ECE INNOVATIONS 2021

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

MUFFAKHAM JAH COLLEGE OF ENGINEERING AND TECHNOLOGY

A COLLECTION OF RESEARCH ARTICLES IN

ELECTRONICS AND COMMUNICATION

VISION OF THE INSTITUTION

To be part of universal human quest for development and progress by contributing high calibre, ethical and socially responsible engineers who meet the global challenge of building modern society in harmony with nature.

MISSION OF THE INSTITUTION

1. To attain excellence in imparting technical education from the undergraduate through doctorate levels by adopting coherent and judiciously coordinated curricular and co-curricular programs

2. To foster partnership with industry and government agencies through collaborative research and consultancy

3. To nurture and strengthen auxiliary soft skills for overall development and improved employability in a multi-cultural work space

4. To develop scientific temper and spirit of enquiry in order to harness the innovative talents

5. To develop constructive attitude in students towards the task of nation building and empower them to become future leaders

6. To nourish the entrepreneurial instincts of the students and hone their business acumen.

To involve the students and the faculty in solving local co

DEPARTMENT VISION

To be recognized as a premier education center providing state of art education and facilitating research and innovation in the field of electronics and communication engineering.

DEPARTMENT MISSION

We are dedicated to providing high quality holistic education in electronics and Communication engineering that prepares the students for successful pursuit of higher education and challenging careers in industry, R& D and Academics

MESSAGE FROM THE DIRECTOR

My heartiest congratulations to the department of ECE for continual issues of the "ECE INNOVATIONS" magazine. The extraordinary vision and immaculate planning of the HOD, Dr. Kaleem Fatima, which coupled with the skills of the staff made the issue of the magazine boldly year after year.

This magazine as in its previous issues brings about the notable achievements of the staff and students in research / projects. I am sure; the readers of this magazine get inspiration and new ideas for their research.

MESSAGE FROM THE HEAD OF THE DEPARTMENT

It is my pleasure to congratulate the ECE DEPARTMENT that has taken the initiative for producing this magazine. It is great to find a considerable number of projects, certainly prove thatour staff and students are adequately equipped and possess necessary skill sets to express their talent.

Reading this magazine would definitely be an inspiration and motivation for all students and staff to contribute even more to the forthcoming issues.

I hope that everyone would continue to give their full efforts to keep the momentum and continue to enhance the standards of the magazine.

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Direction of Arrival using DSP Processor

Project Team:

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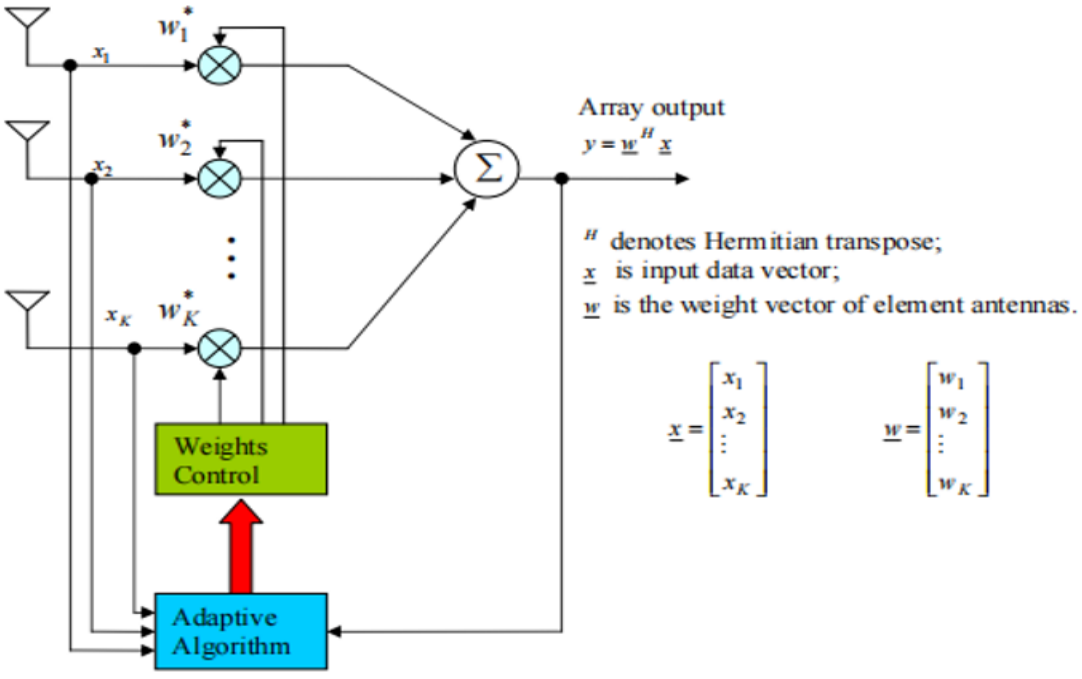
Project Guide: Dr. Ayesha Naaz

Abstract:

Array signal processing is an important branch in the field of signal processing. In recent years, it has developed dramatically. It can be applied in fields such as radio detection and ranging, communication, sonar, earthquake exploration, astronomy, and biomedicine. The field of direction of array signal processing is crucial in investigating the system of spatial multiple sensor arrays, with the main purpose of estimating the signal's spatial parameters and the location of the signal source. Spatial spectrum estimation is also referred to as Direction of Arrival (DOA) estimation. This project focuses on designing and developing an efficient parallel implementation of DOA on DSP TMS320C6713, using the MUSIC algorithm for 1-D and 2-D DOA estimation.



Blind Beamforming Algorithm to Mitigate Interference

Project Team:

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ProjectGuide:
Dr. Ayesha Naaz

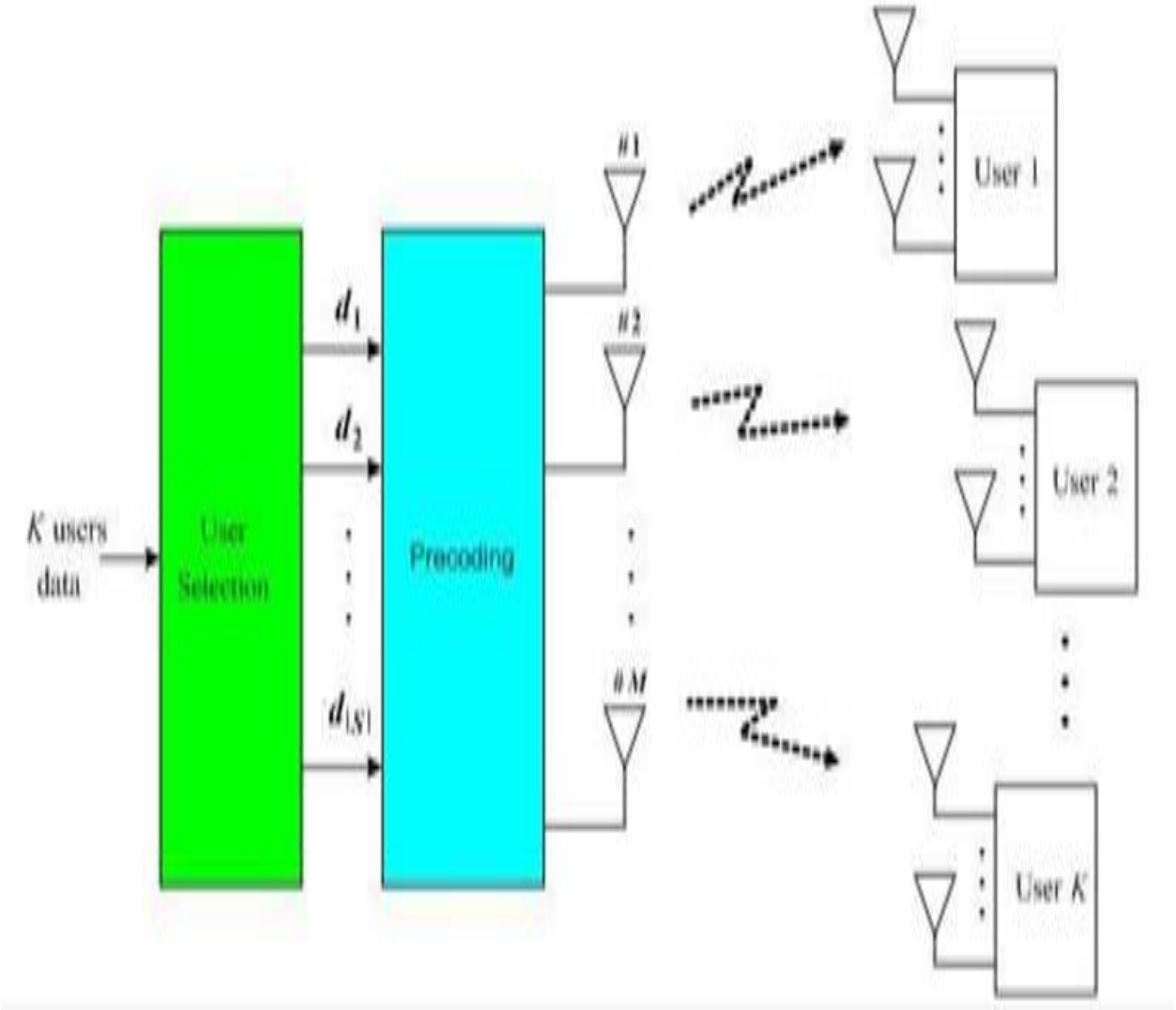
Abstract:
This thesis presents a **blind beamforming technique** for **GPS receivers** aimed at mitigating interference and improving signal quality. The **Global Positioning System (GPS)** is a U.S.-owned service that provides positioning, navigation, and timing (PNT) services. The GPS system is divided into three segments: the space segment, the control segment, and the user segment, with the **U.S. Space Force** responsible for the space and control segments.

The blind beamforming technique improves GPS receiver performance by addressing interference and enhancing GPS signals independently. The term "blind" refers to the fact that no reference or training signal is required for beamforming, making these beamformers more stable and less dependent on array calibration and channel properties compared to non-blind beamformers.

The algorithm is built on a **linear antenna array** and integrates **eigen-decomposition-based subspace techniques** and **multiple independent beamforming techniques**. A signal model is carefully constructed, with emphasis placed on the **projection matrix** derived from the subspace technique. The impact of interference and phase error is discussed, and a subspace method is applied to eliminate strong interferences by projecting the input signal onto a subspace orthogonal to the interference subspace.

In the next phase, **multiple conventional beamformers** are employed to cover the angular space, enhancing the desired GPS signals. The final stage involves **acquisition** and **tracking channel assignment**, where beamformers with the highest power levels for each acquired GPS signal are assigned to tracking channels.

The proposed method is tested against **null steering** and the **Minimum Mean Squared Error (MMSE)** technique using simulated data in various interference scenarios. The algorithm is also applied to real-world data, showing significant advantages over basic null steering techniques.


K users
data
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Selection
Precoding
#1
#2
#M
User 1
User 2
User K

Implementation of Precoding Techniques in Wireless Communication

Project Team:

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ProjectGuide:
Mr. Ifthekharuddin

Abstract:
The **Massive MIMO (Multi Input Multi Output)** system has emerged as a promising solution for increasing high data rate communication in downlink MIMO wireless systems and improving the **Bit Error Rate (BER)**. One of the effective methods to address this is the use of **precoding techniques**, which exploit transmitter diversity by weighting the information stream. This helps reduce the amount of corrupted data in the communication channel.

In **Multi-User MIMO** systems, a significant challenge is **inter-user interference**, which restricts the overall capacity of the system. **Precoding techniques** are implemented to mitigate this interference, enhancing system performance and ensuring efficient communication in wireless systems

Design of 10-bit Pipeline ADC

Project Team:

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ProjectGuide:
Mr. Noorullah Khan

Abstract:
The design of **Analog to Digital Converters (ADCs)** has been a highly active area of research for several decades, driven by advancements in the **Complementary Metal-Oxide-Semiconductor (CMOS)** Integrated Circuit (IC) fabrication process. These advancements have opened new opportunities for improving performance across a wide range of applications. Various ADC architectures, such as **Flash**, **Successive Approximation**, **Sigma-Delta**, and **Pipeline**, have been proposed by researchers. Among these, **Pipeline ADC** stands out for its ability to offer moderate resolution while maintaining high conversion speed, making it ideal for both civil and military applications.

In this project, a **10-bit, 1.8V, 25MS/s pipelined ADC architecture** is developed using **180nm CMOS technology**. The design features key sub-blocks, including an operational amplifier (**Opamp**) with a gain of 42 dB. A systematic design analysis of the 10-bit **50MS/s pipelined ADC** is presented, which incorporates an **opamp-sharing technique** to significantly reduce power consumption.

Simulation results demonstrate that the ADC achieves:

- **Signal-to-Noise Ratio (SNR)** of 58.9 dB,
- **Effective Number of Bits (ENOB)** of 9.3,
- **Spurious Free Dynamic Range (SFDR)** of 64 dB, with a sinusoidal input of 4.858-MHz and 1-Vpp at 50MS/s.

The design consumes less than **24 mW** from a 1.2-V power supply, showing the efficiency of the proposed architecture.

Low-Cost Pulse Oximeter

Project Team:

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Project Guide:
Ms. Maliha Naaz

Abstract:
In today's healthcare practice, physicians often need to monitor multiple medical parameters for patients, whether they are hospitalized or continuing their daily activities at home or work but require constant medical care. **Pulse oximeters** are medical devices designed to measure two important parameters: **blood oxygen saturation (SpO2)** and **heart rate**.

By providing continuous monitoring of oxygen saturation levels, pulse oximeters play a crucial role in the early identification of critical situations in the **circulatory** and **pulmonary systems**. This project aims to develop a **low-cost pulse oximeter**, making it more accessible for widespread healthcare applications, ensuring that patients receive proper and timely monitoring.

Artificially Intelligent Robotic Nursing Assistant AI-RoNA

Project Team:

1. Faiza Tarannum (1604-17-735-002)
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Project Guide:
Dr. Mohammed Arifuddin Sohel

Abstract:
In the midst of today's global health crisis, technology has become an essential tool in combating the **COVID-19 pandemic**, with **Artificial Intelligence (AI)** and **mechanical innovations** playing key roles in maintaining essential services. Robotic technologies are emerging as vital aids, not only for assisting patients but also for keeping healthcare workers, such as doctors and nurses, safe by reducing their direct exposure to the virus.

The **Artificially Intelligent Robotic Nursing Assistant (AI-RoNA)** is designed to help healthcare workers by performing tasks such as identifying symptomatic patients, monitoring vital signs like heart rate and blood oxygen levels, and delivering medication. These robots are capable of cleaning and disinfecting hospital areas, leading exercise routines for patients, and providing real-time updates on patient health conditions. Medical professionals can remotely control and monitor these robots via a wireless network, greatly reducing the risk of **cross-contamination** among healthcare staff.

The introduction of **robotic nursing assistants** offers substantial benefits for healthcare systems by improving sustainability and reliability, especially during times of crisis. By integrating **Artificial Intelligence** and **semi-humanoid robotics**, this project aims to develop a **highly-mobile robotic assistant** to assist healthcare professionals in monitoring patient recovery and providing essential care services. These robotic systems alleviate the burden on healthcare personnel, enabling them to focus on more complex tasks, while patients benefit from increased independence through robotic assistance in routine activities.

Industrial Application Exo-Skeleton (IAES)

Project Team:

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Project Guide:
B. Sucharitha

Abstract:
The demand for **exoskeleton robots** has increased due to advancements in robotic technology and the evolving concept of how robots can be integrated with the human body. Exoskeletons are now being developed to provide unprecedented levels of **muscle power enhancement** and increased mobility, offering benefits such as boosting running speed. While exoskeleton robots are already used in **rehabilitation** for patients, they are also gaining traction in **industrial applications**.

Exoskeletons are being adopted in several industrial sectors to **augment, amplify, and reinforce** the physical capabilities of workers, particularly in the **lower back** and **upper extremities**. They can help reduce **work-related musculoskeletal disorders** by supporting workers in tasks that involve lifting heavy materials or handling overhead tools for extended periods. However, one of the main challenges in adopting exoskeletons on a larger scale is their high cost, making them inaccessible for widespread use in industries.

This project aims to design a **low-cost, efficient exoskeleton** for industrial applications. By re-engineering the design from the selection of materials and actuators to the overall mechanism, the goal is to develop a **cost-effective exoskeleton** that enhances human capabilities by increasing load-lifting capacity by approximately **60%** while offering special capabilities for industrial tasks.

To achieve this, a user-friendly structure is built using **aluminum**, **Delrin**, and **PLA** materials, controlled by an **electromyography (EMG) sensor**. The EMG sensor amplifies signals generated by the wearer's body movements, providing inputs for controlling the exoskeleton. A **linear actuator** is used to provide mechanical support and operate the exoskeleton. The signals from the EMG sensor are processed using a **microcontroller**, which controls the linear actuator to enable the exoskeleton to perform lifting operations, providing enhanced support for industrial workers.

Precision Agriculture using Wireless Sensor Network

Project Team:

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Project Guide:
Dr. Salma Fauzia

Abstract:
Precision Agriculture is a technique that leverages **Information Technology (IT)** to optimize crop yield while minimizing resource wastage. One of the critical components that ensure the success of precision agriculture is the use of **Wireless Sensor Networks (WSN)**. WSN helps in collecting various types of environmental data, which is then used to allocate resources, such as water and fertilizers, in a precise manner, ultimately maximizing yield without overutilizing resources.

In a country like **India**, where several states face **freshwater scarcity**, approximately **70% of freshwater** is consumed by the agriculture sector. Crops like rice, wheat, and sugarcane use a substantial amount of water. Reducing excessive water usage in agriculture is vital to addressing water scarcity issues, but this must be done without compromising the **quality and quantity of the crop yield**. **Precision Agriculture** offers a solution to this challenge.

This project implements **Precision Agriculture** using **WSN** through **RF Transceivers**, and it employs the **AWD (Alternate Wetting and Drying)** technique for the precise allocation of water resources. Data collected by various nodes in the WSN is transmitted to the central **Base Station**, where it is processed according to the AWD algorithm to make decisions on water usage, without the need for manual intervention.

During the course of the project, it was observed that the quality of the crops and their growth were not compromised. Additionally, the project successfully achieved a **34% reduction in water consumption** compared to traditional agricultural practices, proving that **Precision Agriculture** can effectively conserve water while maintaining high crop yields.

Sentiment Analyser

Project Team:

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Project Guide:
Md. Muneeruddin

Abstract:
Social media has provided consumers with ample opportunities to assess product quality by reading and analyzing user reviews on online shopping platforms. Websites like **Amazon.com** offer users the ability to label a review as 'Helpful' if they find its content valuable. This system allows both consumers and manufacturers to efficiently gauge general preferences by focusing on highly rated helpful reviews. However, recent reviews tend to receive fewer votes, and older reviews with higher votes gain greater visibility.

This study addresses these issues by developing an **automated text classification system** that predicts the helpfulness of online reviews, regardless of when they are posted. The study uses data from **Amazon.com**, specifically focusing on reviews related to fine food products. Prior research has primarily explored the correlation between review content and its helpfulness rating. In addition to identifying significant content-based features, this study employs three approaches to predict review helpfulness:

1. **Vectorized features**,
2. **Review and summary-centric features**, and
3. **Word embedding-based features**.

The study compares conventional text classification algorithms, such as **Support Vector Machine (SVM)**, **Logistic Regression**, and **Multinomial Naïve Bayes**, with a **decision tree-based ensemble classifier**, namely **Extremely Randomized Trees**. The results demonstrate that the Extremely Randomized Trees classifier outperforms the traditional classifiers in most cases, except for vectorized features using unigrams and bigrams.

Among the features examined, **vectorized features** consistently performed better than other approaches. Content-based features, such as **review polarity**, **review subjectivity**, **review character and word count**, **average word length**, and **summary character count**, were found to be significant predictors of review helpfulness. This study provides valuable insights into improving sentiment analysis and review helpfulness prediction by focusing on content-based features.

Semiconductor Devices Characterization Using TCAD Tool

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Project Guide:
Shubhangi Saxena

Abstract:
In the modern era, computing systems are designed to perform numerous functions with **high speed**, **low power consumption**, and **reduced propagation delay**. As the number of circuits integrated into a chip continues to increase, the electronics industry constantly faces the challenge of **miniaturizing transistors** to enhance **package density**. This has made the **scaling of CMOS technology** a critical necessity in today's **microelectronics** and **nano-electronics** regimes. However, miniaturization introduces problems such as increased **static power consumption** and the emergence of **Short Channel Effects (SCEs)**, which limit the performance of conventional **MOSFETs**.

This project focuses on the **performance analysis** of **PN Diode**, **0.18µm MOSFET**, and **Double Gate (DG) MOSFET**, utilizing different semiconductor device modeling techniques for electronic circuit simulation. The study presents a **physics-based analytical modeling** approach to predict device behavior under specific conditions, such as applied bias (voltages and currents), environmental factors (temperature, noise), and physical characteristics (geometry, doping levels). Numerical models provide a virtual environment for optimizing device performance under varying conditions, helping validate simulation models for other operational scenarios.

PN junction diodes and **Bipolar Junction Transistors (BJTs)** are widely used in switching applications, including TV deflection circuits, motor drives, and switched-mode power supplies. These devices operate at frequencies lower than 100 kHz, where their speed is limited by **minority charge storage** during the ON state and the reverse recovery time needed to remove these charges. **Uni-polar devices** like **Schottky diodes** and **MOS devices** are faster due to the absence of minority charge storage but come with trade-offs, including lower reverse breakdown voltage and higher heat dissipation compared to bipolar devices.

The **Insulated Gate Bipolar Transistor (IGBT)** offers low on-state losses but is restricted to high-end applications due to its relatively complex technology. **Double Gate (DG) MOSFETs** present a solution by reducing **short channel effects** and providing better control over the threshold voltage through **electrostatic coupling** from two gates on either

side of the channel. The independent control of front and back gates in DG MOSFETs enhances performance and reduces power consumption, especially in circuits below **50nm**.

This project conducts simulations of **Symmetric 30nm Double Gate MOSFETs** using **VTCAD** to study the improvements in performance and efficiency that double-gate structures offer for modern semiconductor devices.

Design and Implementation of Phase Lock Loop using 180nm Technology

Project Team:

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2. Mohammed Abdul Qader (1604-17-735-058)
3. Mohammed Yaseen (1604-17-735-048)

Project Guide:
Mr. Syed Hifazath Ali Khan

Abstract:
This project focuses on the design and implementation of a **CMOS Phase Lock Loop (PLL)** using **180nm CMOS technology**, implemented in the **Cadence tool**. The designed PLL operates in the **2.4 GHz frequency range**, which is commonly used in modern communication systems to enhance speed and performance.

The PLL comprises key components, including:

- **Phase Frequency Detector (PFD)**
- **Charge Pump (CP)**
- **Low Pass Filter (LPF)**
- **Current Starved Voltage-Controlled Oscillator (CSVCO)**
- **Frequency Divider**

The primary goal of the project is to design a PLL capable of achieving a **stable frequency**. **Phase-Locked Loops (PLLs)** are essential in various fields such as **wireless communication**, **television**, **Wi-Fi routers**, **FM demodulation**, **frequency synthesizers**, and more. The stable frequency output of the PLL plays a crucial role in ensuring the efficiency and reliability of these systems.

Deep Learning Based Channel Estimation in Millimeter and Vehicular Communication

Project Team:

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Project Guide:
Mrs. Nazeerunnisa

Abstract:
The application of **millimeter-wave (mmWave) frequencies** represents a promising technology to meet the ever-growing demand for data traffic in advanced wireless communications. However, a substantial challenge in mmWave systems is the **high path loss** that occurs over these frequencies. To mitigate this issue, mmWave systems rely on **beamforming techniques**, which require robust **channel estimation algorithms** to ensure an adequate quality of service.

Channel estimation becomes particularly challenging in **massive multiple-input multiple-output (MIMO)** systems, especially when high accuracy is needed. Traditional **deep learning (DL)** methods face difficulties in estimating accurate channels, primarily due to inadequately designed loss functions.

This project proposes a **deep learning-based channel estimation algorithm** for **multiuser massive MIMO vehicular communications**. A **deep neural network (DNN)** is leveraged to learn the mapping function between the received omni-beam patterns and the mmWave channel, with minimal training overhead. To further enhance channel estimation, a **conditional generative adversarial network (cGAN)** is developed, enabling more realistic channel predictions through adversarial training of two deep learning networks.

The **cGANs** not only learn the mapping from quantized observations to real channels but also adaptively design a loss function to train the networks effectively. Simulation results demonstrate that the proposed algorithm efficiently estimates mmWave channels with negligible training overhead and outperforms existing DL methods. The system also achieves high robustness in multiuser massive MIMO systems, making it an effective solution for vehicular communications.

Deep Learning for Beamspace Channel Estimation in Millimeter-Wave Massive MIMO Systems

Project Team:

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2. Madana Hari Shanker Reddy (1604-17-735-045)
3. Mandalapu Mani Harsha (1604-17-735-049)

Project Guide:
Mrs. Nazeerunnisa

Abstract:
The next generation of telecom networks, known as **Fifth Generation (5GNR)**, began rolling out in late 2018 and continues to expand globally. In addition to faster speeds, 5G is expected to enable a massive **Internet of Things (IoT)** ecosystem, connecting billions of devices with an optimal balance between speed, latency, and cost. To achieve these goals, several technologies have been proposed, with **millimeter-wave (mmWave)** communication and **massive multiple-input multiple-output (MIMO)** being key enablers for 5G.

Massive MIMO technology is seen as a vital component in increasing data rates for future communication systems. One of the promising approaches to **mmWave** or large MIMO systems is to reduce signal processing complexity and RF chain costs without significant performance degradation by utilizing advanced antenna designs like the **Lens Antenna Array (LAA)**, also known as **beamspace MIMO**.

Recently, **mmWave massive MIMO** systems using a **lens antenna array (LAA)** have been proposed, significantly reducing the number of radio frequency (RF) chains required through **beam selection**. While high data rates can be achieved with reduced-dimensional equivalent channels after beam selection, **channel estimation** remains a challenge due to the mismatch between the number of RF chains and antennas.

To improve channel estimation performance, this project proposes a **prior-aided Gaussian mixture LAMP (GM-LAMP)** based beamspace channel estimation scheme. The **GM-LAMP network** is designed to estimate the beamspace channel more accurately, leveraging prior knowledge to improve the estimation process. Simulation results using both the theoretical channel model and the ray-tracing-based channel dataset show that the proposed GM-LAMP network outperforms existing methods in **channel estimation accuracy**.