- To provide an environment most conducive to learning with state of the art infrastructure, well equipped Laboratories and research facilities to impart high quality technical education.
- To emphasize on innovative ideas and creative thinking and prepare them to meet the growing challenges of the industry.
- To inculcate the leadership qualities, multi-disciplinary approach, ethics and lifelong learning in graduates to serve the diverse societal needs of our nation.

Vision of the Department

To produce technically competent Electronics & Communication Engineers with a motive to meet the needs of the industry and evolving society through advanced research, professional ethics and lifelong learning.

Mission of the Department

- To enrich the technical skills of the students through effective teaching-learning practices, continuous assessment methods and eminent faculty.
- To continuously enhance creative thinking, research ability and innovative skills of students through training on core and multidisciplinary technologies and skill enhancement programs.
- To inculcate leadership qualities, ethics, social responsibility and gratitude through outreach programs.

Program Educational Objectives (PEOs)

PEO-1: Attain the global and local opportunities and reach greater heights in their chosen profession by demonstrating technical expertise.

PEO-2: Gain recognition by exhibiting problem solving expertise for addressing significant problems of industry and society.

PEO-3: Become good leaders with ethics and support, contribute and encourage diversity and inclusiveness in their workplace and society.

Program Specific Outcomes (PSOs)

PSO-1: Responsive to ideas: Apply the knowledge on core Electronics and Communication Engineering in order to develop skills to analyze, design and develop innovative solutions for the real world problems.

PSO-2: Domain Expertise: To develop interpersonal skills to demonstrate proficiency using the latest hardware and software solutions by maintaining professional and societal responsibilities.

Program Outcomes (POs)

PO-1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO-2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO-3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO-4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO-5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO-6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO-7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO-8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

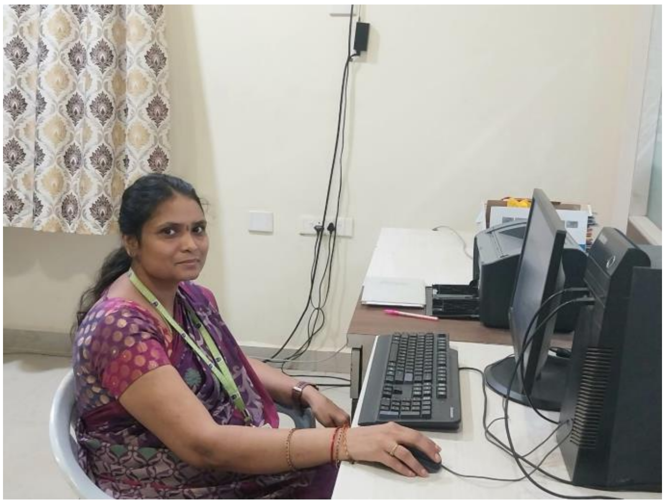
PO-9: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multi disciplinary settings.

PO-10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as ,being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO-11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi disciplinary environments.

PO-12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Professor's Desk

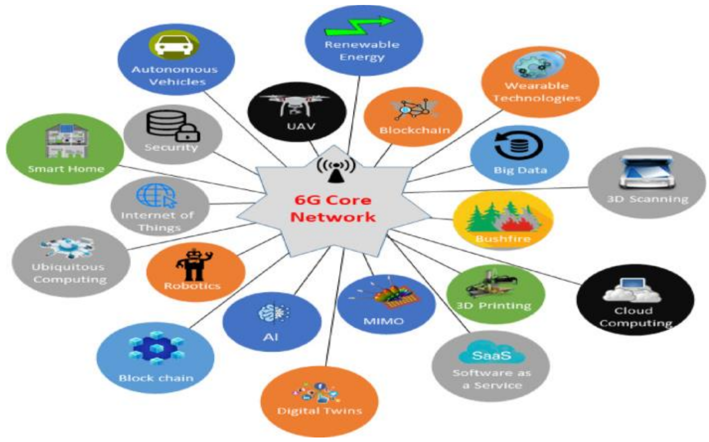


The major challenge for today’s engineering educational institutions is to accommodate the ever varying aspirations of the younger generation because of increasingly changing demand and development in industries. We constantly put efforts to accommodate these aspirations by fine tuning the academics of college with innovative and practical oriented teaching - learning practices along with other developmental activities. Our goal is to change the world through education. It may sound idealistic, but this is precisely our long term goal. It is what motivates the work of everyone at the Narayana Engineering College, Gudur. It inspires our teaching and research. Our approach reflects the educational needs of the 21st century. We focus on our students by providing them with a world-class outcome based education and hands-on experience through research, training, and student forum activities etc. The success of our Electronics and Communication Engineering program is supervised by our eminent faculty, who continue to set the standard for excellence. There is continuous check on the implementation of planned academic activities with desired results in grooming our future generation for employment and for higher studies in India and abroad. A research culture has taken shape in the institute through enhanced R & D activities. Our Institute results and placement speaks about our excellence with many of our students bringing laurel to the college by getting highest ranking in university exams and huge number of students are placed in national & multinational companies, moreover our student’s creativity and determination is evident by this continuous success in various fields.

--Mrs.G.KALYANI

Advancements in 6G Wireless Technologies: A Collaborative Breakthrough

The race toward 6G, the sixth generation of wireless communication, has begun well before the full global deployment of 5G. India is rapidly emerging as a significant contributor in this space through a strategic collaboration between the Indian Institute of Technology (IIT) Hyderabad, WiSig Networks, and Japan’s Sharp Semiconductor Innovation Corporation (SSIC). This team has successfully demonstrated foundational aspects of Beyond 5G and early 6G technologies using a sophisticated Software-Defined Radio (SDR) System-on-Chip (SoC) developed by SSIC. This hardware platform enables engineers to simulate and test advanced network capabilities such as extremely high data rates, ultra-low latency, and enhanced signal processing in experimental settings. The collaboration is aligned with India's ambition to lead in next-generation communication technologies and is strongly supported by the government’s Bharat 6G Vision Document under the Digital India initiative.



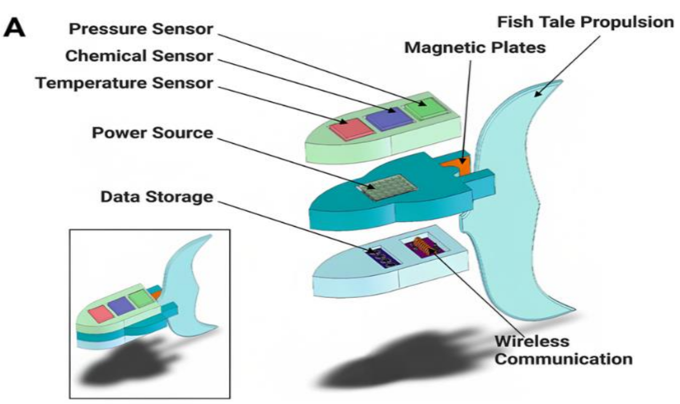
The experimental trials explored key components anticipated in future 6G networks, including millimeter-wave and terahertz spectrum communication, artificial intelligence-driven network control, and edge computing integration. These tests also incorporated massive multiple-input multiple-output (MIMO) systems, which are expected to be central to 6G performance. Compared to 5G, 6G aims to deliver drastically higher speeds (potentially over 1 terabit per second), sub-millisecond latency, and more efficient use of spectrum through higher-frequency bands such as terahertz. The vision for 6G also includes seamless integration of satellite and terrestrial networks, enabling ubiquitous global coverage. Furthermore, 6G is expected to be inherently AI-native, with networks that can learn, self-optimize, and make decisions in real time.

--M. SAI MOKSHITHA (22F11A0441)

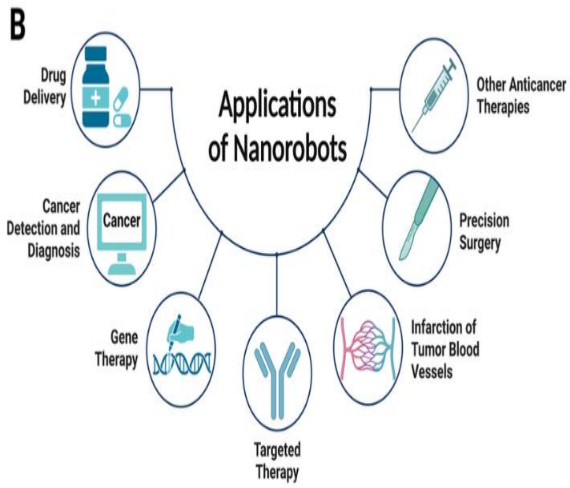
Individual Control of Nanobots: A Leap in Medical and Electronic Applications

The ability to control individual nanobots represents one of the most transformative breakthroughs in nanotechnology, pushing the boundaries of what is possible in both biomedical science and nanoelectronics. Traditionally, nanobots were manipulated as groups, often using magnetic or chemical gradients, but this limited their functionality in precision tasks. Now, through a combination of advancements in nano-fabrication, magnetoelectric materials, and optical trapping techniques, researchers can direct the movement, speed, and functional response of each nanobot independently. These nanobots, often constructed from biocompatible materials such as gold, silica, or DNA-origami structures, can be remotely operated by finely tuned electromagnetic fields or laser pulses, which guide them through complex biological environments.

In the field of medicine, individual nanobot control allows for extraordinary precision in targeted therapy. Scientists can now deliver drugs to specific cancer cells, unclog arteries, or repair cellular damage without affecting neighboring healthy tissues. Some nanobots are even equipped with biosensors capable of detecting local pH changes, enzymatic activity, or biomarkers, enabling them to respond autonomously to disease environments. In electronic applications, nanobots are being used to manipulate atoms and molecules to build nanoscale circuits or repair defects in microchips. This opens up the possibility for creating self-healing electronic systems, adaptive semiconductors, and highly integrated neural interfaces.



The integration of AI and machine learning algorithms into nanobot control systems enhances their capabilities further by allowing adaptive navigation, predictive behavior, and autonomous decision-making based on real-time data. These intelligent bots could one day be programmed to seek out and destroy pathogens, repair tissues, or assemble molecular components with microscopic accuracy. With such possibilities on the horizon, individually controllable nanobots mark a significant step toward a future where smart machines operate within our bodies and devices, reshaping both healthcare and technology.

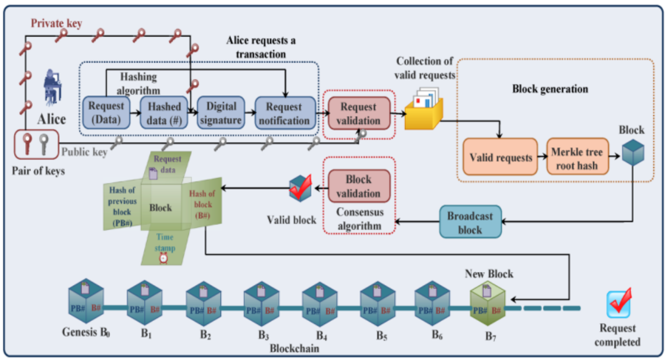


--A. HARSHITHA LEELA(23F15A0403)

Quantum-Encrypted Communication Achieved Over Commercial Telecom Network

The realization of quantum-encrypted communication over a commercial telecom network represents a transformative moment in the evolution of secure data exchange. Researchers have managed to deploy **Quantum Key Distribution (QKD)** across standard fiber-optic infrastructure, enabling ultra-secure communication without the need for specialized quantum-only channels. This achievement demonstrates that quantum communication is not only viable outside of lab environments but is also scalable and integrable with the existing global communication infrastructure. By encoding cryptographic keys into the quantum states of photons, such as polarization or phase, QKD ensures that any attempt at eavesdropping can be instantly detected. This is due to the quantum property known as the observer effect—where the very act of measuring a quantum system disturbs it—providing intrinsic security that classical encryption methods cannot match.

In this recent demonstration, quantum keys were successfully transmitted over tens of kilometers of active telecom fiber while classical data was being transmitted simultaneously, marking a major step toward real-world adoption. The system used trusted nodes and quantum repeaters to preserve signal integrity across longer distances. Moreover, the deployment utilized photon detectors capable of registering single-photon events with high efficiency, ensuring accurate key exchange despite inherent signal losses in fiber networks. This convergence of quantum and classical technologies shows that quantum communication can coexist with today's digital traffic, and it sets the foundation for a future quantum internet.



Applications of such technology are vast and critical. Governments, financial institutions, and defense systems stand to benefit the most, as they require unbreakable security protocols for sensitive data. The growing threat posed by future quantum computers, which could crack traditional encryption algorithms, makes the adoption of QKD not only advantageous but essential. With continued development, we may soon see metropolitan areas linked via quantum-secure backbones, forming the first layers of a global quantum communications network.

Quantum-encrypted communication refers to a highly secure method of transmitting information using the principles of quantum mechanics. Recently, scientists have successfully demonstrated quantum-encrypted communication, marking a significant milestone in cybersecurity.

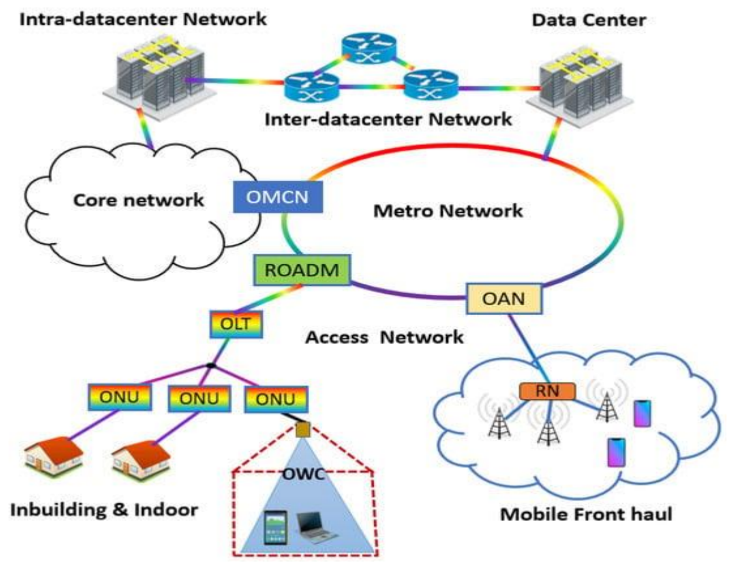
--G. VENKATA SUMANTH (22F11A04A3)

TDK's Optical Breakthrough Addresses Generative AI's Data Bottleneck

As generative AI models continue to grow in size and complexity, they face an increasingly critical data bottleneck—one that threatens to outpace the capabilities of traditional electronic components. TDK Corporation has announced a pioneering optical interconnect solution that could redefine how AI systems handle data transfer and processing. This innovation centers around the development of high-performance photonic components designed to transmit data using light instead of electrical signals. Unlike conventional copper-based interconnects, which are limited by heat, resistance, and bandwidth, TDK's optical solution leverages photonics to enable ultra-fast, low-latency data transmission across and within processing units.

The technology integrates nanophotonic devices such as waveguides, modulators, and photodetectors into silicon chips, allowing them to communicate at speeds exceeding 800 Gbps per link while consuming significantly less power. This is especially important for generative AI workloads like large language models and image synthesis networks, which require massive volumes of data to be moved rapidly between GPUs, memory, and storage. By minimizing electrical bottlenecks and reducing latency, TDK's optical interconnects pave the way for AI systems to scale efficiently without compromising performance or energy efficiency. Additionally, these components can be fabricated using standard CMOS-compatible processes, ensuring that they are both cost-effective and scalable for mass production.

This development arrives at a critical moment when the demands of AI, particularly generative models such as ChatGPT and Stable Diffusion, are pushing existing data center infrastructure to its limits. TDK's innovation could become a foundational element of next-generation AI accelerators and server architectures, facilitating faster training and inference, lower energy usage, and more responsive real-time AI applications. By moving away from traditional electrical pathways and toward photonic integration.



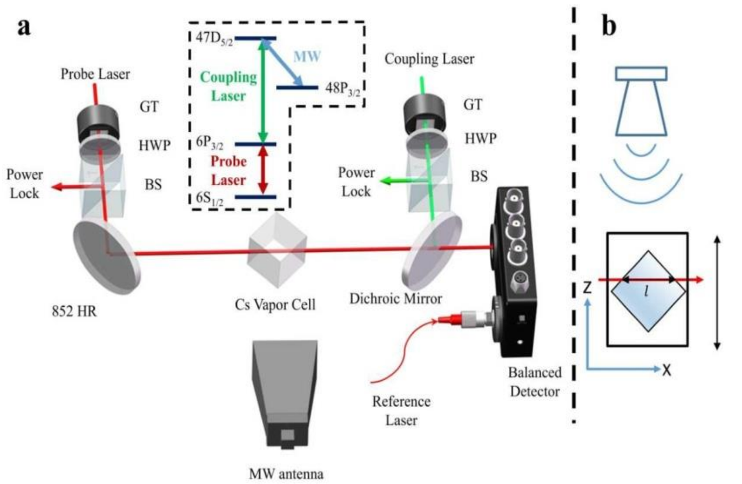
- D. SAISREE(22F11A0499)

Rydberg Atomic Receivers: The Next Frontier in Wireless Communications

Rydberg atomic receivers are emerging as one of the most revolutionary technologies in wireless communications, potentially redefining how signals are detected and processed. These receivers operate on the principles of quantum physics, using atoms excited to extremely high energy levels—known as Rydberg states—to detect electromagnetic waves. In this excited state, atoms become incredibly sensitive to electric fields, allowing them to function as natural antennas capable of capturing a wide range of radio frequencies. Unlike traditional metal-based antennas, which are restricted by material and size limitations, Rydberg atoms can detect signals with extraordinary precision and minimal physical infrastructure. Researchers have successfully demonstrated that such atomic receivers can decode amplitude-modulated and frequency-modulated signals without any traditional RF electronics, by simply observing how the atoms' energy states shift in response to incoming fields. This is achieved through laser interrogation of a vapor of alkali atoms, typically rubidium or cesium, where changes in light absorption reveal the characteristics of the signal.

The use of Rydberg atoms could pave the way for ultra-broadband receivers that cover frequencies from kHz to THz, including those that are currently difficult to access with conventional antennas.

Moreover, because these atomic receivers are inherently quantum in nature, they offer unique advantages in terms of signal sensitivity and immunity to electromagnetic interference. The potential to miniaturize the technology and eliminate much of the bulky RF hardware also makes it attractive for integration into compact and energy-efficient communication devices. As research continues to refine their sensitivity and practicality, Rydberg atomic receivers are poised to become a cornerstone of future wireless infrastructures, offering unprecedented versatility and performance in signal detection.

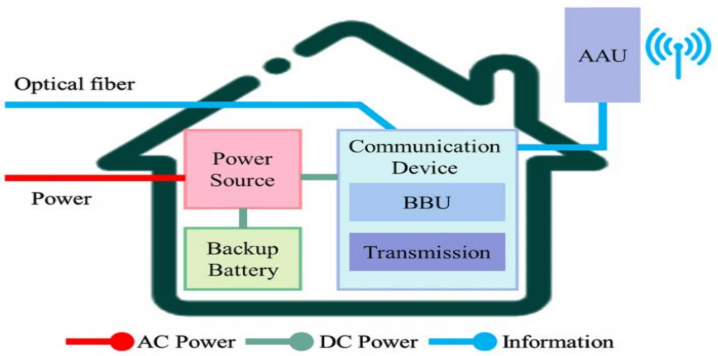


Rydberg atomic receivers represent a groundbreaking advancement in wireless communication technology. These devices use Rydberg atoms—atoms in a highly excited state with electrons that are far from the nucleus—which are extremely sensitive to electromagnetic fields, including radio signals. Unlike traditional antennas that rely on metal components to detect signals, Rydberg atomic receivers detect radio waves by observing changes in the energy levels of these atoms when exposed to electromagnetic radiation. This quantum-based approach allows for the detection of a much broader range of frequencies with exceptional sensitivity and minimal noise. As a result, Rydberg receivers could revolutionize wireless communication by enabling faster, more secure, and more efficient data transmission. They may also play a critical role in next-generation technologies such as quantum networks, deep-space communication, and advanced military systems.

-D.RISHITHA(22F11A0416)

Sustainable Green 5G Networks: Balancing Performance and Energy Efficiency

As 5G networks continue to expand globally, the urgency to address their environmental impact has intensified. Traditional wireless networks consume substantial energy, much of which results in carbon emissions and increased operational costs. To combat this, green 5G initiatives focus on innovative solutions that optimize energy use without compromising the exceptional performance standards expected from next-generation wireless systems. A fundamental approach involves integrating machine learning algorithms that predict network traffic patterns and adjust resources accordingly, allowing base stations and network nodes to enter low-power modes during off-peak hours. This dynamic energy management significantly cuts down on unnecessary power consumption, promoting a more sustainable operation



Another critical advancement is the development of energy-efficient hardware components that include low-power transceivers and processors designed specifically for 5G applications. These components reduce heat generation and improve the longevity of network devices. Furthermore, the deployment of small cells in urban areas enhances coverage and capacity while operating at much lower power levels compared to traditional macro cells. By densifying the network with these small cells, data transmission becomes more localized, which reduces signal loss and energy expenditure. Hybrid energy solutions combining conventional power grids with renewable energy sources, such as solar panels installed on base station towers, help offset reliance on fossil fuels and provide reliable power in remote locations.

Innovative cooling technologies also play an important role in reducing the environmental footprint of 5G infrastructure. Passive cooling and liquid-based cooling systems are replacing energy-intensive air conditioning units, further cutting energy use. Network operators are also increasingly adopting green protocols and standards, encouraging the design of networks with sustainability as a core objective. The convergence of these technological and operational strategies means that future 5G networks can sustain the demands of emerging applications—like augmented reality, autonomous vehicles, and massive IoT deployments—while maintaining energy consumption within environmentally responsible limits. The journey toward green 5G is essential for creating an equitable digital ecosystem that supports innovation without sacrificing the planet's health.

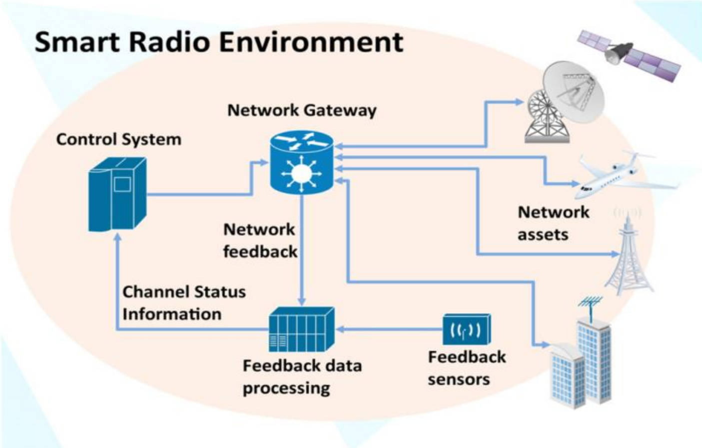
-- P.LAVANYA(24F15A0404)

Reconfigurable Intelligent Surfaces: Transforming Smart Radio Environments

Reconfigurable Intelligent Surfaces (RIS) represent a paradigm shift in wireless communication technology by enabling the control of the physical environment to enhance signal transmission. Unlike traditional wireless networks that rely solely on active components like base stations and relays, RIS uses programmable surfaces embedded with meta-materials that manipulate electromagnetic waves intelligently. These surfaces can adjust the phase and amplitude of reflected signals in real-time, effectively shaping the radio environment to improve signal quality and extend coverage. This capability is particularly crucial in dense urban areas and indoor environments where obstacles such as walls, furniture, and buildings cause signal attenuation and multipath fading, degrading network performance. By deploying RIS on various surfaces within the communication environment, network operators can dynamically reconfigure signal paths, reduce interference, and increase data throughput without additional energy consumption or spectrum allocation.

The passive nature of RIS means it consumes minimal power compared to active transmission devices, contributing to greener and more sustainable wireless networks. Furthermore, RIS technology supports massive connectivity, which is essential for the growing number of

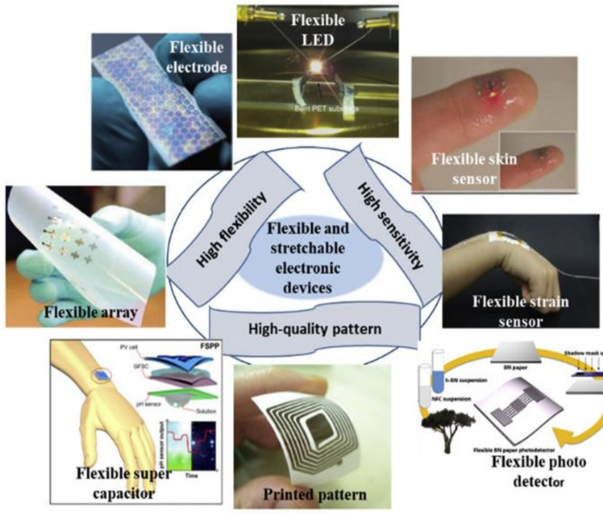
Internet of Things (IoT) devices and smart city applications. When integrated with machine learning algorithms, RIS can learn and predict environmental changes, autonomously adjusting their reflection patterns to maintain optimal network conditions. This adaptability enhances the robustness and reliability of future 6G networks, making them more resilient to environmental variability and user mobility. The low-cost fabrication and ease of integration with existing infrastructure also make RIS an attractive solution for upgrading current networks. As research and development in this field continue, RIS is expected to play a pivotal role in enabling high-capacity, energy-efficient, and intelligent wireless communication systems of tomorrow



--D. PRABHU(24F15A0402)

Flexible and Printed Electronics: Shaping the Future of Wearable Devices

Flexible and printed electronics are revolutionizing the design and functionality of wearable devices by enabling lightweight, bendable, and stretchable circuits that conform to the human body's contours. Unlike traditional rigid electronic components, flexible electronics use advanced materials such as organic semiconductors, conductive inks, and polymer substrates to create circuits that maintain performance while enduring bending, folding, and stretching. Printed electronics, which utilize printing techniques like inkjet or screen printing to deposit conductive and semiconductive materials, allow rapid, low-cost production of customized electronic components on flexible surfaces. These innovations have paved the way for next-generation wearable health monitors, smart textiles, flexible displays, and electronic skin sensors that provide continuous, real-time data without compromising comfort or mobility. The combination of flexibility,



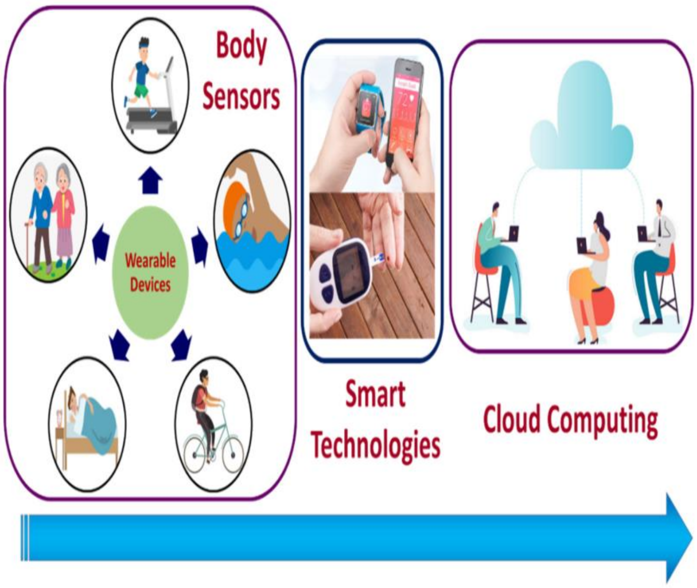
Moreover, flexible and printed electronics enable integration with a variety of materials, including fabrics and plastics, making them highly versatile for wearable tech. Advances in stretchable batteries and flexible sensors further complement this ecosystem, facilitating self-powered and multifunctional devices. As wearable technology demands grow, the ability to produce electronics that can seamlessly conform to irregular surfaces while delivering high sensitivity and connectivity becomes increasingly important. This synergy between materials science, printing technology, and electronic design is driving a wave of innovation that promises to reshape how humans interact with technology daily. With ongoing research enhancing durability, biocompatibility, and environmental sustainability, flexible and printed electronics are set to become foundational to the future of wearable devices, making smart technology more accessible, comfortable, and pervasive.

Flexible and printed electronics are transforming the landscape of wearable technology by enabling lightweight, bendable, and highly adaptable electronic components. Unlike traditional rigid electronics, these systems are built on flexible substrates such as plastic or fabric and are manufactured using advanced printing techniques that deposit conductive materials in precise patterns. This innovation allows electronic circuits to be seamlessly integrated into clothing, accessories, or even directly onto the skin. As a result, wearable devices can become more comfortable, discreet, and durable, while maintaining full functionality for applications such as health monitoring.

--T. BHOOMIKA(23F11A0476)

Integration of Artificial Intelligence in Electronics: Enhancing Smart Systems

The integration of artificial intelligence (AI) into electronics is fundamentally transforming the capabilities and intelligence of modern smart systems. By embedding AI algorithms directly into electronic hardware, devices gain the ability to process data locally, make autonomous decisions, and learn from their environment in real time. This fusion has accelerated the development of applications ranging from smart sensors and autonomous vehicles to industrial automation and consumer electronics like smartphones and wearable devices. AI-enhanced electronics leverage technologies such as edge computing, neural network accelerators, and machine learning chips, enabling faster data processing with reduced latency and improved energy efficiency compared to traditional cloud-based AI solutions. This local intelligence allows devices to operate independently, ensuring privacy, reliability, and responsiveness even in connectivity-limited environments.



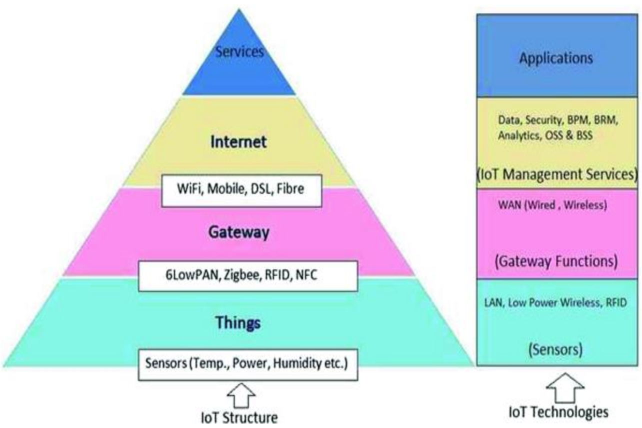
Moreover, AI integration facilitates adaptive system behavior, where electronics can optimize their performance dynamically based on contextual data, user behavior, or environmental changes. This capability enhances functionality in applications like predictive maintenance in manufacturing, personalized healthcare monitoring, and smart home automation.

The convergence of AI with advances in semiconductor technology, sensor miniaturization, and communication protocols is driving the evolution of next-generation electronics that are not only connected but also intelligent and context-aware. As AI algorithms become more efficient and hardware more powerful, the synergy between AI and electronics is expected to unlock unprecedented innovation, making smart systems more capable, intuitive, and responsive to complex real-world demands.

V. RUDRAKUMAR(24F15A4115)

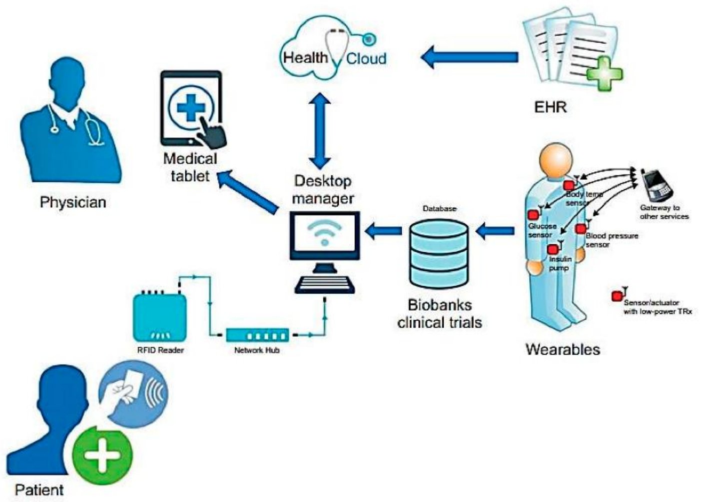
Low-Power Design Techniques for IoT Devices: Trends and Future Directions

With the explosive growth of Internet of Things (IoT) devices in diverse applications ranging from smart homes to industrial automation, low-power design has become a critical focus to extend device battery life and enable sustainable operation. IoT devices often operate in resource-constrained environments where frequent recharging or battery replacement is impractical, making energy efficiency paramount. Modern low-power design techniques encompass hardware and software innovations, including dynamic voltage and frequency scaling (DVFS), power gating, energy harvesting, and ultra-low-power microcontrollers optimized for minimal energy consumption. Additionally, advanced sleep modes and wake-up circuits allow IoT devices to remain in near-zero power states when idle and quickly activate upon receiving relevant signals. On the software side, efficient communication protocols such as Bluetooth Low Energy (BLE), Zigbee, and LoRaWAN reduce transmission power while maintaining reliable connectivity.



Emerging trends focus on integrating energy harvesting technologies like solar, thermal, and vibrational sources to supplement or replace batteries, creating self-sustaining IoT nodes. Edge computing also plays a vital role by enabling local data processing, reducing the need for continuous data transmission and associated power usage. Furthermore, the development of novel materials and semiconductor processes facilitates the creation of smaller, more efficient components that further decrease power demands. As IoT networks scale up, ensuring security and reliability alongside low power consumption becomes increasingly important. Looking ahead, future directions include the integration of AI-driven power management systems that dynamically optimize energy usage based on contextual awareness and workload predictions. These advancements promise to drive the next generation of IoT devices that are not only smarter and more connected but also highly energy-efficient and sustainable.

Low-power design techniques are essential for the development of efficient and long-lasting Internet of Things (IoT) devices, which often operate on limited battery power and are deployed in remote or inaccessible locations. These techniques focus on minimizing energy consumption through optimized hardware, software, and communication strategies. Current trends include the use of energy-efficient microcontrollers, dynamic voltage and frequency scaling (DVFS), and sleep modes that allow devices to power down when not in use. Additionally, energy harvesting technologies—such as solar, thermal, or motion-based power sources—are being explored to extend device lifespans without frequent battery replacements. On the software side, lightweight protocols and edge computing are reducing the need for constant data transmission, thereby saving energy.



Low-power design techniques are becoming increasingly vital as the number of IoT (Internet of Things) devices continues to grow across industries such as healthcare, agriculture, smart homes, and industrial automation. These devices often need to operate continuously for extended periods without frequent maintenance or battery replacement, especially in remote or embedded environments. To meet these requirements, engineers are developing advanced strategies that reduce power consumption at every level of the system.

On the hardware side, innovations include ultra-low-power microcontrollers (MCUs) and sensors that consume minimal energy while performing essential tasks. Techniques like **clock gating**, **power gating**, and **dynamic voltage and frequency scaling (DVFS)** allow devices to adjust performance and power usage based on current workload demands. For example, a temperature sensor may only wake periodically to collect data, staying in a deep sleep mode the rest of the time to save power.

In terms of communication, IoT devices use power-efficient wireless protocols like Bluetooth Low Energy (BLE), Zigbee, LoRaWAN, and NB-IoT, which are specifically designed to reduce the energy cost of transmitting data.

--M. BRUNDHA(23F11A4323)

NARAYANAENGINEERINGCOLLEGE,GUDUR
Dhurjati Nagar, Gudur – 524 101,
Tirupathi(Dist.),AndhraPradesh.
Email:hodece@necg.ac.in