Electronics and Communication Engineering

Federal Institute of Science And Technology (FISAT)®

HoD's Desk

It gives me immense pleasure to present this edition of the Electronics and Communication Engineering Department Technical Magazine, a reflection of the innovation, creativity, and academic excellence that define our department. This magazine showcases the technical achievements, research contributions, and innovative ideas of our students and faculty.

The field of Electronics and Communication Engineering continues to evolve rapidly, with breakthroughs in Artificial Intelligence, Embedded Systems, IoT, VLSI, and next-generation communication technologies transforming the way we live and work. As educators, our mission is to equip students with the knowledge, skills, and ethical values needed to excel in this dynamic technological landscape.

This publication stands as a testament to the dedication, curiosity, and collaborative spirit of our academic community. I hope the articles featured in this edition inspire readers to explore emerging technologies, foster innovation, and pursue excellence in engineering.

I sincerely appreciate the efforts of the editorial team, faculty members, and student contributors in bringing this magazine to life. I also express my heartfelt gratitude to the Management and Principal for their continued encouragement and support.

I congratulate everyone associated with this publication and wish our readers an insightful and enjoyable reading experience.

Dr. Krishna Kumar S
Head of the Department
Department of Electronics and Communication Engineering
Federal Institute of Science and Technology (FISAT)

Editor’s Word

Dear Readers,

It is with great pleasure that we present this edition of the Department of Electronics and Communication Engineering Technical Newsletter. This newsletter reflects the enthusiasm, innovation, and academic excellence of our students and faculty members, showcasing the vibrant learning environment within our department.

This newsletter serves as a platform to share technical knowledge, research highlights, project achievements, industry insights, and innovative ideas. We hope this edition inspires readers to embrace innovation, think creatively, and pursue excellence in engineering and research.

I extend my sincere appreciation to all the students, faculty members, contributors, and the editorial team whose dedication and hard work have made this publication possible. Your commitment to excellence continues to strengthen the reputation of our department.

I encourage every reader to actively participate in technical activities, pursue innovative ideas, and contribute to future editions of this newsletter. Let this publication inspire curiosity, collaboration, and a passion for engineering excellence.

Wishing you an enriching and insightful reading experience.

Happy Reading!

Editor

Department of Electronics and Communication Engineering

THE EDITORIAL BOARD

Our VISION

To emerge as a centre of excellence in Electronics and Communication Engineering churning out informed, innovative, socially committed and quality conscious engineers for the society.

Our MISSION

Foster an environment for multifaceted education rooted in science and contemporary technology

Facilitate quality research and development leading to innovations in the field of Electronics and Communication Engineering

Develop competent young engineers to complement the virtues of the society

PROGRAM SPECIFIC OUTCOMES

After the successful completion of the course, students of the Electronics and Communication Engineering Program will have:

The ability to apply the fundamental knowledge of Electronics and Communication Engineering to analyze, design and develop various types of electronic systems.

Competence in using modern hardware and software tools for developing solutions to engineering problems.

Excellent adaptability to the changing industrial and real world requirements.

PROGRAM EDUCATIONAL OBJECTIVES

Graduates of the program will have the technical expertise to analyze and design hardware and software components of electronic systems, benefiting industry and society.

Graduates of the program will be able to exhibit excellence in the field of Electronics and Communication Engineering and contribute significantly in research and development, enterprise and leadership.

Graduates of the program will be successful, ethically driven professionals with a passion for continuous learning.

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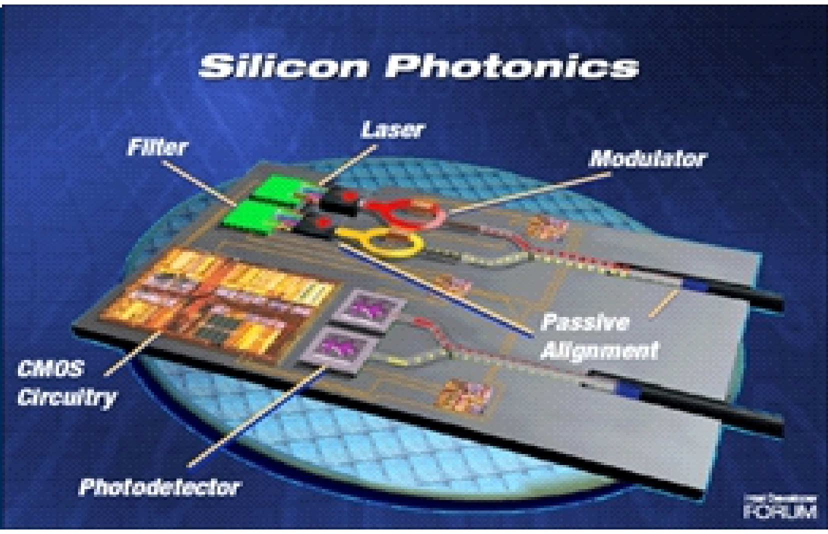


Pranav Ramesh Mannatt
S2 ECE B

Photonic Circuits - Using Light Instead of Electricity

When we talk about circuits, we usually mean electronic circuits-systems that use electricity to process and transfer information. These are what power our phones, computers, and almost every other device we use. But there's another kind of circuit that's gaining attention: photonic circuits, which use light instead of electricity. It might sound futuristic, but it's already becoming a reality.

So, What Exactly Are Photonic Circuits?

In simple terms, photonic circuits are like electronic circuits, but instead of moving electrons, they move photons (which are just particles of light). These circuits can perform similar functions-like switching, transmitting, or processing data-but they do it using light waves. Because light moves incredibly fast, these circuits have the potential to be much faster than traditional ones.

Why Use Light?

There are a few good reasons why using light could be better than using electricity.

First of all, light travels faster than electricity in wires. That means data can be moved more quickly, which could improve the performance of computers and networks.

Second, light can carry more data at the same time by using different wavelengths. This is similar to how fiber optic internet works, and it gives photonic circuits a higher bandwidth than regular electronic ones.

And third, electronic circuits produce a lot of heat, which wastes energy and can cause overheating issues. Photonic circuits produce less heat and use less energy overall.

Basically, photonic circuits could help make our technology faster, more energy-efficient, and better at handling large amounts of data.

How Do They Work?

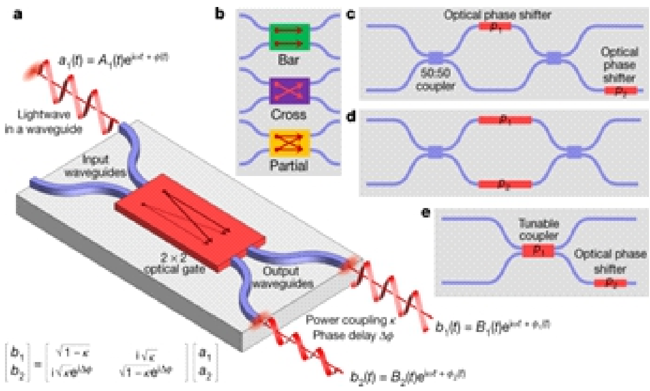
Instead of using wires and components like resistors or transistors, photonic circuits use special optical parts.

Waveguides are used to guide the light around the chip. Think of them like tiny highways for photons, similar to how optical fibers guide light.

Modulators are devices that can control the light, like switching it on and off or changing its intensity.

Detectors are used at the end of the circuit to turn the light signal back into an electrical signal, if needed.

Most photonic circuits are built using silicon, which is the same material used in electronic chips. This makes it easier to combine both electronic and photonic parts together on one chip.



Where Are They Used?

Photonic circuits are already finding real-life applications.

In data centers, they help speed up communication between servers while using less energy.

In telecom networks, they can help process the light signals that already travel through fiber optic cables more efficiently.

Some medical devices use photonic chips as sensors to detect chemicals, gases, or even signs of diseases.

They are also being researched for use in quantum computing, where light is a key part of building quantum systems.

But There Are Some Challenges...

Even though the potential is exciting, photonic circuits still face some problems.

It's hard to make the optical components as small as electronic transistors, so fitting a lot of them onto a single chip is difficult.

Also, manufacturing photonic chips is more expensive and complicated than regular electronics.

However, researchers are actively working on solving these problems, and the field is moving forward quickly.

Final Thoughts

Photonic circuits might seem like science fiction, but they're real and slowly becoming more common. With their ability to move data faster, carry more information, and waste less energy, they could be a big part of the future of computing and communication.

There's still a long way to go, but the progress so far is promising. Who knows-maybe in a few years, our laptops and phones will be powered not by electricity, but by light.

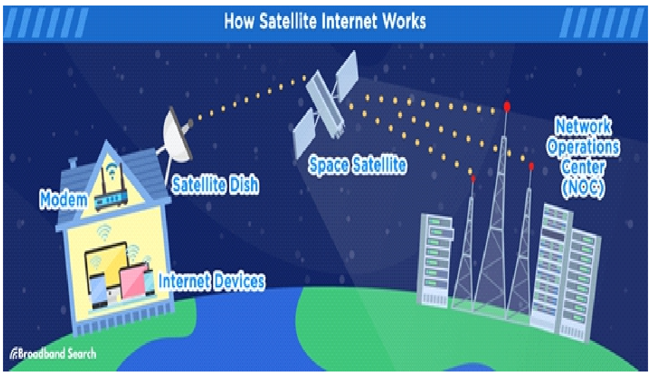
Sreejith T R
S2 ECE B

Satellite Internet: Bridging the Digital Divide from Space

In today's digital world, access to the internet is no longer a luxury—it's a necessity. From education and healthcare to business and communication, the internet plays a critical role in our daily lives. However, many remote and rural regions still struggle with unreliable or no connectivity. That's where satellite internet steps in—a revolutionary technology that's quite literally out of this world.

Satellite internet is a form of broadband service that uses communication satellites to provide internet access. Unlike traditional cable or fiber connections that require physical infrastructure, satellite internet works wirelessly. It allows users in the most isolated regions—deserts, mountains, oceans, even war zones—to stay connected using just a satellite dish and modem.

The working principle is fascinating. When a user sends a request (say, clicking a link), the data is transmitted from a satellite dish installed at their location to a satellite orbiting Earth. This satellite then relays the signal to a ground station, which is connected to the actual internet. The process is reversed to send the requested data back. Although it may sound complex, this entire communication loop happens in a fraction of a second.



As an electronics and communication engineering student, I find satellite internet particularly exciting because it showcases the real-world application of wireless communication, RF systems, and space technology. More importantly, it has the potential to bridge the digital divide—bringing internet access to communities that have been left out due to geography or economic challenges.

Advantages of satellite internet include:

Global Coverage – From Himalayan villages to oceanic ships, it can reach almost anywhere.

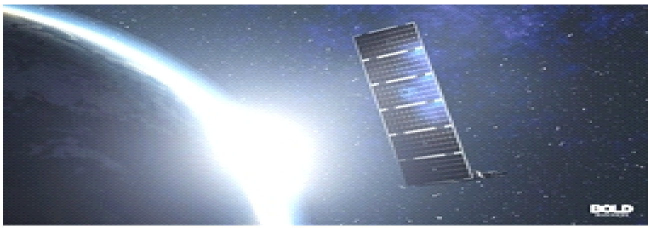
Fast Deployment – No need to dig trenches or lay cables.

Disaster Resilience – Keeps working even when ground networks fail.

Satellite internet isn't without issues. GEO systems can have high latency, affecting gaming or video calls. LEO systems, while faster, require a large number of satellites, raising concerns about space debris and orbital traffic. Additionally, weather conditions can temporarily disrupt the signal.

With ongoing projects like Amazon Kuiper and OneWeb, and the integration of satellite systems into 6G networks, we are entering an era where high-speed internet could be truly universal.

From a student's perspective, this field opens up exciting career paths in space communication, RF engineering, satellite design, and more. Whether you're passionate about space tech or simply care about a more connected world, satellite internet is a topic worth exploring.



ABDUL RIJAS
S4 ECE A

Empowering Innovation: The Technological Leap in Power Electronics

Power electronics is atechnology that useselectronic components to help change, control, and use electricity more effectively and intelligently. Today, withthe growing importance of energy conservation, environmental protection, and device miniaturization, power electronics has become more relevant than ever.

It's used in many of our daily items, such as smart phones, laptops, and electric vehicles, as well as in renewable energy systems like solar and wind power. The field has advanced rapidly, thanks to new materials, better digital control systems, and designs that are more energy-efficient. This article will explore the latest developments in power electronics and its expanding range of applications.

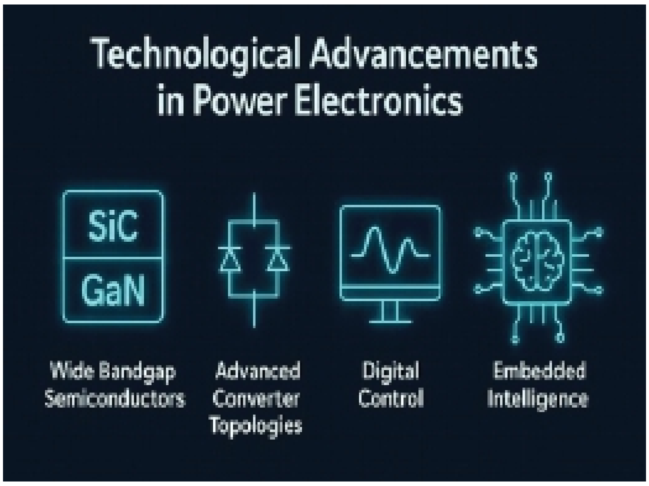
Recent Trends and Innovations in Power Electronics

The field of power electronics hasgrown quickly, thanks to new technologies. Wide Band gap (WBG) semiconductors like Silicon Carbide (SiC) and Gallium Nitride(GaN) are helping devices become more efficient, switch faster, andbe made smaller.

Modern converter designs, such as multilevel and resonant converters, improve performance while wasting less energy. Digital control methods now allow for very precise and adaptable system regulation. Meanwhile, embedded intelligence adds real-timemonitoring and smart decision-making. These innovations are changing how we use power electronics in electric vehicles, renewable energy, industrial machines, and smart grids.

Challenges

Even with all theimprovements, someproblems still exist in powerelectronics.



Heat Management:

As devices shrink and becomemore powerful, they producemore heat, making themharder to keep cool.

Electrical Noise (EMI/EMC):

Fast switching can create unwanted signals that interfere with other electronics. We need special filters to reduce this noise.

Reliability and Safety: In critical applications likecars, airplanes, and medical devices, power systems must be highly reliable. High Cost and Lack of Standards: New materials like Silicon Carbide (SiC) and Gallium Nitride (GaN) are still costly, and there aren't many standard rules for how to use them yet.

High Cost and Lack ofStandards:

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FUTURE TRENDS

Power electronics is headed in some exciting new directions:

Solid-State Transformers (SSTs) :

These are advanced transformers that are smaller, more efficient, and smarter. They could change how we deliver and use electricity.

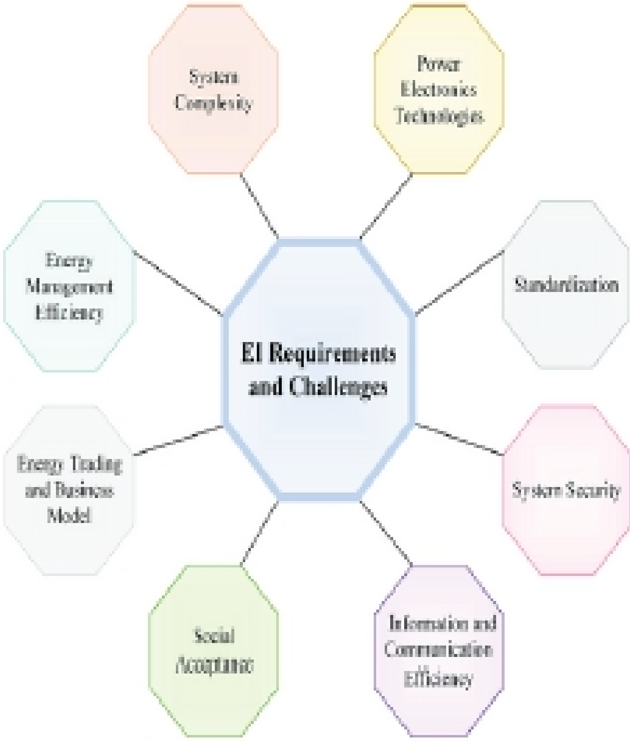
Wireless Power Transfer:

This technology allows devices to be charged without cables— it's especially useful for electric vehicles and mobile electronics.

Quantum Power Electronics:This is still in the early researchphase, but it could lead to newways of controlling and usingelectricity in the future.

Power electronics is central tomodern technological progress. With ongoing improvements in components, converter designs, digital control, and smart systems, it is driving the move toward more efficient, compact, and sustainable energy solutions.

From powering electric vehicles and renewable energy systems toenabling smart cities and next-gen electronics, its impact is huge and widespread. As innovation continues and cutting-edge materials appear, power electronics will remain a key force in shaping a cleaner, smarter, and more energy-efficient future.



ADITYA NAMBIAR
S4 ECE A

Fiber-Optic Drones: A Technical Analysis of Design, Functionality, and Military Applications

Fiber-optic drones represent a significant evolution in unmanned aerial vehicle (UAV) technology, addressing one of the most pressing challenges in modern warfare: electronic warfare (EW) jamming. These drones utilize a physical fiber-optic tether for communication instead of traditional radio-frequency (RF) links, making them immune to signal interference and detection by enemy EW systems. Initially pioneered by Russia and later adopted by Ukraine, fiber-optic drones have demonstrated remarkable effectiveness in contested environments, reshaping battlefield tactics.

Technical Design and Operation

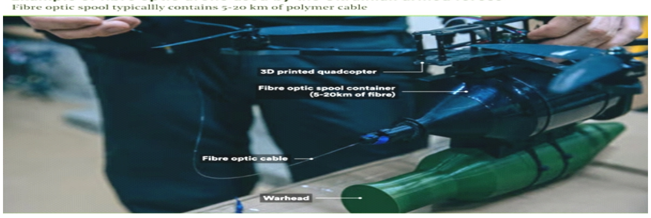
1. Fiber-Optic Communication System

Fiber-optic drones rely on ultra-thin polymer or glass optical fibers (POF or GOF) to transmit control signals and high-definition video feeds between the drone and its operator. The key components include:

Fiber-Optic Cable: Typically, 5–20 km in length, with some prototypes extending up to 50 km. The cable consists of a PMMA (polymethyl methacrylate) core and fluoropolymer cladding for durability and flexibility.

Spool Mechanism: The drone carries a motorized spool that deploys the fiber as it flies, minimizing drag and preventing entanglement. Advanced spools use lightweight materials (300–2000 grams) to optimize payload capacity.

Example of fibre optic drone used by the Ukrainian armed forces
Fibre optic spool typicallly contains 5-20 km of polymer cable



Control Protocol: Most systems digitize RF signals and transmit them via fiber, though emerging designs use broadband RF-over-fiber (RFoF) for enhanced security.

2. Power and Data Transmission

Unlike traditional drones, fiber-optic UAVs do not rely on wireless signals, eliminating vulnerabilities to jamming. The fiber provides:

Low Latency (<1 ms): Critical for real-time control in FPV (first-person view) operations.

High Bandwidth (1+ Gbps): Supports HD/4K video feeds without compression artifacts.

Secure Data Link: Physical tethering prevents signal interception or spoofing.

Some experimental models integrate Power-over-Fiber (PWoF), transmitting laser energy through the fiber to extend flight endurance indefinitely.

Military Applications and Tactical Advantages

1. Anti-Jamming Capability

The primary advantage of fiber-optic drones is their immunity to EW interference. In Ukraine, both sides deploy jammers that disrupt 80–90% of conventional drones, but fiber-optic models remain fully operational.

2. Precision in Contested Environments

Urban Warfare: Fiber drones navigate buildings and tunnels where RF signals fail.

Forests and Electronic Noise: Unlike RF drones, tethered UAVs maintain connectivity in dense foliage or high-EMI zones.

3. Stealth and Survivability

No RF Emissions: Operators remain undetected by signal triangulation.

Low-Altitude Flight: Reduced radar cross-section compared to wireless drones.

4. Case Study: Kursk Counteroffensive (2024–2025)

Russian forces used fiber-optic drones like the Knyaz Vandal to sever Ukrainian supply lines in Kursk, achieving an 80% mission success rate. Ukraine responded with domestic models like Shtorm and Silkworm, but production bottlenecks persist.

Limitations and Engineering Challenges

1. Range and Mobility Constraints

Tethered Range: Limited by cable length (typically ⩽ 20 km).

Maneuverability: Cables snag on terrain, restricting flight paths.

2. Payload Trade-offs

Weight Penalty: A 10 km spool weighs ~1.4 kg, reducing explosive payload capacity.

Drag: Fiber resistance impacts speed and agility.

3. Environmental and Logistical Issues

Battlefield Pollution: Discarded fiber cables (PMMA/fluoropolymers) persist for centuries, posing microplastic and PFAS contamination risks.

Supply Chain Dependence: China dominates POF production, creating vulnerabilities.

Future Innovations and Civilian Applications

1. Hybrid RF/Fiber Systems

Next-gen drones may switch to fiber only when jamming is detected, combining flexibility with resilience.

2. Civilian Use Cases

Disaster Response: Inspecting collapsed structures with uninterrupted feeds.

Telecommunications: Deploying temporary fiber networks in remote areas.

3. Material Science Advances

· Biodegradable Fibers: Reducing environmental harm.

· Stronger, Lighter Tethers: Carbon-nanotube composites could enhance performance.

Conclusion

Fiber-optic drones exemplify how engineering innovation addresses battlefield challenges. While their anti-jamming capability is transformative, limitations in range, payload, and environmental impact require further R&D. For engineers, this technology underscores the importance of interdisciplinary solutions—from optical communications to materials science—in shaping the future of UAVs.

As military and civilian applications expand, fiber-optic drones will likely evolve beyond a stopgap measure into a cornerstone of resilient drone systems. For students, this field offers rich opportunities in robotics, telecommunications, and defense technology.

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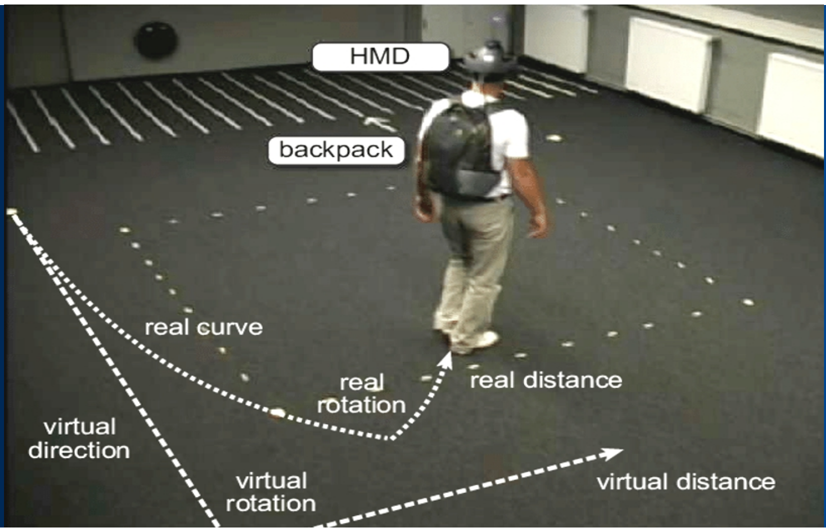


MAIDHILI HARI
S6 ECE B

F-RDW: Improving Virtual Reality Walking by Predicting the User's Future Steps

Virtual Reality (VR) has opened up exciting new ways to explore digital environments. One of the most realistic ways to move around in VR is by walking naturally. However, there's one big problem—our real physical spaces are often much smaller than the vast virtual worlds we want to explore. To solve this, researchers use something called Redirected Walking (RDW), which tricks the user's brain into thinking they're walking straight in VR, even if they're turning or looping in real life.

The issue with most RDW systems is that they rely on techniques that either suddenly stop the user or ask them to turn in place when they get close to the physical boundary. These actions break the sense of immersion. That's why new approaches try to predict where the user is going, so the system can subtly redirect them away from walls and obstacles without them noticing. But earlier prediction methods had a problem: they only worked well in specific types of virtual worlds or made assumptions about how users move. This limits their usefulness in

real-world VR experiences.

This is where F-RDW (Forecasting-Redirected Walking) comes in. F-RDW is a system that predicts where the user is likely to move next using machine learning and then adjusts the VR experience in a smarter way to reduce interruptions. It does this without needing any special setup in the virtual world or assuming how a person will walk.

Testing the Idea

To test the performance of F-RDW, the authors ran simulations and user experiments. In simulations, users walked in different types of virtual rooms, some with lots of obstacles and others that were more open. The results showed that F-RDW helped users walk longer without being interrupted. It also reduced how often users had to “reset” their position.

In real-world testing, users wore a VR headset and walked around a virtual park. They were asked to collect items, like garbage bags, while walking. When F-RDW was used, users had fewer resets and walked longer distances in VR without interruption. Most users said they preferred the experience with F-RDW, even though they weren't told which version they were using.

Why F-RDW Is Useful

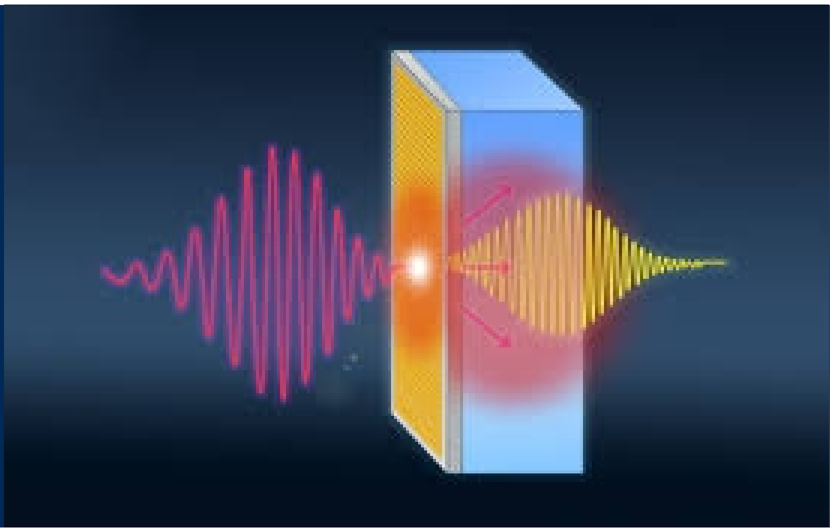
The biggest advantage of F-RDW is that it can be added to many existing RDW systems. It doesn't rely on specific layouts or walking styles, so it can be used in any virtual world. Since it uses prediction, it can make smarter decisions and give users a smoother experience.

Also, the prediction part can be improved further in the future by using more types of user data like body movement or audio. This could make the predictions even more accurate.

Researchers also suggest that the balance between current and future information could be made dynamic, depending on the situation.

Conclusion

F-RDW is a promising step forward in making VR feel more real. By predicting where users are going and planning ahead, it reduces interruptions and makes virtual walking smoother and more enjoyable. It can be added to many types of VR systems, and future updates could make it even better. For anyone working in VR development or interested in immersive experiences, F-RDW shows how smart forecasting can solve real problems in virtual worlds



GOWRI NANDA S
S6 ECE A

Terahertz Topological Insulators: A New Approach to On-Chip Communication

Abstract

As electronic devices get faster and smaller, the way data moves inside chips needs to improve too. Traditional interconnects are starting to fall behind, especially when it comes to speed and energy efficiency. That's where terahertz (THz) communication comes in. When combined with topological insulators, this new method could completely change how signals travel within a chip. This article explains what terahertz topological insulators (PTIs) are, why they matter, and how they might solve current problems in chip-to-chip communication.

Introduction

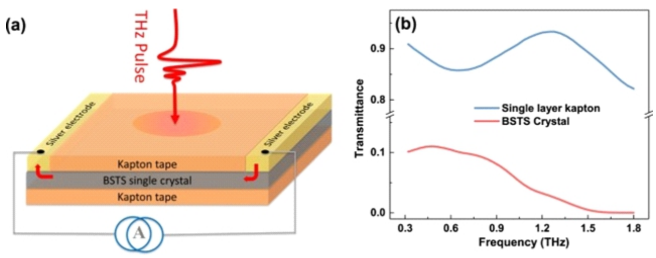
We're in a tech world that keeps getting smaller and faster. Our phones, computers, and even smartwatches are packed with powerful chips. But as these chips get more complex, they need faster ways to send data inside themselves. Right now, copper wires and even optical links are used, but they have limits. They waste energy, can be slow, and don't scale well as chips shrink. This is where terahertz (THz) waves become exciting. They offer super-high data speeds and can be used inside chips. But THz waves are delicate—they scatter, lose strength, and don't handle bends well.

That's why topological insulators are being explored. They can guide signals in a stable way, even around corners, without much loss.

What Are Topological Insulators?

Topological insulators (or PTIs in the photonics world) are special materials that behave like insulators on the inside but allow waves to travel freely along their edges. This might sound complicated, but imagine a hallway where people can walk only along the walls, and no matter how many turns or obstacles there are, they won't bump into anything or get stuck.

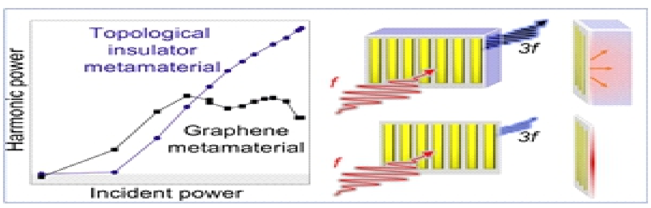
That's how PTIs help THz signals—by letting them move smoothly without interference from imperfections in the chip. They come in different types, like Quantum Hall, Quantum Spin Hall, Floquet, and Quantum Valley Hall. Among these, Quantum Valley Hall PTIs are practical for real chip use because they don't need magnetic fields or fancy modulation, and they work well with standard chip-making processes.



Why It Matters in Real Chips

This isn't just theory. Researchers have already built working PTI-based THz devices. They've used them to send high-speed data, transmit HD video, and even build THz switches and beamformers on a chip. These systems can handle sharp turns in waveguides without losing signal strength and work really well even in small spaces.

With these tools, future Network-on-Chip (NoC) designs can be faster, use less power, and support more features—perfect for AI processors, 6G systems, and other high-performance computing.



What Are the Challenges?

Even though this is promising, there are still some challenges to work through:

Making PTIs with the right precision is tough.

Managing heat on a chip using THz waves isn't easy.

Cost and compatibility with today's chip tech still need improvement.

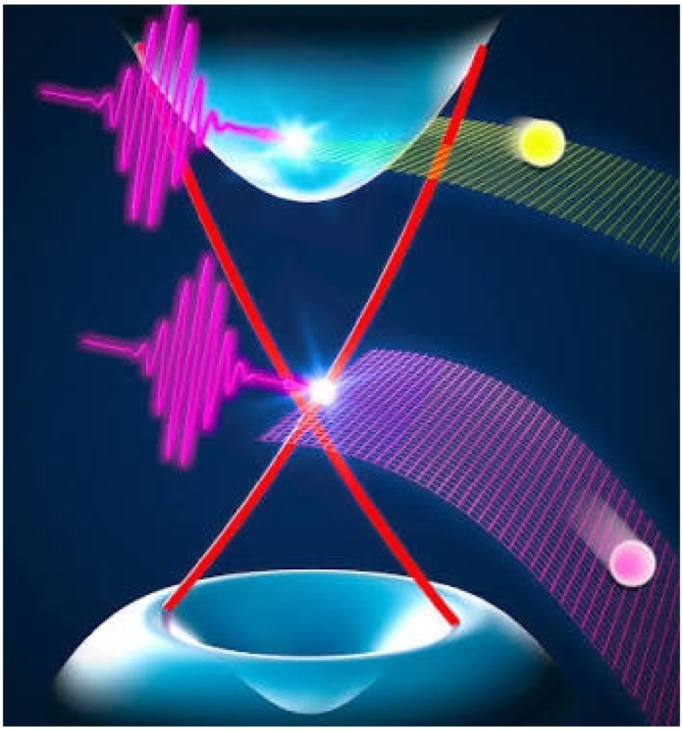
But on the bright side, many of these designs already work with CMOS, which is what most chips are made with. So it's not a huge leap—just some smart engineering and improvements in how we build and integrate these materials.

Looking Ahead

What's really exciting is how this could impact not just communication, but things like quantum computing, real-time AI hardware, and on-chip sensing. PTIs could help build faster and more reliable quantum links. They could also lead to new types of processors that process and store data in the same place—saving both time and energy. As research continues, this could totally change how we design chips for future tech.

Conclusion

Terahertz topological insulators may sound like something out of a textbook, but they're actually a real, practical solution to a problem that's growing fast. As chips get more powerful and complex, we need new ways to move data inside them. PTIs offer one of the most exciting paths forward. They're fast, stable, and energy-efficient. With more research, they could become a key part of next- generation electronics.



SAYUJYA
S8 ECE B

Light Speed 6G: The Rise of the Photonic Brain

"MIT's MAFT-ONN uses light-based neural networks to deliver nanosecond-speed AI inference for future wireless systems."

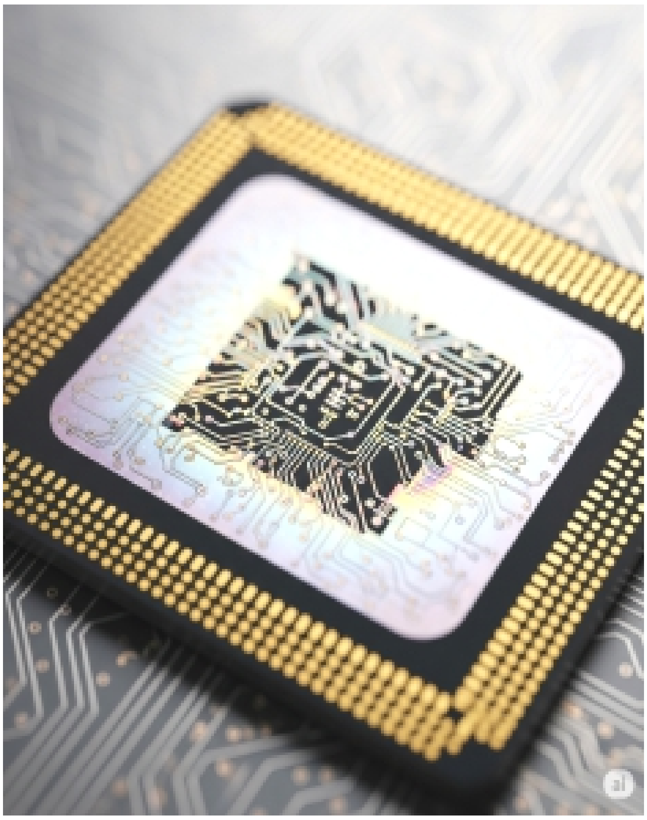
As the modern world becomes increasingly dependent on technology and connected devices, the pressure on existing wireless infrastructure continues to grow. Emerging technologies like autonomous vehicles, smart homes and augmented reality not only demand faster data transmission but also a significant increase in network bandwidth to handle the escalating volume and complexity of data traffic. The finite nature of the current wireless spectrum poses a key obstacle, making it essential to adopt advanced methods to manage spectrum more efficiently and deliver ultra-low latency performance.

This growing challenge is pushing the development of sixth-generation (6G) networks, which are designed to deliver real-time, high-speed, and flexible wireless communication for many advanced applications. However, to unlock the full potential of 6G, major improvements in signal processing and AI-powered computing are needed.

“Fast, Bright & Wireless: A Photonic Leap Into 6G"

In response to this critical need, researchers at the Massachusetts Institute of Technology (MIT) have developed an innovative solution: the Multiplicative Analog Frequency Transform Optical Neural Network (MAFT-ONN). This novel photonic AI accelerator is capable of performing deep learning inference at the speed of light, drastically outperforming conventional digital processors in both speed and efficiency.

Optical systems enable energy-efficient acceleration of neural networks using light-based data processing. However, achieving high performance and scalability in signal processing applications remains challenging.To overcome these limitations, the researchers developed a specialized optical neural network called MAFT-ONN.



"From Signal to Solution in a Single Step"

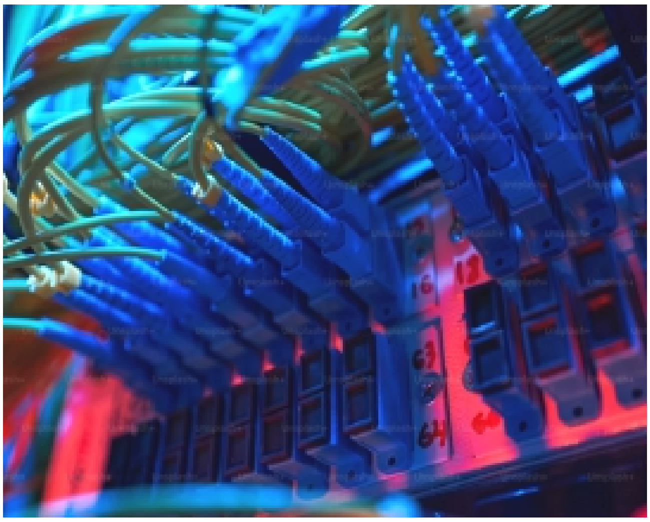
MAFT-ONN works directly in the frequency domain, meaning it processes the wireless signals before converting them to digital form. This helps it handle large amounts of data more efficiently.

They designed the system to carry out both linear and nonlinear operations—which are essential for deep learning—within the same layer, instead of needing a separate device for every small unit or "neuron."Because of this design, one MAFT-ONN device can support up to 10,000 neurons and complete complex calculations in a single step.

The key to this efficiency is a method called photoelectric multiplication, which boosts performance and makes it easier to add more layers without extra hardware.

“Cracking the Code: Teaching AI to Work with Light”

One of the major challenges the researchers faced was adapting machine learning techniques to operate on optical hardware. Standard AI tools were not directly compatible, so the team designed custom models specifically suited to the photonic system. They had to explore how to harness the physics of light to perform computations traditionally handled by electronic circuits, developing specialized solutions that enabled these operations within the optical domain.



"Blink and It's Done"

Simulation showed that MAFT-ONN achieved 85% classification accuracy in a single measurement, with accuracy increasing to over 99% through multiple measurements. The entire inference process was completed in approximately 120 nanoseconds, offering a significant speed advantage over digital radio frequency systems, which typically operate at microsecond-scale latency. With its nanosecond-level processing, MAFT-ONN enables higher accuracy

without a substantial trade-off in speed. For future development, the researchers plan to incorporate multiplexing schemes to enhance computational capacity and scalability. They also aim to extend the architecture to support more complex deep learning models, including transformer networks and large language models (LLMs).

This article is based on research led by Professor Dirk Englund at the Massachusetts Institute of Technology (MIT), as reported by MIT News on June 11, 2025. The original study was supported in part by the U.S. Army Research Laboratory, the U.S. Air Force, MIT Lincoln Laboratory, Nippon Telegraph and Telephone (NTT), and the National Science Foundation.

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