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IMPULSE



NEWSLETTER

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*Electronics & Communication Engineering
Haldia Institute of Technology*

2022

The Institute's Vision and Mission

Vision

To achieve Centre of Excellence in the field of Science, Technology and Management Education for creating dynamic human resources of global standards with capabilities of accepting new challenges.

Mission

- ✓ To impart quality and value based education to raise satisfaction level of all stakeholders.
- ✓ To create competent, creative professionals, and great entrepreneurs who can work as individual or in group in multi-cultural global environments.
- ✓ To prepare citizens who would grow to be competent enough to contribute significantly with personal integrity and civic responsibility for the betterment of mankind throughout their careers and profession.

Department Vision and Mission

Vision:

To produce dynamic human resources of global standards by imparting quality teaching, carrying out research and technology development in the emerging areas of Electronics & Communication Engineering.

Mission:

- ✓ To produce electronics and communication engineers having strong theoretical foundation, good design experience and exposure to research and technology development in frontier areas of electronics and communication engineering.
- ✓ To create competent professionals who can work as an individual or in a group with effective communication and leadership skills meeting the requirements of multi-cultural global environments.
- ✓ To help the student be a successful and responsible engineer for the betterment of mankind by inculcating social and ethical values in professional engineering programme.

Program Educational Objectives (PEOs)

PEO-1: To equip graduates with strong foundation in Electronics and Communication Engineering with an objective of being real time problem solvers.

PEO-2: To provide exposure to emerging technologies in order to become competent both as an individual and team with ever changing industrial requirements.

PEO-3: To prepare successful and responsible engineering graduates with socio-ethical values and leadership qualities in professional engineering practices.

Program Specific Outcomes (PSOs)

After completion of the program, the students will have ability to:

PSO-1: Apply basic knowledge in diversified fields of Electronics and Communication Engineering to solve engineering and socio-ethical problems.

PSO-2: Design, Verify and Validate electronic functional elements for a variety of experiments and projects with skills to analyze, interpret and communicate results either independently or in teams.

PSO-3: Recognize contemporary issues to adapt lifelong learning and develop consciousness for technical, professional, managerial and legal responsibilities.



IMPULSE

Vision

IMPULSE is a yearly newsletter to share upcoming technologies in various fields of Electronics & Communication Engineering. This issue of newsletter introduced the advanced research topics in the field of biomedical signal analysis, wireless communication, and computer vision. These brief technical articles will influence many students and faculty members to extend research works in these fields in near future.

Content

- ✓ Biomedical Signal Processing: Revolutionizing Healthcare with Technology
- ✓ Wireless Communication: Connecting the World Without Wires
- ✓ Challenges of Audio and Speech Processing
- ✓ Use of Speech Technology to Detect Parkinson Disease
- ✓ Image and Video Processing: Enhancing Visual Media with Technology
- ✓ Artificial Intelligence: Transforming the Future

Biomedical Signal Processing: Revolutionizing Healthcare with Technology

Mr. Tirthadip Sinha, Assistant Professor,
ECE

In recent years, biomedical signal processing (BSP) has emerged as a transformative field at the intersection of engineering, medicine, and technology. It involves the analysis, interpretation, and manipulation of biological signals to monitor, diagnose, and treat medical conditions. The continuous advancements in this field have revolutionized healthcare, enabling more accurate diagnoses, personalized treatments, and better patient outcomes.

Biomedical Signal Processing

Biomedical signal processing refers to the use of computational techniques to analyze and process signals generated by biological systems. These signals can be electrical, mechanical, or chemical, and they originate from the human body. Common examples include:

- **Electrocardiogram (ECG):** Measures the electrical activity of the heart.
- **Electroencephalogram (EEG):** Records electrical activity in the brain.
- **Electromyogram (EMG):** Monitors electrical activity in muscles.
- **Electrooculogram (EOG):** Records electrical signals from the eye.

These signals are crucial for diagnosing a variety of medical conditions, including heart disease, epilepsy, neurological disorders, and sleep disorders. However, due to the inherent noise, variability, and complexity of biological signals, sophisticated signal processing techniques are necessary to extract meaningful information from them.



Key Techniques in Biomedical Signal Processing

1. **Filtering:** Biological signals often contain noise or interference from external sources. Filtering techniques are used to remove unwanted components from the signal and retain the important information. For example, in ECG signals, filters can eliminate power line interference and other disturbances.
2. **Feature Extraction:** This involves identifying specific characteristics or patterns in the signal that are indicative of certain physiological states or medical conditions. For instance, in EEG analysis, certain frequency bands can help detect epilepsy or brain activity.
3. **Time-Frequency Analysis:** Many biomedical signals vary over time, and their characteristics change at different frequencies. Time-frequency analysis helps in understanding these variations, making it easier to detect anomalies, such as in speech or heart rate.
4. **Pattern Recognition and Machine Learning:** With the help of artificial intelligence and machine learning algorithms, biomedical signal processing is increasingly being used to identify patterns that are not easily visible to human eyes. These technologies can assist in diagnosing diseases like cancer, Alzheimer's, and Parkinson's by analyzing complex data sets.
5. **Signal Compression:** As biomedical signals can be large and complex, it is important to compress the data

efficiently without losing crucial information. This is especially vital when signals need to be transmitted remotely for telemedicine applications.

Applications of Biomedical Signal Processing

- **Cardiac Monitoring:** BSP techniques are extensively used to monitor heart health. The ECG signal is analyzed to detect arrhythmias, ischemic heart disease, and other cardiovascular conditions. Portable ECG devices and wearable fitness trackers are now commonplace, enabling continuous monitoring of heart health.
- **Brain-Computer Interfaces (BCI):** By analyzing EEG signals, BCIs allow individuals with paralysis or other motor impairments to control devices such as prosthetics, computers, or wheelchairs using only their brain activity. This technology is a game-changer for people with severe disabilities.
- **Sleep Studies:** Signals from various physiological parameters, such as EEG, EMG, and ECG, are used to study sleep patterns. BSP plays a vital role in diagnosing sleep disorders like sleep apnea, insomnia, and narcolepsy.
- **Neurodegenerative Diseases:** For patients suffering from conditions such as Parkinson's or Alzheimer's, biomedical signal processing can provide insights into brain function, track disease progression, and aid in early diagnosis, potentially leading to better treatment options.
- **Telemedicine:** BSP has contributed significantly to the growth of telemedicine. Patients can transmit vital sign data remotely, and doctors can analyze this data in real time, improving access to healthcare in remote areas.

The Future of Biomedical Signal Processing

As the demand for advanced healthcare technologies grows, biomedical signal processing is poised to play an even larger role in transforming how healthcare is delivered. The integration of BSP with emerging technologies like artificial intelligence, machine learning, and big data analytics will make diagnoses faster, more accurate, and personalized.

Future developments in wearable devices, real-time monitoring systems, and advanced imaging techniques will provide healthcare professionals with an unprecedented ability to monitor patient health continuously and proactively. Additionally, breakthroughs in deep learning and neural networks may offer more precise interpretations of complex biomedical signals, further enhancing treatment precision.

Conclusion

Biomedical signal processing is one of the key pillars in modern healthcare, enabling the extraction of valuable information from complex biological data. As technology continues to evolve, the potential of BSP to improve patient care, enhance diagnostic accuracy, and personalize treatment options will only increase. For students and professionals entering this field, the future is exciting, with opportunities to contribute to life-saving innovations and make a lasting impact on global health.

Wireless Communication: Connecting the World Without Wires

Mr. Jayanta Kumar Bag, Assistant
Professor, ECE

Wireless communication is one of the most transformative technologies of the modern era. It allows the transfer of data and information without the use of physical cables, revolutionizing how we connect with each other and the world around us. From mobile phones to satellite networks, wireless communication has reshaped everything from personal interactions to global industries.

Wireless Communication

Wireless communication refers to the transmission of information through electromagnetic waves, such as radio waves, microwaves, and infrared, instead of through physical media like wires or cables. This technology powers many of the devices we use every day, from smartphones to Wi-Fi networks, Bluetooth devices, and GPS systems.



Key Technologies Behind Wireless Communication

1. **Radio Frequency (RF) Communication:** This is the most

common form of wireless communication, used in everything from AM/FM radios to cellular networks. Radio waves are emitted by transmitters and received by antennas on the receiving end.

2. **Microwave Communication:** Microwaves allow for high-frequency communication over longer distances and are used in satellite and point-to-point communication links, including Wi-Fi and cellular networks.
3. **Infrared Communication:** Often used for short-range communication, infrared technology is employed in devices like TV remotes, wireless keyboards, and data transmission between devices like smartphones and laptops.
4. **Satellite Communication:** Satellites enable long-distance communication by relaying signals across vast distances. They are critical for television broadcasting, weather forecasting, and global navigation systems like GPS.

Applications of Wireless Communication

- **Telecommunications:** The advent of mobile phones and 4G/5G networks has drastically changed how people communicate. With wireless communication, we can make calls, send messages, and access the internet almost anywhere in the world.
- **Internet of Things (IoT):** Wireless communication is the backbone of IoT devices, which are interconnected systems that communicate with each other via the internet, from smart homes to health monitors.
- **Remote Control and Automation:** Wireless technology enables remote control of devices, from controlling appliances in homes to industrial machines in factories, improving convenience and efficiency.
- **Healthcare:** Wireless communication is also playing a role in telemedicine,

where health data can be transferred remotely from patients to doctors, enabling real-time monitoring and diagnosis.

The Future of Wireless Communication

As we move toward the future, the demand for faster and more reliable wireless networks continues to rise. The rollout of 5G networks promises faster speeds, lower latency, and the ability to support more connected devices. Looking ahead, technologies like 6G and beyond will likely revolutionize wireless communication even further, integrating artificial intelligence, augmented reality, and smart cities into our daily lives.

Conclusion

Wireless communication has transformed the way we connect, communicate, and live. Its impact on society is undeniable, and as technology evolves, the future of wireless communication promises to be even more exciting, with greater connectivity and endless possibilities.

Challenges of Audio and Speech Processing

Anuska Kumari, 4th Year, ECE

The objective of our research is to design speech recognition systems that are capable of analyzing and processing auditory scenes. Although humans can naturally analyze auditory scenes into meaningful events, and consciously or passively respond to them, computer audition remains a challenging problem and once it succeeds, it will represent a fundamental advance in Audio Signal Processing and Intelligent Systems. Successful computer audition systems will also improve our ability to access and manipulate audio data,

enabling new multimedia applications and interactions for experts and novices alike. Auditory scenes are difficult to parse because source signals composing them overlap and interfere with each other at the same time and frequency. For example, when one is walking on a street, the auditory signal that he/she receives at any time leaves, people chatting, and a car passing by. Furthermore, the ways that these sources mix together and the source signals themselves are constantly changing. Imagine recognizing objects in a visual scene where every object is half transparent (sound sources overlap), objects change their appearance (sound sources change over time) and even disappear or reappear unexpectedly (sound sources become silent and active). A successful speech recognition system must be able to focus source signals in composite auditory scene in spite of the other interfering sources. This challenge raises two fundamental questions: 1) How do we discover and separate a sound event from an audio mixture? 2) What sound events belong to one source versus other sources? To answer these questions, I am interested to do research at three levels:

- ✓ Focusing on source sound by using the speech perception property of human ear. (e.g. identifying footsteps and streaming them together)
 - ✓ Designing the new front end features by employing the human auditory property. (e.g. extracting vocals from music, removing noise to enhance speech)
 - ✓ Leveraging external information (e.g. a musical score or speech transcript) to improve separation and manipulation of sound objects and sources.
-

Use of Speech Technology to Detect Parkinson Disease

Alok Raj, 3rd Year, ECE

The application of science and engineering for the development of humanity and society is always the first priority of research. The concept of signal processing is already a reputed practice to analyze ECG, EEG, MRI, etc. But the latest one is the application of speech processing to detect the neurological disease. It has been a motivation of speech researchers in the recent past. It is difficult to detect the disease in the early stage as it slowly starts to affect the human body. The symptoms of PD usually involve movement impairment, irresistible shaking, difficulty walking. As the disease progresses, cognitive and behavioral changes may arise. According to the literature, voice degradation may be one of the first noticeable symptoms of PD. The early detection of the disease would make it possible to prevent further progression. As per the scientists, in the early stage dysarthria occur frequently in PD. Dysarthria causes reduced speech intelligibility, articulatory and phonatory impairment. By observing the certain parametric changes (phonetical, prosody, etc.) of the speech signal, we can identify the disease.

PD is a neurodegenerative brain disorder that progressively affects the nervous system and causes a large number of symptoms in the patient body. Patients suffer from PD experience changes in cognition and language which make them difficult to think quickly or to understand complex sentences. Speech also becomes soften and monotonous. Full treatment of this disease does not exist but early detection can help the patient to avail early treatment. Parkinson is now a very common disease and approximately 6.3 million people are affected globally. A proper early diagnosis can improve patient's condition and might able to communicate clearly and

loudly with more emphatic facial expression.

Early researches on this have shown promising performance to detect PD by using of speech technology. Parkinson disease progressively affects the total voice production system including vocaltract dysfunction, disorder in larynx and also hyper nasality. Hence, the exact knowledge of symptoms at different stages can help to build a proper diagnosis system.

Image and Video Processing: Enhancing Visual Media with Technology

Prof. (Dr.) Malay Kumar Pandit, Professor, ECE

Image and video processing are at the forefront of technological innovation, significantly shaping industries like entertainment, healthcare, security, and communication. These fields involve the manipulation and analysis of visual data to enhance, compress, and interpret images and videos, making them more useful and accessible.

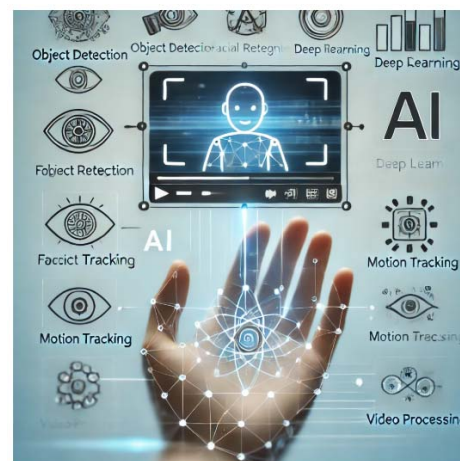


Image and Video Processing

Image processing refers to the use of algorithms and software to manipulate or

enhance images. Video processing, similarly, deals with analyzing and improving video sequences. Both processes involve techniques that modify visual data to improve quality, extract meaningful information, or compress large files for efficient storage and transmission.

Techniques in Image and Video Processing

1. **Image Enhancement:** This technique improves the visual quality of an image by adjusting factors like brightness, contrast, and sharpness. It's often used in photography, medical imaging, and satellite imagery to make subtle details more visible.
2. **Image Restoration:** Unlike enhancement, which adds detail, restoration aims to remove noise or distortions in images, often caused by factors like motion blur or poor lighting.
3. **Compression:** In both image and video processing, compression techniques are crucial for reducing the size of data files without significantly losing quality. Popular formats like JPEG for images and MP4 for videos rely on compression to make files more manageable for storage and sharing.
4. **Object Detection and Recognition:** In video processing, these techniques help identify and track objects across frames. They are vital for applications like security surveillance, autonomous vehicles, and facial recognition systems.
5. **Motion Analysis:** This is the process of tracking and analyzing moving objects in a video. It's essential in fields like sports analytics, film production, and medical diagnostics.

Applications of Image and Video Processing

- **Entertainment:** In film and television, image and video processing is used for

special effects, video editing, and enhancing the visual appeal of content.

- **Healthcare:** Medical imaging techniques like MRI and CT scans rely on advanced image processing to detect diseases and assist in surgeries.
- **Surveillance:** Video processing is used in security systems to monitor and analyze live video feeds, aiding in crime prevention and identification.

Conclusion

Image and video processing are essential in today's digital world, enhancing how we create, analyze, and interact with visual media. As technology evolves, these fields will continue to unlock new possibilities, pushing the boundaries of visual innovation.

Artificial Intelligence: Transforming the Future

Mr. Dibyendu Chowdhury, Assistant
Professor, ECE

Artificial Intelligence (AI) has evolved from a niche area of research into a pervasive technology that influences nearly every aspect of our lives. From virtual assistants like Siri and Alexa to self-driving cars, AI is revolutionizing industries, enhancing productivity, and even transforming the way we think about work and society.

Artificial Intelligence

At its core, Artificial Intelligence is the simulation of human intelligence in machines. AI systems are designed to mimic cognitive functions such as learning, problem-solving, perception, and decision-making. While AI can vary in complexity, most AI today falls into the category of **Narrow AI** — systems designed to perform

specific tasks, such as voice recognition or image classification. **General AI**, a more advanced form that would mimic human-like reasoning across any task, remains theoretical for now.



Key Technologies Behind AI

Several technologies contribute to the rapid advancements in AI:

1. **Machine Learning (ML):** Machine learning allows systems to learn from data, identify patterns, and improve over time. It's at the heart of many AI applications, such as email filtering, recommendation systems, and even self-driving cars.
2. **Deep Learning:** A subset of machine learning, deep learning uses neural networks with many layers to analyze large datasets. This technique powers complex applications like facial recognition, language translation, and medical image analysis.
3. **Natural Language Processing (NLP):** NLP enables machines to understand and generate human language. It's behind voice assistants like Siri and Alexa, as well as chatbots and language translation tools.
4. **Computer Vision:** This technology allows machines to interpret and process visual information, enabling them to "see" and understand their surroundings. Computer vision is used in applications ranging from facial recognition to autonomous vehicles.

Applications of Artificial Intelligence

AI is not confined to research labs or tech companies. It is already making an impact across numerous fields:

- **Healthcare:** AI is revolutionizing healthcare by aiding in medical imaging, drug discovery, and patient care. AI algorithms can analyze medical scans, identify abnormalities, and even predict patient outcomes, helping doctors make better-informed decisions.
- **Transportation:** Autonomous vehicles, powered by AI, are set to reshape the way we travel. These vehicles use AI to process sensor data, navigate roads, and make real-time decisions, reducing human error and improving safety.
- **Finance:** AI plays a key role in algorithmic trading, fraud detection, and customer service. Banks and financial institutions use AI to analyze patterns, predict market trends, and offer personalized financial services.
- **Customer Service:** AI-powered chatbots are increasingly used by businesses to handle customer inquiries, provide support, and assist with sales, enhancing customer experiences while reducing operational costs.
- **Entertainment:** Streaming services like Netflix and Spotify use AI to recommend content based on user preferences, making it easier for users to find shows, movies, and music that align with their tastes.

Ethical Considerations and Challenges

While AI holds enormous promise, it also raises important ethical concerns:

1. **Job Displacement:** As AI automates tasks traditionally performed by humans, there are concerns about job losses, especially in industries like

manufacturing and customer service. This shift calls for reskilling the workforce and adapting to new roles that AI cannot perform.

2. **Bias and Fairness:** AI systems can inherit biases present in the data they are trained on. This can lead to biased decision-making in areas like hiring, lending, and law enforcement, making fairness a significant challenge for developers.
3. **Privacy:** AI systems often rely on vast amounts of personal data, raising concerns about data privacy and security. It's crucial to ensure that AI respects privacy and handles data responsibly.

The Future of AI

AI's potential is vast, and its role in shaping the future is only beginning. As AI continues to evolve, we can expect more sophisticated applications, from smarter healthcare diagnostics to even greater advancements in autonomous technology. However, addressing ethical issues and ensuring responsible AI development will be crucial for ensuring that AI benefits all of society.

Conclusion

Artificial Intelligence is more than just a technological trend—it is a fundamental force that is changing the world around us. As AI continues to develop, its potential to solve complex problems and improve lives is limitless. At the same time, we must navigate its challenges thoughtfully, ensuring that its growth is ethical, fair, and beneficial for everyone.
